University of Mumbai

Project Management

(Institute Level Optional Course)

Semester VIII - Common To All Branches

Strictly as per the New Syllabus (REV-2019 'C' Scheme) of Mumbai University w.e.f. academic year 2022-2023

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Syllabus...

Mumbai University

B.E. Civil Engineering (2019 Course) w.e.f. July 2022

Project Management

Subject Code	Subject Name	Credits
ILOC8011	Institute Level Optional Course – II : Project Management	03

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	-	--	03	-	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessments			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-1	Test-2	Avg.						
20	20	20	80	3	-	-	-	100

Objectives

- To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
- To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Course Contents

▶ Module I : Project Management Foundation — 05 Hrs.

Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI). **(Refer Chapter 1)**

▶ Module II : Initiating Projects — 06 Hrs.

How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics. **(Refer Chapter 2)**

▶ Module III : Project Planning and Scheduling — 08 Hrs.

Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering. Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS). **(Refer Chapter 3)**

▶ Module IV : Planning Projects — 06 Hrs.

Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan.

Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks **(Refer Chapters 4 and 5)**

▶ Module V : Executing Projects — 08 Hrs.

5.1 Executing Projects

Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects.

Team management, communication and project meetings.

5.2 Monitoring and Controlling Projects

Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit.

5.3 Project Contracting

Project procurement management, contracting and outsourcing. **(Refer Chapters 6, 7 and 8)**

▶ Module VI : Project Leadership and Ethics — 06 Hrs.

6.1 Project Leadership and Ethics

Introduction to project leadership, ethics in projects.

Multicultural and virtual projects.

6.2 Closing the Project

Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources. Managing without authority; Areas of further study. **(Refer Chapters 9 and 10)**

Outcomes

Students will be able to :

- Apply selection criteria and select an appropriate project from different options.
- Write work break down structure for a project and develop a schedule based on it.
- Identify opportunities and threats to the project and decide an approach to deal with them strategically.
- Use Earned value technique and determine & predict status of the project.
- Capture lessons learned during project phases and document them for future reference

CHAPTER 1

Module 1

Project Management Foundation

University Prescribed Syllabus

Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI).

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Introduction

Managing a Project is akin to being the coach of the Indian Cricket Team, you get to experience some of the same thrills and exhilarating moments as the coach would surely be getting to experience.

A project is defined as an undertaking of a non-routine, non-repetitive nature having prescribed objectives in terms of scope, time, quality and cost. Within the realm of project planning such projects can be further defined as generally being complex, having a multi-disciplinary involvement and having various phases in their life span. The completion of each of the project phases is usually accompanied by a finished project of some sort.

Project planning is the comprehensive management and control of any or all aspects of a project throughout all phases of its life to achieve those prescribed objectives defined in terms of scope, time, quality and cost. Through the application of appropriate management techniques, the project manager would direct and co-ordinate the efforts of the multi-disciplinary team to achieve the objectives of a project to meet the client's requirements.

IT Project Management is different from the management of any other engineering project, there are various factors which influence and keep on changing during the course of the project. To start with, the needs of the client for whom the project is undertaken are likely to change during the course of the project, there are hardware compatibility issues and software glitches, when one has managed to somehow overcome these issues there are security loopholes and bandwidth problems to deal with. Apart from these technical problems the project manager has to lead a team of technically qualified people having career issues and attitude problems. So overall IT Project Management is a very challenging and makes a very interesting field for study.

1.1 INTRODUCTION TO IT PROJECT MANAGEMENT

1.1.1 Definition of Project

GQ. 1.1.1 *What is a project?*

To study project management it is necessary to first understand the concept of a project.

1. A project is defined as an undertaking of a non-routine, non-repetitive nature having prescribed objectives in terms of scope, time, quality and cost.
2. A project is undertaken to create something new, unique, or to enhance an existing product, service, or system.
3. A project is a temporary endeavor undertaken to create a unique product, service, or result.
4. A project is an endeavor to accomplish specific objectives through a unique set of interrelated tasks and effective utilization of resources.
5. IT projects involve hardware, software and networks to create product, service, or result. A few examples of IT projects are;
6. A new feature is added to an existing software application.
7. New system is developed to increase sales force productivity, improve customer relationship management and enhance supply chain management.
8. A firm decides to implement an integrated ERP project to consolidate its information systems.
9. Replacing the company's manual time keeping system with a web based system within a particular time frame.

1.1.2 Attributes of a Project

GQ. 1.1.2 *State the attributes of a project.*

A few typical project attributes are as follows :

1. Purpose	2. Goal	3. Time frame
4. Interrelated tasks and resources	5. Ownership	6. Risks and Assumptions

▶ **1. Purpose**

- A project has a unique purpose and well defined objectives. It begins with rough ideas and an initial plan which is updated as more information emerges.
- Projects are undertaken to accomplish something of value to the company, maybe, a system or software. The sole purpose of undertaking a project is to produce a tangible product of value to the company.

▶ **2. Goal**

- A goal drives a project. It is the sole motivating factor and defines each activity, task, work, schedule and budget of the project. It provides direction to the team.
- Hence, the project goal should be clearly defined, ambiguity in defining the project goal leads to a project with no end.

▶ **3. Time frame**

- Since a project is a temporary endeavour it has to have a definitive start and end. The time frame for achieving the project goal is estimated based on the duration of the various project activities.
- The completion date of the project is set accordingly. However, for projects where the completion date is fixed, such as the Y2K problem, the starting date has to be set by working backwards.

▶ **4. Interrelated tasks and resources**

- A project is composed of interrelated tasks and utilizes resources such as people, software, hardware and other assets of the company.
- The primary asset for an IT project is people who cross departmental and other boundaries to achieve this unique purpose. Most projects demand the service of people outside the organization such as consultants.
- Resources, however, are expensive and limited hence should be used effectively to meet project objectives. A project is unique and hence it is difficult to estimate the time, budget and resources requirement. Hence, a project involves uncertainty.

▶ **5. Ownership**

- A project has various stakeholders but only one primary customer known as the project sponsor.
- The project sponsor is the "go to" entity for funds, direction and approvals regarding all project related matters. For the project manager the project sponsor is the owner of the project.

▶ **6. Risks and Assumptions**

- Every project has certain risk element, the more complex and big the project greater is the risk. Risk is directly proportional to the size and complexity of the project. Risks can emanate from sources both internal and external to the project team.

- Internal risks could be the resignation of a key project member, while external risks could arise from vendors and suppliers of key hardware and software.
- Assumptions are those unknown variables which are used to estimate key facets of the project. Therefore, the project manager has to identify all the risks and assumptions that could impact the project.

1.1.3 Roles

GQ. 1.1.3 *State the roles of key players in a project?*

The complexity of modern IT projects makes it necessary to employ the services of individuals with varying skills and knowledge. Following are the key players in an IT project.

1. Project manager	2. Project sponsor
3. Subject Matter Expert (SME)	4. Project team member

1. Project manager

- The project manager is the captain of the team and is responsible for the success or failure of the project.
- The project manager has to ensure that all development requirements and processes are in place and are carried out as per the specifications and quality parameters specified.

2. Project sponsor

The project sponsor could be the client or an organizational appointee who is the "go to" person for all project related resource requirement and direction whenever required.

3. Subject Matter Expert (SME)

- It is not necessary for the project manager and team members to be experts in the core subject of the project.
- Hence, every project needs a subject matter expert (SME) who will support the project by providing vital inputs on the subject matter.
- The SME could be user, client, or a subject expert who has specifically been roped in for the project.

4. Project team member

The project team is formed according to the requirement of the project and could comprise of analyst, programmers, network specialists, graphic designers, etc.

1.1.4 What Is Project Management?

GQ. 1.1.4 *What is Project Management ?*

- Project Management has been defined by "The Project Management Body of Knowledge" Guide as : "project management is the application of knowledge, skills, tools, and techniques to project activities to meet project requirements."
- Project planning is the comprehensive management and control of any or all aspects of a project throughout all phases of its life to achieve those prescribed objectives defined in terms of scope, time, quality and cost.

- Through the application of appropriate management techniques, the project manager directs and co-ordinates the efforts of the multi-disciplinary team to achieve the objectives of a project to meet the client's requirements.
- IT Projects can further be defined as generally being complex, having multi-disciplinary involvement and various phases in their life span. The completion of each of the project phases is usually accompanied by a finished project of some sort.
- IT Project Management is different from the management of any other engineering project, there are various factors which influence and keep on changing during the course of the project.
- To start with, the needs of the client for whom the project is undertaken are likely to change during the course of the project, there are hardware compatibility issues and software glitches, when one has managed to somehow overcome these issues there are security loopholes and bandwidth problems to deal with.
- Apart from these technical problems the project manager has to lead a team of technically qualified people having career issues and attitude problems.
- Thus, IT Project Management is a very challenging and makes for a very interesting field of study.
- Most organizations have multiple projects at various stages in their lifecycle at any given period of time. To accommodate all these projects, organizations have to balance their project portfolio with projects varying from low risk to high risk.
- Also, the project portfolio should align with the organizations overall strategy and plan to gain competitive advantage. The portfolio may comprise of dependent and independent projects.
- Dependent projects are managed as a program wherein the activities of multiple projects within the program are coordinated to deliver benefits that are greater than the sum total of the benefits delivered by all the projects within the program.
- The primary reason for having smaller projects within a program and not having the program as a project is that it is easier to coordinate the activities of smaller projects also each project would have its own project manager, team, budget and schedule.
- However, management will have to ensure that each project aligns with the overall objective and plan of the program.
- IT project management presents various organizational opportunities and challenges. The changing face of information technology has a major influence in the evolution of IT project management.
- Project management has been greatly influenced by the changes in the use of computers in business. Hence, before we proceed to study the current state of IT project management it is essential to understand how project management has evolved along with information technology.
- The evolution of IT project management can be traced through three dominant phases, namely, EDP, micro, and network phase.

1.2 NECESSITY FOR PROJECT MANAGEMENT

GQ. 1.2.1 *State and explain the necessity for project management ?*

- Following are a few reasons why an increased need is felt for effective and efficient project management :

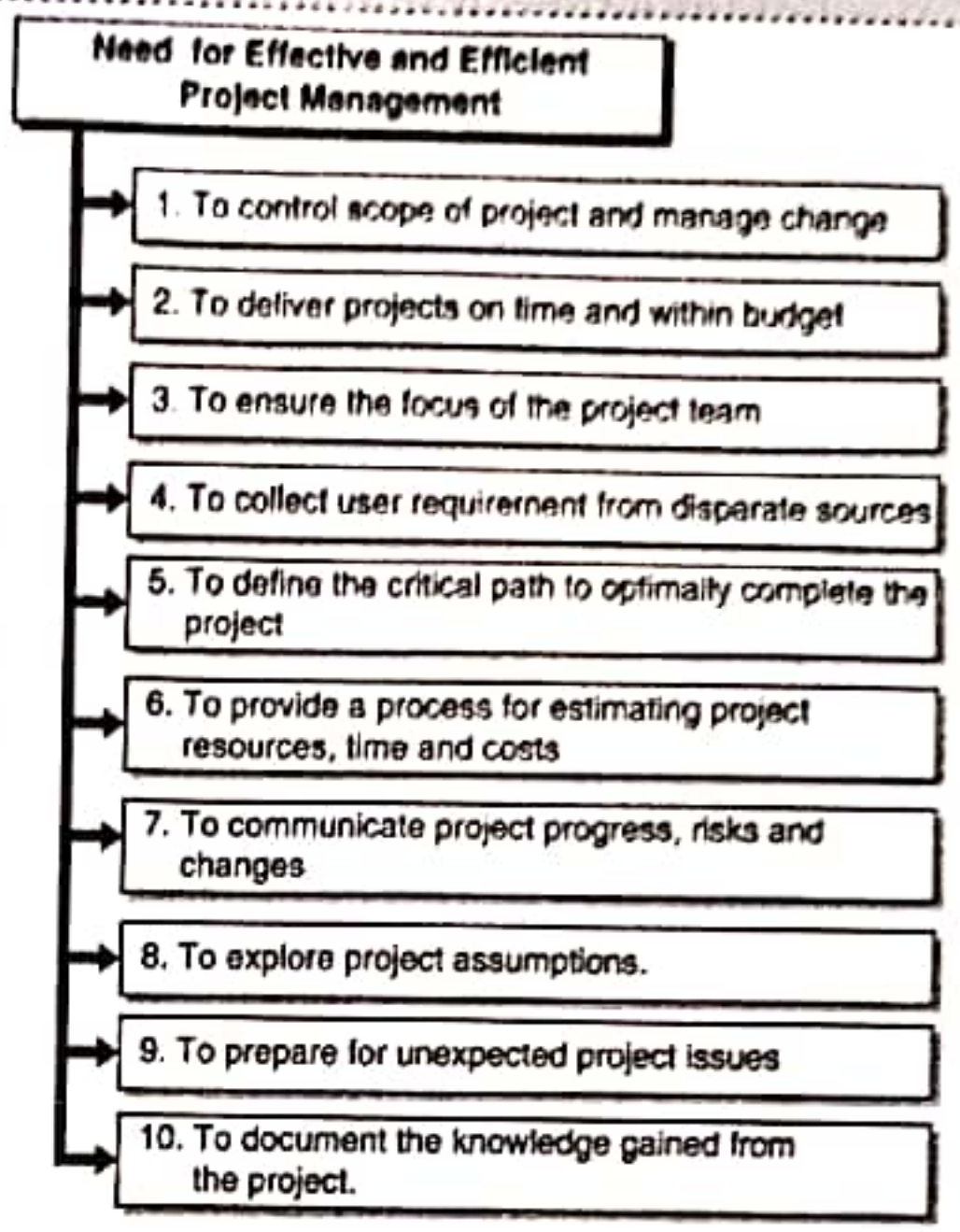

Fig. C. 1.1

▶ **(1) To Control Scope of Project and Manage Change**

- Although the project deliverables are defined at the outset of the project, small changes in project deliverables are common.
- These changes are demanded by customers, stakeholders, management, suppliers or the project team itself. Individually, these change demands may seem acceptable and manageable, but collectively these change demands can lead to a significant expansion in the project scope and can lead to an overrun in schedule and budget.
- However, with project management, if the manager effectively manages the scope of their project, they have a better chance of effectively managing project resources and change.

▶ **(2) To deliver projects on Time and within budget**

- The project management process includes cost calculations such as return on investments (ROI).
- Once ROI is established it is for the project manager to ensure that the project schedule and budget are adhered to else the project will fail to deliver the expected results.

▶ **(3) To ensure the focus of the project team**

- It is common for the project team to drift from the main tasks and spend unnecessary longer time on other tasks.
- Hence, it is the responsibility of the project manager to ensure that the project team focuses on the right tasks by using a clear and concise project charter and that there are no interferences.

▶ **(4) To collect user requirement from disparate sources**

- The project manager at the initiation phase should collect user requirement, project constraints and conduct a feasibility study to build a strong business case justification.
- The primary advantage of collecting input from various sources is that the project manager is able to avoid future dissent from users and is able to communicate project benefits.

▶ **(5) To define the critical path to optimally complete the project**

- Every project is made up of connected activities each having their individual constraints.
- By using the critical path method technique the project manager is able to identify the critical path and thus ensure the successful completion of the project.

- **(6) To provide a process for estimating project resources, time and costs**
  - Solid project management tools and techniques and past experience will enable the project manager to correctly estimate the project resources requirement as well as determine the time required for the completion of the project and the likely expenditure.
  - Such, estimation at the initiation phase will ensure that the project receives adequate commitment from the management and its success is ensured.
- **(7) To communicate project progress, risks and changes**
  - The stakeholders of the project need to be kept updated on the project progress, hurdles encountered and changes incorporated.
  - Every good project management plan has a communication plan that addresses communication issues, provides formats and lays process for execution of the communication plan.
- **(8) To explore project assumptions**
  - Although ample ground work is done for a project there are bound to be a few assumptions on which the project is based.
  - Hence, a good project manager has to delve deeper into user requirements, project constraints and management expectations to understand the hidden project requirements. A project based on too many assumptions could ruin its chances of success.
- **(9) To prepare for unexpected project issues**

  Howsoever, one may be prepared there are bound to be a few issues which may suddenly surface. Hence, the project manager should always be prepared with an alternate plan.
- **(10) To document the knowledge gained from the project**

  The last phase of the project involves the documentation of all that has been learnt at each phase in the project. These documented experiences provide guidance to other project manager in other projects.

1.2.1 What is the Difference between Projects and Operations?

GQ. 1.2.2 *Differentiate between Projects and Operations*

	Projects	Operations
Definition	Projects are temporary and unique initiatives created to achieve a specific objective for an organization.	Operations on the other hand ensure a business or an entity continues to operate as expected and continue to provide its services without discontinuity or issues.
Uniqueness	Project work is unique	Operations work is not unique.
Duration	Projects are one offs – they exist for a temporary duration. A project will be finished when its objectives are met or are no longer valid, and/or it runs out of time/money.	Operations on the other hand are created with the intention of being there forever (while from time to time they also could transform into something very different or cease to exist completely), and they exist for a long time.
Risk	Projects generally tread unknown waters and thus involve a lot of risks.	Operations deal with things that have been dealt with in the past and thus have an operational procedure. Thus the amount of risk associated with operations is relatively less.
Focus	Projects are objective-focused.	Operations are metrics-focused

1.3 TRIPLE CONSTRAINTS OF PROJECT MANAGEMENT

GQ. 1.3.1 *Briefly explain the triple constraints of Project Management*

- The three major constraints of project management are :
  - (i) Delivering on time
  - (ii) Delivering within allotted budget
  - (iii) Ensuring adherence to scope of the project
- In addition to the three constraints the project manager has to also ensure that the quality parameters set for the project are not compromised upon. Thus, we can say that project management is like juggling four balls simultaneously as it involves maintaining a fine balance between delivering on time, within budget, while ensuring that the scope of the project and quality parameters are adhered too.
- Examples of large and complex projects being delivered on all four parameters are few and far between.
- Modern IT projects utilize a wide range of traditional and emerging technologies like cloud and mobile computing. Social media has also influenced customer relationship and opened new avenues to enhance customer experience.
- Project managers will now be involved in projects that are dynamic, geographically dispersed and culturally diverse. Projects have a more profound impact as the risk and reward associated with their outcome is higher.
- Thus, to manage projects with such higher stakes the project manager will require technical and non technical skills and the experience to adapt all these to the dynamically changing project environment.
- Most of the projects are plagued by time and cost overruns. Projects that do not complete on time and within budget can act as a millstone around the neck pulling the company away from the projected trajectory of growth.
- Today, project managers are found struggling with time, cost and resource management challenges and it is difficult for managers to see which project and operational activities they should be working on to find out how much is left in their budget to what capacities are resources being utilized and how to align activities with the demands of business.
- The "90/90 Rule" of project management goes like this: the first 90 percent of a project takes 10 percent of the time and effort; the remaining 10 percent of the project takes the other 90 percent of the time and effort.

1.4 PROJECT MANAGEMENT LIFECYCLE (TYPICAL AND ATYPICAL)

GQ. 1.4.1 *Explain typical project management lifecycle ?*

- Projects do not form the core activity of the organization they are temporary activities with a definitive objective.
- Today, the project lifecycle approach is used in construction, aerospace, government agencies, research and development, manufacturing, electronics and many other industries; however the term project lifecycle may mean different things to different people depending upon the particular application.
- The basic project lifecycle principles are applicable to a wide variety of projects such as new applications, major maintenance and repair projects, relocations and re-organizations, creating new web site, or establishing a new data base centre. Irrespective of the type of project the basic framework shared by every project remains the same.
- The project lifecycle describes the various logical phases in the life of a project from its beginning to its end in order to deliver the final product of the project.

- The idea of breaking the project into phases is to ensure that the project becomes manageable, activities are arranged in a logical sequence, and risk is reduced.
- The phases are so created that each phase at its end provides one or more deliverables. Deliverables are tangible and verifiable products of work that are produced at the end of each phase and define the resources needed for the completion of each phase.
- The review of the deliverables at the end of each phase enables the project manager to evaluate the performance at the end of each phase and take necessary corrective action if felt necessary.
- Although, it is recommended to undertake the phases in a linear sequence, phases could be overlapped to save time. However, overlapping of resources is risky and should be justified.
- In this section we shall be studying the typical or the generic project lifecycle that comprises of phases common to most projects.

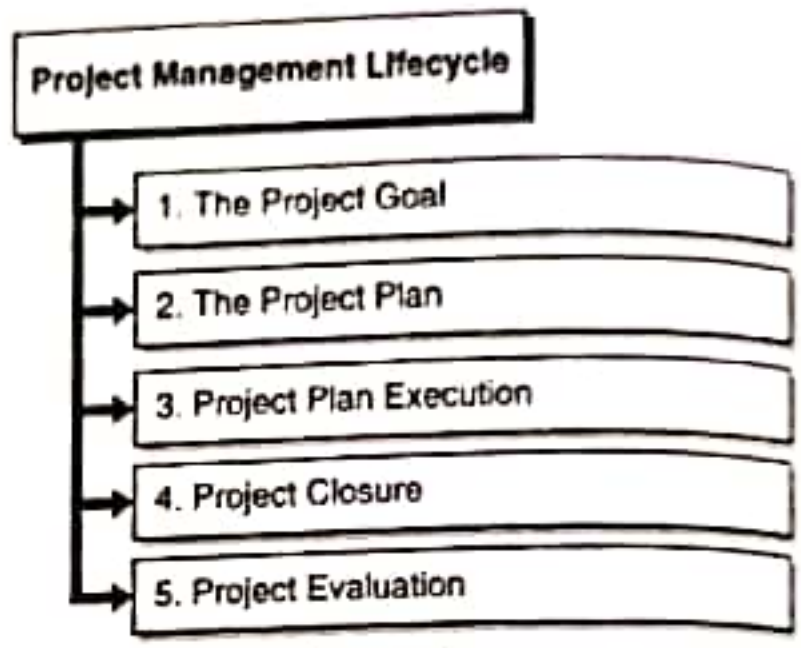

Fig. C 1.2

1.4.1 Typical Project Management

GQ. 1.4.2 *What are the five stages of the typical project life cycle ?*

(1) The Project Goal

- The first step for any project, irrespective of its size and complexity, is defining its overall goal. Every project undertaken aims to provide business value to the organization hence the goal of the project should focus on doing the same.
- Now, the goal of the project needs to be defined initially and clearer as it provides the project team with a clear focus and guides it through each phase of the project. The project is hazy and seems risky at the start, but as the project goal gets defined and starts making progress, things start to look brighter and the probability of success increase.
- At the beginning of the project, the requirement of resources in terms of staff and cost is low; however, it increases as the project makes progress and reduces at the completion stage of the project.

(2) The Project Plan

- The project's goal provides the guidelines and makes it easier for the development of the project plan also known as baseline plan. The project plan is developed to provide answers to various project related queries such as :

  What the project aims to achieve? – The project deliverables

  How does the project team aim to achieve it? – The tasks and activities

  Who all will be involved in the project? – The stakeholders and the project team

  How much will it cost? – The project budget

  How much time will it take? – The project schedule

  What are the risks involved? – Risk identification
- The initial plan serves as a base to gauge the progress made by the project throughout its lifecycle.

(3) Project Plan Execution

The project plan thus developed needs to now be executed. The project's progress should be compared with the baseline plan and communicated to all of the project's stakeholders. The project manager has to constantly monitor the projects' progress, schedule, budget, and resources.

(4) Project Closure

- Project closure marks the culmination of the project; the project may have completed all the work as planned or the project sponsor may have called of the project due to various reasons which we shall study later on in this book.
- However, in the event of the project having completed all the work as planned, the project sponsor should formally acknowledge its successful completion, discharge all resources from the ongoing project, and make necessary payment of dues of any external consultants and suppliers.
- The project closure is also marked by the presentation of a project report that documents all the project deliverables.

(5) Project Evaluation

- It is not possible to evaluate the true value of any IT project immediately after its implementation. Sometimes the goals are long term and the results of the project can only be gauged after the passage of a certain period of time.
- Merely evaluating the success achieved in implementing the hardware and software peripherals of the project does not amount to having succeeded in the project. These are merely means to an end and hence time only will tell whether the project has succeeded in accomplishing what it was set in motion for.
- However, this does not mean that evaluation should not be undertaken immediately. For starters, the project team should document all its experiences – things it did right, things it should have done differently, and all the lessons learned during the entire course of the project.
- This document proves useful in the execution of future projects for the organization. Also, the project manager and his team should be evaluated for their performance. While, the project manager should evaluate each team member and provide feedback to the member as well as the management, the performance of the project manager should be evaluated by a senior manager.
- The feedback proves useful to the team members in honing their skills, understanding where their erred in their role and the mistakes they made. The feedback proves useful in future assignment, promotions and incentives.
- Evaluation of the project manager is carried out in terms of; the project delivering the promised work, abiding by budgetary provisions, following established processes, and ability to manage men and resources.

1.4.2 Atypical (Adaptive) Project Lifecycle

- The pace of technology change in projects makes it difficult for project managers to ensure that the project they are implementing is relevant by the time they are done.
- The atypical or adaptive project lifecycle model is all the more relevant in the technology driven IT project management where change is the only constant and it becomes necessary for the project manager that the project that he is undertaking stays in tune with the constantly changing requirements of its stakeholders.
- Also, traditional software methodologies such as "waterfall" assume that every requirement of the project can be identified before any designing or coding occurs. However, this is far from realty as it is not possible for the stakeholders to tell the development team everything that is needed to be in the software before it is up and running.

- On the other hand, would it not be more pragmatic that the stakeholders describe their vision to the development team and the team develops functional software.
- Many times it has so happened that at the end of the project the development team builds the software it was asked to build, but, in the time it took to create, business environment have changed so dramatically that the product is irrelevant.
- This would mean that the time and money spent on the project is wasted. Therefore, it is more practical to ensure that the end product is still relevant before it is actually finished.
- To overcome these limitations of typical project life cycle methodologies the agile methodology which is an adaptive technology was introduced. The agile methodology helps the team respond to unpredictability through incremental, iterative work cadence known as sprints.

1.4.2.1 Development of Agile

GQ. 1.4.3 *Describe briefly to development of agile methodology ?*

- The agile methodology was the brainchild of Dr. Winston Royce who in his paper entitled "Managing the Development of Large Software Systems" criticised sequential development.
- He was of the opinion that software should not and cannot be developed like an automobile on an assembly line, in which every phase of the project must be completed before the next phase can begin.
- Dr. Royce was against the phase based approach in which developers first gather all of a project's requirements, then complete all of its architecture and design, then write all of the code, and so on. Royce specifically objected to this approach due to the lack of communication between the specialized groups that complete each phase of work.

Why Agile?

- The traditional software development methodologies provide only one chance to get each aspect of a project right. On the other hand, the agile development methodology provides opportunities to assess the direction of a project throughout the development lifecycle.
- Every aspect of development : requirement, design, etc are continually revisited throughout the lifecycle. This is achieved through regular cadences of work known as sprints or iterations at the end of which an incremental product is made.
- The focus of agile methodology is on repetition of abbreviated work cycles as well as the functional product they yield. Iterative re-evaluation of the direction of the project every two weeks provides time to the project team to steer the project in another direction if the need arises.
- Agile SDLC model is a combination of iterative and incremental process models with focus on process adaptability and customer satisfaction by rapid delivery of working software product.
- Agile model believes that every project needs to be handled differently and the existing methods need to be tailored to best suit the project requirements. In agile the tasks are divided to time boxes (small time frames) to deliver specific features for a release. Iterative approach is taken and working software build is delivered after each iteration.

- Each iteration typically lasts from about one to three weeks. Each iteration involves cross functional teams working simultaneously on various areas like planning, requirements analysis, design, coding, unit testing, and acceptance testing. Each build is incremental in terms of features; the final build holds all the features required by the customer
- Agile development methodology of "inspect and adapt" greatly reduce both development costs and time to market. In agile the team can develop software at the same time as they are gathering requirements making it possible for the team to progress faster.
- Also, as the team's work cycle is limited to one to three weeks, it provides stakeholders opportunities to recalibrate releases for success in the business world.
- Agile development helps organization build the right product, instead of being stuck with a product that no one wants to buy. The ability to re-plan the product and optimize its value ensures that the team's work and organization's cost don't do waste.

1.4.2.2 Graphical Illustration of the Agile Model

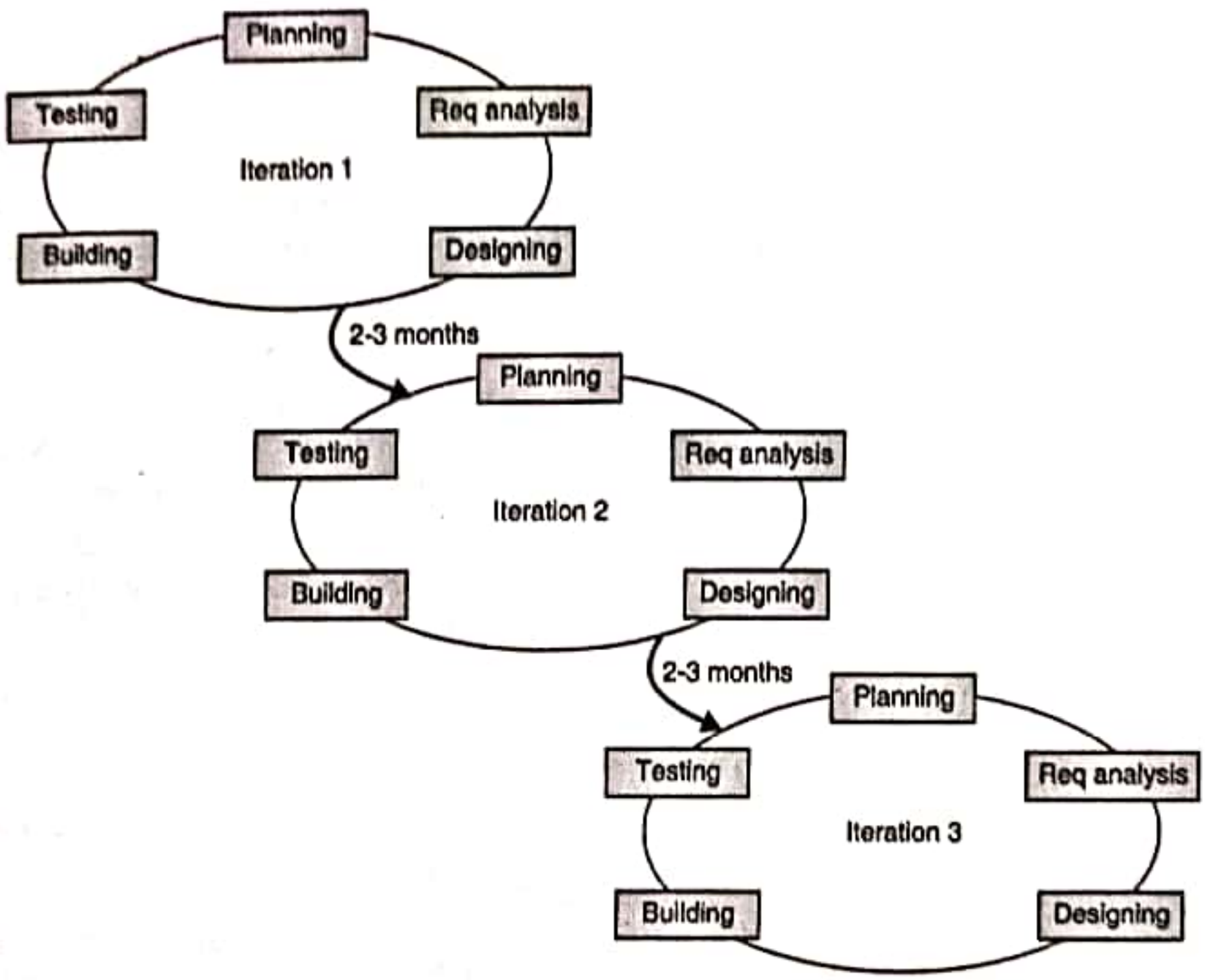

Fig. 1.4.1 : Agile SDLC Methodology

1.4.2.3 Principles of Agile

1. Customer satisfaction by early and continuous delivery of valuable software.
2. Welcome changing requirements, even in late development.
3. Working software is delivered frequently (weeks rather than months).
4. Close, daily cooperation between business people and developers.
5. Projects are built around motivated individuals, who should be trusted.

6. Face-to-face conversation is the best form of communication (co-location).
7. Working software is the principal measure of progress.
8. Sustainable development, able to maintain a constant pace.
9. Continuous attention to technical excellence and good design.
10. Simplicity- the art of maximizing the amount of work not done-is essential.
11. Self-organizing teams.
12. Regular adaptation to changing circumstance.

1.4.2.4 Differentiation between Agile and Traditional SDLC Models

GQ. 1.4.4 *Difference between Agile and Traditional SDLC Models ?*

Sr. No.	Agile SDLC Models	Traditional SDLC
1.	Agile is based on the adaptive software development methods.	Traditional SDLC models like waterfall model are based on predictive approach.
2.	Agile uses adaptive approach where there is no detailed planning and there is clarity on future tasks only in respect of what features need to be developed.	Predictive teams in the traditional SDLC models usually work with detailed planning and have a complete forecast of the exact tasks and features to be delivered in the next few months or during the product life cycle.
3.	There is feature driven development and the team adapts to the changing product requirements dynamically. The product is tested very frequently, through the release iterations, minimizing the risk of any major failures in future.	Predictive methods entirely depend on the requirement analysis and planning done in the beginning of cycle. Any changes to be incorporated go through a strict change control management and prioritization.
4.	Customer interaction is the backbone of Agile methodology, and open communication with minimum documentation are the typical features of Agile development environment. The agile teams work in close collaboration with each other and are most often located in the same geographical location	Customer interaction is practically limited to the beginning of the project.

1.4.2.5 Benefits and Limitations of Agile Methodology

GQ. 1.4.5 *What are the limitation and benefits of Agile methodology ?*

Although, the agile methodology has been widely accepted in the software development industry it is suitable for only few products. Following are the benefits and limitations of the agile methodology :

Benefits of the Agile Methodology

- Is a very realistic approach to software development
- Promotes teamwork and cross training.
- Functionality can be developed rapidly and demonstrated.

- Resource requirements are minimum.
- Suitable for fixed or changing requirements
- Delivers early partial working solutions.
- Good model for environments that change steadily.
- Minimal rules, documentation easily employed.
- Enables concurrent development and delivery within an overall planned context.
- Little or no planning required
- Easy to manage
- Gives flexibility to developers

Limitations of Agile Methodology

- Not suitable for handling complex dependencies.
- More risk of sustainability, maintainability and extensibility.
- An overall plan, an agile leader and agile PM practice is a must without which it will not work.
- Strict delivery management dictates the scope, functionality to be delivered, and adjustments to meet the deadlines.
- Depends heavily on customer interaction, so if customer is not clear, team can be driven in the wrong direction.
- There is very high individual dependency, since there is minimum documentation generated.
- Transfer of technology to new team members may be quite challenging due to lack of documentation.

The most popular agile methods include Rational Unified Process (1994), Scrum (1995), Crystal Clear, Extreme Programming (1996), Adaptive Software Development, Feature Driven Development, and Dynamic Systems Development Method (DSDM) (1995). These are now collectively referred to as agile methodologies, after the Agile Manifesto was published in 2001.

1.5 PROJECT PHASES AND STAGE GATE PHASES

GQ.1.5.1 *Enumerate the different phases of a project*

The Project Management methodology comprises of five phases which are as follows :

(1) Phase I : Project Conceptualization and Initialization

- This is the first stage in the project methodology and is responsible for preparing the ground work for further development. In this stage the idea behind the project is hatched and the goal or purpose of the project is defined.
- The primary project goal is very important in project methodology as it provides a basis for future project decisions and aids in defining the project scope.
- The project goal also serves as a parameter for evaluating the project's success after its completion. If the primary goal of the project is achieved the project could be termed as a success, however, there are other factors like time and cost which also are also to be considered while determining project success.

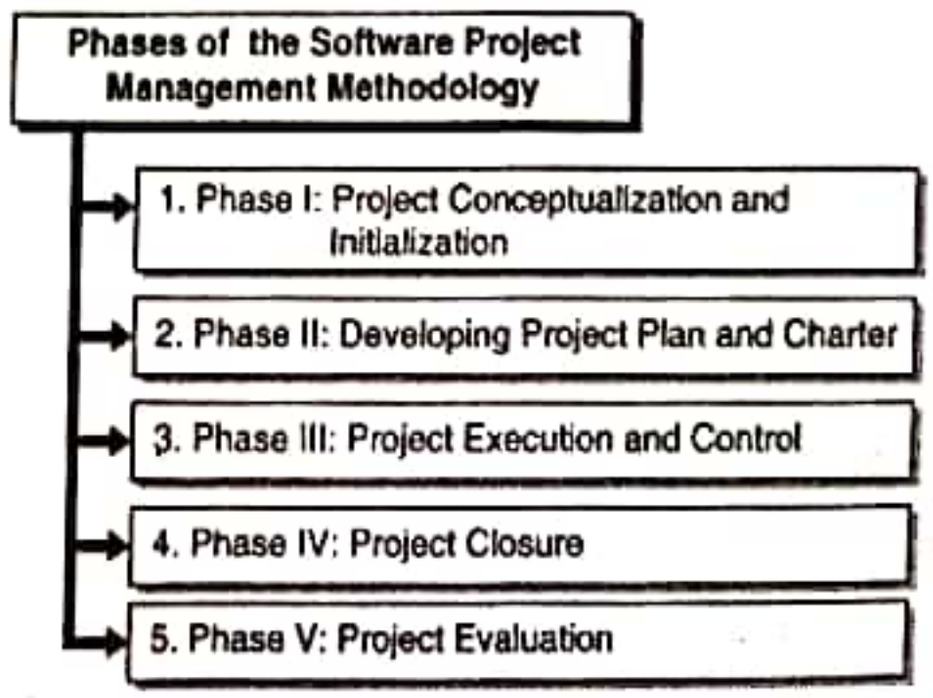

Fig. C1.3

- Project Initiation is the first official step or activity in the project methodology and marks the commencement of the project.
- Project Initiation is based on the business needs that justify the allotment of resources and the expenses that will be incurred on it.
- The primary idea behind Project Initiation is to ensure that the business need is properly understood by the project manager and is kept in mind throughout the lifecycle of the project. Remember, the business need drives the project hence deviation from it is not acceptable. The business need is the direct outcome of the objectives and goals of the organization.
- The Project Initiation stage enables the creation of the project charter that is the official document authorizing the project manager to undertake the project within the organization. As everyone who is party to the project or who is likely to be affected by it is part of the project initiation stage it is easy for the manager to identify the stakeholders.
- The business need which drives the project could vary from organization to organization. While some organizations may feel the need to increase productivity others may feel the need to reach out to more customers or to increase efficiency.
- The project manager needs to understand the business need that is driving the project and also how the project will help the organization in meeting this business need.
- As stated earlier the organizational objectives, goals and mission are behind the business need hence the project manager should understand the objectives and goals of the organization to understand its business needs better.
- The project manager also needs to understand how the outcome of the project will be used by its stakeholders.

▶ **(2) Phase II : Developing Project Plan and Charter**

- A project is defined as an undertaking of non-routine nature to create a new or unique product, service or result. As the undertaking is new or unique and never been done before in the organization, planning is essential.
- The planning process should complement the size and complexity of the project i.e. the larger and more complex the project the greater the planning effort while small routine project require very less planning effort.
- Although, planning is an intrinsic part of each phase of the project methodology it is all the more relevant in this phase where the project plan and charter are developed.
- Another very critical feature of planning is that it is never over, planning is an iterative process, and may require constant changes in its budget, scope, schedule or quality, as per the requirement of the client, stakeholder or the management.
- The project manager will have to depend on his wisdom and experience in developing a good and pragmatic project plan.
- The project manager needs to focus on the project specifics and narrow the project description. It is the time to draft the Project Charter. A project charter is a detailed official document prepared in line with the company's vision and goal describing in detail the finer nuances of the project and chalking out deadlines for the milestones within the project. The Project Charter serves as a road map for the project manager and states the goals that are to be achieved from the project.

- A Project Charter gives a clear definition of the project, its attributes, the end results and the project authorities.
- Project authorities are the people who are responsible for the implementation and success of the project. These people are namely the project in charge/project sponsor, project manager and the project team leaders.
- A project charter is the final official authorization for the commencement of the project to the project manager. It is a green signal to the project manager to commence work on the project.

▶ **(3) Phase III : Project Execution and Control**

- After having developed the project plan it is time to execute the plan. There are two types of processes, one which result in products and other which form the supporting processes.
- The product oriented process play an important role during the execution phase of the project. Quality assurance, risk management, team development, etc form the core of the supporting processes in the project execution.
- Although, the execution process is a part of every project phase it is more active and prominent during the execution and control phase of the project methodology.
- The second part of this phase is the controlling process. The primary objective of the controlling process is to measure and manage the project activities and ensure that they are on the right track towards the goal and adhere to the scope, budget, schedule, and quality parameters.
- The control process identifies deviation from the plan and makes it possible to take corrective action. Although, controlling process is present in each of the phases it has more emphasis in this phase.

▶ **(4) Phase IV : Project Closure**

- The primary objective of the closing process group is to ensure that the project reaches its logical conclusion and to bring the project to an orderly completion.
- The project closure phase is reached when all the project deliverables have been achieved and accepted by the project sponsor.
- At this phase the project team has to also ensure that the project integrates with the day-to-day operations of the organization and delivers information products as required.
- The closure of a project is marked by contract and administrative closure.
- Contract closure indicates that all the project deliverables have been successfully completed and all the agreed upon terms and conditions of the contract have been adhered too.
- Contract closure paves the way for the settlement of dues of outside parties, namely, suppliers and consultants.
- Administrative closure involves the documentation of all project activities and experiences for future references. Although, each project process group has closure of its activities, the major project closing process occurs in this phase.

▶ **(5) Phase V : Project Evaluation**

- The project evaluation phase focuses on evaluating the previous four project process group.
- The project review conducted by the project manager and his team should focus on assessing the positive and negative outcome of the project, things that worked in favour of the project and what went against the project.

- The experiences gained from the project should be well documented for future references.
- The project manager should also identify the best practices from the project that could be incorporated in the project management methodology of the organization. Inculcation of such best practices leads to the evolution of the methodology.
- The second part of the evaluation should take place between the project manager and the project team members and should focus on reviewing individual performance of team members as well as that of the project manager. The review should provide an honest and dispassionate feedback to the individual.
- The third part of the review should be conducted by a neutral party who should review the project, the project manager and the project team. The review should focus on the performance of the team in delivering what was promised to the sponsor, the ability of the team in meeting the objectives of the project scope, budget, schedule, and quality, overall client satisfaction, risks and challenges faced by the project team, the performance of the team as a unit, and the professional and ethical manner in which project activities were handled.
- The last part of the evaluation process should determine whether the project succeeded in providing value to the organization. Although, it may take time to gauge the full implications of the project, this part of the evaluation is essential to determine whether the project was an overall success.

1.6 ROLE OF PROJECT MANAGER

The five most important goals of every project are :

(i) Ensure that the project is completed within the deadlines set

(ii) Ensure that the project is completed within budget

(iii) Ensure user satisfaction

(iv) Ensure that all user requirements are duly met

(v) Ensure team management

(i) Ensure that the project is completed within the deadlines set

- Every project has a deadline within which it has to be completed and it is the duty and responsibility of the project manager to ensure that the deadline is adhered to.
- Although, the project manager and his team may have a role to play in deciding the schedule and at the outset of the project it may have looked feasible but as time passes and requirements change the project may require new strategies and planning making it difficult to complete the project within the stipulated time frame.
- However, the project manager should never lose sight of the deadline and keep pushing the team to complete the project within the time frame originally set.
- Hence, the project manager before committing to the deadline should take into account all eventualities which he and his team may have to encounter. It is always better to have a buffer period in hand.

(ii) Ensure that the project is completed within budget

- Just as every project has a schedule it also has a budget. A budget is a forecast of the expenditure that will be incurred on the project. It is essential that the budget is prepared with considerable thought to all the activities and resources that

would be utilized in the project.

- Hence, a budget is prepared after considerable research and after comparison of prices to get the best possible deals. Like the schedule a budget should leave no stone unturned.
- However, as requirements change there is every likelihood that the original budget may go astray. It is therefore the responsibility of the project manager to ensure that things stay within budget.

▶ **(iii) Ensure user satisfaction**

- Although user satisfaction should be the utmost priority for any project manager and is achieved by delivering the project on time it should in no way be achieved by compromising on the quality of the results.
- Quality of the project output is another project goal of which the project manager should never lose sight of.

▶ **(iv) Ensure that all user requirements are duly met**

- Another very critical goal for the project manager is to ensure that all the user requirements from the project are duly met.
- This would mean getting very detailed inputs from the user on his requirements from the project.

▶ **(v) Ensure team management**

- Along with ensuring that all project goals are met the project manager has to also ensure that his team is happy and contented.
- It is the responsibility of the project manager to provide encouragement, incentives and rewards for the hard work put in by the team in the project.
- Remember, no project is complete without a team and hence it is the responsibility of the manager to ensure the well being of all the team members.
- Achievement of these goals is no mean task as it is akin to juggling with five pins at the same time.
- The project manager should ensure that these goals are outlined to the project management team at the very beginning, there in no way for the delivery of the goals to be delayed in any way as everyone will always be aware of what they need to achieve and by when.

1.7 NEGOTIATION AND RESOLVING CONFLICTS

GQ. 1.7.1 *What is negotiation ?*

- Negotiation is one of the most common approaches used to make decisions and manage disputes. It is also the major building block for many other alternative dispute resolution procedures.
- Negotiation is a problem-solving process in which two or more people voluntarily discuss their differences and attempt to reach a joint decision on their common concerns.
- Negotiation requires participants to identify issues about which they differ, educate each other about their needs and interests, generate possible settlement options and bargain over the terms of the final agreement.
- Successful negotiations generally result in some kind of exchange or promise being made by the negotiators to each other.

- The exchange may be tangible (a commitment of time or a particular behaviour) or intangible (such as an agreement to change an attitude or expectation).
- Because negotiation is such a common problem-solving process, it is in everyone's interest to become familiar with negotiating dynamics and skills.

1.7.1 Conditions for Negotiation

GQ. 1.7.2 *State the conditions of negotiation ?*

A variety of conditions can affect the success or failure of negotiations. The following conditions make success in negotiations more likely.

1. **Identifiable parties who are willing to participate :** The people or groups who have a stake in the outcome must be identifiable and willing to sit down at the bargaining table if productive negotiations are to occur. If a critical party is either absent or is not willing to commit to good faith bargaining, the potential for agreement will decline.
2. **Interdependence :** For productive negotiations to occur, the participants must be dependent upon each other to have their needs met or interests satisfied. The participants need either each other's assistance or restraint from negative action for their interests to be satisfied. If one party can get his/her needs met without the cooperation of the other, there will be little impetus to negotiate.
3. **Readiness to negotiate :** People must be ready to negotiate for dialogue to begin. When participants are not psychologically prepared to talk with the other parties, when adequate information is not available, or when a negotiation strategy has not been prepared, people may be reluctant to begin the process.
4. **Means of influence or leverage :** For people to reach an agreement over issues about which they disagree, they must have some means to influence the attitudes and/or behavior of other negotiators. Often influence is seen as the power to threaten or inflicts pain or undesirable costs, but this is only one way to encourage another to change. Asking thought-provoking questions, providing needed information, seeking the advice of experts, appealing to influential associates of a party, exercising legitimate authority or providing rewards are all means of exerting influence in negotiations.
5. **Agreement on some issues and interests :** People must be able to agree upon some common issues and interests for progress to be made in negotiations. Generally, participants will have some issues and interests in common and others that are of concern to only one party. The number and importance of the common issues and interests influence whether negotiations occur and whether they terminate in agreement. Parties must have enough issues and interests in common to commit themselves to a joint decision-making process.
6. **Will to settle :** For negotiations to succeed, participants have to want to settle. If continuing a conflict is more important than settlement, then negotiations are doomed to failure. Often parties want to keep conflicts going to preserve a relationship (a negative one may be better than no relationship at all), to mobilize public opinion or support in their favor, or because the conflict relationship gives meaning to their life. These factors promote continued division and work against settlement. The negative consequences of not settling must be more significant and greater than those of settling for an agreement to be reached.
7. **Unpredictability of outcome :** People negotiate because they need something from another person. They also negotiate because the outcome of not negotiating is unpredictable.
8. **A sense of urgency and deadline :** Negotiations generally occur when there is pressure or it is urgent to reach a decision. Urgency may be imposed by either external or internal time constraints or by potential negative or positive

consequences to a negotiation outcome. External constraints include: imminent executive or administrative decisions, or predictable changes in the environment. Internal constraints may be artificial deadlines selected by a negotiator to enhance the motivation of another to settle. For negotiations to be successful, the participants must jointly feel a sense of urgency and be aware that they are vulnerable to adverse action or loss of benefits if a timely decision is not reached. If procrastination is advantageous to one side, negotiations are less likely to occur, and, if they do, there is less impetus to settle.

9. **No major psychological barriers to settlement :** Strong expressed or unexpressed feelings about another party can sharply affect a person's psychological readiness to bargain. Psychological barriers to settlement must be lowered if successful negotiations are to occur.

10. **Issues must be negotiable :** For successful negotiation to occur, negotiators must believe that there are acceptable settlement options that are possible as a result of participation in the process. If it appears that negotiations will have only win/lose settlement possibilities and that a party's need will not be met as a result of participation, parties will be reluctant to enter into dialogue.

11. **The people must have the authority to decide :** For a successful outcome, participants must have the authority to make a decision. If they do not have a legitimate and recognized right to decide, or if a clear ratification process has not been established, negotiations will be limited to an information exchange between the parties. A willingness to compromise. Not all negotiations require compromise. On occasion, an agreement can be reached which meets all the participants' needs and does not require a sacrifice on any party's part. However, in other disputes, compromise--willingness to have less than 100 percent of needs or interests satisfied--may be necessary for the parties to reach a satisfactory conclusion. Where the physical division of assets, strong values or principles preclude compromise, negotiations are not possible.

12. **The agreement must be reasonable and implementable :** Some settlements may be substantively acceptable but may be impossible to implement. Participants in negotiations must be able to establish a realistic and workable plan to carry out their agreement if the final settlement is to be acceptable and hold over time.

13. **External factors favorable to settlement :** Often factors external to negotiations inhibit or encourage settlement. Views of associates or friends, the political climate of public opinion or economic conditions may foster agreement or continued turmoil. Some external conditions can be managed by negotiators while others cannot. Favorable external conditions for settlement should be developed whenever possible.

14. **Resources to negotiate :** Participants in negotiations must have the interpersonal skills necessary for bargaining and, where appropriate, the money and time to engage fully in dialogue procedures. Inadequate or unequal resources may block the initiation of negotiations or hinder settlement.

1.8 CONFLICT MANAGEMENT

GQ. 1.8.1 *What is conflict management in the workplace ?*

- Conflicts are an integral part of our personal and professional life. Conflict is all pervasive. Projects are vibrant and dynamic entities, made up of a large variety of individuals that differ in many ways, giving rise to various types of conflicts.
- In any situation involving more than one person, conflict can arise. The causes of conflict range from philosophical differences and divergent goals to power imbalances.

- Unmanaged or poorly managed conflicts generate a breakdown in trust and lost productivity. Conflict may have positive or negative consequences depending upon the way it is approached and managed.
- Avoiding the conflict or fighting a win-lose battle has negative consequences such as deteriorated cooperation and team work, increased hostilities, communication barriers or breakdowns, suspicion, people getting hurt, stress levels increased, productivity hampered etc. For small businesses, where success often hinges on the cohesion of a few people, loss of trust and productivity can signal the death of the business.
- With a basic understanding of conflict management strategies, managers can better deal with conflicts before they escalate beyond repair.

1.8.1 Concept of Conflict

GQ. 1.8.2 *Explain concept of conflict ?*

- The word 'conflict' conveys different meanings. Conflicting mind indicates duality or dilemma in mind over a certain issue, 'conflicting views' indicate differences of opinions between two or more people.
- They are in 'conflict' means each party to the conflict is challenging the other to meet their goals. A conflict is not always synonymous with quarrel or fights, thought it may result in that. It represent clash in a less literal sense between goals, ideas, ideologies, actions, style or principles.
- Conflict is different from competition. A process that begins when one party perceives that another party has negatively affected, or is about to negatively affects something that the first party cares about.
- In simple words, conflict may be understood as collision or disagreement. Conflict between two individuals or departments occurs when one party frustrates the attempts of another.
- Conflict may be negative or affective. Cognitive conflict refers to differences in perspectives or judgments about issues. Affective conflict is emotional and directed at other people. Affective conflict is likely to be destructive because it can lead to anger, bitterness of opinion and develop better ideas and solutions to problems.
- Conflict needs to be cognitive and not affective. Differences exist between conflict and competition. In competition, one party does not prevent the attempts of others.
- But in conflicts it does happen. Conflict occurs when two or more people oppose one another because their needs, wants, goals, or values are different. Conflict is almost always accompanied by feelings of anger, frustration, hurt, anxiety, or fear.
- Conflict management is the practice of identifying and handling conflict in a sensible, fair, and efficient manner. Conflict management requires such skills as *effective communicating, problem solving,* and *negotiating* with a focus on *interests.* People belong to different – Background, Point of View, Values, Need Personalities.
- When they interact tension are developed Dissension, Confusion, Hostility, Disunity, Harsh treatment, Lack of cooperation are common features.
- Conflict is s state of opposition or disagreement or collision between persons, ideas or interests. Also we can say it is the struggle between incompatible or opposing needs, wishes, ideas, interests or people. There are different types of Conflicts- it may be negative or positive, Constructive or Destructive, Intrapersonal or Inter Personal.

1.8.2 Conflict Management in Projects

GQ. 1.8.3 *State the reasons for conflict within projects?*

On account of the diversity of the opinions and interest projects are breeding ground for conflicts. Team members, management and stakeholders are likely to disagree on the progress, decisions and solutions within the project. Hence, it is essential for the project manager to maintain balance and lead the parties involved in conflict to a solution that is in the best interest of the project.

The most common reasons for conflicts within projects are :

(i) Schedules (ii) Resources

(iii) Technical reasons (iv) Project costs

(v) Priorities (vi) Policies and procedures

(vi) Personalities

The basic five conflict management strategies are as follows ;

1. **Accommodating :** The accommodating strategy essentially entails giving the opposing side what it wants. The use of accommodation often occurs when one of the parties wishes to keep the peace or perceives the issue as minor. Team members who use accommodation as a primary conflict management strategy, however, may keep track and develop resentment.
2. **Avoidance :** The avoidance strategy seeks to put off conflict indefinitely. By delaying or ignoring the conflict, the avoider hopes the problem resolves itself without a confrontation. Those who actively avoid conflict frequently have low esteem or hold a position of low power. In some circumstances, avoiding can serve as a profitable conflict management strategy, such as after the dismissal of a popular but unproductive team member. The hiring of a more productive replacement for the position soothes much of the conflict.
3. **Collaboration :** Collaboration works by integrating ideas set out by multiple people. The object is to find a creative solution acceptable to everyone. Collaboration, though useful, calls for a significant time commitment not appropriate to all conflicts.
4. **Compromising :** The compromising strategy typically calls for both sides of a conflict to give up elements of their position in order to establish an acceptable, if not agreeable, solution. This strategy prevails most often in conflicts where the parties hold approximately equivalent power. Project managers frequently employ compromise during contract negotiations when each party stands to lose something valuable, such as a necessary service.
5. **Competition :** Competition operates as a zero-sum game, in which one side wins and other loses. Highly assertive personalities often fall back on competition as a conflict management strategy. The competitive strategy works best in a limited number of conflicts, such as emergency situations.

There are few conflict management strategies by Robbins :

1. **Problem Solving :** Getting to the bottom of the problem and solving it through open discussion between warring parties. This could work out to be the best possible solution.
2. **Shared Goals :** Design goals which can be achieved only when conflicting parties cooperate.
3. **Deployment of Resources :** Deploy more resources in case the crux of the problem is resources.

4. **Avoidance :** Avoid the conflict. Though easier said than done. It could also later come back to you bigger and haunt you.
5. **Compromise :** Win some, lose some approach.
6. **Use of Authority :** Project manager puts his foot down and decides on the outcome without consulting the two parties.
7. **Altering Human Variable :** Alter conflicting behaviors and attitudes through training and behavior change techniques
8. **Altering Structural Variables :** Change interaction patterns of conflicting parties through restructuring of organization, job redesign, transfers, etc.

1.9 ORGANIZATION AND TEAM STRUCTURES

For the effective functioning of the product development process it is not only important to have a proper development process in place but also organize the team effectively. In this section we will be studying the various types of organizations which are used for product development.

1.9.1 What are Organizations

GQ. 1.9.1 *What are organizations ?*

- Organizations are ubiquitous in today's world.
- Organizations wield far-reaching and comprehensive powers to deeply influence all aspects of human life.
- We live, essentially within, or as members of, some or other organization at all times and during all stages of our life viz. Childhood, adult age, and even old age.
- It is crucial and imperative, precisely on account of a for mentioned fact, that we develop deeper insights as far as nature, functions and objectives of organizations are concerned.
- Indeed, organizations area sold as humanity itself. People come together and form organizations to achieve certain goals.
- Political organizations, business organizations, cultural organizations, charity organizations, educational organizations, research organizations, religious organizations, defence organizations etc. Are some of the organizations we all are familiar with.
- Organizations are some what abstract entities which are law abiding and in many cases may possess a legal persona or identity.
- Human enterprise and ingenuity, visionary leadership and socio-culturally and legally acceptable purpose or mission, are the essential prerequisites for any organization to come into existence.
- In any organization, people working in diverse roles, capacities and on various positions assigned to them within the organization-strive to attain common organizational goals.
- People derive their identities such as social, familial, cultural, professional, organizational, and even spiritual in many cases, from their association with the organizations.
- Individual harbours his own paradigms and perceptions regarding organization and goings on within it. This has profound effects on human behaviour while working within the organization, and it makes organization a very complex social system.

1.9.2 Characteristics of an Organization

GQ. 1.9.2 *Explain characteristics of an organization ?*

- It has well defined and agreed up on common purpose.
- It involves assignment of tasks and activities. This involves dividing the work which enhances efficiency and proficiency both.
- It has clearly defined deliverables for its sub-functions and individuals working within it.
- It has clearly defined roles, responsibilities and authorities at all levels.
- People depict dynamic human element of the organization and strengths and weaknesses and customs and mores of the people can't be ignored, rather they have to be the prime considerations while activity groupings and empowering. There are people and people processes.
- It has form a land informal channels of communication within it.
- There are rules and regulations governing people and processes.
- Organizations function within environment of which economic, social, political and legal factors are the major constituents. Coordination and cooperation are very basic elements of organizations and processes involved in it.

1.9.3 Organizational Links-Functions, Projects or a Combination

GQ. 1.9.3 *What are the function of organizing structure ?*

- In any organization there are various forms of links which may take place some formal and some informal.
- There may be are porting link where one individual has to report to another which is the normal nature of relationship in an organization or there might be an informal link which may take place due to sharing of the same facilities like premises, transportation etc.
- There may be several different ways in which one may be linked to another individual and there could also be a combination of the formal as well as informal linkage.
- Now irrespective of the links that exist between individuals within the organization they can be classified according to the functions and the projects that these individuals work on.

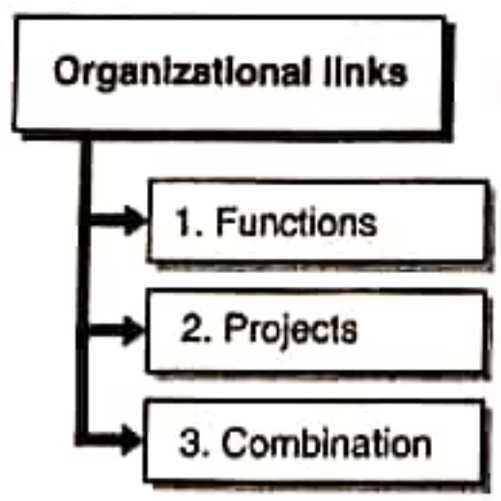

Fig. C. 1.4 : Organizational Links

▶ **1. Function**

- Function within an organization structure is an area of responsibility and the individual who undertake stopper form that function has either specialized training, education or/and experience.
- Now if we analyze the generic product development process for functions we will observe them to be marketing for the initial need identification, design function for the designing of the product, production function for the physical production of the product etc.

In the organization of the product development process we will have individuals who will be linked by functions.

▶ **2. Projects**

Projects area set of activities in the product development process to which individuals apply their expertise let us say developing of the concept or designing the product, building and testing prototypes etc.

3. Combination

- We also have individuals from different functions working on the same project or many projects.
- From the above linkages we get two organizational structures;

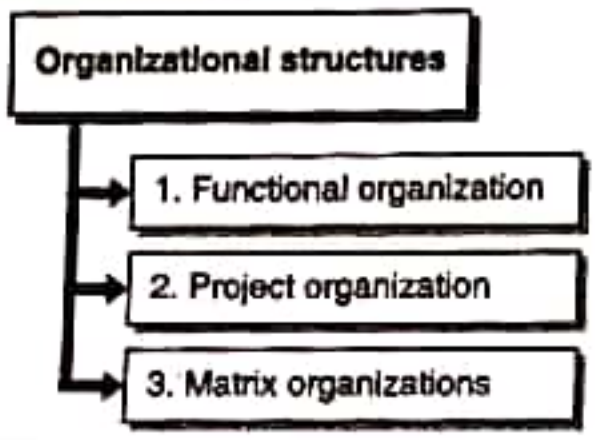

Fig. C. 1.5 : Organizational structures

▶ **1. Functional Organization**

- Here the organizational links are amongst those who perform similar functions. We may have the designing team all with similar expertise working together and reporting to their manager who is responsible to the performance and output from the function
- They will be located in the same premises and share a common budget.
- They will be working in different projects without having any formal links to any other individual from that project. Other functions will also be performing in a similar manner.

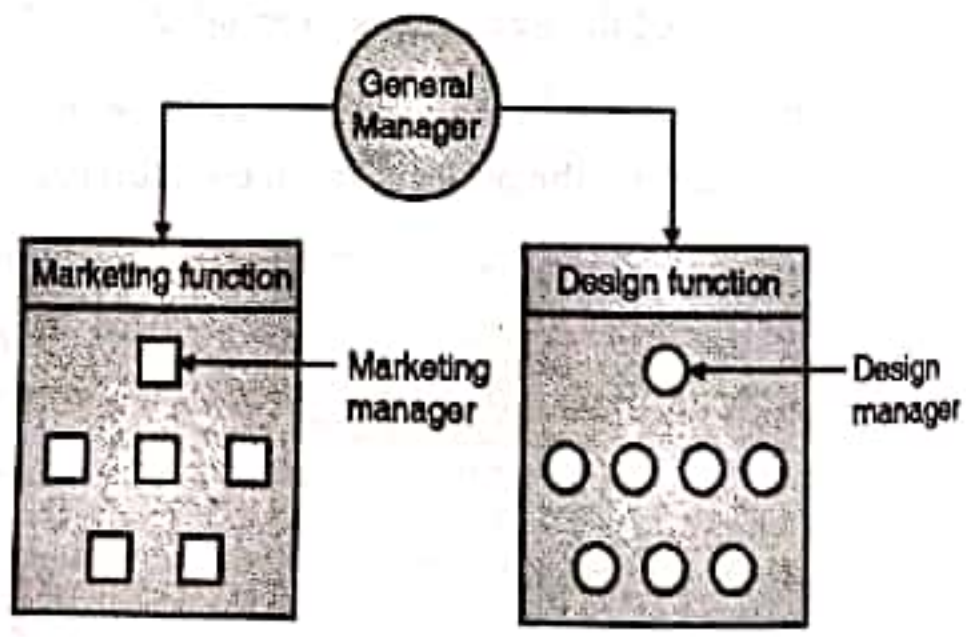

Fig. 1.9.1

2. Project Organization

- A project organization is a temporary thing. It will only exist from the projects start until it send. All the project team members are coming from different functions within the organization.
- They will all have a temporary assignment to the project. So, they have not only a project boss (the project manager), but also their' normal' boss, who orders him around when the employee is not in the project.
- Normally a functional manager is appointed as the leader of the project. Performance evaluation of the project team will be handled by the project manager and the team will be located in separate location.
- The project organization should be a result from the project strategy, it should be constructed in such a way that the strategy can be implemented within the environment of the project.
- A very obvious example: if the strategy contains an aspect of having independent reviews ,the organization should support its independence, by creating a separate working group with notice to the other team members.

3. Matrix Organizations

- Matrix Organization is a combination of two or more organization structures namely Functional Organization and Project Organization.
- The organization is divided into different functions, e.g. Purchase, Production, R&D, etc. Each function has a Functional (Departmental) Manager, e.g. Purchase Manager, Production Manager, etc.
- The organization is also divided on the basis of projects e.g. Project A, Project B, etc. Each project has a Project Manager e.g. Project A Manager, Project B Manager, etc.
- The employee has to work under two authorities (bosses). The authority of the Functional Manager flows downwards while the authority of the Project Manager flows across (side wards).
- So, the authority flows downwards and across. Therefore, it is called "Matrix Organization".

There are two variants of the Matrix Organization.

(a) Heavy weight Project Organization

- In this form of matrix organization the project is given more weight age than the function.
- The project manager has complete budget authority and is responsible for the performance evaluation as well as the resources that are allocated. The projects involved are heavy and important to the organization.

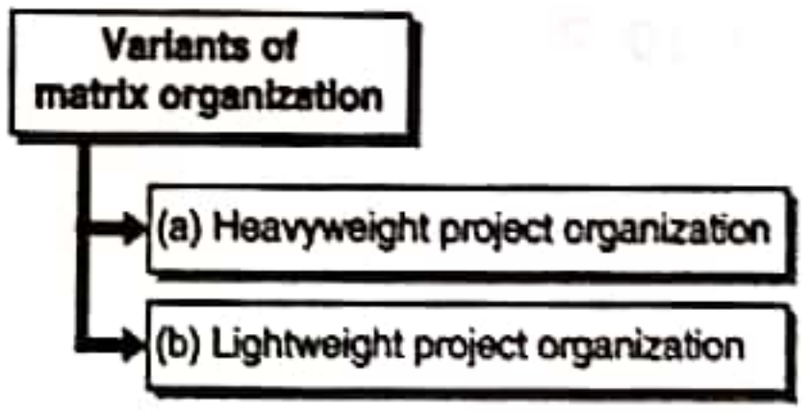

Fig. C. 1.6 : Variants of matrix oorganization

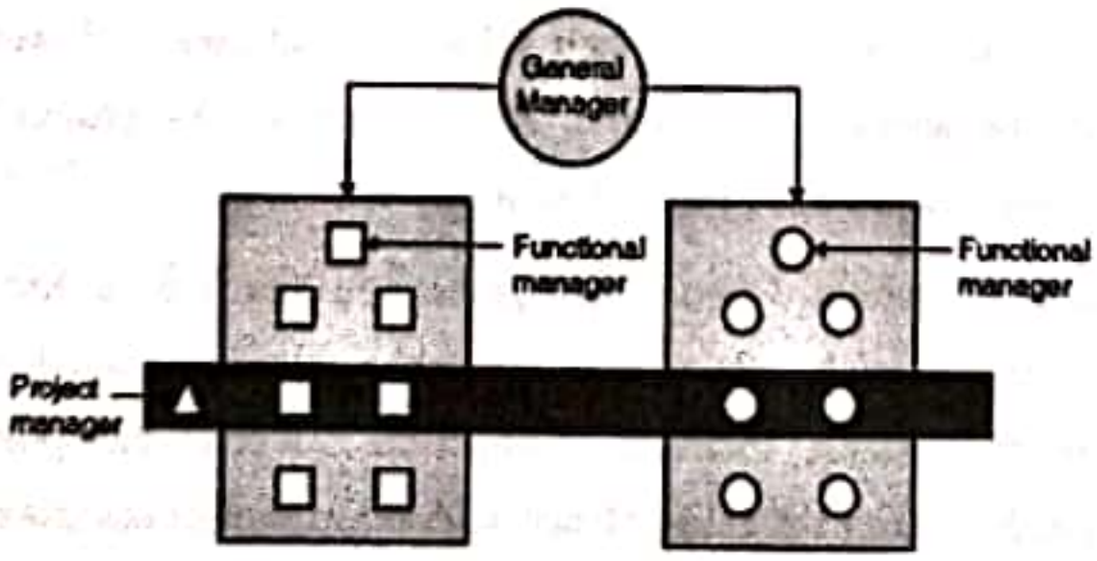

Fig. 1.9.2

▶ **(b) Light weight Project Organization**

- Unlike heavy projects here projects involved are light or less important to the organization and the functional links are stronger.
- The functional has more authority and is incharge of the performance evaluation as well as budgets. The project manager is only responsible for scheduling and coordination of the people in the project.

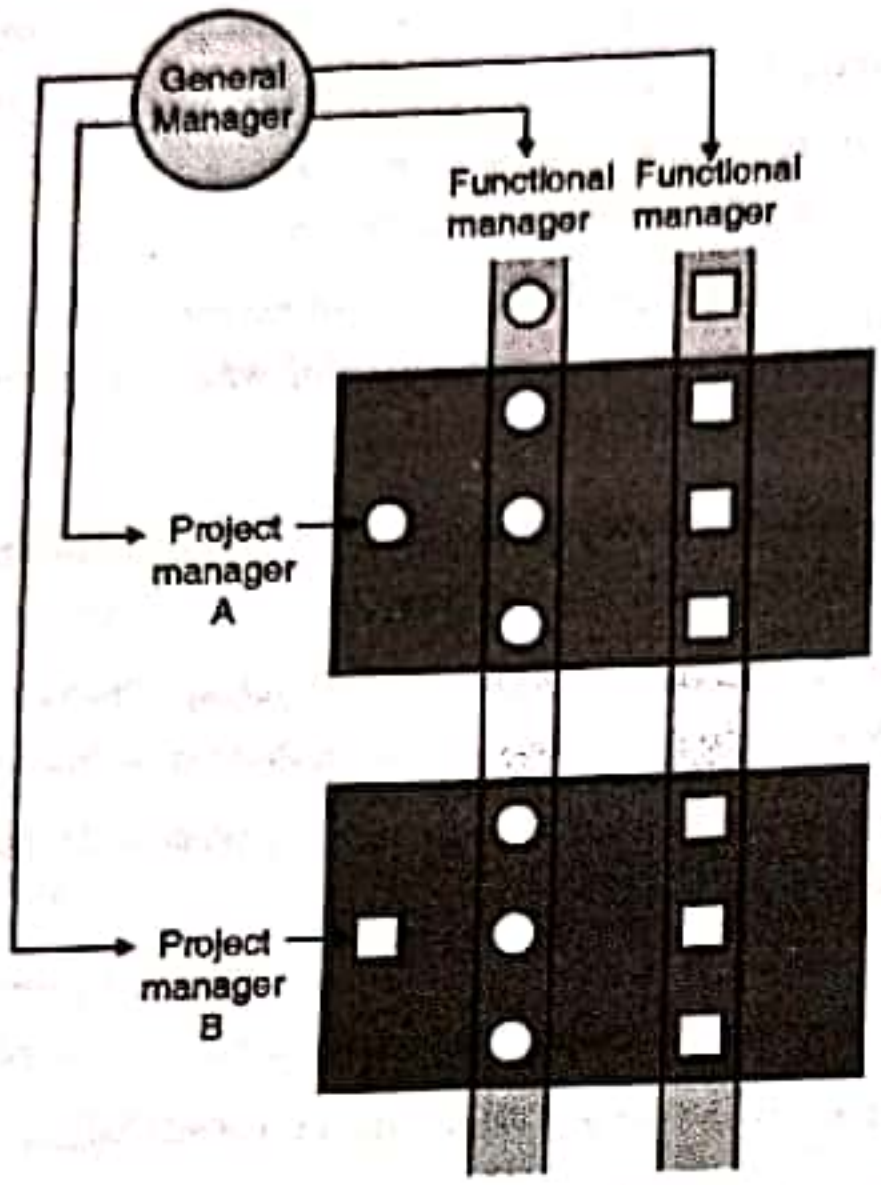

Fig. 1.9.3

⏭ 1.10 PMBOK

GQ. 1.10.1 *What is PMBOK ?*

- The Project Management Body of Knowledge Guide (PMBOK Guide) prepared by the Project Management Institute, USA, includes proven traditional as well as well as innovative practices in the area of project management.
- The purpose of the PMBOK Guide is to identify the "good practices" that are applicable to most projects, most of the time and that there is wide spread consensus about their value and usefulness. However, "good practices" does not mean that knowledge should be applied uniformly to all the projects; the project management team should be responsible for determining what is appropriate for their project.
- The PMBOK Guide is used by various Project Management Institutes as a foundation for their professional development program. However, this guide only addresses project management practices that are generally recognized as "good practices", there are other external standards on organization project management that are also recognized as "good practices" but are not addressed by the guide. Hence, to develop an overall view of project management external additional information should also be refereed.

- The PMBOK Guide proves useful to;
  - Senior Executives
  - Project Managers
  - Functional Managers
  - Project Team Members
  - Stakeholders
  - Trainers
  - Consultants
  - Researchers

1.10.1 PMBOK Knowledge Areas

GQ. 1.10.2 *What are the areas of project management ?*

The PMBOK defines nine knowledge areas for understanding project management and are as follows :

1. Project Integration Management Knowledge Area
2. Project Scope Management Knowledge Area
3. Project Time Management Knowledge Area
4. Project Cost Management Knowledge Area
5. Project Quality Management Knowledge Area
6. Project Human Resource Management Knowledge Area
7. Project Communication Management Knowledge Area
8. Project Risk Management Knowledge Area
9. Project Procurement Management Knowledge Area

1. Project Integration Management Knowledge Area

- This area includes the processes and activities needed to identify, define, combine, unify and coordinate the various processes and activities within the project management process groups.
- Integration activities are crucial to project completion. Integration management focuses on coordinating the project plans development, execution, and control.

2. Project Scope Management Knowledge Area

- This area includes all the processes that are needed to ensure that project scope includes all the work required to be completed by the team, and only the work required to complete the work successfully.
- Scope management assures that project work expected from the team is defined accurately and completely and that the work is undertaken and completed as planned. Also, it is essential for Scope management to include proper scope management procedures.

3. Project Time Management Knowledge Area

- This knowledge area includes the processes required to develop, monitor, and manage the project schedule such that the timely completion of the project is accomplished.
- Time management identifies project phases and activities and then estimates and sequences them. The assignment of resources to ensure the timely completion of the project while ensuring that the project scope and objectives are met is also included in this area.

▶ 4. Project Cost Management Knowledge Area

This includes the processes involved in planning, estimating, budgeting and controlling costs so that the project can be completed within the approved budget.

▶ 5. Project Quality Management Knowledge Area

Includes all the activities of the organization that determine qualities policies, objectives and responsibilities so that the project will satisfy or exceed the needs of the stakeholders for whom the project had been undertaken.

▶ 6. Project Human Resource Management Knowledge Area

- This area focuses on managing the most important resource on a project.
- It includes the processes that organize and manage the project team.

▶ 7. Project Communication Management Knowledge Area

This area focuses on developing processes that are required to ensure timely, accurate, and appropriate generation, collection, distribution, storage, retrieval, and disposition of project information.

▶ 8. Project Risk Management Knowledge Area

This includes all the processes associated with risk management planning, identification, response and monitoring on a project.

▶ 9. Project Procurement Management Knowledge Area

- All resources i.e. people, hardware or software, needed for the project may not be available within the organization and it may need to procure some from outside sources.
- The procurement management area includes the processes to purchase or acquire these products or services to perform the work.
- The concepts associated with information systems and software engineering when integrated with the nine knowledge areas outlined in PMBOK provide the foundation for IT project management.
- Since, the PMBOK guideline are generic to any project, the integration of information systems management and software engineering with PMBOK concepts helps distinguish IT projects from other projects such as construction and engineering.

Chapter Ends...

□□□

CHAPTER 2

Module 2

Initiating Project

University Prescribed Syllabus

How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.

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Introduction

Managing a Project is akin to being the coach of the Indian Cricket Team, you get to experience some of the same thrills and exhilarating moments as the coach would surely be getting to experience.

A project is defined as an undertaking of a non-routine, non-repetitive nature having prescribed objectives in terms of scope, time, quality and cost. Within the realm of project planning such projects can be further defined as generally being complex, having a multi-disciplinary involvement and having various phases in their life span. The completion of each of the project phases is usually accompanied by a finished project of some sort.

Project planning is the comprehensive management and control of any or all aspects of a project throughout all phases of its life to achieve those prescribed objectives defined in terms of scope, time, quality and cost. Through the application of appropriate management techniques, the project manager would direct and co-ordinate the efforts of the multi-disciplinary team to achieve the objectives of a project to meet the client's requirements.

2.1 PROJECT FEASIBILITY

GQ. 2.1.1 *Why do project need a project feasibility. Study.*

- Projects are expensive and hence before project initiation a preliminary study called a feasibility study needs to be conducted to determine the validity of the project. The primary objective of the feasibility study is to ensure that the organization is on the right track and is focusing on the right problem with respect to the project. A feasibility study is undertaken to determine the information needs of the prospective users and the resource requirements, costs, benefits and the technical viability of the project.
- A feasibility study is a report of the research that the project manager has undertaken. It helps in determining the validity or scope of the entire project or a part of the project. As the title indicates the feasibility study tells the management if a problem is solvable or a business opportunity is realizable. Some feasibility studies may also cover the financial implications of undertaking the project. The financial part of the feasibility study will tell the management whether it makes financial sense in undertaking the project. It will indicate the Return on Investment.
- The project manager while preparing the feasibility report should refrain from expressing his opinion about the feasibility of the project. The report should be highly factual and down to the point. It should cover all the aspects of the project, its ability to address the problem or realize the business opportunity, financial implications, and the value that it will add to the organization.
- The project manager should be fair in his assessment and should not be tempted to impose new technology merely for the sake of technology. Many a times in projects it has been observed that project managers utilize technology merely to display their technical expertise. Technology for the sake of technology is no good; it should add value to the organization. The project manager, in his report, should express how the new technology will benefit the organization.

The feasibility study comprises of the following :

1. **Executive Summary :** The purpose of the executive summary is to provide the reader with a brief summary of the findings of the feasibility study.

2. **Define the Business Problem or Opportunity :** In this section the business problem that the organization is encountering and its impact on the functioning of the organization is discussed. In case there is an opportunity that the organization wants to utilize that too will have to be defined and how it will benefit the organization has to be stated. The business goals or objectives can be utilized to link the project to the opportunity or problem. Also, the benefits of the proposed technology are to be stated in the report. The report should also identify the areas or people who are likely to be affected by the introduction of the new technology.

3. **Purpose of the Feasibility Study :** Although the primary purpose of any feasibility study is to determine the practicality of an opportunity or the solubility of a problem there are number of other reasons for which a feasibility study can be undertaken. To determine whether a particular product should be bought or made in house. It's a typical make-or-buy problem.
   - Compare various software and hardware solutions.
   - Determine capability resource gap with the new technology.
   - The purpose of this section is to describe the intent of the feasibility study.

4. **Assessment of Alternatives :** A feasibility study involves various alternative solutions for the business problem or opportunity. The project manager has to state in the report the alternatives evaluated, basis for selection of the alternatives, and the manner in which the alternatives differ from one another.

5. **Impacted Areas :** This section of the feasibility study identifies the impacted people, addresses the issues concerning the users, and determines the capability resource gap. Some of issues addressed are :
   - Probably downtime that the users will experience on account of the implementation of the project.
   - Phased introduction of the new technology within the organization.
   - Assessment of requirement for training, the number of users requiring training, the training period, and the resources that will needed to impart training.
   - Learning curve of the new software.
   - How will the new software integrate with the organizations existing software.
   - Does the new software require specific hardware?
   - Compatibility of new software with the existing operating system.
   - Period before an upgrade to the new software will be available.
   - This section will also cover the process of implementation of the new technology.

6. **Financial Issues :** This section of the feasibility report will address all the financial issues related to the project. The issues addressed here are;
   - Price of the new technology
   - License fee and renewal period
   - Cost of training
   - Additional financial burden arising out of requirement for trained personnel
   - Cost of labour to implement the technology
   - Technical support from vendor

- Loss incurred for not adopting the new technology
- Return on Investment analysis

7. **Project Manager's Recommendation :** This is the final section in the feasibility report and will contain the project manager's personal recommendation for or against the implementation of the proposed technology. The project manager should cover the working of the technology, its implementation process, and the resources required. The section should also cover the other alternatives that could be used and a comparison of how they measure up to the proposed technology.

2.2 SELECTING PROJECT STRATEGICALLY

GQ. 2.2.1 *Describe the role of strategy in project management.*

The strategic project selection consists of six interrelated managerial tasks :

- The process kicks off with a stakeholder's analysis.
- Following the stakeholder's analysis, the strategic vision, mission and objectives of the organization are established. This provides long-term direction and a sense of purposeful action.
- Central to the strategic process is the decision to make the most of the business resources (internal) and environmental factors (external). Analysis of internal and external factors allows management to set and/or review objectives and strategies and generate alternative options.

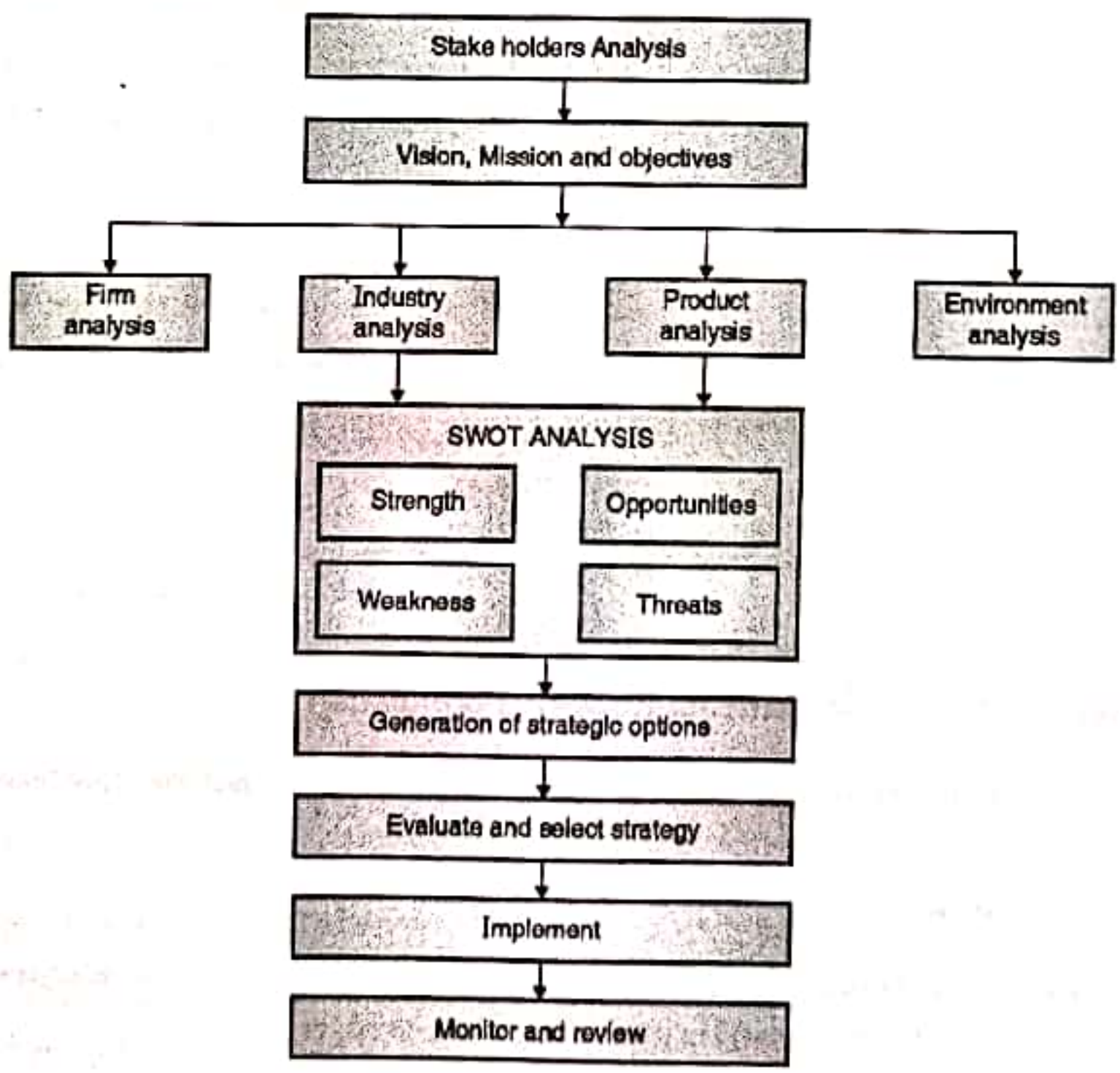

Fig. 2.2.1 : Strategic Management Process

- The strategic alternatives are screened using qualitative and numerical analysis, the most appropriate strategy is selected from these options.
- Once the strategy has been selected it has to be implemented and executed efficiently and effectively. This involves resource planning and allocation, for an existing organization this may also require organizational changes.
- The process is for a medium to long term and the review process is carried out annually. Evaluating performance and initiating corrective adjustments in vision, long-term direction, objectives, strategy, or execution in light of actual experience, changing conditions, new ideas, and new opportunities.

2.2.1 Stakeholder Analysis

Stakeholders are those who can affect or be affected by the project. Stakeholder analysis though not a lengthy process is a tricky one as it requires the management to identify the conflicting expectations of different stakeholders and their power and influence on the organization.

2.2.2 Vision, Mission and Objectives

1) Vision

Sets the purpose of the business organization. It also states the direction of where it attempting to go. It gives broad direction. For example, "to become leading publisher in India".

2) Mission

The mission statement outlines how the vision is to be translated into reality. It also states what is to be done to achieve the vision. For example, the publisher may decide to achieve its vision statement by creating a distribution system in each state.

3) Objectives

These are quantifiable targets which will enable management to gauge the success of the strategy. It enables measuring the success of the strategy. The business should set objectives against which the success of the strategy can be measured. The objectives should be measured.

- Specific
- Measurable
- Achievable
- Relevant
- Time
- Bound

2.2.3 Analysis of Factors Influencing Strategy Formulation

Businesses are subject to various factors which influence its strategies and over which they have limited or no control at all.

1) Environment Analysis

Government policies, change in customer attitude, technology change. It is important that the organization be watchful for these forces and predicts the environment in which it might have to operate.

▶ **2) Firm Analysis**

Very important that the firm identifies its own resources and analyses them for their ability to deliver. Firms should allocate and utilize resources in the most efficient manner to get maximum return on investment.

▶ **3) Industry Analysis**

- To develop a good and sound strategy for the business it is necessary to understand the industry in which the business is operating or proposes to operate.
- The competitive forces within the industry have a huge bearing on the strategy formulation.
- It is important that the strength of the competitors is analysed. The size and trends of the industry also need to be taken into account. How should the formulated strategy be adapted and how will the industry respond to the strategy.

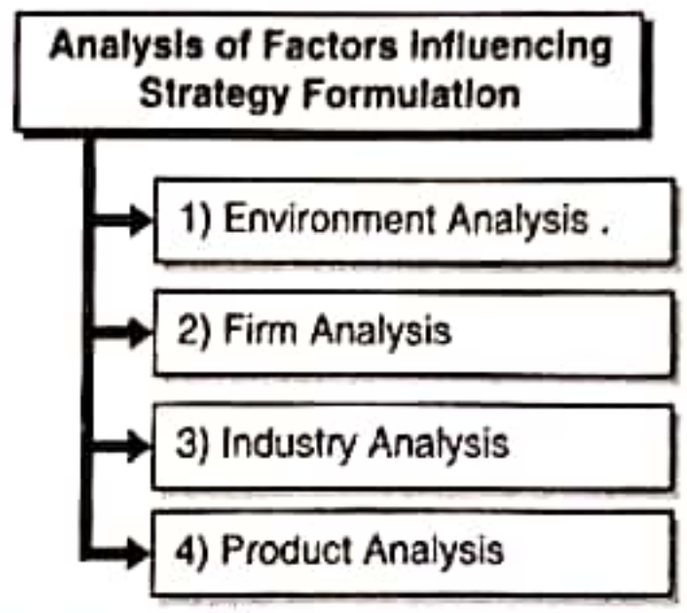

Fig. C2.1 : Analysis of factors influencing strategy formation

Module 2

▶ **4) Product Analysis**

- The business needs to analyse the competitive position of its products in the context of the developments in the market.

2.2.4 SWOT Analysis

SWOT analysis combines the analysis of the firm's internal and external environment. The strengths, weaknesses, of the firm are in context of the opportunities and threats. The aim of this analysis is to achieve an optimum match of the firm's resources with the environment with the objective of attaining competitive advantage.

- The firm should build on its strengths.
- Adopt a strategy that either hides its weaknesses or reduces them.
- Makes maximum of the opportunities using its strength.
- Anticipates threats and reduces their exposure.

2.2.5 Generate Strategic Options

Strategic options are generated based on the analysis undertaken so far. The strategies generated should be able to :

- Provide the firm competitive advantage
- Explore alternative strategic direction
- Alternative methods to employ strategies.

2.2.6 Evaluating Strategic Options

- It is very difficult to identify which strategic option to select despite all the analysis. Strategic management is considered to be more an art than science.
- Despite all this the decision maker should resort to the various qualitative and quantitative techniques available to finalize the strategy.

2.2.7 Implementation, Monitoring and Review

- At the implementation stage the strategy has to be clubbed with the operational plan, organization chart, clear job description, procedures and manuals, budgets and control systems.
- Budgets ensure that execution as per plan. Budgetary objectives and constant monitoring ensure that strategic objectives are accomplished.
- The above explanation captures two main elements that go to the heart of the field of strategic management.
- First, the strategic management of an organization entails three ongoing processes: analysis, decisions, and actions.
- That is, strategic management is concerned with the analysis of strategic goals (vision, mission, and strategic objectives) along with the analysis of the internal and external environment of the organization.

Next, leaders must make strategic decisions. These decisions, broadly speaking, address two basic questions :

- What programmes should we implement?
- How should we implement these programmes?
- These questions also often involve an organization's domestic operations. And last are the actions that must be taken. Decisions are of little use, of course, unless they are acted on. Firms must take the necessary actions to implement their strategies. This requires leaders to allocate the necessary resources and to design the organization to bring the intended strategies to reality.

2.3 PROJECT SELECTION MODELS (NUMERIC/SCORING MODELS AND NON-NUMERIC MODELS)

GQ. 2.3.1 *Write brief about project selection models.*

- A project involves a complete cycle of activity, which includes planning, appraisal (as a pre-project construction assessment), implementation, evaluation (as post-project assessment) and monitoring; it also includes termination (i.e. when the project is closed down).
- Project appraisal forms a key element of this and should in principle address the whole project cycle. It is crucial to the decision making process on whether to proceed with the project or not and on the form of the project.
- Planning for a project will itself be rooted within the context of the area, time and circumstances where it is being proposed.
- All the project resources (men, material, and money) are scarce and have to be put to optimum use. Hence, rational allocation of resources is of utmost importance.
- Available resources should be used in a manner which is consistent with the overall socio-economic objectives.
- The problem becomes more acute when there are several competing projects each giving a rate of return higher than the minimum cut off rate.
- The technique of project appraisal considerably facilitates the selection of the most viable project.
- Every firm has a limited number of resources available and usually a number of ways of converting these resources into the required outputs, several options are usually open in terms of the ways in which the required transformation of resources to outputs can take place.

- It is necessary to justify the use of a particular option in practice. This requires a comparison of all these options as well as an assessment of each one in search of the 'best' alternative.
- It is the objective of an appraisal exercise to achieve this end. Consisting essentially of an analysis of a proposal to invest resources, this process provides the basis for making a decision to accept one of a number of ways of investing the resources, or of rejecting the proposal altogether.
- Project Appraisal is defined as the detailed evaluation of the project to determine the political, social, environmental, techno-legal, financial and economical feasibility of the project and the managerial competence required for its successful operation.
- Such appraisal is done by project promoter for identifying the right project and by financial institutions to determine the financial feasibility of the project.
- From a promoter's perspective, project appraisal enables him to ascertain whether the project will give him the required rate of return.
- When faced with several projects he will select the project that suits him and also has a good rate of return.
- From a financial institution's perspective, project appraisal enables them to ascertain the contribution the project is likely to make to the national economy and to determine the repaying capacity of the promoter.

2.3.1 Primarily Project Appraisal Includes

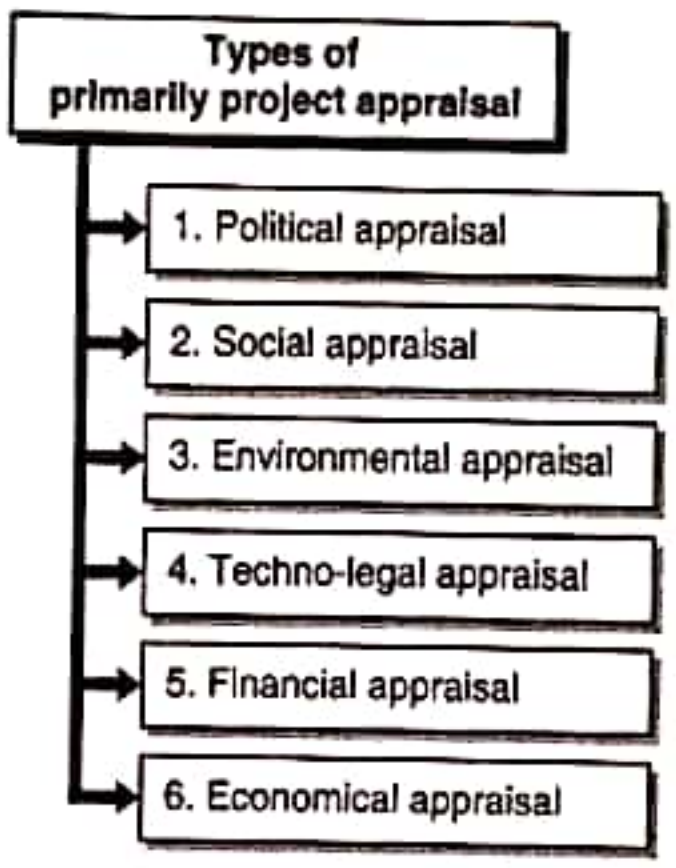

Fig. C2.2 : Types of Primarily Project Appraisal

2.3.2 Political Appraisal

- Construction projects are at the heart of the society and their importance is growing as they deliver sustainable development through knowledge, skills and potential expertise.
- The political analysis of a project addresses the political concerns of the elected representatives as well as the members of the planning board.

The political analysis of every project especially major engineering development project is essential as the planning process incorporates political involvement at two steps :

1. Determination of the community goals is assumed to be the responsibility of the elected representatives. The selection of the construction project is a political process with information and advice being provided by

professional engineers and planners. The goals and objectives of the proposed project should be consistent with the community values and principles. All the project options should be developed as per the rationally determined need of the society. The decision makers, in this case the elected representatives are influenced by the rational evaluation of the various project options put forward by project promoter.

2. Routine decisions for the planning of engineering development projects are taken by professionals within the planning agency.

- However, for complex engineering proposals the decision is taken by elected representatives and begins with the presentation of a specific development proposal rather than multiple project options.
- The political appraisal process involves the following:
  - (i) A project proposal of a specific development project is made by the project promoter.
  - (ii) The promoter of a specific project gathers political support through influence, compromise, or manipulation.
  - (iii) In case the elected representatives suggest some changes in the project those are incorporated and the project is represented.
  - (iv) The proposal is cleared or rejected by the government.

2.3.3 Social Appraisal

- Development projects impose a series of costs and benefits on the society. These costs and benefits can be social, environmental or economic in nature and in most cases involves all the three.
- A social appraisal of a development project reviews the project right from its identification and design phase through to implementation and monitoring, from a social perspective.
- Social appraisal pays particular attention to the impact of the development project on different stakeholders of the project, their opportunity for participation and the projects contribution to poverty reduction.
- Stakeholders are individuals, groups or organizations that have a direct interest in the outcome of the project. Stakeholders of a development project include; management, project manager, employees, beneficiaries and the community.
- The stakeholder analysis will yield the following :
  - (i) Identification of the various stakeholders of the development project.
  - (ii) Interest of these stakeholders in the development project.
  - (iii) The manner in which they will be affected by the proposed development project.
  - (iv) Identification of the project priorities between different groups.
  - (v) Determine the capacity of the various stakeholders to participate in the development project.
- The stakeholders of the development project can be grouped as primary, secondary and key stakeholders.
- Primary stakeholders are the direct beneficiaries of the development project but are in a relatively weak position to influence the outcome of the project.
- Secondary stakeholders are indirectly affected by the project and are frustrated by a lack of access to information or may be in weak position due to social constraints.

- In contrast to the above two categories of stakeholders, key stakeholders have the time, money, organizational capacity and political power to influence the project.
- However, if the key stakeholders are not interested in the project they could pose a risk to the project's success by withholding support.
- **Example :** in a rural road development project involving manual labour the primary stakeholders are the ones who are going to directly benefit once the road gets completed, secondary stakeholders are the labour and local businesses while the key stakeholders would be the ones who would direct control the sanctioning and implementation of the project.
- The power to ensure the successful outcome of the project lies in the hands of the secondary and key stakeholders.

2.3.4 Environmental Appraisal

- The environmental appraisal will help determine whether the project will have any adverse effects on the environment.
- The environmental appraisal will provide the project manager with a good quantification of the biophysical and social impacts from the project.
- Most countries have designed an Environmental Impact Assessment (EIA) policy and legislation to identify impacts and mitigation measures for the approval of projects.
- Traditionally EIA was designed to operate at the project level; however the process has now been extended to sectoral levels.

EIA has been defined as :

- "An assessment of impacts of a planned activity on the environment".
- "A procedure for assessing the potential environmental impacts of a project before it is built, so that these impacts can be properly considered during the decision-making process and so that imitative measures for detrimental impacts can be defined".
- The results of the assessment provide decision-makers with a balanced assessment of the environmental implications of the proposed action and the alternative examined.
- The assessment is then used by decision-makers as an information base upon which a decision is made. The overall goal of an EIA is to achieve better developmental interventions through protecting the environment (human, physical and biotic).

2.3.5 The Objectives of an Environmental Analysis

- To provide decision-makers with analysis of the total environment so that decisions can be made based on as nearly complete and balanced information as possible.
- To assess and present unquantifiable effects that are not adequately addressed by financial, economic analysis and other technical reports.
- To provide information to the public on a proposal.
- To formalise the consideration of alternatives to a proposal being considered, in order that the least environmentally harmful means of achieving the given objective can be chosen.
- To improve the design of new developments and safeguard the environment through the application of mitigation and avoidance measures.

- The Environment Impact Assessment includes the comprehensive study of present Environment Status along with the probable impacts of upcoming project and the mitigation measures.
- Baseline information is set up on all the required aspects viz. Air Environment, Water Environment, Noise environment, Land Environment, Socio economic environment, Ecological environment
- After assessing the present environmental status, the impacts of the proposed project are superimposed. The final scenario of the aspect is visualized with requisite models for forecasting.
- The evaluation of the environmental aspects is carried out and the required mitigation measures are delineated.

2.3.6 Techno-Legal Appraisal

GQ. 2.3.2 *Write a short note on technical appraisal.*

- In any construction project the modalities of technical work needs to be executed within the legal safeguards. The terms defined in the contract between the owner and the contractor should be crystal clear for anyone to understand and should also be acceptable to both the parties.
- The contract between the owner and the contractor needs to be drafted as per the technical terms agreed between the parties and under the statuette law of land.
- A techno-legal appraisal of the project contract will help identify those terms of the project which may be difficult to adhere to.
- Although, it is a universal truth that the terms agreed and written always varies to certain extent during implementation, such variations may lead to disputes.
- A techno-legal appraisal of the project contract will help in supplementing the primary terms in the contract with secondary terms.
- These secondary terms will come in handy in case of changes in the primary clauses of the contract. These secondary terms which are added after the techno-legal appraisal of the project contract expand applicability of terms and allow understanding the expected differences and accordingly built up knowledge in advance.
- The inbuilt secondary terms will not allow the contractor to manipulate terms after agreement & during implementation. This works as major tool to avoid the disputes between parties at later date and will automatically help achieve success and satisfaction.
- Many instances are available to prove that the intention of any party changes as time goes by or as implementation takes place. It has been observed that at many occasion general society, 50% of affected party accepts the changes as it may be directed by (stronger part) contractor.
- The Techno – legal appraisal at this level will support the weaker party, each time the contractor tries to dictate upon his terms, he can be shown the secondary terms to be applied in cases of changes on primary terms. Thus disputes can be avoided and project will be successfully.

2.3.7 Financial Appraisal

- The financial assessment of some projects is fairly simple. Take the example of a housing development builder. The costs of such projects are pretty well defined; land cost, design, construction, marketing and interest.
- The revenue side of such projects has the selling price which is determined in advance multiplied by the number of units. Sales take place during the entire construction phase.
- In such a project, calculating profits is straight forward. The time scale of such projects is not very long (2 to 3 years) and most of the relevant figures can be estimated accurately.

- The financial appraisal remains crucial as part of the overall approach to major infrastructure project appraisal. Commercial sector investors provide a significant part of funding for many projects and sometime the sole funding.
- Even where public bodies contribute very significantly to a project, commercial funding may be a major part determinant of whether it proceeds.
- In consequence financial appraisal methodologies, such as Financial Cost Benefit Analysis (CBA), have to be used.
- However, it is in the interests even of commercial investors that the project contributes to sustainable development and thus provides a return over the project life. This means that the method of financial appraisal must be conducted with the other appraisals.
- The usual approach of financial appraisal is through a Financial Cost Benefit Analysis. This assesses the projected flows of cash for the project: capital spending, operational costs and revenues. It includes only directly attributable expenditures and incomes.
- From these it calculates the overall rate of return as a single figure, usually Net Present Value (NPV). The results of the Financial CBA then become a key component in the overall Multi Criteria Analysis (MCA) appraisal.

2.3.8 Economical Appraisal

- This includes an analysis of economic soundness of the project and the quantification and valuation of costs and benefits to ensure financial viability.
- Social Cost Benefit Analysis (CBA) is used for determining the attractiveness of a proposed investment in terms of the welfare of society as a whole.
- By presenting social benefits and costs in a monetary format, CBA not only facilitates choices between alternative investment options but also gives an idea of the project worth.
- The technique is principally used with regard to public sector investments. CBA differs from financial appraisal which views an investment solely from the perspective of individual participants, focusing on private benefits and costs and using market prices.
- In contrast, CBA adopts a much broader approach, considering both monetary and non-monetary benefits and costs, and uses prices that more accurately reflect economic, environmental and social values.
- The divergence between private and social costs and benefits arises for three reasons:
- Not all costs and benefits fall on the immediate group of individual participants; some may have wider impacts.
- Not all costs and benefits have market prices.

- Not all market prices reflect the true costs and benefits to society.
- Nevertheless, once social costs and benefits have been identified and valued, the methodology for conducting a CBA follows a similar procedure to financial appraisal.
- Choices between investment options may be based on a comparison of Net Present Values at the test discount rate, the Internal Rate of Return, payback periods, and benefit: cost ratios.

Methodology for conducting CBA

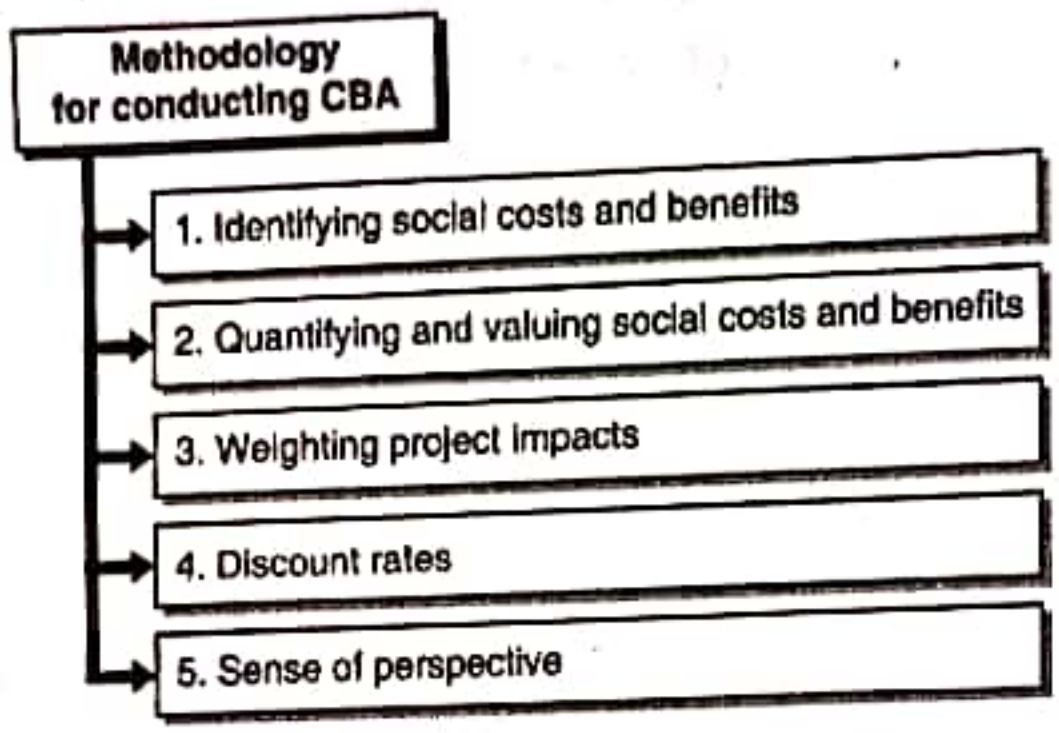

Fig. C2.3 : Methodology for conducting CBA

1. Identifying social costs and benefits

- Thorough social and gender appraisals will identify most of the social costs and benefits associated with a proposed investment.
- For the purposes of the CBA, they are drawn together under the headings of costs and benefits.

2. Quantifying and valuing social costs and benefits

- While it is often possible to express social costs and benefits in physical units, the biggest challenge in conducting a social CBA is placing meaningful monetary values on them.
- Many social costs and benefits do not have a market price. However, unless they have a monetary value, it is not possible to include them in the CBA along with any financial benefits and costs.
- For tangible social costs and benefits, it is possible to derive approximate prices. One method is to identify the opportunity cost of using a resource or service.
- This represents the value of the next best alternative or opportunity forgone in order to use a resource for a particular purpose.
- Thus the shadow wage rate of family labour working at home would be the wages that could have been earned working outside the home.
- For intangible social costs and benefits, it is not possible to estimate monetary values. Nevertheless, for projects with a substantial amount of intangible benefits, comparisons can be made between the cost effectiveness of different proposals to achieve similar outcomes.
- This technique of Cost Effectiveness Analysis is widely used in health sector appraisal.

- Adjustments are also made for goods and services that have market prices but the latter are distorted from their economic value.
- Shadow prices take account of market price distortions, such as transfer payments, foreign exchange distortions and market imperfections.

3. Weighting project impacts

- The distribution of project impacts between different groups in the community may be weighted to reflect project priorities.
- For example, more significance may be attached to income earned by women from female-headed households than married men.
- However, the process of devising weights is highly subjective and many recommend that such decisions should be left to politicians.

4. Discount rates

- Often governments and donors set test discount rates that vary according to the type of project. At present, discount rates for public sector investments stand at 12%; for projects with a strong poverty or environmental focus, rates may be as low as 3%.
- For private sector investments, discount rates usually reflect commercial rates of interest.

5. Sense of perspective

- The process of CBA is not an exact science. The findings of a CBA should be seen to add insights into the decision-making process rather than being subjected to rigorous interpretations.
- Consequently, when identifying and valuing the social costs and benefits, it is important to focus on the more significant impacts and not to spend too much time on the minor details.

2.3.9 Criteria for Project Selection

GQ. 2.3.3 *Explain the criteria for project selection.*

- Despite the project undergoing Multiple Criteria Appraisal (MCA), it should be stressed that the financial appraisal of projects costs and benefits remains crucial as part of the overall approach to major infrastructure project appraisal.
- Commercial sector investors provide a significant part of funding for many projects and sometime the sole funding.
- Even where public bodies contribute very significantly to a project, commercial funding may be a major part determinant of whether it proceeds.
- The usual approach of financial appraisal is through a Financial Cost Benefit Analysis, Net Present Value (NPV), Internal Rate of Return (IRR), Pay-back Period, and Break Even Analysis.
- In this section we shall be studying these tools of financial appraisal of projects.

2.3.10 Cost Benefit Analysis

GQ. 2.3.4 *Write a short note on : Benefit cost ratio*

GQ. 2.3.5 *Write a short note on concepts of benefit cost analysis.*

- Cost Benefit Analysis (CBA) is a tool used to determine the worth of a project. It is used to assist in making judgments and appraising available options. CBA is a quantitative analytical tool to aid decision-makers in the efficient allocation of resources.
- It identifies and attempts to quantify the costs and benefits of a project and converts available data into manageable information.
- The strength of the method is that it provides a framework for analysing data in a logical and consistent way. CBA helps managers answer questions such as :
  - (i) Does the project provide a net benefit to the community as a whole?
  - (ii) Should the proposed project be undertaken?
  - (iii) Should the project be continued?
  - (iv) Which of various alternative projects should be undertaken?
- A CBA adds rigour to a project evaluation because, it expresses outcomes (benefits) and inputs (costs) in money terms and thus facilitates comparisons across different types of projects.
- CBA is generally the preferred method when markets or prices do not adequately reflect all the costs and benefits of a project.
- When markets are competitive and most costs and benefits are reflected in market prices, financial evaluation can provide an adequate guide to the social viability of a project.
- Financial evaluation is also important when government has financial objectives or responsibilities to fulfil.

2.3.11 Need for Cost Benefit Analysis

- The main reason for undertaking a CBA is to determine whether a project will make the community better or worse off. Some of the key benefits of undertaking a CBA are discussed below.
- CBA aims to quantify the net benefits to the community of a project expressed in terms of money value, percentage return or ratio.
- This provides a common basis for comparison with any other project that has been similarly assessed.
- The basic idea of CBA is that it reflects the value of a project to the community. In the process, the value to key stakeholders will also be estimated.
- For example, in conducting an evaluation of a rehabilitation service, the value to the recipients of the service would be determined, whether in terms of long-term lifetime earnings, enhanced sense of personal well-being, or some other significant factor.
- A key advantage of CBA is that it provides a quantitative measure of the net benefit of an investment, allowing direct comparisons between dissimilar projects.

- A CBA provides an estimate of the worth of a project relative to an accompanying estimate of what would happen in the absence of the proposal.
- The difference between these values can be viewed as the 'value added' from adopting a project.
- CBA's emphasis on the quantification of costs and benefits on a comparable basis, it is a useful technique to add to an evaluation strategy.

2.3.12 Cost-Benefit Analysis Process

- The purpose of a CBA is to provide information that will materially assist decision-making.
- The assessment involves identifying, quantifying and, where possible, valuing in money terms the costs, benefits and uncertainties of each option.
- It also involves quantifying costs and benefits that occur at different points in time on a comparable basis.

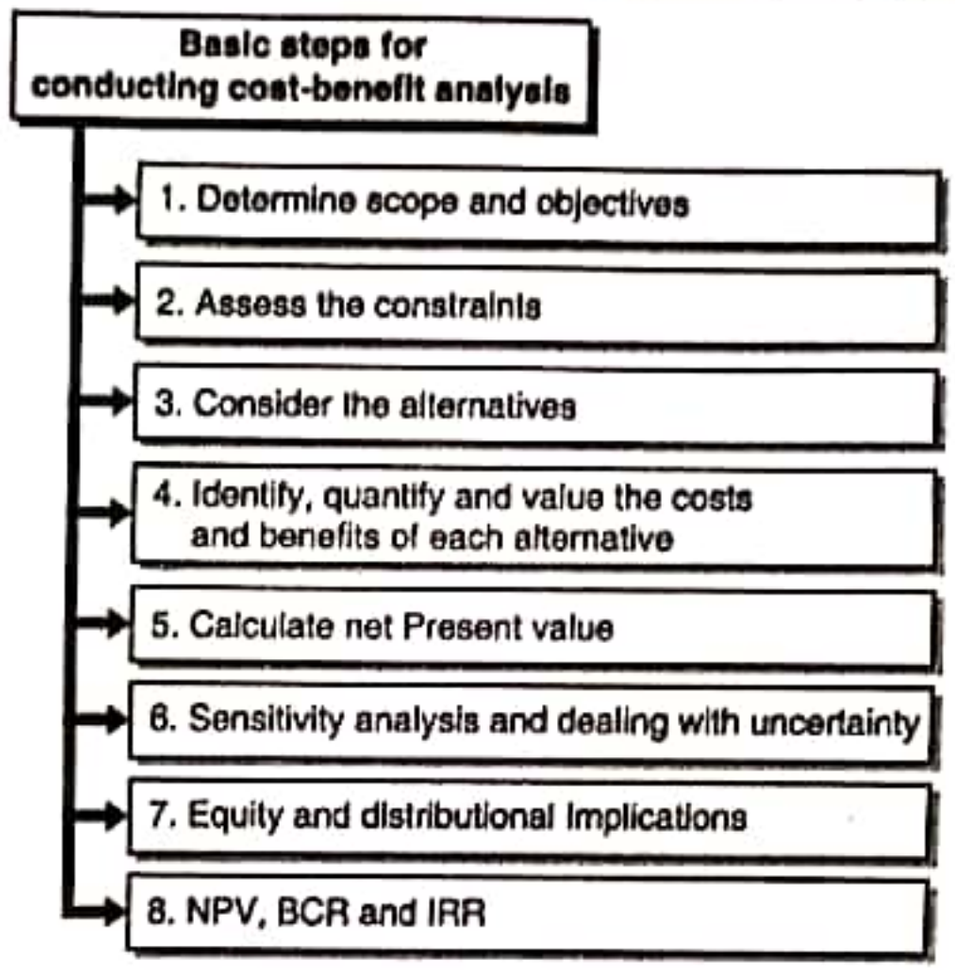

Fig. C2.4 : Basic Steps for conducting Cost-Benefit Analysis

▶ **1. Determine scope and objectives**

- Objectives should be defined, initially, in terms of the market requirements that warrant government intervention.
- Following this, the outcomes expected from undertaking the proposal should be identified. They should be clearly distinguished from the means of meeting them.
- Further, the objectives should not be so general that it will be difficult to establish subsequently whether, or to what extent, they have been met.

▶ **2. Assess the Constraints**

- The next step is to identify the constraints in meeting the objectives to ensure all alternatives examined in the analysis are feasible.
- Constraints may be financial, distributional, institutional, managerial, environmental and political in nature.

▶ **3. Consider the Alternatives**

- A CBA involves the identification and specification of a set of alternatives. While it is important to provide decision-makers with a range of options, the process of developing and analyzing these can be expensive and time consuming.

- For major investments, it may be necessary to outline various potential options and then to have decision-makers select, after a preliminary screening, a smaller number for detailed appraisal.
- In any case, an appropriate level of consultation should be undertaken as best practice, either formally or informally, in creating a set of alternatives.
- To illustrate, take the case where an agency is considering whether to purchase a commercial property.
- The CBA should cover alternative options facing the agency, such as doing nothing, acquisition of the property, or upgrading/renovating the existing property.

▶ **4. Identify, quantify and value the costs and benefits of each alternative**

- A critical step in the CBA process involves identifying, quantifying and valuing the costs and benefits of each alternative.
- The types of benefits and costs will depend on the project. To illustrate, consider the construction of a toll motorway to relieve traffic congestion.
- Relevant costs would include the labour, capital and material costs to construct the road and the value of the land as reflected in the loss of the use of the land for alternative purposes.
- Benefits of the motorway would include lives saved, reduced travel time (which generally results in fuel and productivity benefits) and possibly the reduction of traffic on alternative routes, including the impact on inlet and outlet roads.
- Typical costs of a proposal would include:
  - Initial capital costs.
  - Capital costs of any buildings, equipment, or facilities that need to be replaced during the life of the project.
  - Operating and maintenance costs over the period of project.
  - Costs which cannot be valued in money terms.
- Typical benefits of a proposal would include:
  - Benefits which can be valued in money terms, in the form of revenues, cost savings or non-market outputs.
  - Benefits which cannot be valued in money terms.
- Estimating the magnitude of costs can be difficult and will normally involve input from accountants, economists and other specialists.
- The conceptual basis for valuing costs in CBA is their 'opportunity cost'. Implementing a project requires the use of resources (or inputs) that could be utilized elsewhere.
- The opportunity cost reflects the benefits forgone by society in not using these resources for an alternative purpose.
- The opportunity cost of a resource is measured by its value in the 'next best' or most valuable alternative use.

▶ **5. Calculate Net Present Value**

- In CBA, the Net Social Benefit (NSB), or the excess of total benefit over total cost, is represented by the Net Present Value (NPV) of the proposal.

- Before determining the value (or NPV) of a proposal, the costs (C) and benefits (B) need to be quantified for the expected duration of the project.
- The NSB is calculated by subtracting the cost stream from the benefit stream and is represented as follows:

  $$NSB = B - C$$

- The NPV of a proposal is determined by applying a 'discount rate' to the identified costs and benefits. It is necessary to 'discount' costs and benefits occurring later relative to those occurring sooner.
- This is because money received now can be invested and converted into a larger future amount and because people generally prefer to receive income now rather than in the future.

- Valuing each alternative by calculating NPVs facilitates comparison between proposals that exhibit different timing of their benefits and costs.
- Projects with positive NPVs generally indicate an efficient use of the community's resources.

The NPV is calculated as follows:

$$NPV = \sum_{0}^{1} \frac{(B_t - C_t)}{(1+r)^t}$$

Where, Bt is the benefit at time t;

Ct is the cost at time t; and

r is the discount rate.

- Where all projected costs and benefits are valued in real terms, they should be discounted by a real discount rate.
- This can be estimated approximately by subtracting the expected (or actual) inflation rate from the nominal discount rate. If nominal (current price) values are used for projected costs and benefits, they should be discounted by a nominal discount rate.
- The discount rate can also be varied to test the sensitivity of the proposal to changes in this variable and, implicitly, to the phasing of costs and benefits.
- The Internal Rate of Return (IRR) is typically presented as supplementary information to the NPV. The IRR is the discount rate that will result in a NPV of zero. The project's IRR needs to be above the benchmark discount rate for the project to be considered viable.

6. Sensitivity Analysis and dealing with uncertainty

- The values of future costs and benefits on which the NPV is based are forecasts that cannot be known with certainty.
- While they should forecast expected values, it is important to test the NPV for 'optimistic' and 'pessimistic' scenarios.
- This is achieved by changing the values of key variables in the analysis, such as the discount rate, costs and benefits, and measuring the impact of the changes on the NPV.
- This is known as sensitivity analysis and is a critical component of any CBA.

- Where the NPV is shown to be very sensitive to changes in a variable, the analyst should check on the appropriateness and impact of this variable, and whether any changes to the design of the project or underlying assumptions are warranted.
- Uncertainties or situations with unknown probabilities, that could have a significant impact on the project outcome should be clearly detailed in the report and, if necessary, monitored during implementation.
- When dealing with uncertain data, the expected value should be used. The expected value is the weighted sum of the likely outcomes (each outcome having its own probability of occurring).
- In order to attempt to quantify the likely impact, a probability may be assigned to a particular variable where dealing with uncertain data.
- These probabilities are then used as weightings in order to derive an expected value.

▶ **7. Equity and Distributional Implications**

- There may also be broader social justice considerations where a project involves a significant redistribution of income, regardless of the net economic gains to the community.
- For example, a limitation may arise if the costs fall on low-income earners and the benefits accrue to higher income earners.
- Cost-benefit analysts should provide project managers and policy makers with an indication of the income distributional effects of a proposal. This may be useful where distributional impacts rather than economic efficiency are the objective.
- Benefits are typically measured in terms of estimated willingness to pay prices for a good. However, willingness to pay is generally constrained by income and wealth, which are not distributed equally in the community.
- In these circumstances, the project's NPV may be considered an inadequate measure of its worth to society and decision-makers would need additional information on the distributional consequences of the project to determine its overall merit.

▶ **8. NPV, BCR and IRR**

- Net Present Value (NPV) is the preferred selection criterion because of its simplicity. The NPV of a project must be greater than zero.
- There are, however, other common rules in addition to NPV such as the Internal Rate of Return (IRR) and the Benefit Cost Ratio (BCR).
- The IRR is the discount rate at which the NPV of the project is zero.
- The decision-maker is implicitly asked to make a judgment as to whether this rate of return is 'acceptable' or not. If the recommended discount rate were 8 per cent, then projects having an IRR greater than 8 per cent would be regarded as 'acceptable'.
- The IRR criterion is commonly used by international financial institutions.
- The BCR can be estimated by calculating the present value of benefits to the present value of costs. A ratio of greater than 1 show there is net benefit to a particular project having considered the present values of the costs and benefits.
- The BCR should always be greater than 1 in order for the benefits of a proposal to exceed the associated costs.

- Both the IRR and BCR may not be appropriate in certain circumstances. The IRR may mislead where alternative projects differ in scale or where projects have different lengths of life.
- BCRs may also give incorrect rankings when projects differ in size. While BCRs are useful for ranking a number of projects they are sensitive to the way costs are defined and may not generate a definitive outcome.
- It is therefore recommended that the rules be used only as supplementary information to the consideration of the NPV for a project.

Ex. 2.3.1

Calculating NPV and BCR Calculate the NPV and BCR of a project with a life span of 5 years and a real discount rate of 8%.

☑ Soln. :

$$\text{Discount Factor} = \frac{1}{(1+r)^t}$$

Where:

r = real discount rate

t = the year of the project

For e.g.: the discount factor for the second year will be calculated as:

$$\frac{1}{(1+0.08)^2} = 0.857$$

Table P. 2.3.1

Year	Cost (lakhs)	Benefit (lakhs)	Discount Factor (8%)	NPV of Costs = Costs x Discount Factor	NPV of Benefits = Benefits x Discount Factor
1	50	0	0.926	46.3	0
2	40	30	0.857	34.28	25.71
3	30	40	0.794	23.82	31.76
4	20	60	0.735	14.7	44.1
5	10	90	0.681	6.81	61.29
Total				125.91	162.86

Hence, the project is expected to generate a net benefit = NPV of Benefits – NPV of Costs

= 162.86 – 125.91 = 36.91

BCR Ratio can be represented as follows:

BCR = NPV of Benefits/ NPV of Costs

= 162.86/ 125.91 = 1.29

A ratio greater than 1 indicates that the project will generate profits.

Module 2

Ex. 2.3.2

A company is thinking about investing Rs. 10 lakhs in a new project. According to budget analysis the company will generate the following cash flows. The rate of interest is 12% should the company invest in the new project ?

Table P. 2.3.2

Year	Cash flow in Rs.
1	2 lakhs
2	6 lakhs
3	8 lakhs
4	2 lakhs

☑ Soln. :

Initial investment = 10,00,000

i = 12 %

NPV method calculation

$$\text{NPV} = \sum_{t=1}^{n} \frac{C}{1+K^t} - \text{Initial investment}$$

$$= \left[\frac{2,00,000}{(1+0.12)^1} + \frac{6,00,000}{(1+0.12)^2} + \frac{8,00,000}{(1+0.12)^3} + \frac{2,00,000}{(1+0.12)^4}\right] - 10,00,000$$

= [178571.42 + 478316.32 + 569424.19 + 127103.61]

– 1000000 = 353415.54 Rs.

∴ NPV > 0, company should invest in new project.

2.3.13 Net Present Value (NPV)

- The Net Present Value (NPV) Method and the Internal Rate of Return (IRR) Method are two types of discounted cash flow methods that are adopted to undertake the financial appraisal of projects.
- In the Discounted Cash flow methods all the projected cash inflows and outflows for a capital budgeting project are discounted to their present value using an approximate interest rate.
- Three discounted cash flow methods are generally used in capital budgeting.
  - (i) Net Present Value (NPV)
  - (ii) Internal Rate of Return (IRR)
  - (iii) Profitability or Desirability Index
- All discounted cash flow methods are based on the time value of money, which means that an amount of money received today is worth more than an equal amount of money received in future.
- To simplify the process of evaluating proposals using discounted cash flows, the assumption is made that cash flow from a project occur at the end of accounting period.
- Under the NPV method, all cash inflows and outflow are discounted at a minimum acceptable rate of return, usually the firm's cost of capital.
- If the present value of the cash inflows is greater than the present value of the cash outflows, the project is acceptable i.e. NPV > 0, accept and NPV < 0, reject.
- This means that the NPV of the benefits from a project should be greater than the NPV of costs of that project.
- The difference between the two NPV's should be positive. In other words, a positive NPV means the project earns a rate of return higher than the firm's cost of capital.

Merits

1. NPV recognizes the time value of money thereby making the method more credible.
2. The whole stream of cash flows throughout the project life is considered.
3. A changing discount rate can be built into the NPV calculations by altering the denominator.
4. This method is useful for selection of mutually exclusive projects.

Limitations

1. It is difficult to calculate as well as understand and use in comparison with the payback method.
2. The calculation of discount rate which is critical to the method presents serious problems. In fact, there is difference of opinion even regarding the exact method of calculating it.
3. This method may not give satisfactory results in case of projects having different effective lives.

Ex. 2.3.3

Excel Constructions wants to buy a mixer with a cost of Rs. 35,000 and annual cash savings of Rs. 11,000 for each of 5 years. The cost of capital is 12%.

Soln. :

With uniform cash flows, the present value (PV) is computed using the present value of and annuity of 5 payments of Rs. 11,000 each at 12 percent, the NPV is calculated as follows:

PV of Cash inflows = 11,000 (PV 1 – 5 years @ 12%)

= Rs. 39,634

Less : Present Value of Cash outflows 35,0000

Net present value of the project 4634

Since NPV is positive the project is acceptable since the net value of earnings exceed by Rs. 4634 the amount paid for the use of the funds to finance the investment.

Ex. 2.3.4

The cost of a project is Rs 100000/- and has regular cash flows of Rs 25000/- for a period of 5 years. What is the NPV if the firm expects 12% per annum? Is the project financially feasible?

Soln. :

$$NPV = \sum_{t=1}^{n} = \frac{B_t}{(1+r)^t} - \text{Initial investment}$$

Where

B_t = Benefit at time t

h = Life of project

r = discount rate

t = year

$$= \frac{25,000}{(1+0.12)^1} + \frac{25,000}{(1+0.12)^2} + \frac{25,000}{(1+0.12)^3} + \frac{25,000}{(1+0.12)^4} + \frac{25,000}{(1+0.12)^5} - 11,00,000$$

$$= 22,321 + 19,936 + 17857 + 15,923 + 14,204 - 1,00,000$$

$$= 90,241 - 1,00,000 = -9759$$

As NPV < 0 the project is not acceptable

Ex. 2.3.5

Excel construction has the resources to implement one of the two projects that has been offered to it. Using NPV suggest the one project the company should accept. The firm expects returns of 12 % per announce

Soln. :

Table P. 2.3.5

	Project A	Project B
Estimated cost	3,00,000	4,00,000
Estimated life	5	5
Annual benefits		
1	1,25,000	1,50,000
2	1,50,000	1,70,000
3	1,00,000	1,25,000
4	90,000	1,00,000
5	80,000	90,000

$$NPV = \sum_{t=1}^{n} = \frac{B_t}{(1+r)^t} - \text{Initial investment}$$

Project A

$$NPV = \frac{1,25,000}{(1+0.12)^1} + \frac{1,50,000}{(1+0.12)^2} + \frac{1,00,000}{(1+0.12)^3} + \frac{90,000}{(1+0.12)^4} + \frac{80,000}{(1+0.12)^5} - 3,00,000$$

$$= 111607 + 1,19,617 + 71,428 + 57334 + 45454 - 3,00,000$$

$$= 4,05,430 - 3,00,000 = 1,05,430$$

Project B

$$NPV = \frac{1,50,000}{(1+0.12)^1} + \frac{1,70,000}{(1+0.12)^2} + \frac{1,25,000}{(1+0.12)^3} + \frac{1,00,000}{(1+0.12)^4} + \frac{90,000}{(1+0.12)^5} - 4,00,000$$

$$= 1,33,928 + 1,35,566 + 89285 + 63694 + 51136$$

$$= 4,73,609 - 4,00,000$$

$$= 73,609$$

Module 2

Although both the projects have a positive NPV or NPV > 0 they both are feasible. However, as the firm has resources for only one project. Project A should be selected as it has a better NPV.

The Net Present Value relies on the time value of money and the timings of cash flows in evaluating projects. All cash flows are discounted at the cost of capital and NPV assumes that all cash inflows from projects are re-invested at the cost of capital.

As a decision criterion, this method can be used to make a choice between mutually exclusive projects. The project with the highest NPV would be assigned the first rank, followed by others in the descending order.

Ex. 2.3.6

Following data pertains to two projects. Rank the projects based on B/C ratio and NPV value.

Table P. 2.3.6

Particulars	Project X	Project Y
Investment in Rs.	110000	110000
Cash inflow in Rs Year 1	31000	71000
Year 2	40000	40000
Year 3	50000	40000
Year 4	70000	20000
Interest Rate (%)	14	14

☑ **Soln. :**

Calculation of benefit cost ratio

Project X

$$BCR = \frac{\frac{31,000}{(1+0.14)^1} + \frac{40,000}{(1+0.14)^2} + \frac{50,000}{(1+0.14)^3} + \frac{70,000}{(1+0.14)^4}}{1,10,000}$$

$$= \frac{27192.98 + 30778.70 + 33748.57 + 41445.61}{1,10,000}$$

$$= 1.21$$

Project Y

$$BCR = \frac{\frac{71,000}{(1+0.14)^1} + \frac{40,000}{(1+0.14)^2} + \frac{40,000}{(1+0.14)^3} + \frac{20,000}{(1+0.14)^4}}{1,10,000}$$

$$= \frac{62280.70 + 30778.70 + 26998.88 + 11841.60}{1,10,000}$$

$$= 1.199$$

Thus, project X has Rank I and project Y has Rank II.

Calculation of net present value

Project X

$$NPV = \sum_{t=1}^{n} \frac{C}{1+K^t} - \text{Initial investment}$$

$$= 1,33,665 - 1,10,000 = 23,165$$

Project X = Rank I

Project Y

$$NPV = 1,31,899 - 1,10,000 = 21,899.88$$

Project Y = Rank II

Ex. 2.3.7

Following are the details of project A and B. Suggest which one is to be accepted by using

1. NPV 2. BCR (i = 8%)

Table P. 2.3.7

Years	Project A	Project B
0	4,00,000	4,50,000
1	1,20,000	1,40,000
2	1,25,000	1,45,000
3	78,000	76,000
4	80,000	65,000
5	75,000	60,000
6	–	90,000

☑ **Soln. :**

Calculation of net present value

Project A

$$NPV = \frac{12,000}{(1+0.8)^1} + \frac{1,25,000}{(1+0.8)^2} + \frac{78,000}{(1+0.8)^3} + \frac{80,000}{(1+0.8)^4} + \frac{75,000}{(1+0.8)^5} - 4,00,000$$

$$= -9956.5 \text{ Rs.}$$

Project B

$$NPV = \frac{1,40,000}{(1+0.8)^1} + \frac{1,45,000}{(1+0.8)^2} + \frac{76,000}{(1+0.8)^3} + \frac{65,000}{(1+0.8)^4} + \frac{60,000}{(1+0.8)^5} + \frac{90,000}{(1+0.8)^6} - 4,50,000$$

$= 9602$ Rs.

Thus, project B is to be selected.

Calculation of benefit lost ratio

Project A BCR $= \frac{390044}{4,00,000} = 0.975$

Project B : BCR $= \frac{459602}{4,50,000} = 1.02$

Thus, project B is to be selected.

Ex. 2.3.8

Following data pertains to project A and B has a net cash flow as follows.

Which project is to be selected by using NPV and B/C ratio method ? Consider rate of interest i = 10%.

Table P. 2.3.8

Proposal	End of years				
	Initial Investment	Annual Income (Rs.)			
		1	2	3	4
A	1,00,000	32,000	76,000	34,000	28,000
B	1,00,000	30,500	25,000	45,000	80,000

☑ **Soln. :**

Calculation of net present value method

Project A

$$NPV = \frac{32,000}{(1+0.1)^1} + \frac{76,000}{(1+0.1)^2} + \frac{34,000}{(1+0.1)^3} + \frac{28,000}{(1+0.1)^4} - 1,80,000$$

$= [29090.90 + 62809.91 + 25563.90 + 19178.08] - 1,00,000$

$= 36642.79$

Project B

$$NPV = \frac{30500}{(1+0.1)^1} + \frac{25,000}{(1+0.1)^2} + \frac{45,000}{(1+0.1)^3} + \frac{80,000}{(1+0.1)^4} - 1,00,000$$

$= [27727.27 + 20661.15 + 33834.58 + 54794.52] - 1,00,000$

$= 37017.52$

Calculation of benefit cost ratio method

Project A

BCR $= \frac{136642.79}{1,00,000} = 1.366$

Project B

BCR $= \frac{137017.52}{1,00,000} = 1.37$

Thus project B is selected by both methods.

Ex. 2.3.9

The data pertaining to project A and B given bellow.

Suggest which one is to be accepted using NPV method. Company expects a return of 10%.

Table P. 2.3.9

Project	Initial Investment (Rs.)	Annual Benefits (Rs.)		
		1st Year	2nd Year	3rd Year
A	50,000	35,000	15,000	18,000
B	40,000	23,400	20,600	11,000

☑ **Soln. :**

Calculation of NPV method

Project A

$$NPV = \left[\frac{35,000}{(1+0.1)^1} + \frac{15,000}{(1+0.1)^2} + \frac{18,000}{(1+0.1)^3}\right] - 50,000$$

$= [31818.18 + 12396.69 + 13533.83] - 50,000$

$= 7748.70$

Project B

$$NPV = \left[\frac{23,400}{(1+0.1)^1} + \frac{20,600}{(1+0.1)^2} + \frac{11,000}{(1+0.1)^3}\right] - 40,000$$

$= [21272.72 + 17024.74 + 8270.67] - 40,000 = 6568.13$

Thus, project A is to be selected.

Module 2

Ex. 2.3.10

What do you understand by NPV method ? The cost of project is Rs. 80,000 it has a cash inflow of Rs. 30,000 for a period 4 years. What is NPV if firm expects 12 % per annum ?

Soln. :

Calculation of NPV method

Project A

$$NPV = \left[\frac{30,000}{(1+0.12)^1} + \frac{30,000}{(1+0.12)^2} + \frac{30,000}{(1+0.12)^3} + \frac{30,000}{(1+0.12)^4}\right] - 80,000$$

$$= [26785.71 + 23915.81 + 21353.40 + 19065.54] - 80,000$$

$$= \mathbf{11120.46}$$

Ex. 2.3.11

Following are the details of project A and B. Suggest which one is to be accepted by using

1. NPV 2. BCR (i = 8%)

Table P. 2.3.11

Years	Project A	Project B
0	4,00,000	4,50,000
1	1,20,000	1,40,000
2	1,25,000	1,45,000
3	78,000	76,000
4	80,000	65,000
5	75,000	60,000
6	–	90,000

Soln. :

Calculation of net present value

Project A

$$NPV = \frac{12,000}{(1+0.8)^1} + \frac{1,25,000}{(1+0.8)^2} + \frac{78,000}{(1+0.8)^3} + \frac{80,000}{(1+0.8)^4}$$

$$+ \frac{75,000}{(1+0.8)^5} - 4,00,000 = -9956.5 \text{ Rs.}$$

Project B

$$NPV = \frac{1,40,000}{(1+0.8)^1} + \frac{1,45,000}{(1+0.8)^2} + \frac{76,000}{(1+0.8)^3} + \frac{65,000}{(1+0.8)^4}$$

$$+ \frac{60,000}{(1+0.8)^5} + \frac{90,000}{(1+0.8)^6} - 4,50,000$$

$$= 9602 \text{ Rs.}$$

Thus, project B is to be selected.

Calculation of benefit lost ratio

$$\text{Project A : BCR} = \frac{390044}{4,00,000} = 0.975$$

$$\text{Project B : BCR} = \frac{459602}{4,50,000} = \mathbf{1.02}$$

Thus, project B is to be selected.

2.3.14 Internal Rate of Return

GQ. 2.3.6 *Write a short note on : IRR method* — MU - May 2013, 4 Marks

GQ. 2.3.7 *Write short note on : IRR method* — MU - May 2016, 8 Marks

- Internal Rate of Return (IRR) is the interest rate that discounts an investment's future cash flows to the present.
- The interest rate equates the present value of cash inflows with the present value of the cash outflows. This in turn means that at this interest rate the NPV is zero.
- While setting the discount rate in NPV the cost of capital is considered in determination of the net present value while in internal rate of return, the net present value is set to zero and the discount rate which satisfies this condition is determined.
- The discount rate at which the NPV is zero is called as Internal Rate of Return.
- The procedure for calculating IRR depends on whether the cash flows are annuity (equal year wise) or non-uniform.

Steps in determining IRR for an annuity

1. Determine the payback period of the proposed investment.
2. From the table of Present value of Annuity look for a year that is equal to or close to the life of the project.
3. From the year column, find two discount factors closest to payback period, one larger and other smaller than it.
4. From the interest column find the two interest rates corresponding to these discount factors.
5. Determine IRR by interpolation.

- However, when cash flows are not uniform, trial and error methods or a computer should be used to find the IRR.
- If the IRR is computed manually, the first step is to select an interest rate that seems reasonable and then compute the net present value of the individual cash flows using that rate.
- If the net present value is positive, then the interest rate used is low, i.e. IRR is higher than the interest rate selected.
- A higher interest rate should then be selected and the present value of the cash flows be computed again. If the new interest rates results in negative net present value, then the interest rate selected is high and a lower interest rate is to be selected.
- The process is to be repeated until the present value of cash inflow is equal to the present value of the cash outflows.
- The above trial and error method of calculating the interest rate is tedious hence computers are used in calculating IRR.

Advantages

1. Like NPV, IRR too considers the time value of money.
2. IRR is easier to understand and relate to, hence is readily adopted by businesses.
3. It is consistent with the overall objective of selecting the project with the maximum yield since the acceptance of a project is based on comparison of the IRR with the required rate of return.

Limitations

1. It involves tedious calculations as it produces multiple rates which are confusing.
2. In evaluating mutually exclusive proposals, the project with the highest IRR would be selected. However, this is no guarantee that it is the most profitable and consistent with the objectives of the firm.

IRR Calculations

- The calculation of IRR is a bit complex than other capital budgeting techniques. We know that at IRR, Net Present Value (NPV) is zero, thus:

NPV = 0; or

PV of future cash flows – Initial Investment = 0; or

$$NPV = \left[\frac{B_1}{(1+r)^1} + \frac{B_2}{(1+r)^2} + \frac{B_3}{(1+r)^3} + \ldots\right] - \text{Initial investment}$$

Ex. 2.3.12

Following data pertains to two projects A & B. Suggest which one is to be selected based on

(i) NPV @ 10% interest (ii) IRR

Table P. 2.3.12

Particulars	Project A	Project B
Initial Investment (Rs.)	4,00,000	3,50,000
Annual Income (Rs.) Year 1	1,50,000	1,00,000
Year 2	2,00,000	3,00,000
Year 3	80,000	50,000
Year 4	1,00,000	90,000
Year 5	20,000	60,000

☑ **Soln. :**

Calculation of net present value

Project A

$$NPV = \sum_{t=1}^{n} \frac{C}{1+K^t} - \text{Initial investment}$$

$$= \frac{1,50,000}{(1+0.1)^1} + \frac{2,00,000}{(1+0.1)^2} + \frac{80,000}{(1+0.1)^3} + \frac{1,00,000}{(1+0.1)^4} + \frac{20,000}{(1+0.1)^5} - 4,00,000$$

$$= 44,477 \text{ Rs.}$$

Project B

$$NPV = \sum_{t=1}^{n} \frac{C}{1+K^t} - \text{Initial investment}$$

$$= \frac{1,00,000}{(1+0.1)^1} + \frac{3,00,000}{(1+0.1)^2} + \frac{50,000}{(1+0.1)^3} + \frac{90,000}{(1+0.1)^4} + \frac{60,000}{(1+0.1)^5} - 3,50,000$$

$$= 1,25,135 \text{ Rs.}$$

$\therefore$ NPV of project B > project A.

Thus, project B is to be selected.

Calculation of IRR

Project A

$$IRR = \frac{1,50,000}{(1+j)^1} + \frac{2,00,000}{(1+j)^2} + \frac{80,000}{(1+j)^3} + \frac{1,00,000}{(1+j)^4} + \frac{20,000}{(1+j)^5} - 4,00,000$$

Thus, by using trail and error method.

$$IRR = 15.18\ \%$$

Project B

$$IRR = \frac{1,00,000}{(1+i)^1} + \frac{3,00,000}{(1+i)^2} + \frac{50,000}{(1+i)^3} + \frac{90,000}{(1+i)^4} + \frac{60,000}{(1+i)^5} - 3,50,000$$

Thus, by using trial and error method.

$$IRR = 25.66\ \%$$

Ex. 2.3.13

What do you understand by NPV method ? State the project is feasible or not by NPV method if project cost is Rs. 200000 has cash flow of Rs. 30000 for a period 5 years. Firm expects returns at 10% per annum.

☑ **Soln. :**

Calculation of IRR

The discount rate i = 10

$$0 = \frac{30,000}{(1+0.1)^1} + \frac{30,000}{(1+0.1)^2} + \frac{30,000}{(1+0.1)^3} + \frac{30,000}{(1+0.1)^4} + \frac{30,000}{(1+0.1)^5} - 2,00,000$$

$$= 27272.72 + 24793.38 + 22539.44 + 20490.40 + 18627.63 - 2,00,000$$

$$= 113723.57 - 2,00,000$$

$$0 = -86276.42$$

$$NPV < 0$$

Thus project is not feasible.

Ex. 2.3.14

A company wishes to invest in a new project. It has two alternatives A and B. Following data is available. Which project will the company select based on NPV and IRR.

Particulars	Project A	Project B
Initial Investment	10,50,000	12,75,000
Cash Inflows in Rs		
Year 1	5,50,000	7,50,000
2	7,00,000	5,00,000
Interest Rate	10 %	10 %

☑ **Soln. :**

Calculation of NPV

Project A

$$NPV = \sum_{t=1}^{n} \frac{C}{1+k^t} - \text{Initial Investment}$$

$$= \frac{5,50,000}{(1+0.1)^1} + \frac{7,00,000}{(1+0.1)^2} - 10,50,000$$

$$= (\quad 500000 + 578512.39) - 10,50,000$$

$$= \mathbf{28512.39\ Rs}$$

Project B

$$NPV = \sum_{t=1}^{n} \frac{C}{1+k^t} - \text{Initial Investment}$$

$$= \frac{7,50,000}{(1+0.1)^1} + \frac{5,00,000}{(1+0.1)^2} - 12,75,000$$

$$= (681818.18 + 413223.14) - 12,75,000$$

$$= \mathbf{-179958.68\ Rs}$$

Hence, project B is not feasible. Project A is to be selected

Calculation of IRR

Project A

$$IRR = \frac{550000}{(1+i)^1} + \frac{400000}{(1+i)^2} - 10,50,000$$

Trial 1 : Let us = Consider i = 10 %

$$0 = \frac{550000}{(1+0.1)^1} + \frac{700000}{(1+0.1)^2} - 10,50,000 = 28512.39$$

Trail 2 : Let us consider I = 20 %

$$0 = \frac{550000}{(1+0.2)^1} + \frac{700000}{(1+0.2)^2} - 10,50,000$$

$$= 4,58,333.33 + 4,86,111.11 - 10,50,000$$

$$= -1,05,565.56$$

Thus, by trial and error method, at i = 11.95, RHS = 0

$$\therefore \mathbf{IRR = 11.95}$$

Thus, Project A is selected.

Module 2

Ex. 2.3.15

The initial outflow of a project is 2,13,000 and the each inflows for the first four years are expected to be 65,2000, 96,000,73,100 and 55,400 respectively. Find the IPR of the project

☑ **Soln. :**

Assume r= 10 % then

$$NPV = \left[\frac{65,200}{(1+0.10)^1} + \frac{96,000}{(1+0.10)^2} + \frac{73,100}{(1+0.10)^3} + \frac{55,400}{(1+0.10)^4}\right]$$

$$= [59272 + 79,338 + 54962 + 37\ 945] - 2,13,000$$

$$= 2,31,517 - 2,13,000$$

$$\mathbf{NPV = 18,517}$$

As NPV is greater than zero we will have to increase discount rate continuing to both the same procedure we get

NPV @ 14 % discount rate to be Rs. 204 /-

and NPV @ 15 % discount rate to be Rs. 3975 /-

Hence IRR is somewhere between 14 % and 15 %. However as NPV is fairly close is zero at 14 % value of r. We can safely assume the IRR to be 14 %.

Ex. 2.3.16

Find IRR for the project with following details.

1. Duration of project - 5 years
2. Initial investment - Rs. 10,000/-
3. Periodic return - Rs. 5,000 per year.

☑ **Soln. :**

Calculation of IRR

Trail 1

Let us consider the discount rate (i) = 40

$$\therefore 0 = \left[\frac{5000}{(1+0.4)^1}+\frac{5000}{(1+0.4)^2}+\frac{5000}{(1+0.4)^3}+\frac{5000}{(1+0.4)^4}+\frac{5000}{(1+0.4)^5}\right]-10000$$

$$= 10175.80 - 10000 = 175.80$$

Trial 2

Let us consider the discount rate (i) = 50

$$0 = \left[\frac{5000}{(1+0.5)^1}+\frac{5000}{(1+0.5)^2}+\frac{5000}{(1+0.5)^3}+\frac{5000}{(1+0.5)^4}+\frac{5000}{(1+0.5)^5}\right]-10000$$

$$= 8683.11 - 10000 = -1316.88$$

HINT

$$\text{IRR} = 40 + \left[\frac{10175.80 - 10000}{1492.69} \times 10\right] = 41.17\ \%$$

Thus at $I = 41.17$, RHS = 0

$$\therefore \text{IRR} = 41.17\%$$

Ex. 2.3.17

A company wishes to invest in a new project. It has two alternatives A and B. Following data pertains to the two alternatives.

Table P. 2.3.17

Particulars	Project A	Project B
Initial investment	1,00,000	1,50,000
Cash inflows year 1	70,000	90,000
Cash inflows year 2	50,000	85,000
Interest Rate	10%	10%

Which project will the company select based on N.P.V. and I.R.R.?

☑ **Soln. :** Calculation of NPV method

Project A

$$\text{NPV} = \left[\frac{70,000}{(1+0.1)^1}+\frac{50,000}{(1+0.1)^2}\right]-1,00,000$$

$$= [63636.36 + 41322.31] - 1,00,000$$

$$= 4958.6$$

Project B

$$\text{NPV} = \left[\frac{90,000}{(1+0.1)^1}+\frac{85,000}{(1+0.1)^2}\right]-1,50,000$$

$$= [81818.18 + 70247.93] - 1,50,000$$

$$\text{NPV} = \mathbf{2066.11}$$

Thus, project A is to be selected.

Ex. 2.3.18

A project cost is ₹ 1,00,000. Its estimated life is 6 years with an average annual cash flow of ₹ 40,000. Calculate IRR for the same.

☑ **Soln. :**

Calculation of IRR

Trial 1

Let us consider the Discount Rate i = 30

$$0 = \left[\frac{40,000}{(1+0.3)^1}+\frac{40,000}{(1+0.3)^2}+\frac{40,000}{(1+0.3)^3}+\frac{40,000}{(1+0.3)^4}+\frac{40,000}{(1+0.3)^5}+\frac{40,000}{(1+0.3)^6}\right]$$

$$-1,00,000$$

$$= 1,05,714.39 - 1,00,000 = \mathbf{5714.39}$$

Trial 2

Let us consider the discount Rate i = 40

$$0\left[\frac{40,000}{(1+0.4)^1}+\frac{40,000}{(1+0.4)^2}+\frac{40,000}{(1+0.4)^3}+\frac{40,000}{(1+0.4)^4}+\frac{40,000}{(1+0.4)^5}+\frac{40,000}{(1+0.4)^6}\right]$$

$$-1,00,000$$

$$= 86,712.22 - 1,00,000 = \mathbf{-13280.78}$$

Thus, at i = 32.7, RHS = 0

IRR = 32.7 %

2.3.15 Payback Period

UQ. 2.3.8 *Write a short note on : Payback period.* MU - May 2013, 4 Marks

UQ. 2.3.9 *Explain Payback period method with the help of suitable example.* MU - April 2015 (2012 Pat.), 4 Marks

- The payback period is the traditional method of assessing project investments and uses the non discounting technique.
- This method is a computationally simple project evaluation approach that has been used for many years. The procedure is to determine how long it takes a project to return the cost of the original investment.

Merits

(i) This method is quite simple and easy to understand, and is based on the premise that there is no profit of any project unless the payback is over. When funds are limited it is always better to select projects having shorter payback periods. This method is suitable to industries where the risks of obsolescence are very high.

(ii) The payback period can be compared to a break-even point, the point at which costs are fully recovered but profits are yet to commence.

(iii) The risk associated with a project arises due to uncertainty associated with the cash inflows. A shorter payback period means less uncertainty towards risk.

Limitations

(i) The method does not give any considerations to time value of money. Cash flows occurring at all points of time are simply added.

(ii) This method becomes a very inadequate measure of evaluating two projects where cash inflows are uneven.

Ex. 2.3.19

A project costing Rs. 15 lakhs yields annually a profit of Rs. 2 lakhs after depreciation @12.5% (straight line method) but before tax 50%.

In this case cash inflow = Profit after tax + Depreciation = Rs. 2,00,000 - Tax Rs. 1,00,000 + 1,87,500.

Soln. :

$$\text{Payback period} = \frac{\text{cost of the project}}{\text{annual cash inflow}}$$

$$= 15,00,000/\ 2,87,500 = 5.2 \text{ years.}$$

2.3.16 Break Even Analysis

UQ. 2.3.10 *Write detailed note on Break Even Point analysis.* MU - April 2011, 6 Marks

UQ. 2.3.11 *Define "Break - Even Analysis". Explain the principles and uses of Break-Even Analysis.* MU - April 12, 6 Marks

UQ. 2.3.12 *Explain the principles of Break Even Analysis.* MU - Oct. 12, 4 Marks

UQ. 2.3.13 *Explain with neat sketch Break Even Analysis.* MU - April 2015 (2012 Pat.), 4 Marks

UQ. 2.3.14 *Write a short note on Break even analysis.* MU - May 13, 3 Marks

- Break even analysis is the analytical technique used to study the effect on profit with changes in cost of production, volume of production and prices of final products.
- This analytical technique is known as CVP analysis. The break even analysis is most commonly known form of CVP analysis. Break even analysis establishes a relationship between cost and revenues with respect to volume.
- Break even analysis is undertaken to identify the Break Even Point (BEP) of production. BEP is the point at which cost or expenses and revenue are equal.
- That is there are no profit and no loss. It is an equilibrium point at which the company does not make any profits nor incurs any losses.
- This means that if the quantity sold is below the BEP the company will incur a loss and if it manages to sell above the BEP it will make profits.
- However, if the company fails to increase the quantity that it sales it can alternatively make profits by
  1. Reducing the fixed costs
  2. Reducing variable costs
  3. Increasing the selling price of their products.
- The company could adopt one or all of the above options to improve its bottom line. However, by doing so it would be reducing the breakeven point.
- The company would now have a new breakeven point which would be lower than the one before thereby enabling the company to make profits.

BEP Calculations

- In the linear CVP (Cost Volume Profit) analysis model, the break-even point can be measured in terms of Total Revenue (TR) and Total Costs (TC).
- BEP is where the total revenue is exactly equal to total cost.

That is Total Revenue = Total Costs

i.e. TR = TC

- Total revenue is the amount of revenue generated by the company and is equal to quantity (Q) multiplied by selling price (P).

Total cost is the sum of fixed (F) and variable (V) Costs at quantity

$$TR - TC = \text{Profits (which at BEP are 0)}$$

$$\therefore \quad TR - TC = 0$$

$$P \times Q - (F + V \times Q) = 0$$

$$Q = F \times (P - V)$$

$$\therefore \quad BEP = FC / (P - VC)$$

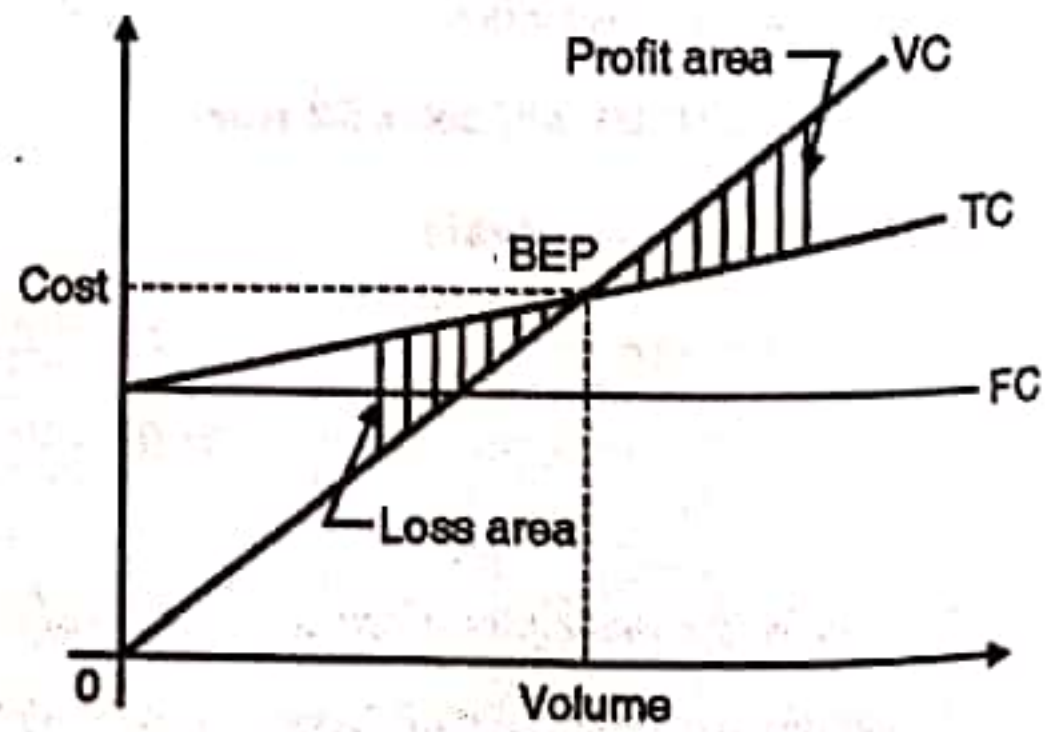

Fig. 2.3.1 : Graphical representation of Break even analysis

Assumptions of Break Even Analysis

Break even analysis is based on the following assumptions

1. Break-even analysis assumes that fixed costs are constant but in real situations this is true only in the short period of time. In the long term fixed costs undergo change and affect the BEP.
2. Break-even analysis assumes that average variable costs are constant per unit of output atleast in the range of probable quantities of sales.
3. Break-even analysis assumes that the quantity of goods produced is equal to the quantity of goods sold.

Applications of Break Even Analysis

Break even analysis allows a business organization

1. To Measure profit and losses at various levels of production.
2. To Measure profit and losses at various levels of sales.
3. To predict and calculate the effect of changes in price of sales.
4. To study the relationship between fixed cost and variable cost.
5. To forecast the effect on profitability when cost and efficiency changes.

Ex. 2.3.20

Nirmiti associates has following details

Fixed cost = Rs. 50 Lakh

Variable cost per unit = Rs. 200

Selling price per unit = Rs. 400

Find 1. Break equal quantity

2. Break even sales

3. Contribution of actual production quantity is 80,000

4. Represent graphically BEU and sales costs.

Soln. :

Fixed cost = Rs. 50 Lakhs

Variable cost per unit = Rs. 200

Selling price per unit = Rs. 400

(i) Break even quantity $= \dfrac{\text{Fixed cost}}{\text{Selling price per unit} - \text{Variable cost per unit}}$

$= \dfrac{50,00,000}{400 - 200}$

= 25,000 units

(ii) Break even sales = 25000 × 400

= 10,00,0000

(iii) Actual production quantity = 80,000

∴ Contribution per unit = 400 – 200 = 200

∴ Contribution = 200 × 80,000

= **16,00,0000**

Ex. 2.3.21

Surya associates have following details

(i) Fixed cost = Rs. 30 Lakhs

(ii) Variable cost per unit = Rs. 150

(iii) Selling price per unit = Rs. 300

Find (i) Break even quantity

(ii) Break even sale

(iii) Actual production quantity is 80,000 find out contribution.

Soln. :

Fixed cost = Rs. 30 Lakhs

Variable cost = Rs. 150

Selling price per unit = Rs. 300

(i) Break even quantity $= \dfrac{\text{Fixed cost}}{\text{Price per unit} - \text{Variable cost per unit}}$

$$= \frac{30,00,000}{300 - 150}$$

= 20,000 units

(ii)Break even sale =20000 × 300 = 60,00,000

(iii)Actual quantity = 80,000

Contribution per unit = 300 – 150 = 150

∴ Contribution = 150 × 80,000

= 12,00,0000

2.4 PROJECT PORTFOLIO PROCESS

GQ. 2.4.1 *Explain the project portfolio process.*

- A portfolio is a collection of projects, programs and other associated work that are grouped together to facilitate effective management of that work to meet strategic business objectives.
- The projects and programs within an organizations portfolio may not necessarily be associated with each other and the allotment of funding and resources is on the basis of priority and risk/reward equation.
- Organizations manage their portfolio on the basis of specific goals such as maximizing the value of the portfolio by evaluation of projects and programs that could enhance the existing value of the portfolio and excluding projects not meeting the portfolio's strategic objectives.
- Other goals for managing portfolio could be balancing the portfolio investment and for efficient use of resources.
- Portfolio management is the application of management techniques to the investments, projects, programs and activities of the company.
- The primary objective of project management is the quantification of previously undertaken projects and programs, enabling measurement and objective evaluation of investment scenarios.

2.4.1 Subprojects

- Large and complex projects are frequently divided into more manageable sub projects.
- In some cases the subprojects are also referred to as projects and managed as one. These subprojects have all the ingredients of a project and hence it makes business sense in addressing them as a project.
- Another peculiarity of subprojects is that they may be contracted to an external party or another functional unit within the organization.

2.4.2 Project Management Office

- A project or program management office (PMO) is an organizational unit that centralizes and coordinates the management of portfolio, projects, programs, subprojects, and other related activities within its domain.
- The PMO acts as the governing body for all project and program related activities that lie within its ambit. It is not essential for the projects and program administered by the PMO to be related. However, in many organizations the projects and programs administered by a PMO are related in some manner based which the PMO will coordinate and manage these projects.
- PMO's not only manage and coordinate activities for achieving project activities but also provide support functions such as training, software, and policy and procedure standardization.
- Domain specific PMO's are entrusted with the authority to act as stakeholders and key decision makers during the initiation stage of each project within its ambit.

- Such PMO have the authority to make recommendation, initiate corrective actions and also terminate the project in case it is no longer consistent with the business objectives.
- In addition to the management of projects and programs PMO's are also involved in the selection, management and deployment of shared resources such as project personnel and in special cases of also dedicated resources.

Hence, the key features of PMO can be summed as:

- Central authority for setting and monitoring project timelines and budgets.
- Setting and coordinating overall project quality standards between project manager and quality personnel.
- Managing communication across all projects within its domain.
- Sharing and coordinating resources across all projects within its domain.
- Identification and development of project management methodology, best practices and standards for all projects within its domain.
- Management of project policies, procedures, templates and shared documents.
- Management of shared and unique risks for all projects within its domain.
- Management and operation of shared tools for all projects.
- Providing guidance and mentoring project managers.

2.4.3 Difference between Project Manager and Project Management Office

GQ. 2.4.2 *Difference between Project Manager and Project Management Office.*

	Project Manager	Project Management Office
Organization	A project manager is a temporary post that is attained by a person and is held till the completion of the project.	The Project Management Office is a permanent organizational structure that overlooks the management of projects and programs undertaken by the organization.
Objectives	A project manager is responsible for delivering project specific objectives within the constraints of the project.	The Project Management Office has to include an enterprise wide perspective. The PMO manages major program scope changes and can utilize them to better attain business objectives.
Resources	The project manager utilizes the project resources to best meet the project objectives.	The PMO is responsible for optimizing the use of shared project resources across various projects within its domain.
Operational Scope	The project manager manages the scope, schedule, budget and quality of the project deliverables.	The PMO manages the overall risk and opportunities and the interdependencies among projects.
Report	The project manager reports project progress and project specific information to its stakeholder which in some cases is the PMO.	The PMO provides a consolidated report of the various projects and programs within its purview to the management of the organization.

2.5 PROJECT SPONSOR AND CREATING CHARTER

GQ. 2.5.1 *Write the project sponsor and creating charter.*

Project Initiation is the first official step in the Project Management Lifecycle and marks the commencement of the project. Project Initiation is based on the business needs that justify the allotment of resources and the expenses that will be incurred on it. The primary idea behind Project Initiation is to ensure that the business need is properly understood by the project manager and is kept in mind throughout the lifecycle of the project. Remember, the business need drives the project hence deviation from it is not acceptable. The business need is the direct outcome of the objectives and goals of the organization.

The Project Initiation stage enables the creation of the project charter that is the official document authorizing the project manager to undertake the project within the organization. As everyone who is party to the project or who is likely to be affected by it is part of the project initiation stage it is easy for the manager to identify the stakeholders.

The business need which drives the project could vary from organization to organization. While some organizations may feel the need to increase productivity others may feel the need to reach out to more customers or to increase efficiency. The project manager needs to understand the business need that is driving the project and also how the project will help the organization in meeting this business need. As stated earlier the organizational objectives, goals and mission are behind the business need hence the project manager should understand the objectives and goals of the organization to understand its business needs better. The project manager also needs to understand how the outcome of the project will be used by its stakeholders.

2.5.1 Stake Holders

The stakeholders of the project are those people who have some interest in the outcome of the project. Hence, it is imperative that the project manager identifies all the stakeholders and establishes the project requirement with them. The stakeholders may a single person, a group, entire department or the entire organization. The stakeholders will be able to provide valuable inputs to the project requirement that will prove useful in ensuring the success of the project. However, not all stakeholders influence the projects outcome there are some key stakeholders who have a major influence on the outcome of the project. The project manager should identify these key stakeholder's and get inputs from them on their specific requirements from the project.

The stake holders to the project are;

- End users : are the people who will actually be using the project
- Project In charge/ Project Sponsor : the person in the organization who has the authority to grant the resources and sign the charter.
- Project team : people actually working on the project.
- Functional managers : managers in charge of the various functional departments of the organization.
- Project Manager : the person in charge of the project.
- Business Partners : suppliers, customers, and vendors

Along with the specific requirements from the key stakeholders the project manager should also gather information on the time frame for the completion of the project, cost criteria and any other technical constraint that may come in way of the success of the project. Once all the project requirements have been gathered the project manager can go to the next stage of project planning.

2.5.2 Identifying Project Purpose and Needs

As mentioned earlier that it is imperative that the project manager develops a clear understanding of the purpose behind the project. Ambiguity should be avoided as it is likely to cost the organization dear. Clarity of purpose will help the organization save in terms of cost, time and effort and the project will be a success. Therefore, the first step in project management is to understand the purpose of the organization behind the project. Once the project manager is aware of what the project should produce he can get around with its planning.

Once the requirements and purpose behind the project have been defined, the project manager can determine the time frame that will be required for the completion of the project. Although, the management of the organization has set some time frame for the completion of the project the project manager should make his own estimation based on the requirements available with him. For estimating the time frame the project manager should be aware of the end result of the project. The end result of the project can be discussed with the project in charge.

With the end result decided upon the project manager can chalk out the path that the project should take. The project manager is responsible for setting the goals and deciding on the path to get there. However, the project manager should develop the path after thorough discussion with the all the key stake holders.

IT Project Management is a complex balancing act of technology and external factors such as demand, market conditions and technological changes. Hence, the project manager should ensure the following in the first place;

- Project has clearly defined objectives
- Project has well defined end results
- Project should spell out the exact requirements
- Project should take into account any industry standard and regulation
- Project should also take into account any government regulation that it should abide by
- Project should have reasonable time frame for completion
- Project in charge has the authority to take decisions
- Project should have committed resources

On his part the project manager should have a very inquisitive mind. He should question each concept, technology and the time that will be taken for its implementation. The project manager should not judge everyone with the same yardstick. Every person in the organization is bound to have varying knowledge of IT. Hence while deciding on the technology that will be utilized in the project the project manager needs to seek answers to the following questions;

- Effect of the proposed technology on the users
- Effect of the proposed technology on other solutions
- Compatibility of the proposed technology with other operating systems
- Experience of other companies using the proposed technology
- Track record of the vendor of the proposed technology.

2.5.3 Project Charter

GQ. 2.5.2 *Write short note on project charger.*

The first step in the project initiation stage was the determination of the business need and identification of key stakeholders. However, till this time all the project discussions were broadly based and were general descriptions. The project manager needs to focus on the project specifics and narrow the project description. It is the time to draft the Project Charter.

A project charter is a detailed official document prepared in line with the company's vision and goal describing in detail the finer nuances of the project and chalking out deadlines for the milestones within the project. The Project Charter serves as a road map for the project manager and states the goals that are to be achieved from the project.

A Project Charter gives a clear definition of the project, its attributes, the end results and the project authorities. Project authorities are the people who are responsible for the implementation and success of the project. These people are namely the project in charge/project sponsor, project manager and the project team leaders.

A project charter is the final official authorization for the commencement of the project to the project manager. It is a green signal to the project manager to commence work on the project.

2.5.4 Purpose of the Project Charter

A project charter serves the following purpose;

- Defines the business need
- Identifies the project sponsor
- Authorizes the project
- Identifies the project manager, grants authority and makes him responsible for the management of the project.

2.5.5 Elements of the Project Charter

The project charter contains all the relevant information related to the project and includes;

I. **Official Project Title :** Every project has a name by which it is identified. The name is usually based on the kind of work the project is undertaking.

II. **Project Sponsor :** The name, designation and contact details of the person who has authorized the project.

III. **Project Manager :** The name, designation and contact details of the person who is responsible for the implementation of the project. However, it is not always that the project manager is a part of the same organization he may also be a free lance project consultant who has been hired by the company specifically for the project.

IV. **Purpose of the Project :** Every project that is undertaken addresses some problems. Hence, the charter should spell out the need or purpose behind the project. This serves as a constant reminder to the project manager.

V. **Key Deliverables :** The key results expected from the project

VI. **Road Map for Work :** The road map will contain of the approach that the project manager has adapted.

VII. **Project Schedules :** Timeline for the completion of the major milestone stages in the project.

VIII. **Project Resources :** Specifies the budget for the various stages of the project and other key resources and players of the project.

IX. **Constraints :** Specifies the assumptions and constraints of the project.

X. **Risks :** Every project has certain risk factor associated with it, hence it is always beneficial for the project manager to identify the risk factors associated with the project and be ready with solutions to tackle them.

2.6 PROJECT PROPOSAL

GQ. 2.6.1 What are the project proposal ?

It is not always that the project manager is a permanent employee of the organization. Many a times, we find organizations availing of the services of independent IT professionals for the implementation of specific IT projects. These IT professionals are selected on the basis of their technical expertise, experience as well as the proposal that they submit to the organization. Once the proposal has been accepted by the organization, both the parties enter into a contract which is legally binding on both.

Howsoever, keen the external IT professional may be in clinching the deal he should never over commit to the client on the project. The IT professional should properly take into account all the aspects of the project and its nuances and then commit to the completion date and price. If the IT professional over promises and fails to deliver he will be held liable and may eventually lose the contract and a permanent blot on his image.

From the organizations point of view, the biggest advantages of working with an outside professional is that apart from bringing in the required technical expertise and fresh perspective they are totally into the project all the time. An in house project manager has various other activities to cater to and hence may not be able to dedicate himself totally to the project.

While dealing with an external project manager the organization demands the following :

- **Bid :** An indication of how much the IT professional would charge the client to carry out the potential project when competing with other freelancers/businesses.
- **Estimate :** An approximation of the overall project costs based on past projects of similar scope or extrapolating on whatever information is available.
- **Proposal :** An interpretation of the client's specific needs and how the IT professional plans to execute and charge for it.
- **Contract :** A legally binding agreement between the IT professional and the client that includes any contract provisions.

Project proposals and contracts may seem interchangeable, however, in reality they are two very different things, and one never exists without the other.

2.6.1 Elements of a Proposal

A Request for Proposal (RFP) is a document that is used to solicit bids, quotes or proposals from prospective suppliers. On the other hand, a proposal is a document prepared by suppliers when there are different approaches for meeting the requirement of the organization. In the RFP the supplier may propose the use of various software, hardware and networking solutions to meet the requirements of the organization.

Developing an RFP is a time consuming process and begins by determining the project needs that cannot be fulfilled internally and for which the organization will need to avail the services of outside suppliers. The task of determining the

needs that can be met internally and those that cannot be met need to be left with the project manager and the project team. Along with determining the needs for which external suppliers are required the project manager and his team should also determine when, where, and how much of these resources would be required.

The idea behind an RFP is to prepare a level playing field for all the prospective suppliers by stating in clear terms the requirements of the organization and all other technical specifications. An unambiguous document enables all suppliers to send their proposals clearly and also enables the organization to compare and evaluate proposals of various suppliers.

Although, price is an important factor in determining the choice of supplier there are other factors such as experience, technical capability, track record, financial stability, after sales service, etc which should be taken into account while determining the choice of supplier.

The organization should obtain proposals from a reasonable number of reputed suppliers. To invite proposals the organization should either directly contact reputed suppliers and send them the RFP or could release an advertisement in the newspaper, internet or the trade journal and get suppliers to send their proposals. The project manager should also invite prospective suppliers for a meeting and update them on the requirement and provide answer to their queries.

These items are a general framework and more or less should be a part of any proposal regardless of the type of work being done.

- **Summary of project :** Identify the scope of work.
- **Overall budget and costs :** Identify what the overall project budget looks like. At this point the IT professional will have to negotiate with the organization and give a written estimate of total cost.
- **Breakdown of each task and associated costs :** Identify the specifics of each task and justify associated costs. Some costs may be fixed while others may be more variable. Some of the costs may be speculative and hence need to be indicated. Making sure the client knows this ahead of time will make it easier should unexpected costs arise.
- **Payment Schedule :** States the manner in which the payment for the work undertaken is expected.
- **Provisions :** Identify any provisions that are specific to the project. Provisions are an extremely important piece of the proposal as they allow the IT professional to set his terms in a legally-binding manner. The provisions included within the project proposal should include any that are specific to the project as well as any that are general to the business. Those provisions will be restated within the contract along with a general summary of the proposal.
- **Signatures :** Even though the proposal likely won't be a legally binding contract once it has been negotiated and agreed upon, it is still good to sign off and have the client sign off on it as well.

2.6.2 Elements of a Contract

After the proposal has been finalized and agreed upon, it is time for the contract. Some of the very essential elements of a contract are;

1. **The Scope of Work :** The Scope of Work should describe in detail what the freelancing IT professional is expected to do for the organization. A vague or incomplete Scope of Work is a recipe for problems down the road, with the client claiming that the work doesn't meet their specifications. So, clarity in Scope of Work is of utmost importance. The client should know exactly what to expect before the work starts.

2. **Deadlines :** Few things cause more disruption in a freelancer's life than a client suddenly moving up a deadline. Make sure the contract states when the work is due. If the project is broken up into phases, assign a deadline to each phase. It can't hurt to say in the contract that if the scope of work changes, the deadline is also subject to change, and vice versa.
3. **Payment :** The IT professional can be paid by the hour, by the project, or whatever other arrangement the two parties devise. But whatever the arrangement it has to be clearly mentioned in the contract.
4. **Payment Timing and Late Fees :** the timing of the payment is as important as the amount that is being paid. In some cases payment is made against the delivery of the work while in some cases time is given to the client to make the payment. If an advance is expected the freelancer should mention so.
5. **Early Termination :** Clients sometimes change their minds and cancel projects. If the work has already commenced and the client pulls the plug, the freelancer is likely to suffer. In contract-speak this scenario is known as "early termination," and it's important that the freelancer and the client have a plan in place should it happen. The freelancer might agree that the client will pay him a pre-determined amount of money, if they terminate the agreement early. Or, maybe they agree that the client will pay him for the work you've completed as of the termination date, an amount that will have to be determined in the future. In any event, it's a good idea to make sure the contract provides that the freelancer gets paid for partially completed work.

2.7 EFFECTIVE PROJECT TEAM

GQ. 2.7.1 *Describe briefly effective project team.*

- A project manager is not only expected to manage project tasks, deadlines and resources but also deal with individuals with varied personalities, ambitions and motivations. Therefore being a project manager is more about being a leader, it is about getting to know your team: recognize the leader within the team, the person ready to go the extra mile, ones who are ready to help others and the ones who always have a habit of cribbing.
- The best way to manage a team is to set the example yourself. However, before we get to study team development and team building let us first understand what teams are.

2.7.1 Meaning of the term 'Team'

- "A team is a small number of people with complementary skills who are committed to a common purpose, set performance goals and approach for which they hold themselves mutually accountable."
  - "The team can also be defined as a group of individuals which shares a common purpose and develops common understanding of this purpose, common agreement on it and total commitment to it, galvanized into a single functional unit fully oriented and focused on the tasks towards the agreed upon purpose."
  - "The team is united and integrated in efforts and accountability at all stages and times."
- Teams are groups of two or more people who interact and influence each other, are mutually accountable for achieving common goals associated with organizational objectives and perceive themselves as a social entity within an organization.
- All teams exist to fulfil some purpose, such as assembling a product providing a service, designing a new manufacturing facility or making an important decision.

- Team members are held together by their interdependence and need for collaboration to achieve common goals.
- All teams require some form of communication so members can coordinate and share common objectives. Team members also influence each other.
- All teams are groups because they consist of people with a unifying relationship. But not all groups are teams; some groups are just people assembled together without any necessary interdependence of organizational focused objective.
- Along with formal work teams, organizations consist of formal and informal groups. But informal groups are not initiated by the organization and usually do not perform organizational goals.
- A team is a small number of people with complementary skill who are committed to a common purpose, common performance goals, and an approach for which they hold themselves mutually accountable.
- "A team is a group of people working together towards a common goal." as 'a group of people, contributing their individual knowledge and skills but working together to achieve a common goal/task.'
- A team is any group of people organized to work together interdependently and cooperatively to meet the needs of the Org. by accomplishing a purpose and goals.
- Teams are created for both long term and short term interaction. A project development team, an executive leadership team, and a departmental team are long lasting planning and operational groups.

2.7.2 Characteristics of a Team

- As in a group a team too includes few people. The number should be restricted to facilitate interaction and ensure smooth functioning of the team.
- The team formed should include people possessing mix of all the skills that will be required for the task. The skills required could be technical, interpersonal, decision making, problem solving etc. It is not necessary that every person in the team should possess all the skills.
- The idea behind forming a team is that it is not possible for one person to have all the skills required for a particular task.
- The individual skills should complement the skills of the other members. Example a cricket team has bowlers, batsman, wicketkeepers, specialist fielders etc.
- There is a common purpose that team members believe in. They have total commitment to its purpose. Teams translate their common purpose into specific performance goals. There is clarity and agreement on specific performance goals.
- A team needs to agree on a common approach, develop direction, momentum and commitment by working to shape meaningful purpose.
- Mutual accountability for results defines a team. This means that members have an undeclared commitment to the task undertaken. They promise to do everything possible to achieve the task.
- Teams produce discrete work products through joint contribution of their members. The team plans, controls and improves on its own work processes. Output of the team is much more than sum total of output of individual team members.
- Teams undertake various managerial functions and have captive source of relevant expertise, skills and talent within it. Teams nurture and develop the skills needed for the task.

- The leader of the team has to ensure that the team is focussed on the task. He has to facilitate full expression of members and maintain harmonious relations among members.

2.7.3 Benefits from Team

Individuals are the smallest units within their teams and their personal abilities affect various outcomes in their teams. Teams often arise when employees come together to accomplish a common goal. Teamwork within the workplace not only benefits workers but also significantly affects business.

Module 2

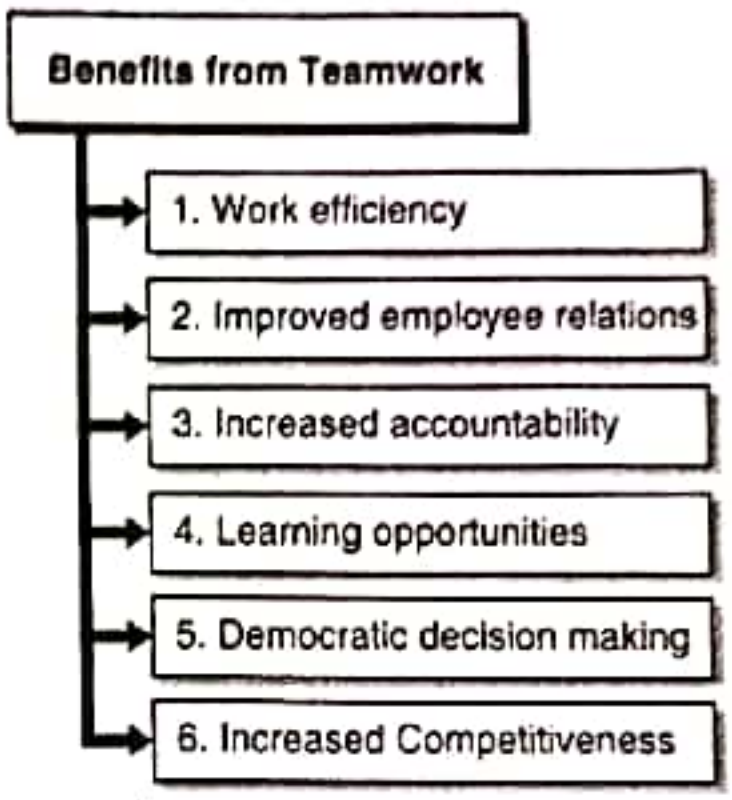

Fig. C2.5 : Benefits from Teamwork

1. Work efficiency

- Teamwork enables you to accomplish tasks faster and more efficiently than tackling projects individually.
- Co-operating together on various tasks reduces workloads for all employees by enabling them to share responsibilities or ideas.
- Teamwork also reduces the work pressure on every worker, which allows him to be thorough in the completion of the assigned roles. In sharing ideas or responsibilities, every employee should have a role that suits his specialization. You should also consider employees' levels of interest in the project at hand, which positively influences the efficiency or speed of their output in accomplishing the task.

2. Improved employee relations

- Teamwork is important in an organization because it provides employees with an opportunity to bond with one another, which improves relations among them.
- It also strengthens the bond among the employees and they feel motivated to work and achieve the targets.
- Workers who constitute a team working on a project often feel valued upon the successful completion of such tasks.
- A situation in which all of them find a chance to contribute towards the tasks improves relations within the team and enhances their respect for each other.
- Improved employee relations also result from the fact that teamwork enhances cohesion among members, thanks to increased trust among them.
- Some kind of team building activities must be undertaken from time to time to encourage the team members to work hard and realize their dreams.

3. Increased accountability

- Teamwork increases the accountability of every member of the team, especially when working under people who command a lot of respect within the business.
- Team members do not want to let each other down and hence do their best to contribute to the successes of their teams.

- In contrast to working solo on a project, peer pressure is usually high within teams such that cases of low morale are less likely to impact individuals. Since teams are committed towards their work they will give whole-hearted efforts for its success.

▶ **4. Learning opportunities**

- Cooperating on a project is an opportunity for new workers to learn from more experienced employees. Teams often consist of members who differ from one another in terms of skills or talents.
- Working together is a great opportunity to acquire skills that an employee never had beforehand. Unlike working alone on a project, teamwork affords people the opportunity to challenge the ideas of each other and come up with a compromise solution that contributes to the successful completion of the task.
- Employees benefit superior work performance, reduced stress. In team working every employee gets a platform for voicing his suggestions etc.

▶ **5. Democratic decision making**

- Decision making in team functioning is more democratic.
- Everybody feels on equal footing and everybody gets a feeling of due importance and recognition.

▶ **6. Increased Competitiveness**

- Team work enhances the morale and self confidence of the employees and this helps the Org. in increasing its competitiveness in the mkt.
- An atmosphere of innovation, creativeness and dynamism is created.

⏭ 2.8 STAGES OF TEAM DEVELOPMENT AND GROWTH

- Developing teams is not an instantaneous process; it takes time and commitment on the part of the project manager to develop one.
- A project team is a collection of people; some may have worked together while some may have never met before. Also, as projects are temporary, teams too are viewed as a temporary arrangement and therefore there may be a lack of effort and willingness amongst team members to develop relationships.
- The goal of team development is not to develop long lasting relationship but to develop a team that can effectively complete the project. Therefore, the onus to develop the team lies with the project manager.
- The stages of project team development are as follows:

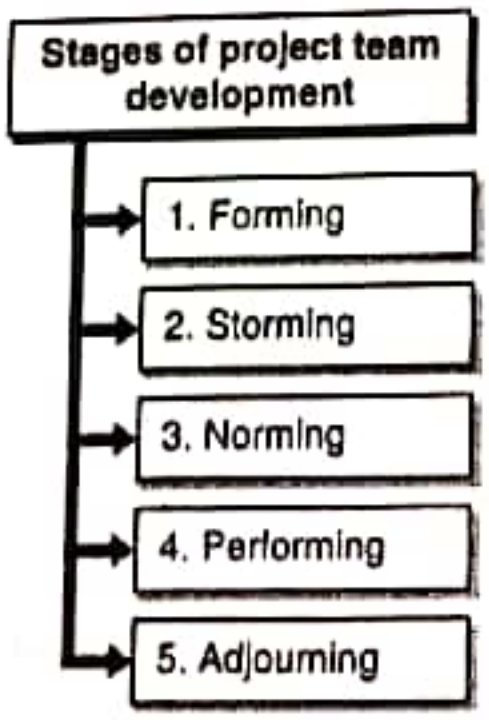

Fig. C2.6 : Stages of Project Team Development

1. Forming

This is first stage wherein team members come together and get to know each other. Team members get to know the role expected from them and their colleagues within the team.

2. Storming

During this stage the hierarchy within the team is decided upon and lines of communication are finalized.

3. Norming

Once hierarchies and roles have been established it is time to get on with the project work. During the Norming stage the team members commence working on the project.

4. Performing

At this stage the project work is in full steam, team members have settled in their roles and focus on completing the project work. The team is working as one cohesive unit.

5. Adjourning

Projects are temporary in nature and the team formed has to disperse to other projects or to their regular work on the completion of the project.

2.8.1 Team Building

- We have seen that teams are powerful units of collective performance. The importance of teams lies in the fact that real teams work, and they work wonders.
- Understanding importance of team building is important because the manager should be convinced that it's worth the time and effort to build the team.
- With good team-building skills, you can unite employees around a common goal and generate greater productivity. Without them, you limit yourself and the staff to the effort each individual can make alone.
- Team building is an ongoing process that helps a work group evolves into a cohesive unit. The team members not only share expectations for accomplishing group tasks, but trust and support one another and respect one another's individual differences.
- The role as a team builder is to lead the team toward cohesiveness and productivity. A team takes on a life of its own and the leader has to regularly nurture and maintain it.

2.8.2 Need for Team Building

- The management of every organization starts getting symptoms that there is an utmost necessity to form teams.
- The following are the symptoms that signal a need for team building :
  - Decreased productivity
  - Conflicts or hostility among team members
  - Confusion about assignments, missed signals, and unclear relationships
  - Decisions misunderstood or not carried through properly

- Apathy and lack of involvement
- Lack of initiation, imagination, innovation; routine actions taken for solving complex problems
- Complaints of discrimination or favoritism
- Ineffective staff meetings, low participation, minimally effective decisions
- Negative reactions to the manager
- Complaints about quality of service

2.8.3 Steps to Building an Effective Team

- Most successful teams shape their purposes in response to a demand or opportunity put in their path, usually by the top management. This helps teams get started by broadly framing the company's performance expectations.
- The top management is responsible for clarifying the charter, rationale and performance challenge for the team, but management also must leave enough flexibility for the team to develop commitment around its own spin on that purpose, set of specific goals, timing and approach.
- To lead a team effectively, you must first establish the leader. Remember that the most effective team leaders build their relationships of trust and loyalty, rather than fear or the power of their positions.
- Once the leader is firmly established it is for him to form the team that will enable him to achieve the task.
- Team members should never be selected on the basis of only good personal relations or designated position in the organization structure.
- An appropriate blend of right skills must be ensured in teams. It goes without saying that no team can claim all requisite skills at its disposal from within. However, teams, team relationship and teamwork are very conducive to learning, acquiring and perfecting new skills.
- Once the team has been formed the members need to be assigned specific tasks. Teams are committed to the common understanding on how to go about the work. There is clear agreement among the team members on:
  - Specific jobs assigned to each individual.
  - Scheduling the activities and following the schedule strictly.
  - Expertise and skills wanting development.
  - Criteria for continuation of team membership.
  - Decision making process.
- Specific performance goals are evolved from the common purpose. Specific performance goals help in achieving following :
  - Define work products other than organizational mission and individual goals.
  - Facilitates clear communication and constructive conflict within the teams.
  - Maintains focus on getting the results.
  - Produces levelling effect conducive to team behavior.
  - Allow teams to achieve small wins while it pursues broader purposes.
  - Motivate and energize the teams.

- Establish team values and goals; evaluate team performance. Be sure to talk with members about the progress they are making toward established goals so that employees get a sense both of their success and of the challenges that lie ahead. Address teamwork in performance standards. Discuss with your team:
  - What do we really care about in performing our job?
  - What does the word success mean to this team?
  - What actions can we take to live up to our stated values?
- There are some ways to address the issue of team performance:
  - Less margin and tolerance for laidback style.
  - Deliverables that are not easy to achieve or are, rather, demanding in nature and are challenging.
  - Overall direction to team thinking and actions.

- Set ground rules for the team. These are the norms that you and the team establish to ensure efficiency and success. They can be simple directives (Team members are to be punctual for meetings) or general guidelines (Every team member has the right to offer ideas and suggestions), but you should make sure that the team creates these ground rules by consensus and commits to them, both as a group and as individuals. There should be clarity on behavioural standards expected:
  - Team members are expected to attend all team meetings with due preparation.
  - Discussions should have substance and there should not be any exceptions for active participation in discussions.
  - Decisions made in the meeting are only important and the interpersonal dynamics – bitter at times – should blow over.
  - There should be proper homework done by members. Facts, figures, data etc should be proactively sought, analyzed and challenged.
  - The tasks are assigned to each team member and completion is reported, presented and discussed among the team members.
  - Faceoff between team members is inevitable. However, it should not be destructive; rather, it should pave the way for novel ideas and approaches to the problems.
  - Contribution of every team member is real and verifiable.

2.8.4 Effective Teamwork

- Now that the team has been formed, the leader has to ensure that it performs the task allotted effectively.
- In the current business scenario, organizational success hinges on effective teamwork. For the team to be effective there has to be mutual respect, trust, and cooperation.

1. Role of Leader

- The leader should consider each employee's ideas as valuable. He should act as a harmonizing influence.
- Look for chances to mediate and resolve minor disputes; point continually toward the team's higher goals. Be clear when communicating. Be careful to clarify directives.

- Encourage trust and cooperation among team members. Remember that the relationships team members establish among themselves are every bit as important as those you establish with them.
- As the team begins to take shape, pay close attention to the ways in which team members work together and take steps to improve communication, cooperation, trust, and respect in those relationships.
- Make sure that you have a clear idea of what you need to accomplish; that you know what your standards for success are going to be; that you have established clear time frames; and that team members understand their responsibilities.

Fig. C2.7 : Key points in Effective Team work

▶ **2. Cooperation**

- Encourage team members to share information. Emphasize the importance of each team member's contribution and demonstrate how all of their jobs operate together to move the entire team closer to its goal.
- Delegate problem-solving tasks to the team. Let the team work on creative solutions together.

▶ **3. Communication**

- Remember that communication is the single most important factor in successful teamwork. Facilitating communication does not mean holding meetings all the time.
- Instead it means setting an example by remaining open to suggestions and concerns, by asking questions and offering help, and by doing everything you can to avoid confusion in your own communication

▶ **4. Consensus**

- Set objectives, solve problems, and plan for action. While it takes much longer to establish consensus, this method ultimately provides better decisions and greater productivity because it secures every employee's commitment to all phases of the work. Establish a method for arriving at a consensus.
- You may want to conduct open debate about the pros and cons of proposals, or establish research committees to investigate issues and deliver reports.

▶ **5. Encourage listening and brainstorming**

- As manager, your first priority in creating consensus is to stimulate debate. Remember that employees are often afraid to disagree with one another and that this fear can lead your team to make mediocre decisions.
- When you encourage debate you inspire creativity and that's how you'll spur your team on to better results.

⏭ 2.9 THE BUSINESS CASE

GQ. 2.9.1 *Discuss about the business case.*

- The desire to utilize information technology to improve the efficiency and effectiveness of the organization has lead to an increase in the number of IT projects undertaken within organizations.

- However, the utilization of information technology without a thorough understanding of its risk and cost implications has lead to the failure of many IT projects. The haphazard utilization of information technology merely because it is available is not judicious.
- The rampant failure of IT projects on account of the inability of projects to deliver returns as compared to the time and resources invested in them is an indicator of the need to develop some sort of analysis or feasibility study which would indicate the true value of the project for the organization.
- The business case arises out of this need and provides an analysis of the technical feasibility, costs, risks, returns, and organization value of various projects. It provides the basis on which informed decision on the projects can be taken.
- Although, the business case may sound very similar to a project plan or budget it should not be mixed up with one. The business case is a document that provides the top management with all the information needed to select the projects that are to be funded.
- Although creation of the business case document is very much similar to the feasibility report in most of the cases it is a separate document.
- Like the feasibility study the business case too helps the management in justifying the cost that will be incurred on the project and its return on investment.
- The business case is built on the relevance of the business goals and objectives and the cost of the proposed technology that can get the organization there.
- The business case takes into account the cost of the solution, break-even point, return on investment, and maintenance cost.
- Along with the quantitative issues the business case may also address qualitative issues such as; working comfort, increased efficiency, improved morale, etc.
- The business case is very similar to an investment proposal. Hence, the developer of the business case has to present compelling facts and figures in favour of the project and base his argument in the most logical manner.
- However, the business case developer in no way should digress from the facts of the project and the analysis should be as dispassionate as possible. A good business case should;
  - Detail all possible impacts, costs and benefits.
  - Be clear and logical in comparing the cost-benefit impact of each project alternative.
  - Include all pertinent information.
  - Systematically summarize all the findings

Module 2

2.9.1 Developing the Business Case

Although, IT projects are undertaken for a plethora of reasons such as; improve customer service, reduce costs, improve communication, integrate customers, suppliers and partners, improve decision making, etc, the underlying objective behind each reason is to create organizational value by way of improving efficiency and effectiveness.

The priority amongst the various reasons for undertaking IT projects differs from organization to organization. It is up to the top management to evaluate the various project proposals and select those which will create maximum organizational value. Therefore, the objective of the business case is to evaluate and advocate how the IT project will create value for the organization and improve its efficiency and effectiveness.

Steps in developing the business case:

- **Step I : Forming the team**
  - Developing the business case should not be a single man's responsibility.
  - On the other hand, a team comprising of stakeholders, managers, users and IT specialists should be formed. The team so formed should bring in all the requisite knowledge, experience, information and expertise required to develop the business case.
  - Of the team, the stakeholders are the people who are going to be affected by the project and hence their point of view needs to be presented in the business case document.
  - Business managers bring in a higher level of perspective which is so essential for the business case. The users are the ones who understand the requirements that the project has to fulfil. While the IT specialists understand the risks and benefits associated with IT and should present their perspective in the business case.
  - According to Schmidt, there are several advantages of having a team develop the business case :
    - **Credibility :** As a team is made up of individuals from various organizational areas they possess expertise, knowledge and experience that may not be readily available outside the realms of their operations. A team also provides different perspectives to the project and provides inputs that an individual developer may tend to overlook.
    - **Alignment with organizational goals :** The managers in the core team can align the business case with the long term strategic goals of the organization. Aligning the project with the strategic goals of the organization further strengthens the business case. The business case should also highlight how the successful completion of the project will help achieve the overall goals and objectives of the organization.
    - **Access to real costs :** The team members selected should have specific expertise and should be privy to information that will assist in building a realistic estimate of the costs.
  - The other advantage of forming a team from various areas of the organization is that enables the project manager to manage resistance during project implementation.
- **Step II : Developing Measurable Organizational Value (MOV)**
  - Measurable organizational value (MOV) is the IT projects overall goal and its measure of success. For any project the MOV should align with the organization's overall mission, objectives and goals. The term Measurable Organizational Value was coined by Jack Marchewka as an alternative to the more popular return on investment (ROI). According to Jack Marchewka the projects MOV should be :
    - Measurable
    - Provide value to the organization
    - Agreed upon by all the core team members.
    - Verifiable at the end of the project.
    - Guide the project throughout its lifecycle.
    - Align with the organizations strategy and goals.

- A clear MOV will enable the team to know where the project should go, it will be like the road that the whole project lifecycle should take. In case the project deviates from its path, the relevant decisions and adjustments will be based on the MOV which can be vital in achieving the overall goal.

Steps in developing the MOV

i) Identifying the desired area of impact

- The desired area of impact expected from the IT project is the primary reason for undertaking the project.
- To identify the desired area of impact the project manager should find out from the project sponsor how the idea of the project came about.
- Although, the answers could be vague it would provide the project manager with some elementary background as to how decisions are made in the organization.

ii) Identifying the desired value of the project

- The value that a project brings to an organization could be in terms of doing something faster, better, cheaper, or on increasing the market share.
- The project manager should identify and highlight what the project could potentially deliver to the organization.

iii) Developing an appropriate metric

- Once the desired value of the project has been identified it is time to quantify the value that would be delivered. So for example a proposed business information system would enable a company to process customer orders faster, the management would be better off in learning the reduced customer order cycle time.
- Therefore, the value should be quantified and expressed in terms of a metrics i.e. in terms of time, money, percentage or a specific value.

iv) Setting a time frame for achieving the MOV

The time frame for achieving the MOV should also be mentioned. Some MOV's are immediately achievable on the completion of the project, for example the reduction in customer order cycle time, however, some like increase in market share may take time.

v) Verifying with stakeholders

Getting the metric value and time frame verified and approved from the stakeholders adds value to claims made in the business case.

vi) Summarize the MOV in a clear and concise statement

The MOV should be mentioned in a clear and concise statement.

Step III : Identifying Alternatives

- All the alternative solutions to the problem or opportunity need to be delved upon in the business case. These alternatives should also enable the company to achieve the desired MOV.
- The alternative of maintaining status quo i.e. not doing anything and continuing with the present situation could also be a solution that needs to be looked into.

- However, the business case should put forth compelling reasons to bring about change and the cost that would be incurred in continuing with the existing process, systems or product.
- The cost incurred could be in terms of downtime, maintenance cost and systems failure.

▶ **Step IV : Defining Feasibility and Assess Risk**

- The feasibility and risk associated with each alternative solution should be analysed. Feasibility is the probability of successfully implementing an alternative while risk focuses on what can go wrong and what must go right.
- Feasibility and risk analysis will enable the project manager to identify alternatives that are not worth pursuing.
- Feasibility is viewed in terms of economic feasibility, technical feasibility, and organizational feasibility. Risk analysis focuses on its identification, assessment, and response.

▶ **Step V : Defining Total Cost of Ownership**

- The total cost of ownership of the application needs to be accounted for before any decision on implementing it is to be taken.
- Total cost of ownership is over and above the cost of purchasing or developing the application and as such includes cost of purchasing/developing, training, maintaining and supporting the application over its entire lifetime.
- Thus, total cost of ownership calculation is complex and hence the project manager has to authenticate his calculation with data sources, assumptions and methods for arriving at the cost.

▶ **Step VI : Defining Total Benefits of Ownership**

- The total benefits of ownership includes direct and indirect benefits associated with each alternative. Benefits could be in terms of increased efficiency, improved productivity, improved customer service, improved accuracy and efficiency, or improved decision making. However, not all benefits all easy to identify and quantify.
- Every alternative has certain tangible and intangible benefits. Tangible benefits are easy to identify and quantify as they lead to cost savings.
- On the other hand, though intangible benefits are identifiable they are difficult to quantify. The project manager should try and quantify intangible benefits by linking them to tangible benefits.

▶ **Step VII : Analyzing alternatives**

Once costs and benefits have been identified it is time to compare all the alternatives and arrive at one that best meets the requirement of the organization. Financial models such as ROI, Payback and Net Present Value and Scoring Models are used to analyze the alternatives.

▶ **Step VIII : Recommend Solution**

After analyzing each alternative the one that best suits the company should be recommended for approval.

Chapter Ends...

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CHAPTER 3

Module 3

Project Planning and Scheduling

University Prescribed Syllabus

Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering. Project cost estimation and budgeting. Top down and bottoms up budgeting. Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).

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3.1 WORK BREAKDOWN STRUCTURE (WBS)

GQ. 3.1.1 What is work breakdown structure ?

A project is a sequence of unique, complex, and connected activities having one goal that must be accomplished within a specific time, budget and according to specifications. The principles of project management apply to most projects. A key factor for successful project management is to see projects as a series of interrelated tasks.

- A Project Scope document is typically used to communicate to the Project Manager the project mission and scope, and enable the Project Sponsors to allocate a budget and officially indicate acceptance, agreement, and start date. Failure to establish budget, scope and support at the outset will invariably lead to project crisis at a later date.
- The project scope statement defines all the project deliverables. These defined deliverables are then clubbed together to form the Delivery Definition Table (DDT). The Delivery Definition Table contains the sequence of the delivery of the deliverables. The Delivery Definition Table is then used to create the Delivery Structure Table (DSC) which contains the work packages which is then further used to create the Work Breakdown Structure.
- After the approval of the Project Scope Statement the next step in the project planning process would be the creation of the Work Breakdown Structure (WBS). The Project Manager must translate the initial project definition into an itemized project plan that addresses the lowest levels of implementation details. The method for accomplishing this is the Work Breakdown Structure. The WBS document lists task deliverables and identifies all activities required to produce the final project deliverables. The WBS document is a categorization and decomposition of the project scope statement. The project scope statement is broken down into smaller and more manageable components or tasks. Each task set can be estimated for cost and time within the project.

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- The WBS is a critical process as it forms the basis for other management processes such as resource allocation, time scheduling, cost control, and risk management. Failure to conduct WBS basically means that a project management methodology has not been properly undertaken.
- WBS is utilized to:
  - Break activities into smaller tasks
  - Identify the phases of activities, including milestone tasks which indicate completion of each phase
  - Sequence the tasks
  - Estimate the duration of tasks
  - Schedule the tasks
  - Identify the needed resources for each task
  - Estimate the resource costs

3.1.1 Work Breakdown Structure Guidelines

- The top level indicates the final deliverables i.e. the objective of the project.
- The final deliverable is decomposed into sub-deliverables which contain work packages that are assigned to a particular function or department.
- The work packages define the work duration and costs for the tasks required to produce the sub-deliverables.

- Work packages should not exceed 10 days of work.
- Work packages should be independent of other work packages.
- Work packages should be unique and should not be duplicated elsewhere in the WBS.

3.1.2 Benefits of Work Breakdown Structure

GQ. 3.1.2 *Write benefits of work break down structure.*

- In addition to defining and organizing the project work the Work Breakdown Structure has a number of benefits.
- WBS enables the project manager to allocate budgets to the top level of the structure.
- Departmental WBS enables faster estimation of departmental budgets.
- WBS facilitates allocation of time and cost estimates based on which the project schedule and budget can be developed.
- WBS enables the tracking of project cost performance and identification of issues and problem areas in project management.
- WBS can be used to identify potential risks in the project. These risks can be tracked and reviewed during the execution of the project.
- WBS can also be used to identify communication points and formulate a communication plan across the projects.
- If there is a delay in the execution of project sub deliverables the WBS will enable the project manger to identify the major deliverables that will be impacted.

3.1.3 Work Breakdown Structure

- The WBS results in an official Project Plan for review and approval by sponsors. The WBS will ideally use a software instrument, like Microsoft Project, to create an automated Gantt chart. In a Gantt, inter-dependencies of tasks are indicated by cascading arrows; instances where one activity cannot begin until another is completed. Project milestones, time points that indicate a completion of key tasks, and deliverables that are tangible outcomes of the project are also clearly identified.
- A Gantt chart is a key component within the Project Plan because it visually presents details that otherwise can be lost in a long narrative.
- The Gantt graphically portrays the task list, assigned resources especially the responsible personnel for the task, schedule with begin and end dates, and task dependencies. Software automation flags completed and late tasks so that a powerful visual map of project progress status can be viewed.
- Instead of the limited and cumbersome process of paper documentation, the software Gantt chart provides a shared on-line tool for dynamically tracking and communicating among team members, and generating official progress reports to sponsors.

3.1.4 Developing the WBS

- Project managers, project team and Subject Matter Experts (SME) typically develop a WBS as a precursor to a detailed project schedule and budget estimate. Although, there are different methods of decomposing project work and creating WBS, the starting point for deriving a WBS would be identifying the main deliverables of the project.
- The next step would be to convene a meeting of all team members and subject matter experts, who would then brainstorm all the work required to complete project deliverables successfully. The involvement of all team members and subject matter experts increases the likelihood of the resulting WBS being comprehensive.
- Team members and subject matter experts identify all project deliverables and milestones and then decompose them one at a time into a detailed and sequential list of activities required to complete them.

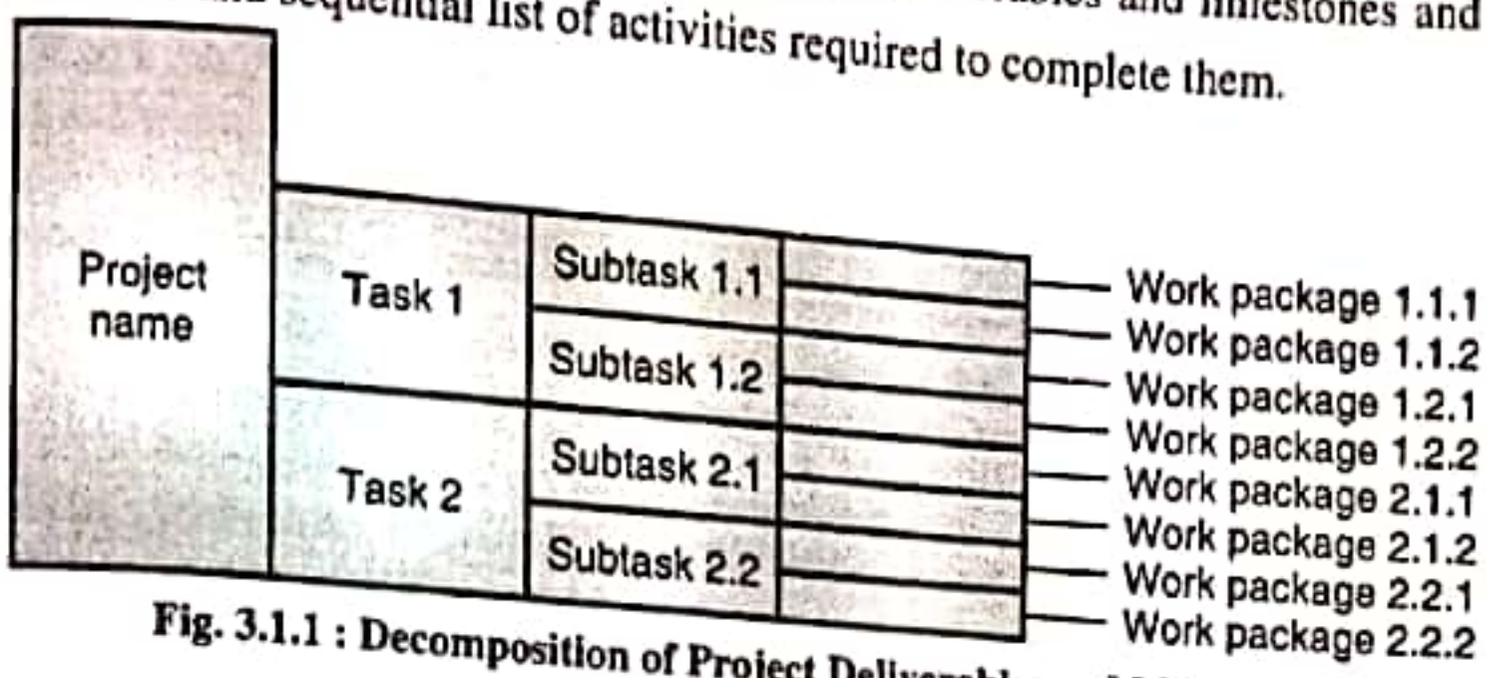

Fig. 3.1.1 : Decomposition of Project Deliverables and Milestones

- It is logical to create a WBS based on the nature of the project work. However, this is possible only in projects where it is possible to identify the phases of project. In projects where the focus of the project execution is not clear, the project manager would be better off in categorizing the project components and then decomposing.
- There are no hard and fast rules to the level and manner of breakdown of the WBS. Some project managers break down the WBS till it is not possible to break any further. However, this method is not recommended as the tasks created would be too small to manage, measure, and assign. Therefore, for a small project the work could be broken down into a few days of work while for a large project the work could be broken down into weeks of work.
- The general rule is the "two weeks" rule; no task is broken to anything less than two weeks of work i.e. the smallest task in the WBS will require a period of two weeks to complete. Another rule in creating the WBS is the "8/80" rule.
- This rule suggests that the smallest work package in the project should take no more than 80 hours to complete or no less than 8 hours to complete. In short, no task should be smaller than 8 hours of work and should not be larger than 80 hours of work.
- WBS Dictionary that lists and defines WBS elements should accompany the WBS. The WBS dictionary defines each work package in the WBS.
- The dictionary identifies each component of the WBS and how they relate to the project scope. The description of each element of the WBS is stated in simple language that everyone can understand. The WBS dictionary contains the following :

(i) Code of accounts

(ii) Description of the task

(iii) Person responsible for the task

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(iv) Task dependencies

(v) Schedule of the task

(vi) Resources required for the task

(vii) Cost to create the task

(viii) Quality requirements of the task

(xi) Technical details of the task

(x) Acceptance criteria of the task

(xi) Contract information

- WBS and WBS dictionary are not the schedule but the building blocks for the schedule. The WBS and WBS dictionary are not static documents and are subject to change as more information related to the project emerges.
- A Project Team that has substantial changes to its WBS should reference the project's Change Management Plan for guidance on management of changes to project scope.

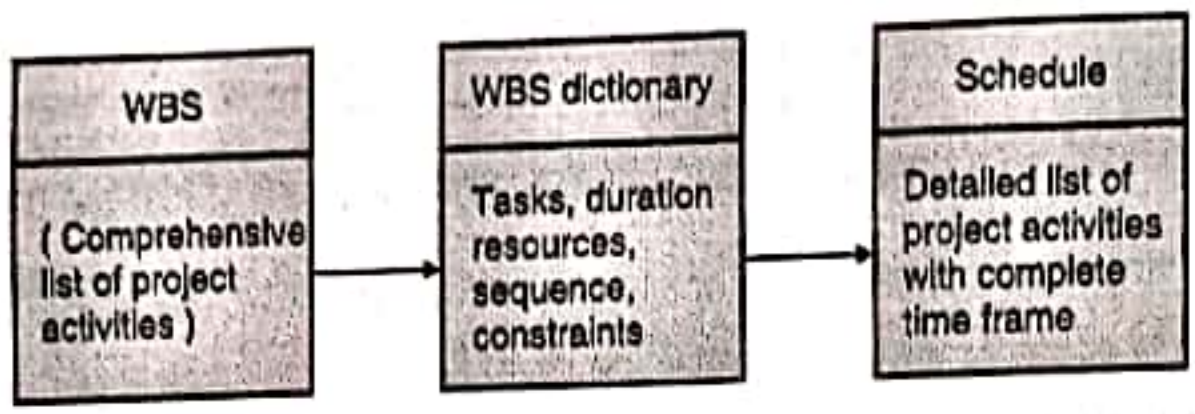

Fig. 3.1.2 : WBS – WBS Dictionary

3.1.5 WBS Diagram and Numbering System

- The WBS numbering system or the "code of accounts" is a system that shows the different level of WBS components and identifies which component belongs to which part of the WBS. Every level has a unique number assigned so that the work can be identified and tracked over time. A WBS may have varying numbers of decomposition levels, but there is a general scheme for how to number each level so that tasks are uniquely numbered and correctly summarized. Below is the general convention for how tasks are decomposed :
  - **Level 1 :** Designated by 1.0. This level is the top level of the WBS and is usually the project name. All other levels are subordinate to this level.
  - **Level 2 :** Designated by 1.X (e.g., 1.1, 1.2). This level is the summary level.
  - **Level 3 :** Designated by 1.X.X (e.g., 1.1.1, 1.1.2). This third level comprises the subcomponents to each level 2 summary element.
- This effort continues down until progressively subordinate levels are assigned for all work required for the entire project. If tasks are properly subordinated, most project scheduling tools will automatically number tasks using the above convention.

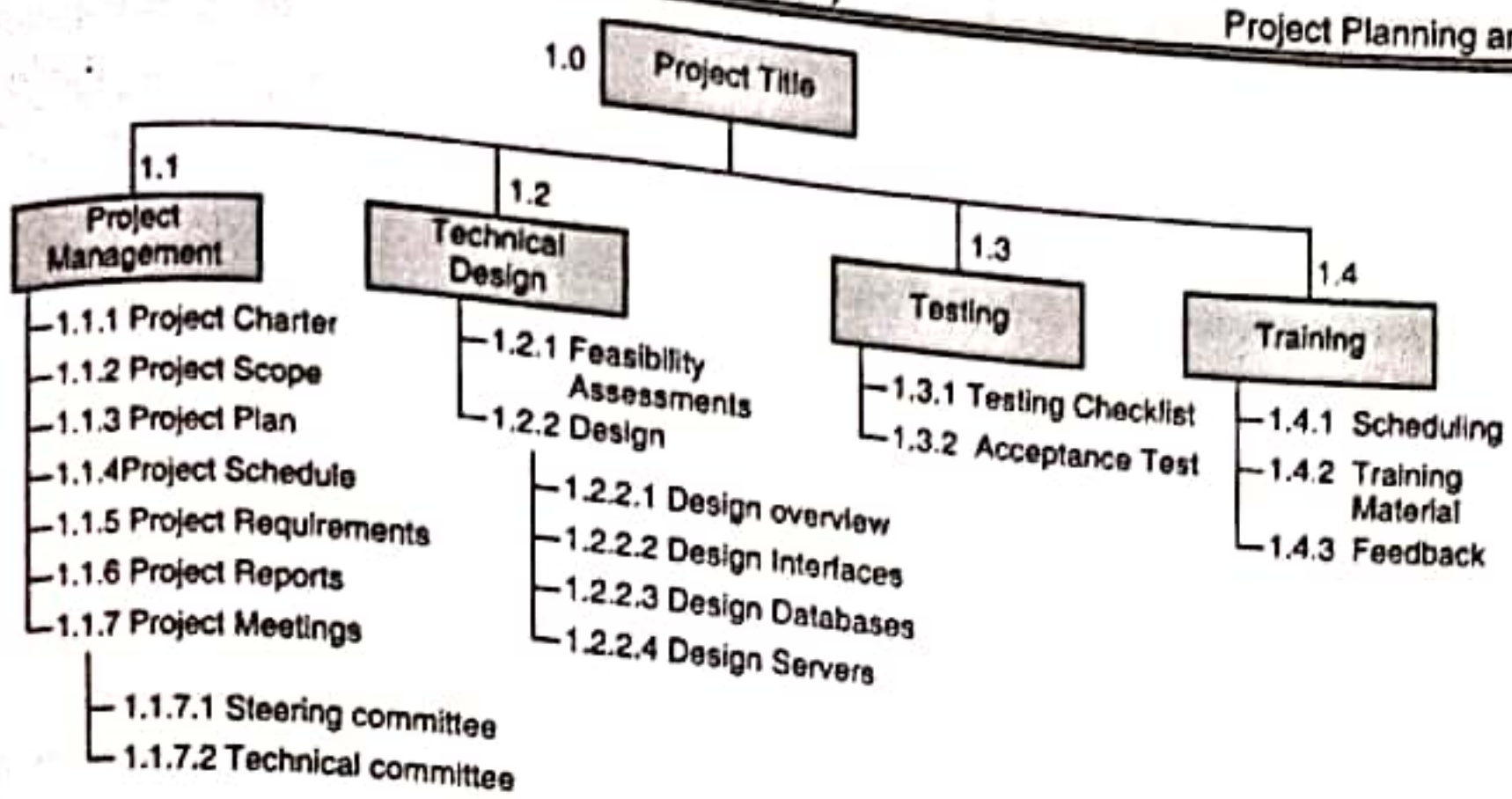

Fig. 3.1.3 : Work Breakdown Structure Diagram

- A WBS diagram starts with a graphic box at the top, which represents the entire project. Then, there are sub-components under the box. These boxes represent the deliverables of the project. Under each deliverable, there are sub-elements listed. These sub-elements are the activities that should be performed in order to achieve the deliverables.
- In addition to the general use of WBS, there is specific objective for deriving a WBS as well. WBS is the input for Gantt charts, a tool that is used for project management purpose. Gantt chart is used for tracking the progression of the tasks derived by WBS.

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3.2 LINEAR RESPONSIBILITY CHART

GQ 3.2.1 *What is LRC in project management.*

- Once the work breakdown structure has been developed, the only activity remaining for the project manager before commencing actual project execution is the creation of the linear responsibility chart (LRC) also known as Linear Chart (LC) or Matrix Responsibility Chart (MRC).
- The work breakdown structure provides the project manager with a framework of all the project tasks and activities. However, these tasks need to now be assigned to appropriate people, who will be able to take them to their logical end.
- Along with cost estimating, schedule planning and resource allocation, the project manager has to assign responsibility and accountability for the completion of the tasks identified in the WBS. A LRC allows the project manager to assign human resources to each task.
- The project manager is required to make decisions about assigning of responsibility for project activities, actions, and decisions. This warrants the creation of a linear responsibility chart or responsibility matrix.
- The linear responsibility chart or matrix provides answers to the question "who". It clearly defines the people responsible for core project activities, actions and decisions. Thus, a linear responsibility chart enables affixing accountability and responsibility for project related activities.
- A linear responsibility chart establishes a clear structure that assigns and keeps track of who is doing what. It's vital for clarifying working relationships, making sure there are no gaps in the work breakdown structure.

- The linear responsibility chart establishes clear authority-responsibility relationship among its team members so as to remove confusion and conflict in the project. It links the project task to the responsible person which ensures effective implementation of project to achieve defined objectives within constraints.

3.2.1 Linear Responsibility Chart Construction

- A linear responsibility chart is prepared to find out responsibility centre of all key activities in the project. A linear responsibility chart is similar to a common spreadsheet and is divided into rows, columns and numbers.
- The rows indicate project responsibilities, activities, and authorities, while columns identify the position of the project participants and numbers indicate the degree of authority and responsibility existing between rows and columns.
- Numeric symbols are assigned to the task leaders and assistants indicating their role, such as, primary, support, review and approval. The person responsible for submitting a specific deliverable holds the primary responsibility while others working on the task are for supporting or reviewing. The approval role usually rests with the project manager.

Steps for creating the LRC

1. Create a table and insert all the responsibilities in the columns and available human resources in the rows. The human resources could be identified by their names or their employee code or a project code specifically assigned.

ii. Identify the key roles in the team, the usual key roles are as follows: 1 = primary responsible, 2 = support work, 3 = must be consulted, 4 = may be consulted, 5 = review, 6 = final approval.

iii. Understand the strengths and weaknesses of each team member and assign roles accordingly.

iv. Develop the LRC along with team members so that will understand and agree to the responsibility assigned to them.

However, to use the LRC effectively the project manager needs to understand the relationship between each task and that some tasks may be completed before others. This means that a task cannot be assigned to another member until the previous member has finished his work. The project manager has to ensure that the tasks are evenly distributed and no one is idle or waiting for the other to finish. Also, the tasks have to be in accordance with the person's capability.

Linear Responsibility Chart	Team Member #1	Team Member #2	Team Member #3	Team Member #4	Project Manager	Consultant	Project Sponsor
1.1.1 Project Charter	2	4	2	2	1	2	5
1.1.2 Project Scope	2	2	4	3	1	2	6
1.1.3 Project Plan	3	4	2	3	1	2	4
1.1.4 Project Schedule	1	2	2	2	6	2	4
1.1.5 Project Requirement	4	1	2	2	6	2	4
1.1.6 Project Report	2	4	1	2	6	2	4
1.1.7 Project Meeting	2	2	2	1	6	2	4

LRC Keys

i) 1 = Primary Responsibility ii) 2 = Support Work

iii) 3 = Must be Consulted iv) 4 = May be Consulted

v) 5 = Review vi) 6 = Final Approval

3.2.2 Advantages and Disadvantages of LRC

GQ. 3.2.2 *Write advantages and disadvantages of LRC.*

Advantages

i) It describes the role of project participants in project matters. Authority, responsibility and accountability for project activities are delineated among various project participants. Problem-solving becomes easier.

ii) Communication is facilitated. It cuts red tape.

iii) It is a useful tool for supervising of authority and responsibilities.

iv) There is delegation of authority.

v) It postures coordination because it clarifies rules and responsibility, authority and responsibility relationships for project activities among the participates. It reduces confusion and conflict between project manager and functional managers. It helps to monitor responsibility of project participants. It combines organizational structure with work breakdown structure which makes easy to fix responsibility to project participants.

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Disadvantages

i) It does not describe about people interactions in the project. It is a mechanical aid.

ii) All relationships may be difficult to delineate.

iii) Customer-imposed requirements may limit its usefulness.

iv) It acts as mechanical tools for fixing responsibility only but not defines the relationship between project participants. It tries to express authority-responsibility relationship in specific terms. But situation and degree of all relationship may be difficult to express. Project is customer oriented and always impose requirement. The requirement may limit the usefulness of LRC.

3.3 INTERFACE COORDINATION AND CONCURRENT ENGINEERING

Introduction

Interface management process helps manage key interfaces that arise during the planning and execution of the project. In order for the project to eliminate waste (time and capital), interfaces must be managed. The interface management process consists of planning, identification, approving, auditing and closing-out interfaces. Closing out these interfaces is critical to the successful implementation and execution of the project. This procedure addresses the following :

- Outline the process for successfully coordinating and managing all key interfaces.
- Define the responsibilities for each of the teams involved with the interface requests such that the individuals are accountable to follow up the required actions.

- Define how key interfaces are identified, logged into an interface register and tracked until completion.
- Logging all key interfaces into an accessible register, and actively keep the interface register up to date.
- Define the workflow that interface requests will follow throughout their life cycle.
- Establish the process to monitor the status of the interface requests contained within the register, and actively make certain that all requests are closed-out in a timely manner.
- Implement the system by which the parties coordinate their interface activities.
- Facilitate communications between parties, including conflict resolution.
- Promote clear and consistent communication among the involved project team members for transmitting interface information.

What are Interfaces

An interface is defined as a point of connect between entities working on a common project. This point can be :

- Physical - Physical interaction between components
- Functional - Functional Requirements between systems
- Contractual - Interactions between subcontractors/suppliers
- Organizational - Information exchanged between disciplines
- Knowledge - General information exchanged between parties
- Resource - Points of dependencies between equipment, material, and labor suppliers

☞ Internal Interface

An internal interface is one where the complete responsibility lies within CONTRACTOR's scope of work.

☞ External Interfaces

Any part of the Scope of Work under the responsibility of Contractor which may influence, or be influenced by, the scope of work covered by any other contract related to the Project.

☞ Key Interfaces

- Key interfaces are interfaces that are managed by the {Project} Interface Management Team, nominated leads and/or interface coordinator.
- The {Project} Interface Coordinator will oversee and monitor these interface activities and will provide proactive support to the nominated focal points for coordinating interfaces within each discipline.

Objectives

The primary objectives of this procedure and its implementation are as follows :

- Identify the appropriate personnel who will be responsible for each interface request and for resolution of the interface request.
- Provide a system which will facilitate the identification of interfaces, and address the specific interface request requirements.

- Establish a procedure that promotes efficient management of interface issues from initiation to close out.
- Define methods for communication and coordination of interface requests between various parties.
- Facilitate clear and frequent communications amongst parties.
- Facilitate the agreement of a schedule for interface request resolution and close-out.
- Define a means for the control, expediting, and reporting of progress on the transfer of interface requests.
- Define processes of assurance that interface requests are effectively identified and managed.

Principles

Company's expectations for Contractor's Interface Management Procedure are to :

- Ensure internal interfaces are identified and managed early via a structured process;
- Ensure agreement between Contractor and Contractor groups on roles, responsibilities and timing for providing such information;
- Promote clear, accurate, timely and consistent communication with CONTRACTOR groups for transferring internal interface information required to progress the Services;
- Identify internal interface issues with potential for impacts to cost or schedule quickly and communicate to all relevant Contractor groups, including Company, in order to minimize their impact;
- All participants within the Contractor and Contractor groups are responsible for identifying and communicating internal interface issues to their lead supervisor, manager, or the designated

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Interface Coordinators

- Internal interface issues will be identified, catalogued, assessed for impact, assigned and managed throughout the duration of the PROJECT;
- Internal interface issues will be resolved at the appropriate working level within the Project organization to minimize rework (for example, engineers responsible for the design and design verification);
- Regularly advise Company on the status of resolution of internal interface issues;
- Internal interface activities will be coordinated with other CONTRACTOR work groups and process such as Management of Change, HES, QMS, and Risk Management to improve process efficiencies and avoid duplication of efforts.

All internal interfaces, whether with subcontractors or suppliers or consultants, shall be established through written procedures. These procedures shall ensure :

- Development of comprehensive internal interface matrices and registers.
- Full understanding of work scope accountabilities and responsibilities by all CONTRACTOR and CONTRACTOR group personnel.
- Information distribution through a formal system at the required times.
- Regular, documented meetings and other communication to complete internal interface agreements and agree on assignments, actions, and dates for tasks to be completed.

- Single-point accountability for internal interfaces.

Interface Procedure

General

The Interface Management Process for {PROJECT} shall follow these steps :

- Identify the Interface Manager for {PROJECT}
- Develop Interface Management Plan and Procedures.
- Identify the various teams that will interact with one another to resolve interfaces
- Identify the individual or individuals that will act as Interface Coordinator for each team
- Select the workflow that each interface request will follow
- Implement Interface Management training to all relevant interface personnel
- Organize interface workshops with project entities to Identify Key Interfaces and required dates
- Execute Interface Requests with involved parties as needed using WIMS
- Monitor, Track and Report on Performance and Progress to completion. The key activity at each of these steps is to conduct collaborative interface coordination meetings and elevate any conflicts or non-performing interfaces to the PIM for resolution.

Roles and responsibilities

Interface manager

- Develops and implements the Interface Management Procedure.
- Ensures consistency in the project wide application of the Interface Management Procedure.
- Oversees and monitors project wide internal and external interface management activity.
- Maintains the master Interface Request Register.
- Regularly reports on status of key interface activity.

Interface coordinator

- Participate in Interface Meetings with affected/involved parties as required to manage interfaces.
- Review outgoing interface requests and serve as interface request approver
- Ensure resolution of inbound interface requests
- Actively monitor interface request register to: expediting requests and open/update/close requests on behalf of their team
- Provide collaborative interface resolution support.
- Serve as PMT liaison between contractor and operating plant point of contact.
- Inform Interface Manager of potential impacts due to unsatisfactory resolution response.

Concurrent Engineering

- Concurrent engineering, also known as simultaneous engineering, is a method of designing and developing products, in which the different stages run simultaneously, rather than consecutively.
- It decreases product development time and also the time to market, leading to improved productivity and reduced costs.
- Concurrent Engineering is a long term business strategy, with long term benefits to business. It is a management and engineering philosophy for improving quality and reducing costs, and lead time from product conception to product development for new products and product modifications.

Benefits of concurrent engineering

1. **Competitive Advantage :** Reduction in time to market means that businesses gain an edge over their competitors.
2. **Enhanced Productivity :** Earlier discoveries of design problems means potential issues can be corrected soon, rather than at a later stage in the development process.
3. **Decrease Design and Development Time :** Make products which match their customer's needs, in less time and at a reduced cost.

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3.4 PROJECT COST ESTIMATING AND BUDGETING

Introduction

- Another major resource needed for the successful completion of the project is money. The project will need a budget to pay the people resource as well as to buy material resources such as software and hardware. The project needs a budget to determine the amount of money and the moment it would be needed. Hence, the project manager needs to estimate the total cost of the project.
- A budget is based on the cost inputs from vendors, suppliers, and hourly rates of the people who will be working on the project. Hence, to get the budget the project manager has to estimate the costs of all the resources that go into the implementation of the project.
- A budget serves many purposes;
  - It conveys to project stakeholders the cost of creating the deliverables that they desire. This enables them to finalize their requirement based on the ROI of that particular deliverable and its relevance in the entire project.
  - The project budget tests the project managers understanding of the finer nuances of the project. A project with a faulty budget is surely bound to go off track and place to project in jeopardy.
- A budget not only serves as an estimate of the cost of the project but also facilitates control of the project expenses. The budget will tell you what you can include in the project and what you have to leave out of it. In some cases the project may have to be put off because of non availability of funds for the project. A budget serves as a financial guide to where the project is headed.

3.4.1 Cost Estimating

GQ. 3.4.1 *Why is cost estimating important.*

- Cost estimation is an important tool that can affect the planning and budgeting of a project. Because there are a finite number of resources for a project, all of the features of a requirements document can often not all be included in the final product.
- A cost estimate done at the beginning of a project will help determine which features can be included within the resource constraints of the project (e.g., time).
- Requirements can be prioritized to ensure that the most important features are included in the product. The risk of a project is reduced when the most important features are included at the beginning because the complexity of a project increases with its size, which means there is more opportunity for mistakes as development progresses. Thus, cost estimation can have a big impact on the life cycle and schedule for a project.
- Cost estimation can also have an important effect on resource allocation. It is prudent for a company to allocate better resources, such as more experienced personnel, to costly projects. Manpower loading is a term used to measure the number of engineering and management personnel allocated to a project in a given amount of time.
- Most of time, it is worse for a company if a costly project fails than if a less costly project fails. When tools are used for estimation, management and developers can even experiment with trading off some resources (or factors) with others while keeping the cost of the project constant. For example, one trade-off may be to invest in a more powerful integrated development environment so that the number of personnel working on a project could be reduced. Cost estimation has a large impact on project planning and management.
- Cost estimation should be done throughout the project life cycle. The first time cost estimation can be done is at the beginning of the project after the requirements have been outlined. Cost estimation may even be done more than once at the beginning of the project.
- For example, several companies may bid on a contract based on some preliminary or initial requirements, and then once a company wins the bid, a second round of estimation could be done with more refined and detailed requirements. Doing cost estimation during the entire life cycle allows for the refinement of the estimate because there is more data available. Periodic re-estimation is a way to gauge the progress of the project and whether deadlines will be able to be met.
- Effective monitoring and control of the software costs is required for the verification and improvement of the accuracy of the estimates. The success of a cost estimate method is not necessarily the accuracy of the initial estimates, but rather the rate at which the estimates converge to the actual cost.
- An organization that does a great deal of contract work would place more importance on the initial estimates. However, in general, the method will be better if it converges quickly to the actual cost of the project. At the end of the project, all estimation methods have the opportunity to converge to the actual cost because enough information is available.

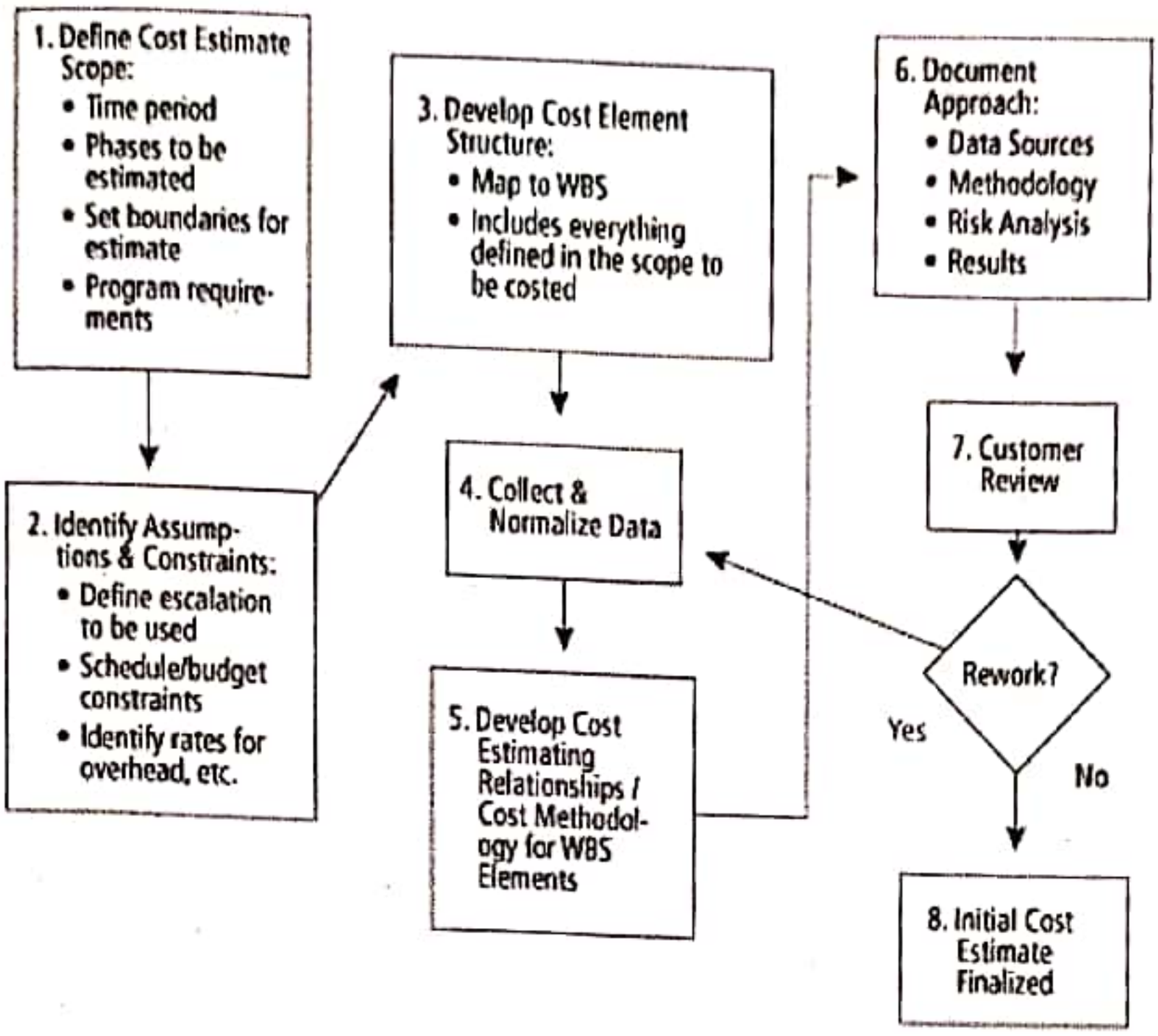

Fig. 3.4.1 : General Depiction of Cost Estimating Process

1. **Define Cost Estimate Scope :** The initial step is to define the possible scope of the cost model. The scope will determine the content of the cost elements that must be included in the model. Sources for scope definition of a program include the project management plan, the scope statement, the WBS, and any requirements documentation, etc.

2. **Identify Assumptions and Constraints :** Assumptions are statements that are used to limit the scope of the model. They are a "given" as opposed to a "fact." They usually relate to a future occurrence and therefore contain uncertainty. Assumptions must be evaluated during sensitivity analysis. Constraints are usually fixed, externally imposed boundaries such as schedule, policies, and physical limitations.

3. **Develop Cost Element Structure :** The cost element structure can also be thought of as a chart of accounts. It is a listing of the possible categories of cost contained in the model. Each element must be defined so that all costs are covered, and there are no duplications of costs within the structure.

4. **Collect and Normalize Data :** Cost data is collected for all of the elements within the model. Information from benchmark research and actual cost experience is used. Normalization is the process for ensuring that cost data are comparable.

5. **Develop Cost Estimating Relationships :** The cost data is used to develop equations that will be entered into the cost model. The equations will be the basis for estimating costs as a function of system capacity and service level.

6. **Document Approach :** Documentation is provided for each cost element that indicates the sources of data, assumptions used, and any equations that have been used in the calculations.

7. **Customer Review :** A walk-through on the model and results is conducted with the sponsor to ensure that all expected costs have been adequately represented and to achieve acceptance of the estimate.

3.4.2 Cost Estimating Process

1. Bottom-Up Cost Estimate

GQ. 3.4.2 *What is difference between a top down and bottom up cost estimate.*

- To overcome the hurdles posed by technology fluctuations, project manager should adopt the bottom-up cost estimate approach. In the bottom-up cost estimate a detailed estimate of each work component is prepared.
- As Work Breakdown Structure (WBS) and WBS dictionary define each element of the project deliverable they form the base of bottom-up cost estimate. The project manager assigns a monetary value to the completion of each phase within the WBS.
- The project is divided into phases and each phase is assigned a cost value based on the work packages within the phase. The monetary value assigned depends on the time required to complete the phase and the software and hardware requirements. Working from the bottom of the project the manager assigns monetary value to each component of the project to finally arrive at the total cost of the project.
- Each of these factors should be assigned a monetary value to complete the total phase of the project. The project manager starts from the bottom and works his way to the project deliverables. Each factor has a monetary requirement assigned which is used in arriving at the final cost.
- The following issues need to be taken into consideration while creating the budget:

Creating the WBS and the WBS dictionary

- The WBS indicates all the deliverables created in the project and hence are considered an important tool for the creation of the cost estimate for the project.
- The work packages in the WBS will help determine the resources needed to create the project deliverables.

Creating phases

- It is easier to estimate the cost of single phases rather than the entire project.
- Creating phases facilitates the identification of milestones and assigning the resources and time required for the completion of each phase.

Integrating phases

- The creation of the budget helps in addressing concerns related to downtime, work lag, time required for completion and the time required by the project manager to ensure that the tasks are being completed as per the schedule of the project.
- Monetary value helps people in understanding the gravity of the situation.

Consider the complete workload required to complete the project

- An estimate will be accurate if and only if the complete workload i.e. the amount of work, in hours, required to complete each phase of the project is correctly determined. Thus, the man-hours necessary to complete each phase of the project must be taken into consideration while estimating.

- A monetary value should be assigned to these man hours to determine the exact expenditure of the implementation.
- In the event of the workload being outsourced, the hourly rate will also include overhead and administrative expenses that the organization will incur in getting the work done. Therefore, the project manager should be aware of all the costs that go into the final cost of the project.

Cost for utilizing specialized services

- Many projects are not within the realm of the project manager and require the services of subject matter experts. The project may also require the team to be trained for its testing and implementation.
- These specialized services may prove costly if overlooked during the estimating process and hence need to be planned before the commencement of the project.

Cost for purchasing/leasing equipment

- Although it is easier to account for equipment that is purchased for a particular project it is a bit difficult when the same equipment is leased.
- However, both the costs i.e. cost of leasing and purchasing should be compared before arriving at any decision.

Cost incurred on miscellaneous production expenditure

- There are a handful of expenses which are incurred on every project but always fail to be accounted for.
- Costs incurred on photocopying, developing and designing user manuals, etc need to be taken into consideration before arriving at the final cost.

Cost incurred on adhering to quality standards

The various levels of testing needed to ensure the quality of the project needs to be accounted for.

Cost incurred on risk management

- Although risks are vague in the initial stages of the project and information on risk emerges as planning progresses.
- Cost will be incurred on rework, risk mitigation and schedule delays caused due to risks.

3.4.3 Creating an Allowance for Change

- While estimating the project manager needs to provide an allowance for change. Allowance for change can work not only for estimating costs but also while estimating the time that will be taken to perform a particular project task.
- Thus, while estimating costs the project manager should create an average estimate for each phase of the project by factoring best and worst case scenarios into components that may fluctuate on price.
- Creating an allowance for change, also called as three point estimating provides for three estimates, namely, worst case estimate, most likely (average estimate) and optimistic estimate.
- Not all elements of the estimate will come close to the worst case estimate or for that matter the most likely estimate.
- Some elements may reach the worst case estimate and some may reach the optimistic estimate, thus evening out the effect.

- Following are the factors that help in determining the cost estimate of each element of the project :
  - Prior experience
  - Historical information
  - Fixed quotes from suppliers
  - Standard costs

3.5 TOP-DOWN AND BOTTOMS UP BUDGETING

GQ. 3.5.1 *What is Top-down cost estimate.*

- In this form of estimating the project manager takes the budget of a similar project and estimates the budget for the current project. Project managers use this approach when they undertake projects which are similar to the ones they have implemented in the past.
- The information available with the project manager allows him to save time on estimating the cost of the project using the bottom-up approach. However, this approach is not so useful for IT projects as most of them are new and IT infrastructure changes rapidly making it difficult to work on historical information. Hence, these estimates are not reliable and are not acceptable to management as the final estimate.

3.5.1 Analogous Estimating

GQ. 3.5.2 *Describe analogous cost estimating.*

- In many organizations, project estimates are grossly inaccurate and useless to decision-makers. The project managers estimate cost and duration by just providing estimates that have no factual basis. It's particularly tough to make the opening estimates at the beginning of a project when very little of project details are available and the uncertainty is high.
- Usually the project manager has never done a project like the new one but the management still wants an accurate cost and duration estimates.
- The management need decision-making data about how long it will take and how much it will cost to decide whether the project's worth doing. Very often, the project manager can easily find out how long the management want the project to take and how much they want it to cost.
- Even the management may be confused about the difference between a good accurate estimate and the numbers they want. This estimating cycle is what causes 70% of the projects in some organizations to finish late and over budget. This high failure rate not only undermines the credibility of individual project managers but it makes it almost impossible for the organization to launch strategic initiatives that may require synchronization of a number of projects.

3.5.2 How Analogous Estimating Works

- Analogous estimating is accurate and based on hard data. It is easy to implement and also offers the potential for substantially increasing the organization's success rate on projects from 30% to 60% and above.

- Organization needs to keep track of the hours of work that each team member works on a project each week as well as the costs incurred to get the project done. In as little as 3 months, the organization will have a good start on a database for estimating new projects.
- This data gives the best possible tracking on project progress and is the basis for analogous estimating.
- Obviously, the new projects are not identical to ones already completed. Nevertheless, some of the tasks and some of the deliverables in the new project are going to be similar to tasks and deliverables in the old one.
- Project managers may have to look through a number of previously completed projects to find tasks and/or deliverables that are roughly similar to those in the new project.
- The longer the organization builds these archives of its project work and cost data the more valuable it will be. After a year or two, it becomes relatively easy for project managers to find similar deliverables and tasks. They focus the rest of the estimating process on finding these analogous deliverables.
- Then the project manager and sponsor make adjustments to the historic data to reflect the differences between the old project and the new one.
- As an example, a new project may require a training session for the employees who will work on the new procedures and processes that the new project produces. Project manager could look at the hours' worth of work to needed to create the training class curriculum in a previous project.
- He might also look at the actual classroom time used on the previous project. Then the project manager would consider the differences in complexity, scale, scope and focus between the old project and the new. The project manager for the trainers in human resources might compare the two training efforts and say that the new one is 20% more difficult and will take 20% more time.
- Then the project manager would adjust the historic data. Getting input from the people who will do the work is exceedingly valuable and puts a project manager in a position where he can present the data on the work and cost of deliverables that has a solid basis in reality.
- Certainly, we can debate the size of the adjustment factor but when we do we are still discussing the actual amount of work for a training class based on a previous project and that is much better than taking data plucked from the sky.
- We can use analogous estimating to develop initial estimates when a project is first considered or initiated. We can also us it when we are making estimates of the work and duration of the team members' tasks.
- We can use the analogous estimating technique at any level of the project. We can use it for the project's overall work and duration. We can also use it to estimate the work and duration on individual tasks we will assign to team members.

Parametric Modelling

- An estimating technique that uses a statistical relationship between historical data and other variables, for example lines of code in software development, to calculate an estimate for activity parameters, such as scope, cost, budget, and duration.
- This technique can produce higher levels of accuracy depending upon the sophistication and the underlying data built into the model. An example for the cost parameter is multiplying the planned quantity of work to be performed by the historical cost per unit to obtain the estimated cost.

3.5.3 Elements of Budgets and Estimates

GQ. 3.5.3 *What are the elements of Budgeting.*

- The project budget is critical as funding is based on it, project success is derived from how closely you manage to it and without it you can't perform any work on the engagement. Properly pricing the project – properly estimating the costs that go into the project – is critical for any size engagement.
- Therefore, it's always a good to examine the elements that go into the overall project budget and study the influence of the inputs to the project costs and budget. Let's examine the key types of costs that go into the project budget.

3.5.3.1 The People Costs

- These are the costs associated with the personnel on the project. They include salaries and the cost of benefits (such as vacation time and health insurance) if they apply.
- Employee or contractor salaries and expenses are one of the biggest budget items on any project and especially IT projects.

3.5.3.2 The Administrative Costs

- Administrative costs are the everyday costs that support the work of the project but are not necessarily directly related to a specific task on the project. Phone expense, copier paper, heating expenses, and support personnel are examples of administrative costs.
- Project teams have to work and meet somewhere, so that means that there is some sort of facilities expense in the form of rent, lease, or mortgage payments. If the building or facility was leased or purchased specifically for the project, it would be classified as a project cost instead of an administrative cost.

3.5.3.3 Project Resource Costs

- Resource and project costs include things such as materials needed for specific tasks, equipment leases, travel expenses, and so on.
- These expenses are specific to the project. Resource costs are typically the largest expense and estimating these costs will require research by the project manager and team.
- If you as the project manager have initial budget input or responsibility for creating the initial project budget, then careful examination of each of these categories will help you come up with a reasonable budget for the project. If not, being aware will help you identify what may have been missed and it will certainly help you as you manage the project budget on an ongoing basis throughout the engagement.

3.5.3.4 Direct costs vs. Indirect Costs

- In addition to the three categories of project costs we discussed above, there are also two types of costs: direct and indirect costs.
- Direct costs include costs such as salaries, equipment rentals, software, and training for team members. Any cost that can be directly attributed to project work is a direct cost.

Direct costs = Cost specifically related, to the work of the project

- Indirect costs are not specific to the project. When your project team works with other members of the organization who are not working on the project in the same building, things like the lease cost of the building would be considered an indirect cost because it is not specifically related to the project.
- Another indirect cost would be administrative staff who will be assisting you with project activities but aren't assigned specific project tasks themselves.

Indirect costs = Costs associated with the project but not directly related to the work of the project.

- Each organization is different, so work with accounting to see how indirect costs should be handled in your project budget.

3.6 NETWORK AND SCHEDULING TECHNIQUES

3.6.1 PERT Technique

- PERT was developed in the context where many activities associated with the project had never been attempted previously (e.g. R & D and Software projects).
- PERT was developed to handle projects where time duration for each activity is no longer just a single time estimate, (i.e. decision-makers best guess) but is a random variable which is characterized by some probability distribution - usually a β (beta)-distribution. To estimate the parameters of the β-distribution (the mean and variance), the PERT model requires three time estimates for each activity.

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- From these times a single value is estimated for future consideration. The three-time estimates required are as under.

(i) **Optimistic time (t_o or a) :** The shortest possible time (duration) in which an activity, can be performed assuming that everything goes well.

(ii) **Pessimistic time (t_p or b) :** The longest possible time required to perform an activity under extremely bad conditions. However, such conditions do not include acts of God like earthquakes, flood, etc.

(iii) **Most likely time (t_m or m) :** The time that would occur most often to complete an activity, if the activity was repeated under exactly same conditions many times. Obviously, it is the completion time that would occur most frequently (i.e. model value).

- The β-distribution is not necessarily symmetric, the degree of skewness depends on the location of t_m to t_o and t_p. Thus the range specified by the optimistic time (t_o) and pessimistic time (t_p) estimates is assumed to enclose every possible estimate of the duration of the activity.
- The most likely time (t_m) estimate may not coincide with the midpoint $(t_o + t_p)/2$ and may occur to its left or to its right as shown in Fig. Because of these properties, it is justified to assume that the duration of each activity may follow Beta (β)-distribution with its unimodal point occurring at t_m and its end points at t_o and t_p.

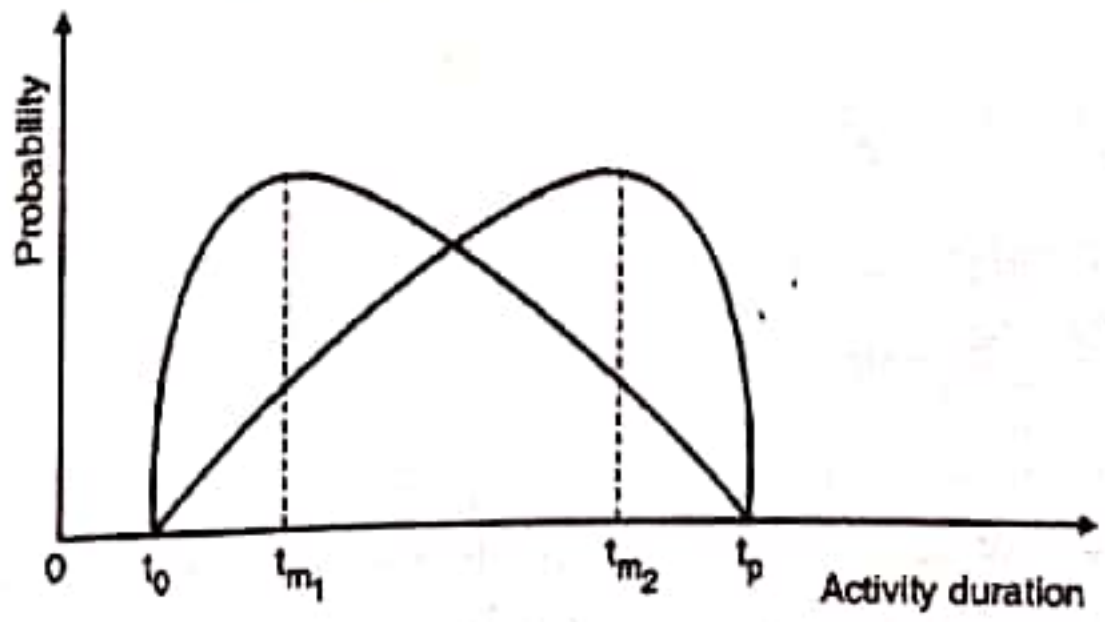

Fig. 3.6.1 : An Example of a Beta Distribution

- In Beta-distribution the midpoint $(t_o + t_p)/2$ is assumed to weigh half as much as the most likely point (t_m). Thus the expected or mean (t_e or μ) time of an activity, that is also the weighted average of three time estimates, is computed as the arithmetic mean of $(t_o + t_p)/2$ and $2\ t_m$. That is

$$\text{Expected time of an activity } (t_e) = \frac{(t_o + t_p)/2 + 2\,t_m}{3} = \frac{t_o + 4\,t_m + t_p}{6}$$

- With uncertain activity time, variance can be used to describe the dispersion (variation) in the activity time values.
- The calculations are based on an analogy to the normal distribution where 99 per cent of the area under normal curve is within $\pm 3\sigma$ from the mean or fall within the range approximately 6 standard deviation in length, therefore the interval (t_o, t_p) or range $(t_p - t_o)$ is assumed to enclose about 6 standard deviations of a symmetric distribution.

Thus, if σ_i denotes the standard deviation of the duration of activity i, then

$$6\sigma_i \equiv t_p - t_o \qquad \text{or} \qquad \sigma_i = \frac{t_p - t_o}{6}$$

$$\text{Variance of activity time, } \sigma_i^2 = \left[\frac{1}{6}(t_p - t_o)\right]^2$$

- If we assume that the durations of the activities are independent random variables, then the variance of the total critical path's duration is the sum of the variances on the critical path. Suppose σ_c is the standard deviation of the critical path. Then

$$\sigma_c^2 = \sum \sigma_i^2 \text{ and } \sigma_c = \sqrt{\sum \sigma_i^2}$$

3.6.2 Estimation of Project Completion Time

- Since we expect variation in the activity duration, therefore the chance of completing the project in a desired time and the duration necessary for obtaining any desired probability of actually meeting the scheduled time can be calculated as discussed below :
- The probability distribution of times for completing an event can be approximated by the normal distribution due to central limit theorem. Thus, the probability of completing the project in the schedule (or desired) time, T_s is given by

$$\text{Prob}\left(Z = \frac{T_s - T_e}{\sigma_p}\right)$$

where, T_e = expected completion time of the project

Z = number of standard deviations the scheduled times (or desired completion times) lies away from the mean or expected date.

$$\sigma_i^2 = \sigma_1^2 + \sigma_2^2 + \sigma_n^2$$

is the sum of variances of critical activities.

The desired completion time of the project can be calculated as:

$$T_s = Z\sigma + T_e$$

- Where, value of Z corresponds to the probability of project completion time. The computation of T_s enables a decision-maker to make certain commitments knowing the degree of risk assumed.

The expected completion time of the project is obtained by adding the expected time of each activity lying on the critical path. Since it is assumed that the two activities are independent, therefore variance of the critical path can be known by adding variance of critical activities. We will understand PERT with the help of following example.

Ex. 3.6.1

A small project is composed of 7 activities whose time estimates are listed in the table below. Activities are identified by their beginning (i) and ending (j) node numbers.

Activity	Estimated Duration (weeks)		
(i – j)	Optimistic	Most Likely	Pessimistic
1 – 2	1	1	7
1 – 3	1	4	7
1 – 4	2	2	8
2 – 5	1	1	1
3 – 5	2	5	14
4 – 6	2	5	8
5 – 6	3	6	15

Module 3

(a) Draw the network diagram of activities in the project.

(b) Find the expected duration and variance for each activity. What is the expected project length ?

(c) Calculate the variance and standard deviation of the project length. What is probability that the project will be completed ?

(i) at least 4 weeks later than expected time.

(ii) no more than 4 weeks later than expected time.

(d) If the project due date is 19 weeks, what is the probability of not meeting the due date.

Given	Z	0.50	0.67	1.00	1.33	2.00
	Prob	0.3085	0.2514	0.1587	0.0918	0.0228

Soln. :

The network diagram of activities in the project is shown in Fig. The earliest and latest expected time for each event is calculated by considering the expected time of each activity as shown in Table.

Table P. 3.6.1

Activity	t_o	t_m	t_p	$t_e = \frac{(t_o + 4t_m + t_p)}{6}$	$\sigma^2 = \left[\frac{(t_p - t_o)}{6}\right]^2$
1 – 2	1	1	7	2	1
1 – 3	1	4	7	4	1
1 – 4	2	2	8	3	1
2 – 5	1	1	1	1	0
3 – 5	2	5	14	6	4
4 – 6	2	5	8	5	1
5 – 6	3	6	15	7	4

The E-values and L – values bases on expected time (t_e) of each activity are shown in Fig. P. 3.6.1.

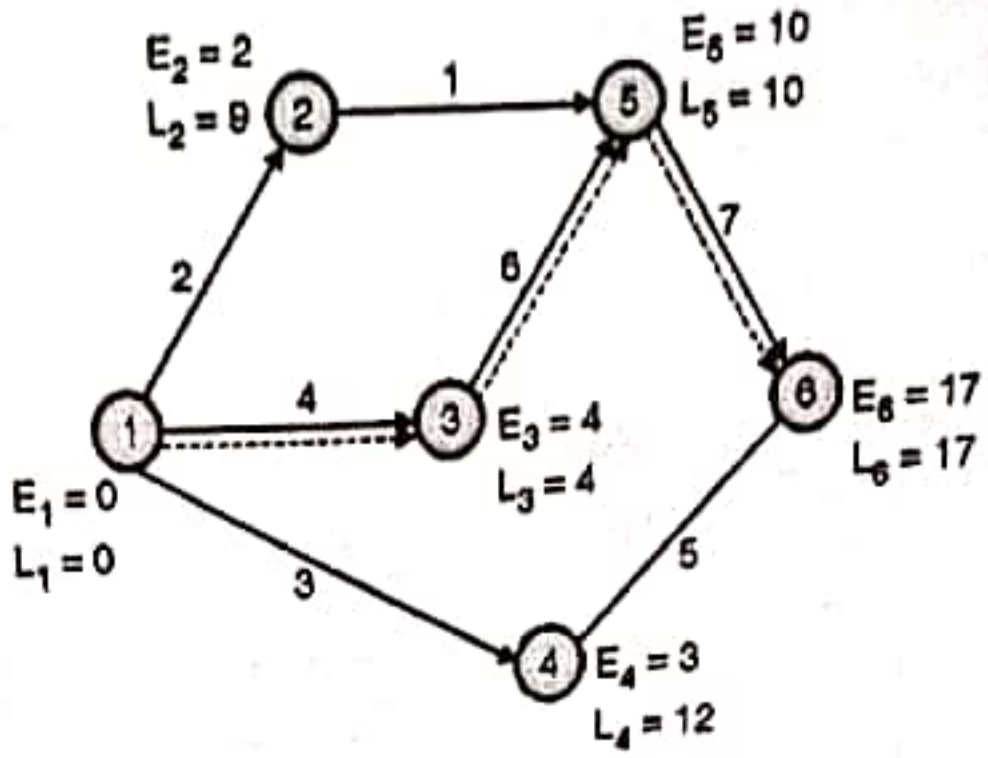

Fig. P. 3.6.1 : Network diagram

(a) Critical path is : 1 – 3 – 5 – 6.

(b) The expected duration and variance for each activity is shown in table 7.4. The expected project length is the sum of the duration of each critical activity. That is,

Expected project length = 1 – 3 – 5 – 6 = 4 + 6 + 7 = 17 weeks.

(c) Variance of the project length is the sum of the variances of each critical activity, that is

Variance of project length = 1 – 3 – 5 – 6 = 1 + 4 + 4

= 9 weeks.

Therefore, Standard deviation,

$$\sigma_p = \sqrt{9} = 3$$

(i) Probability that the project will be completed at least 4 weeks earlier (i.e. 13 weeks) than expected time of 17 weeks is given by

$$\text{Prob.}\left\{Z \le \frac{T_s - T_e}{\sigma_p} = \frac{13-17}{3}\right\} = \text{Prob. } \{Z \le -1.33\} = 0.5 - 0.4082 = 0.0918$$

Thus the probability of completing the project in less than 13 days is 9.18 per cent.

(ii) Probability that the project will be completed in 4 weeks later (i.e. 21 weeks) than expected time of 17 weeks is given by

$$P\left\{Z \ge \frac{21-17}{3}\right\} = P\{Z \ge 1.33\}$$

$$= 0.5 + 0.4082 = 0.9082.$$

3.6.3 Critical Path

- In the previous section we have computed the earliest and latest time of all the project activities. Once that is over with as project manager you would be eager to know the minimum time required for the completion of the entire project. For this you would be required the critical path of the project.
- The critical path denotes the sequence of events that determine the project completion date. It is the longest path from project start to completion.

- Every project has multiple paths from project start to completion but there is only one path that takes longer than any other path in the project network diagram and this is our critical path.
- A path is series of continuous activities through the network that start from the initial node of the network to its final node.
- Now, every network has multiple paths that start from the initial node and culminate at the final node.
- However, all these paths are not critical paths. The critical path is the longest path.

3.6.4 Why is the longest path the critical path

GQ. 3.6.1 *Why is the longest path the critical path ?*

- This is because a delay in any activity on this path is going to lead to a delay in the completion of the project. However, a project could have more than one paths vying for the title of critical path.
- The Critical path is the continuous chain of critical activities in a network diagram.
- It is the longest path starting from start to completion and is shown by a thick line or double lines crossing the activity line in the network diagram.
- In some cases a project may have more than one critical path. This means that there may be two or more than two paths that may be consuming the same time for their completion.
- In such case all these paths are considered to be critical to the completion of the project and are thus critical paths of the project.

Ex 3.6.2

In the table below are given activities of a construction period along with their duration. Draw a network diagram and also identify the critical path.

Table P. 3.6.2

Activity	Duration
1 - 2	3
1 – 3	2
1 – 4	6
2 – 4	5
2 – 5	7
3 – 4	2
4 – 5	4

Soln. :

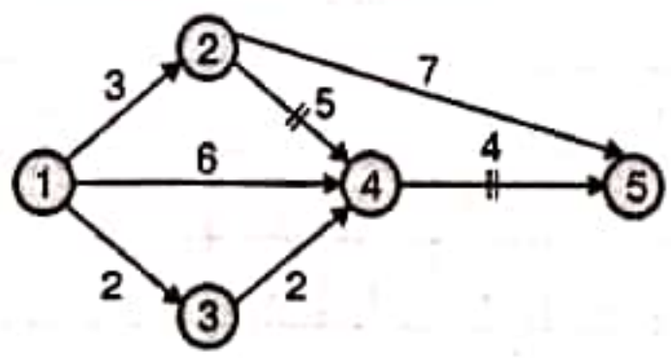

Fig. P. 3.6.2

Four different paths can be traced from beginning to end of the network and total time for each path can be calculated as follows :

Table P. 3.6.2(a)

Sr. no.	Path	Total duration (days)
1	1 – 2 – 5	3 + 7 = 10
2	1 – 2 – 4 – 5	3 + 5 + 4 = 12
3	1 – 4 – 5	6 + 4 = 10
4	1 – 3 – 4 – 5	2 + 2 + 4 = 8

The path which takes the longest time is called the critical path. Here second path, i.e. 1–2–4–5, is longest and hence the critical path.

Table P. 3.6.2(b)

Activity	Normal time (days)	Earliest Time		Latest Time		Total Float
		Start	Finish	Start	Finish	
1 – 2	3	0	0	3	3	0
1 – 3	2	0	0	2	6	4
1 – 4	6	0	0	8	8	2
2 – 4	5	3	3	8	8	0
2 – 5	7	3	3	12	12	2
3 – 4	2	2	6	8	8	4
4 – 5	4	8	8	12	12	0

- As the total float of activities 1 – 2, 2 – 4, and 4 -5, is 0 they are the critical activities of the project and the critical path is 1-2-4-5.
- Also, based on the size of the total float activities 1 -4, and 2 -5 are sub-critical activities and activities 1-3 and 3-4 are non-critical activities.
- However for bigger networks, a more systematic approach is needed. It is possible to indentify the critical path by study of earliest and latest times at which an event can occur.

Ex. 3.6.3

The following data pertains to a small construction project. You are to draw the network diagram, find project duration and mark critical path.

Table P. 3.6.3

Event	A	B	C	D	E	F	G	H
Activity	1-2	1-3	1-4	2-3	2-5	3-5	4-6	5-6
Duration	2	4	3	0	1	6	5	7

Soln. :

▶ **Step 1 :** We will first be drawing the network diagram based on the data in the table. The number next to activity on the arrow denotes the duration of the activity and the one in the bracket denotes the manpower required to complete the activity. Activity D is a dummy activity and hence has no duration.

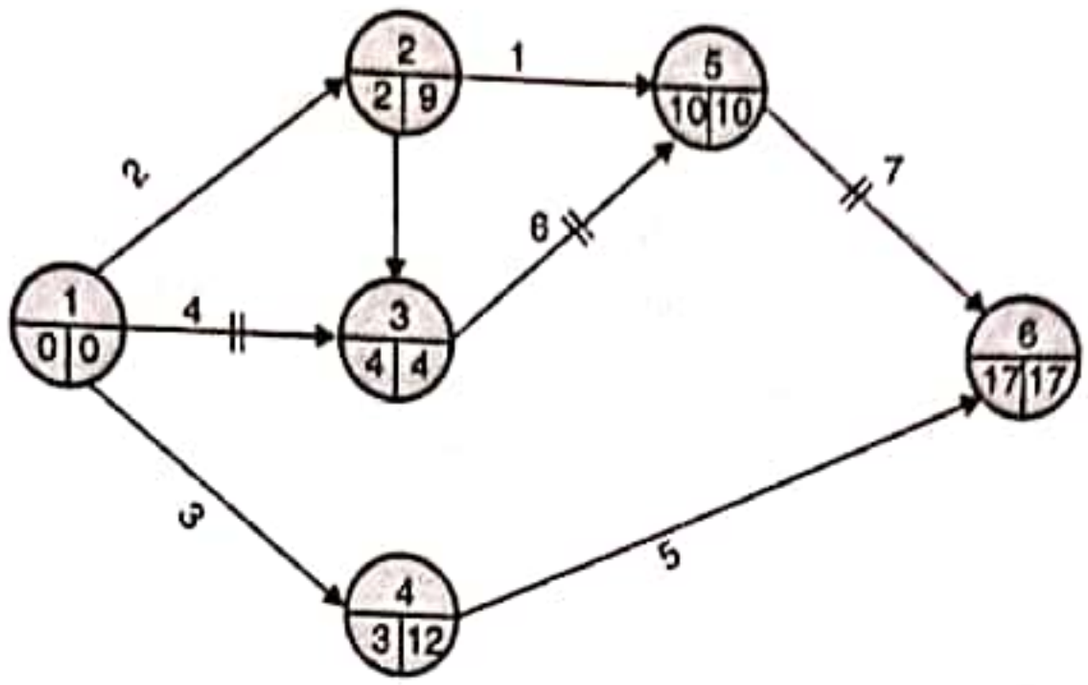

Fig. P. 3.6.3

▶ **Step 2 :** In the next step we shall calculate the earliest and latest start and finish times of all the activities. This will denote the project duration which in this case is 17 days. The critical path is 1 -3 – 5 – 6.

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Table P. 3.6.3(a)

Activity	Normal time (days)	Earliest Time		Latest Time	
		Start	Finish	Start	Finish
1 – 2	2	0	2	7	9
1 – 3	4	0	4	0	4
1 – 4	3	0	3	9	12
2 – 3	0	0	0	0	0
2 – 5	1	2	3	9	10
3 – 5	6	4	10	4	10
4 – 6	5	3	8	12	17
5 – 6	7	10	17	10	17

▶ **Step 3 : Conditions of Critical Path**

The following conditions are applicable for locating the critical path in a network.

i) **Condition 1 :** When the earliest start time (ES) of an activity equals the latest finish time (LF) at the head of the arrow and if the ES equals the LF at the tail of the arrow, then the activity is probably a critical activity. E.g. for activity 3 – 5 the ES at the head of the arrow i.e. activity 5 – 6 is 10 which is the same as the LF while the ES at the tail of the arrow is 4 which also coincides with the LF.

ii) **Condition 2 :** once the first condition has been met then only can we test the activity for the second condition for qualifying as a critical activity. Under the second condition the difference between the ES time at the head of the arrow and the ES time at the tail of the arrow should be equal to the duration of the activity. E.g. for activity 3 – 5 the difference between the head of the arrow and the ES at the tail of the arrow is 6 which is exactly the duration of the activity. Thus activity 3 – 5 is a critical activity. Similarly other activities can be tested to find out whether the lie on the critical path.

The CPM uses the Network Model in which activities are depicted as nodes on the network and events signify the beginning/ending of activities and are depicted as lines between the nodes. The objective of critical path analysis is to estimate the total project duration and to assign starting and finishing times to all activities involved in the project. This helps in checking actual progress against the scheduled duration of the project.

3.6.5 Gantt Chart

GQ. 3.6.2 *How do you create a Gantt chart.*

GQ. 3.6.3 *What is Gantt chart used for.*

- A Gantt chart or more popularly known as the bar chart is one of the most commonly used project management tools and are used in tracking project schedules.
- Although, the Gantt charts were originally devised by Karol Adamiecki in the 1890's, they were later on modified by Henri Gantt, an American engineer and management consultant, and hence they are widely known in western countries as Gantt charts.
- Gantt chart provide a standard format for displaying project schedule information by listing project activities and their corresponding start and finish dates in a calendar format. These charts are also referred to as bar charts as activity start and finish dates are shown by horizontal bars.
- The primary reason for the popularity of the Gantt charts is because they are easy to plot and simple to understand.
- The Gantt adopts a very simple process of showing activities (tasks or events) displayed against time.
- A Gantt chart is a graphical representation of a project plan on a time scale. The X axis of the chart represents time i.e. project duration while the Y axis represents activities in the form of rectangular bars.
- The position and length of the bar reflects the start date, duration of the activity and the end date of the activity.
- Each horizontal bar represents one specific activity to be performed and the beginning and end of each bar represents the commencement and completion of the activity.
- The Gantt chart enables the user to :
  - Identify the various activities in the project
  - Identify the beginning and end of each activity
  - Identify the duration of each activity
  - Identify the overlapping of activities
  - Identify the start and end date of activities

- Therefore, in simple terms a Gantt chart enables the user to understand what has to be done i.e. the activities to be performed and when it is to be done i.e. the schedule of the activities.

1. **Creating Gantt chart**

- Gantt charts are widely used in business to describe and monitor all kinds of projects according to the rules of project management.
- The basic requirement of a Gantt chart is a detailed project plan. A project plan is a series of interdependent tasks that need to be performed in a particular order, for example you create a WBS before developing a project scope statement.
- Project plans have a specific start date, corresponding to the start of the first task, and a specific end date, corresponding to the end of the last task.
- The project plan can be created by using the Work Breakdown Structure, which splits tasks into sub tasks and creates a task hierarchy.
- Once the project plan is complete the project manager can create the Gantt chart. The X axis will have specific units of time designated such as days, weeks, etc. Activities on Y Axis are listed in order of the earliest start on the project.
- Activities are first listed out vertically in a logical sequence of execution. Tentative duration of each activity is estimated based on the availability of resources.
- Activities on the Gantt chart should coincide with the activities on the WBS which in turn should coincide with the activity list and milestone list.
- The scheduling starts from the project start date and tasks start as soon as possible which means that the project finishes at the earliest possible date. However, while scheduling the project manager has to keep in mind the number of working days in the week and the number of working hours in the day.
- The tasks are named and duration and resources are assigned to each task. The project manager will need to specify the dependencies between the project tasks.
- Any change in the timing of a task affects all the tasks that depend on it. If a task runs ahead of schedule, the Gantt should recalculate the dates of all the tasks that depend on it in order to take advantage of the time gained. Conversely, if a task is delayed, all the tasks that depend on it are rescheduled, which may or may not impact the overall end date of the project.
- The Gantt chart for IT project management contains milestones, summary tasks, individual task duration and arrows showing task dependencies.

Example

Activity No	Activity Description	Duration in Days	Remarks
1	Task1	5 days	
2	Task2	2 days	
3	Task3	6 days	Starts with activity 2

Activity No	Activity Description	Duration in Days	Remarks
4	Task4	4 days	Starts 2 days after activity 3 or after completion of activity 2
5	Task5	4 days	Starts after completion of activity 4
6	Task6	12 days	Starts after completion of activity 5
7	Task7	3 days	Starts after completion of activity 6
8	Task8	2 days	Starts after completion of activity 5
9	Task9	5 days	Starts after completion of activity 6
10	Task10	12 days	Starts 3 days after starting of activity 9
11	Task11	4 days	Starts with activity 10
12	Task12	12 days	Starts 3 days after starting of activity 11
13	Task13	6 days	Starts 1 days after starting of activity 12
14	Task14	5 days	Starts after completion of activity 13
15	Task15	4 days	Starts after completion of activity 14

Total duration without considering overlapping of activities = 86 days

Actual duration after considering the overlapping of activities = 86 – 37 = 49 days

2. Using Gantt Charts to compare actual dates with planned dates

- The Gantt chart can be used to evaluate progress on a project by showing actual project information. The chart can be designed to compare the planned and actual project schedule information.
- The planned schedule dates for activities are called the baseline dates and the planned schedule is called baseline schedule.
- The Gantt chart includes columns depicting the actual and finish dates for each activity and columns depicting the baseline start and finish for each activity. A one on one comparison enables project stakeholders to compare the actual progress with the planned.

3.6.5.1 Advantages of Gantt Chart

GQ. 3.6.4 *Write advantages of Gantt Chart.*

- Gantt chart provides vital information in simple graphical and tabular format
- Gantt chart is easy to understand by everyone in all levels of hierarchy starting from top management to workers working on the project.
- Gantt chart is a tool in which project planning, scheduling and controlling all these activities can be performed using a single chart.
- Using Gantt chart manager can easily find out the work load on machines and current status of the work progress.

- Gantt chart is flexible to apply with some common changes.
- Project monitoring and evaluating the project is easy by using Gantt chart.

3.6.5.2 Limitations of Gantt Chart

- Gantt chart does not provide the details regarding the operations progress.
- Interrelationship between various operations is not clear in Gantt chart.
- Gantt chart is static in nature and for changes in schedule and plans, the entire old Gantt chart need to be replaced by a new one.
- Gantt chart does not provide information related to manpower, machinery performance and breakdowns.
- CPM (Critical Path Method) and PERT (Program Evaluation Review Technique) are project management techniques, which have been created to overcome the limitations of Gantt.

3.6.5.3 Milestone Chart

GQ. 3.6.5 *Explain milestone chart.*

- Milestones, as we have seen, are important part of the project schedule especially for large projects. Project managers like to focus on meeting milestones so as to emphasize the project accomplishment.
- Milestone charts are similar to Gantt Charts only that they highlight the scheduled completion of major deliverables and key external interfaces.
- The Gantt chart can also be made to incorporate the milestones within the project. Milestones are marked by the completion of various project activities/tasks and hence are created by entering them as tasks with zero duration.

Module 3

3.7 FORMULATING A NETWORK MODEL

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

1. The steps in network planning are as follows :

- Identify and list the category of activities involved from the start to the completion of the project. The activities are grouped in categories which are different from each other.
- Arrange the list of activities in sequential order of their performance. There may be activity which can be started only after the completion of some other activity, whereas there may also be some other independent activity which can be started simultaneously.
- Also, some activities may be started after the lapse of certain time of a certain previous activity. It is essential that the project manager studies each activity, understands their interrelationship and the duration each activity would take.
- In network planning, such independent and inter-dependent activities are laid down along with their estimated time schedule, i.e. the duration estimated from the start to the completion of the activity.
- Network planning of the project schedule makes the monitoring and controlling of the project easier than to look around the list of activities and locate lapses, if any.

- The network planning as detailed here is a tool available to the project management for a systematic project scheduling.
- Under such method the inter-relationship of the various activities involved in the project schedule will be visible in the total plan and, as such, steps can be taken to economise the consumption of resources, wherever possible.
- Classical approach to project planning such as the Gantt Charts lacked completeness in three fronts.
- These charts failed to show the logical sequence of activities and their interdependence.
- These charts could not indicate how a failure of performance in one task would affect others and the overall project in terms of time and cost.
- These charts could not show the possibilities of reducing time by expediting a limited number of specified tasks and thereby aim at project cost trade off.
- To overcome these three basic limitations of Gantt charts the technique of Network Planning was developed. These limitations of Gantt charts are the strengths of Network Planning.
- Also, the rapid advancement in technology, increased complexity of project planning and the requirement for speedy execution prompted the need for a more versatile project planning technique.
- Network Planning techniques have proved to be an effective management tool for planning, scheduling and controlling of complex projects involving the interlinking of numerous tasks.
- Network Planning is a systematic quantitative structured approach to problem solving in project management. Network Planning is easy to understand and analyze and hence a very popular tool in project planning.
- Network Planning often referred to as logic diagrams are a great way to understand and visualize how the project will proceed.
- Network Planning is a sequence of steps (activities), commonly represented by blocks, that are lined together in the logical sequence in which they are to be performed.
- The network/logic diagram follows the completion of the work breakdown structure. Once the logic diagram has been completed a clear picture of the required sequence of events and activities for the project emerge.
- The project team is able to clearly see the logic rules affecting activities.
- The following logic-network diagram will make things more clear. The example taken to explain the concept is from our daily lives and hence is simple to understand. We shall be studying the making of a cup of tea through the logic-network diagram.

2. Network Planning explained through the simple process of Tea making

- Imagine that you are making tea. We could break the process down into several jobs or activities, some of which depend on others to have finished before they can start.
- The activities each need one person to do them. No-one can do two things at once. Here is a list of all the jobs:
- Clean cup, boil water, put bag in cup, pour water into cup, add sugar, add milk, drink tea.
- The problem is that you can't pour water into a dirty cup. You must clean the cup before pouring in the water. We can summarize the order in which we do the activities in a precedence table.

Table 3.7.1

Activity	Predecessor Activity
Clean Cup and Saucers (A)	-
Pour water in kettle and boil (B)	-
Put tea bag in cup (C)	A
Put water in cup (D)	B and C
Add Sugar (E)	A
Remove Tea Bag (F)	D
Add Milk (G)	F
Drink Tea (H)	E and G

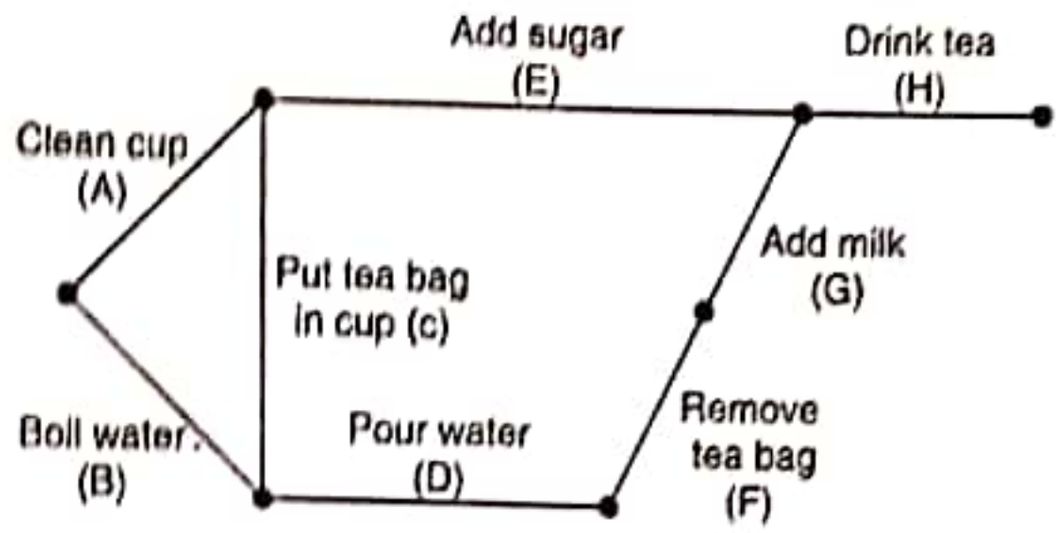

Fig. 3.7.1

- The network developer should identify a few things within the project activities before attempting the network diagram.

3. Parallel workflows

Activities which can be started at the same time. In the above example getting the cups and saucers and pouring water in the kettle and boiling can start simultaneously. None of these activities rely on each other.

4. Logical sequence

- The activities should all fit together in a logical sequence. For example milk should not be added until the tea bag has been removed.
- The logical links are referred to as the Finish/Start logic links i.e. the succeeding activities cannot start until the preceding activity has finished.
- The finish/start logic forces a deeper level of understanding of the events and activities which must be carried out.

3.7.1 Evolution of Network Planning

- In the 60's an entirely new approach to planning was evolved by the US Navy assisted by Lockheed Missile Systems division.
- This came to be known as Program Evaluation Review Technique (PERT). On the other hand Remington Rand produced the Critical Path Method (CPM) and this was the first in the stream of industrial applications.
- Over the years the nomenclature of these approaches changed to eventually result into network analysis. Network Analysis is a whole family of which CPM, PERT and Precedence Network Analysis are members.

3.7.2 Advantages of Network Planning

GQ. 3.7.1 *Write advantages of network planning.*

In Network Planning, sequencing and scheduling of activities of a project are treated in a composite frame. This frame sets out tasks, their sequences and also their interrelationship through an arrow diagram.

Network Planning has the following advantages :

- It enables thorough planning.
- It increases coordination amongst tasks.
- It identifies bottleneck tasks in advance and enables application of remedial measures.
- It helps to revise thinking and increases the user's awareness of the problems involved and their relative importance in the overall operation.
- It enables the project manager to focus his attention on those activities that are in difficulty rather than on those activities that are progressing smoothly.
- It indicates optimum start and finish time for each activity in an operation.
- It enables faster modifications in the plan to accommodate changing circumstances.
- It permits reporting and facilitates corrective action.
- The most important advantage is that it enables the project manager to control operations and secure completion of the project by keeping a continuous watch on the critical events.
- Reduction in costs by recourse to alternative resource's planning is another added advantage. Thus the advantages provided by Network Analysis prove its superiority over traditional techniques such as Gantt and Milestone chart.
- Critical Path Method (CPM), Program Evaluation and Review Technique (PERT) and Precedence Network Analysis (PNA) are the most widely used network planning techniques.

3.7.3 Steps in drawing a Network – Activity-On-Arrow

- **Step 1 :** Study the project with a proper perspective.
- **Step 2 :** Define broad activities of the project. An activity is the smallest unit of work and has definite duration, definite start and end, logical relationship with other activities in the project, consumes resource, and has an associated cost.

  Activity is denoted by an arrow. Arrow direction shows the project progress. Name of activity is written above the arrow while duration is mentioned below it. Example: for construction of a building procuring material, laying foundation, plumbing, electric wiring, etc are basic activities.

- **Step 3 :** Assign an arrow for each activity with a starting and finishing node termed as start and end events. The beginning or completion of an activity is termed as an event. It is also known as node. It indicates a particular instant of time at which some milestone has been achieved e.g. excavation started, concreting finished. It is shown by a circle. Obviously activity starts with an event and ends also with an event.

  Event does not consume any time or any other resource. Usually nodes are numbers, such as 1, 2, 3 etc., to maintain the uniqueness in their identification from left to right in the direction of the progress of the project.

- **Step 4 :** Determine the position of a particular arrow through three basic queries.

- Which activities must immediately precede this arrow?
- Which activities cannot be started until the completion of this activity e.g. laying foundation cannot start unless the required material in procured.
- Which activities can be done side by side with this activity e.g. procurement of pipes, paints, etc can be undertaken simultaneously.
- Thus we have three basic forms of arrow diagram:

Arrow Diagram I

Activity A precedes activity B or activity B succeeds activity A. Example: the site will have to be cleaned before the line out can be undertaken.

Fig. 3.7.2

Arrow Diagram II

Activity A precedes activities B and C which can run concurrently. Example: once the structure of the house (Activity A) is ready, plumbing (Activity B) and electric wiring (Activity C) can run simultaneously.

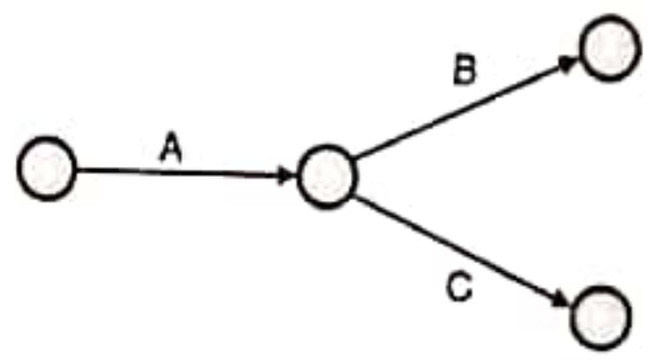

Fig. 3.7.3

Arrow Diagram III

Activities A and B can run simultaneously. Activity C cannot be undertaken unless both A and B are completed. Example: Completion certificate (Activity C) of a new house cannot be obtained unless the finishing and cleaning activities are complete.

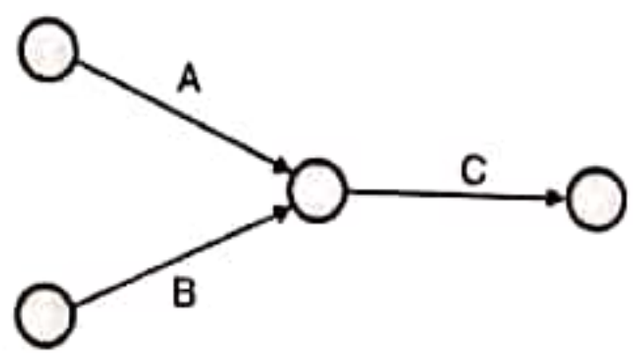

Fig. 3.7.4

3.7.4 Events, Activities and their Inter-relationship in Network Diagram

Events in the project diagram represent project milestones, such as the start or the completion of an activity (task) or activities, and occur at a particular instant of time at which some specific part of the project has been or is to be achieved. Events are commonly represented by circle (nodes) in the network diagram.

Events can be classified into following categories

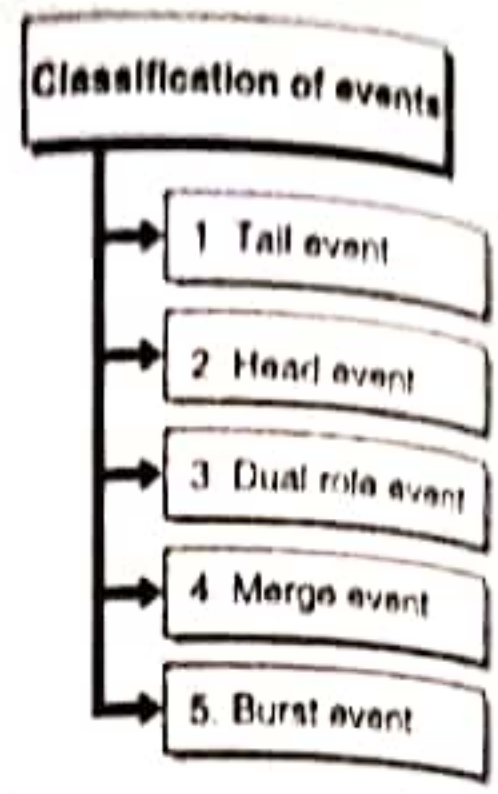

Fig. C3.1: Classification of Events

▶ **1. Tail Event**

An event which defines the beginning of an activity is called a tail event. It is called so as it is at the tail end of the arrow.

▶ **2. Head Event**

An event which marks the completion of an activity is called a head event. It is located at the head of the arrow.

▶ **3. Dual Role Event**

- A node which plays both the roles of head as well tail event is known as dual role event. In the above figure Node 1 is the tail event of activity A and Node 2 represents the head event or the completion of activity A.
- On the other hand Node 2 is the tail event of activities B, C, & D and is thus a dual role event.
- Further on Nodes 3, 4, & 5 are head events for activities B, C, & D while they are also tail events for E, F, & G thus making them also dual role events. However, Node 6 is only a head event for activities E, F, & G.

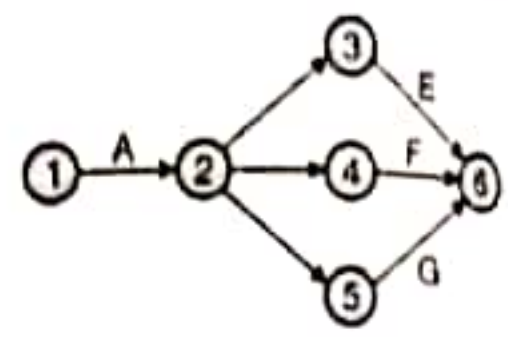

Fig. 3.7.5

▶ **4. Merge Event**

An event which represents the joint completion of more than one activity is known as merge event.

▶ **5. Burst Event**

- An event which represents the initiation (beginning) of more than one activity is known as burst event.
- Events in the network diagram are identified by numbers. Each event should be identified by number higher than allotted to its immediately preceding event to indicate progress of work.
- The numbering of events in the network diagram must start from left (start of the project) to the right (completion of the project) and top to the bottom. Care should be taken that there is no duplication in the numbering.

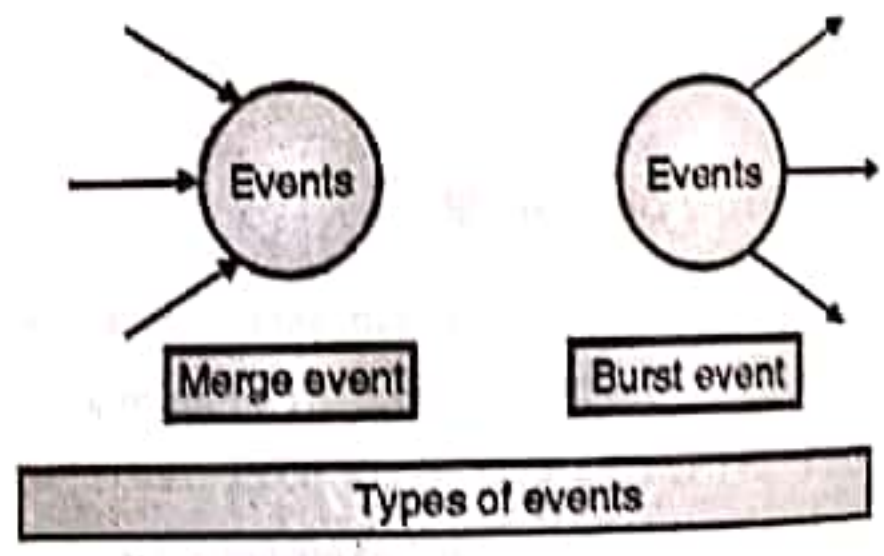

Fig. 3.7.6

Activities

- Activities in the network diagram represent project operations or tasks to be conducted. As such each activity except dummy consumes time and resources and incurs costs.
- An arrow is commonly used to represent an activity with its head indicating the direction of progress in the project.
- Activities are identified by the numbers of their starting (tail or initial) event and ending (head or terminal) event. An arrow (i, j) between two events; the tail event i represents that start of the activity and the head event j represents the completion of the activities shown in the Fig. 3.7.7.

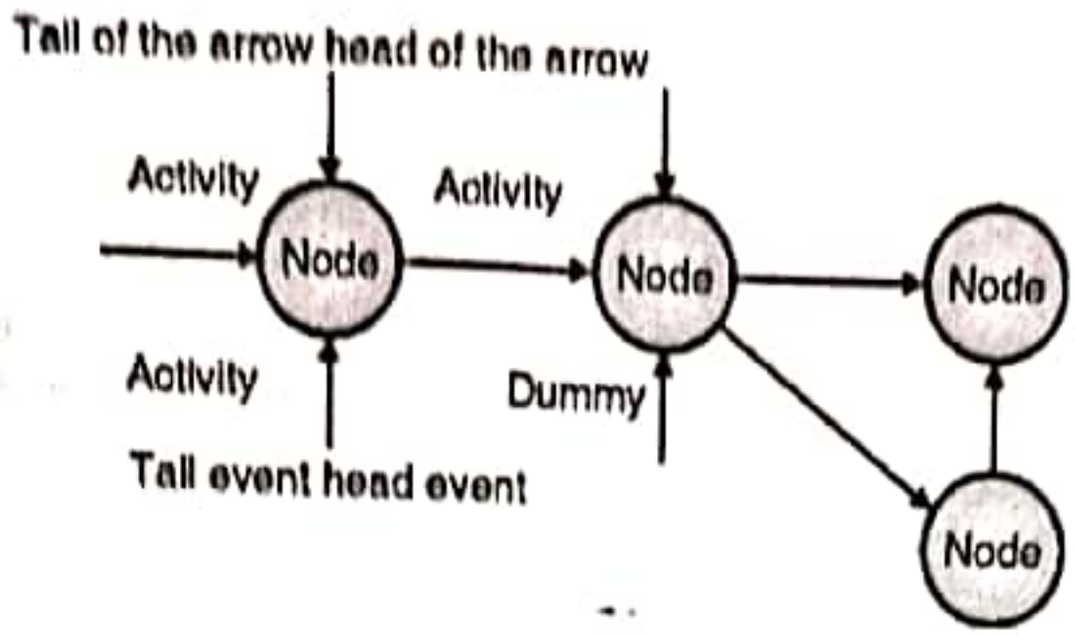

Fig. 3.7.7 : Activity-Node Relationship in Network Diagram

The activities can be further classified into the following three categories

▶ **1. Predecessor Activity**

An activity which must be completed before one or more other activities start is known as predecessor activity.

▶ **2. Successor Activity**

An activity which starts immediately after one or more of other activities are completed is known as successor activity.

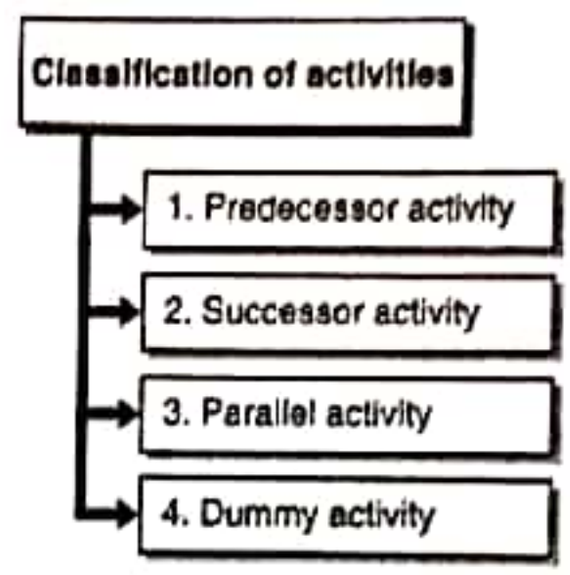

Fig. C3.2 : Classification of Activities

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▶ **3. Parallel Activity**

Activities that occur simultaneously and are independent of each other are called parallel or concurrent activities.

▶ **4. Dummy Activity**

- An activity which doesn't consume either any resource and/or time is known as dummy activity.
- A dummy activity in the network is added only to establish the given precedence relationship among activities of the project and is needed when (a) two or more parallel activities in a project have same head and tail events, or (b) two or more activities have some (but not all) of their immediate predecessor activities in common. A dummy activity is depicted by dotted line in the network diagram.

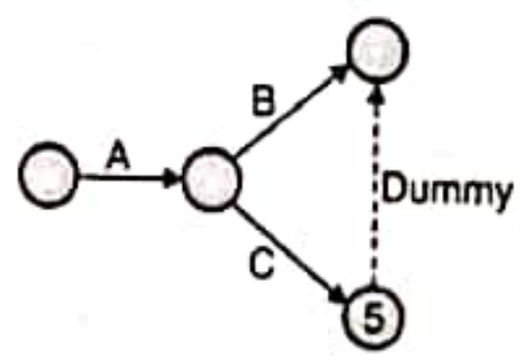


Fig. 3.7.8

3.7.5 Numbering the Events

- It is a practice in Network Analysis to number the events in such a way that the event at a start of an activity has a smaller number than the event at the finish.
- The purpose of such a procedure is two-fold. It enables to identify activities by the numbers of start and end events and helps in the systematic calculation at scheduling stage. Example: activities A to D can be identified by numbers of start and end events.

Activity	Identified as
A	(1,2)
B	(2,3)
C	(2,4)
D	(3,4)

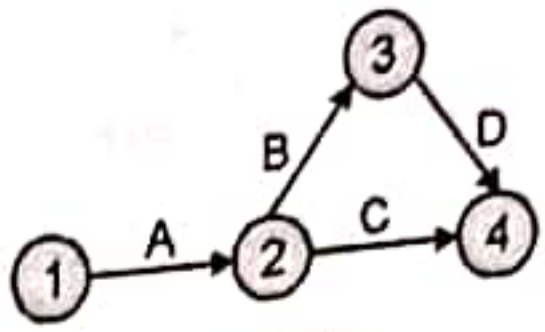


Fig. 3.7.9

Fulkerson's Rule for Numbering Events

- The starting event (having no predecessor activity is numbered as 1) other events are numbered in increasing order from 1 to rightwards
- If there are more than 1 initial event found in a diagram, anywhere they are to be numbered from top to bottom in increase order. No two events can have the same number in any case.

3.7.6 Use of Dummy Arrows for Dummy Activities

- There are two basic needs of dummy or dotted arrows. One is for the uniqueness in identifying the activities.
- **Example :** Suppose activities B, C and D can all start as soon as A is complete and activity E has to wait until B, C, and D are complete. The activities with the event numbers can be shown in the following manner.

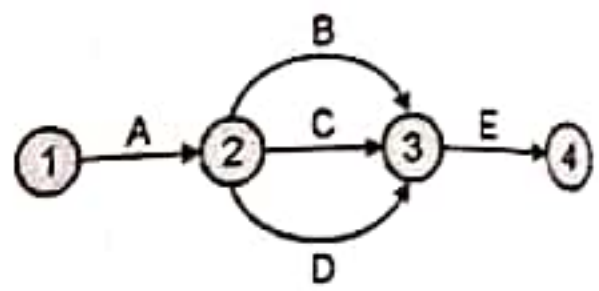


Fig. 3.7.10

- Though the sequence of activities is correctly shown in the above arrow diagram, this would mean that activities B, C, and D would all be denoted by (2, 3). This would create an ambiguity and hence to clear this ambiguity two dummy arrows are introduced into the diagram as shown below.
- Now activities B, C and D are represented without ambiguity by (2, 3), (2, 5) and (2, 4) respectively. It should be noted that dummy arrows have zero duration and do not consume any resource.

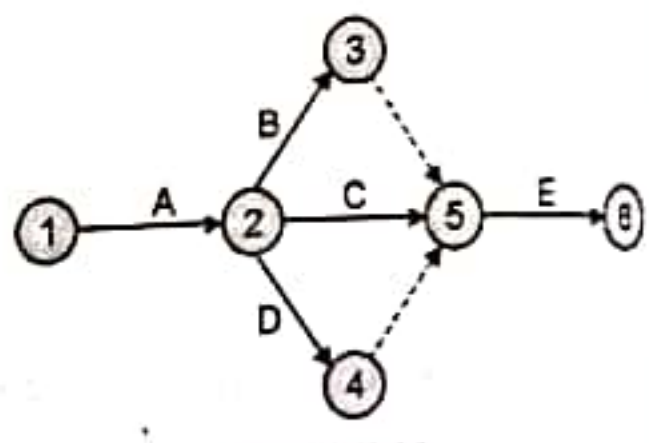


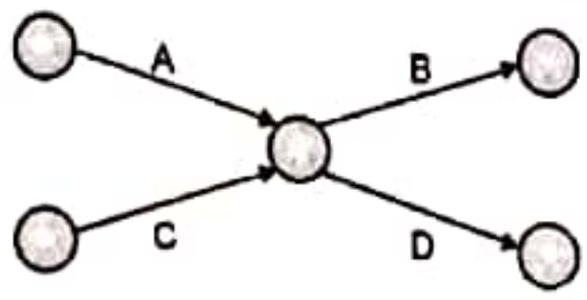
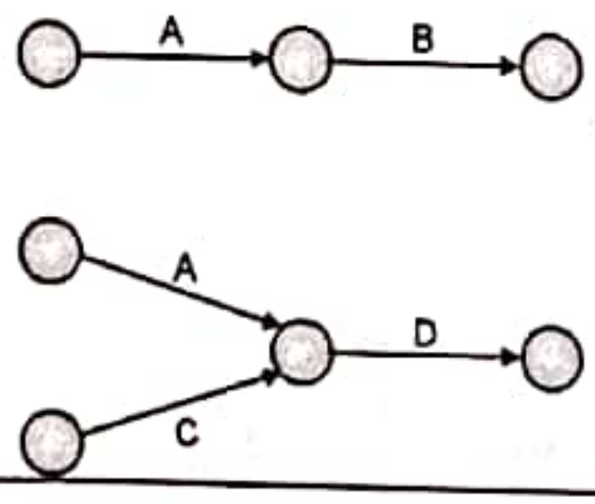
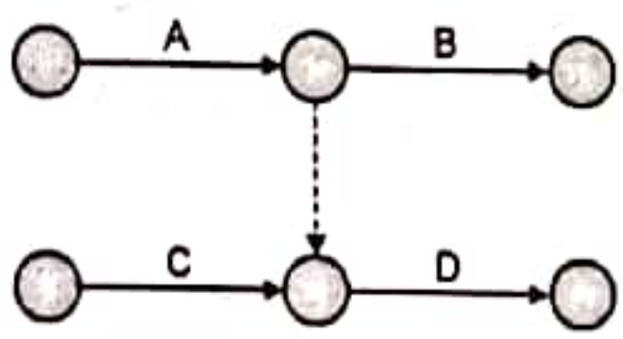
Fig. 3.7.11

- The second need for dummy arrows is to show correct logical sequence of activities.
- To develop a better understanding of dummy arrows let us study the following example.
- **Example :** Assume your car develops a puncture while you are travelling. Then the activities to be followed would be as follows :

Activity Code	Activity Description
A	Remove tyre
B	Repair Puncture
C	Remove spare tyre
D	Fit spare tyre

- Now activities B and D must follow activity A and, in addition, activity D must also follow activity C.

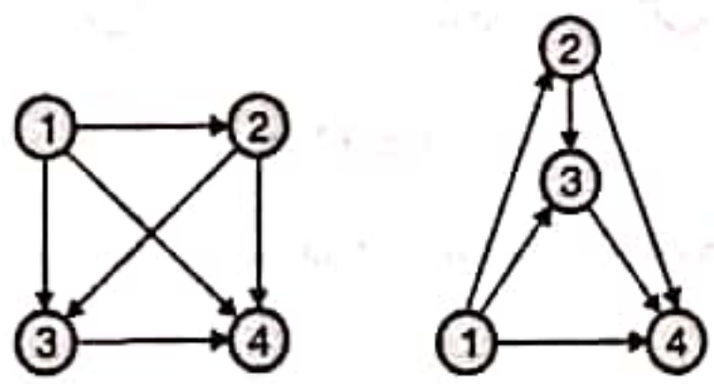
- To start with, some wrong arrow diagrams along with mistakes in them are shown for the above. Correct arrow diagram is then drawn by using a dummy arrow.

Sr. No.	Arrow diagram	Comment
(i)		Wrong because activity B in our example need not follow activity C.
(ii)		Through the sequence is correctly shown this arrow diagram is not correct because a single activity A is shown by more than one arrow.
(iii)		Correct the dotted arrow indicates that activity A precedes activity D.

- The first arrow diagram is wrong as activity B need not follow activity C. The second arrow diagram is correct as activity A precedes activity D.

3.7.7 Tips for Drawing Network Diagrams

- You may find it difficult to draw network diagrams that are easy to understand initially as the number of individual arrows become fairly large.
- However, with practise you will be able to develop an eye for developing networks. The hints for drawing networks will help you in drawing networks that are easy to understand.
- In the figures below the Fig. 3.7.12'b' and not figure 'a' is the preferred way in which network diagrams should be drawn.



(a) (b)

Fig. 3.7.12

(1) Avoid drawing arrows which cross one another.

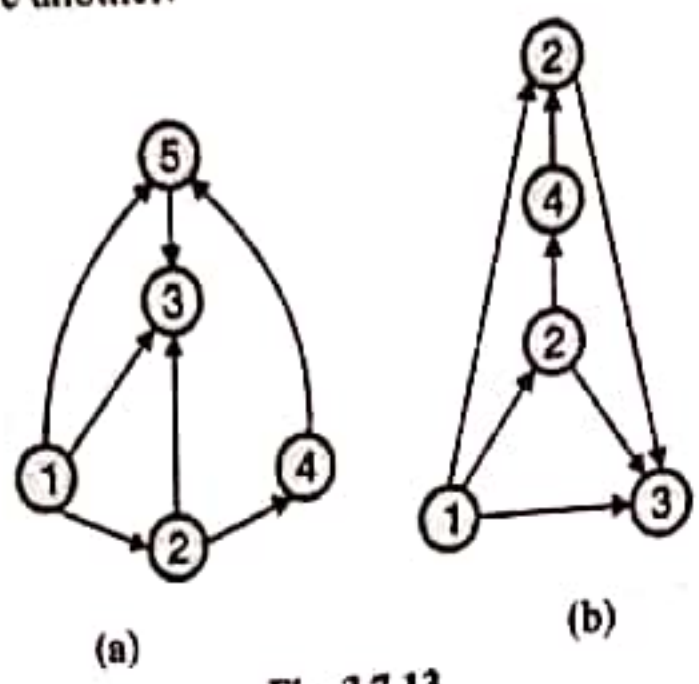


Fig. 3.7.13

(2) While drawing the arrows should be straight

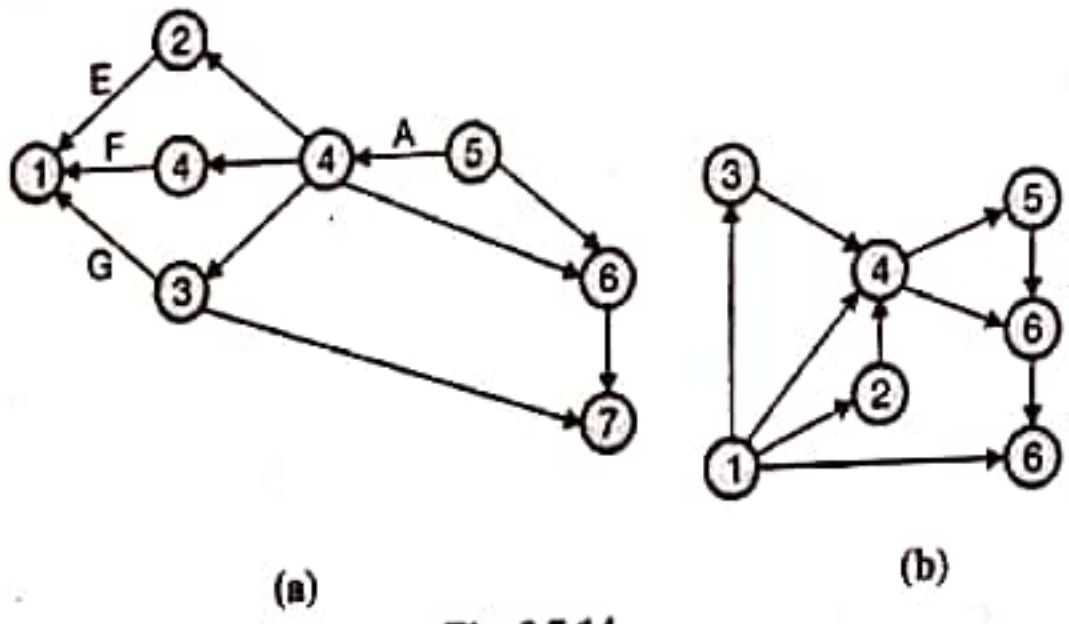


Fig. 3.7.14

(3) Avoid wide variation in the length of the arrows

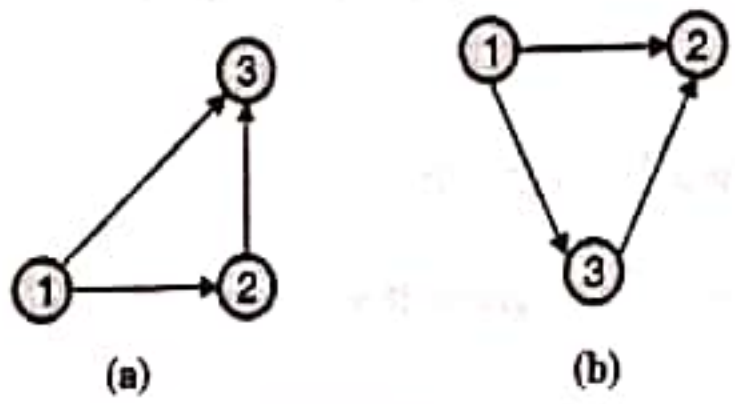


Fig. 3.7.15

(4) The angles between the arrows should be kept as large as possible

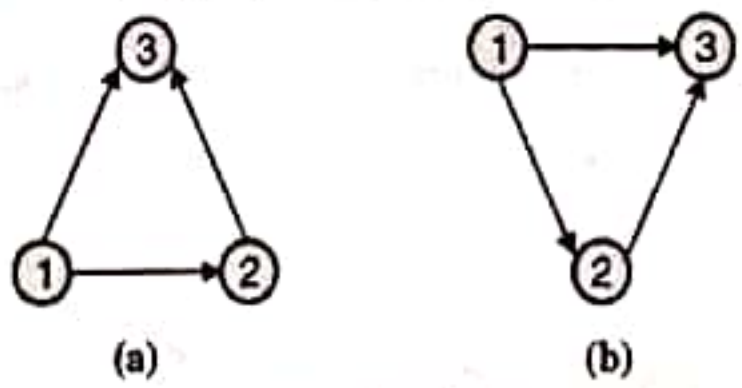


Fig. 3.7.16

(5) A later event should always be drawn on the right side of an earlier event.

3.7.8 Drawing Networks - Illustrative Examples

Ex. 3.7.1

The interdependence of a job consisting of eight activities A to H is given below :

Table P. 3.7.1

Activity	A, B, C	D	E	F	G	H
Predecessor activity	None	B	B	B	A and D	C and E

Draw a neat network and number the events.

Soln. :

The network is given below :

Events are numbered with the convention that finish event has a higher number than start event for each activity.

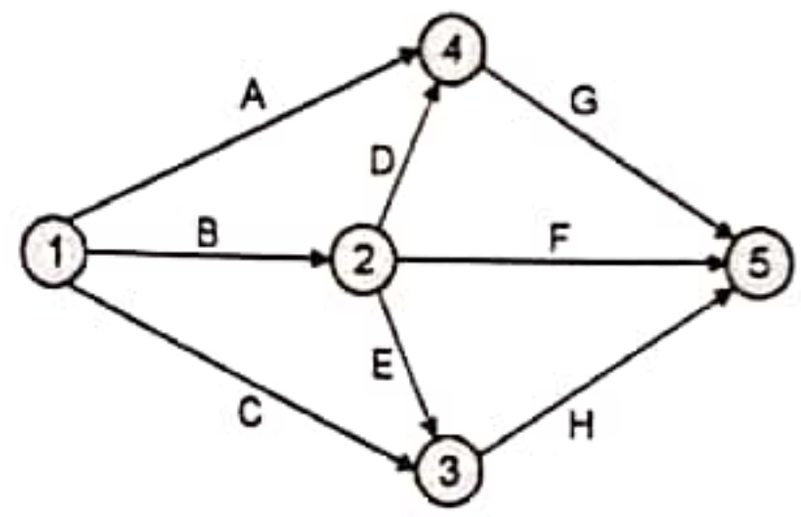


Fig. P. 3.7.1

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Ex. 3.7.2

Interdependence of a project consisting of 11 activities A to K is given below :

Table P. 3.7.2

Activity	Interdependence
A, B, C	Starting activities.
D	Depends on B, controls G and H
E	Depends on C, controls J
F	Depends on A, controls I
G, H	Depends also on C
I	Depends on G
J	Depends on E
K	Depends on I and H.

If J and K are last activities, draw a neat network and number the events.

Soln. :

The network is given below :

Events are progressively numbered in the direction of the arrow. One dummy arrow (4 – 5) helps in establishing the logical sequence of activities described in the problem.

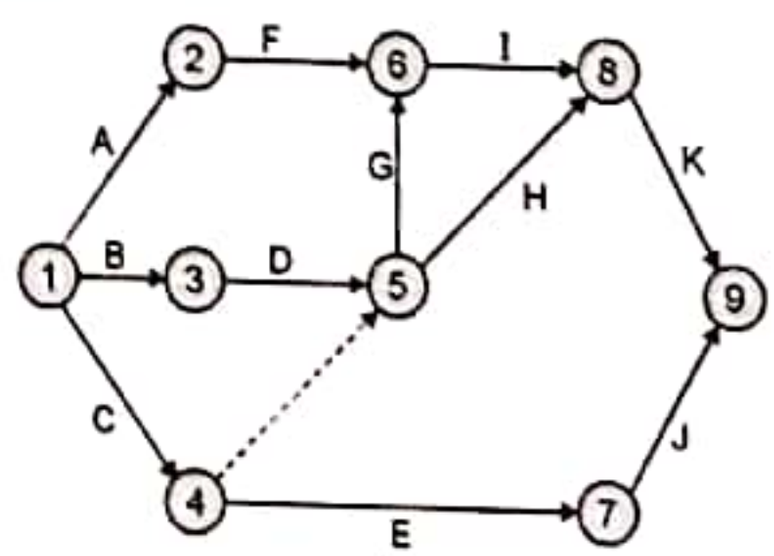

Fig. P. 3.7.2

Ex. 3.7.3

The construction of a house involves the following thirteen activities :

Table P. 3.7.3

Activity	Predecessor Activity
A	-
B	-
C	B
D	A
E	C
F	C
G	F
H	F
I	H
J	I
K	D, E, G, J
L	I
M	K, L

Soln. :

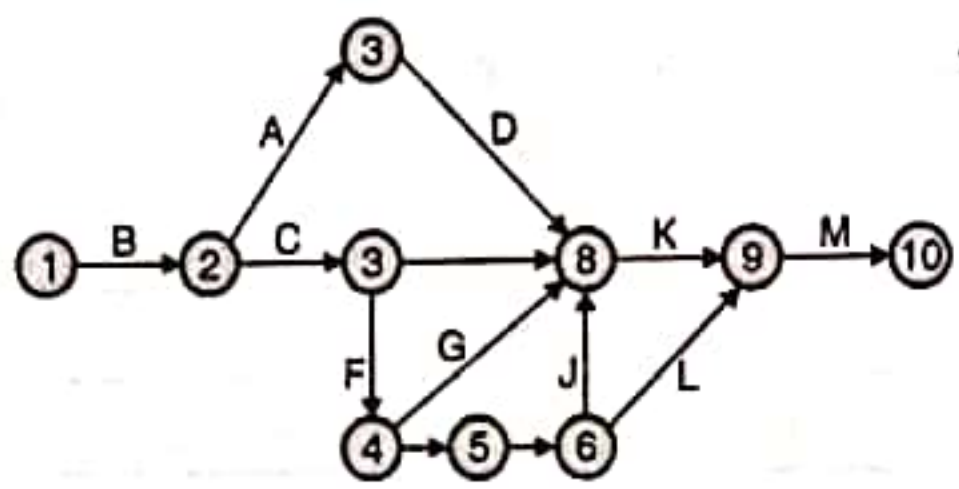

Fig. P. 3.7.3

Ex. 3.7.4

A small construction project has ten activities and their interdependence is as follows:

Table P. 3.7.4

Activities	Predecessor Activity
A	-
B	A
C	B
D	B
E	C
F	E
G	D
H	F, G
I	H
J	I

☑ **Soln. :**

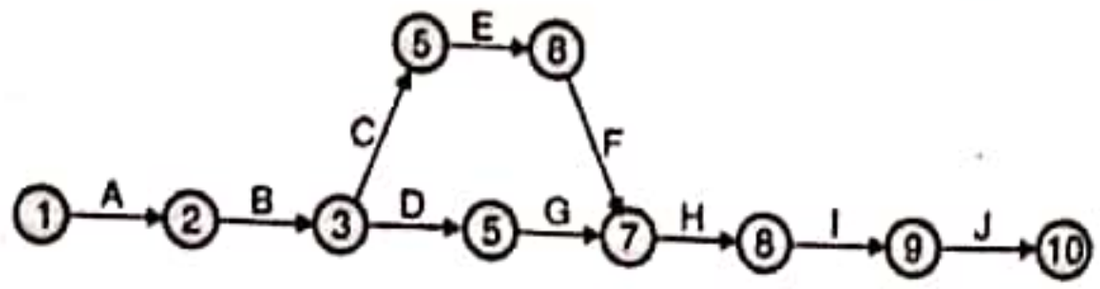

Fig. P. 3.7.4

Ex. 3.7.5

The interdependencies in a construction project are as follows: Activities A, B, C and D can start simultaneously right at the beginning. Activity B controls activities E and F. Activities A, C, E and F control activity J. Activities G, H and I cannot start unless activities A and E are completed. Activity G controls activity K. Activity L cannot start unless activities K and H are completed. When activities L, K, J and D are over the project is complete.

☑ **Soln. :**

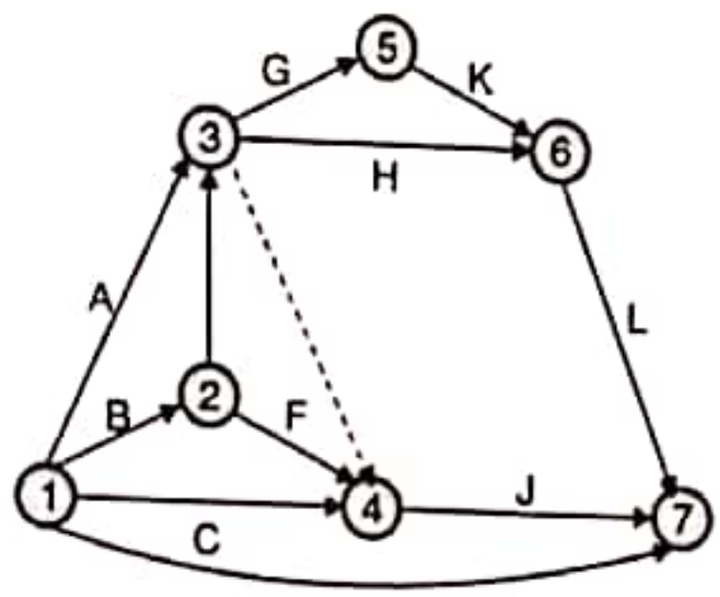

Fig. P. 3.7.5

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Ex. 3.7.6

Draw network diagram by using the following data. :

(i) Activities A, B, C are starting activity

(ii) Activity D follows activity C

(iii) Activity A precedes follows activity F

(iv) Activity E follows act B and C

(v) Activity G follows activities E

(vi) Activity G is terminal activity.

☑ **Soln. :**

Network diagram

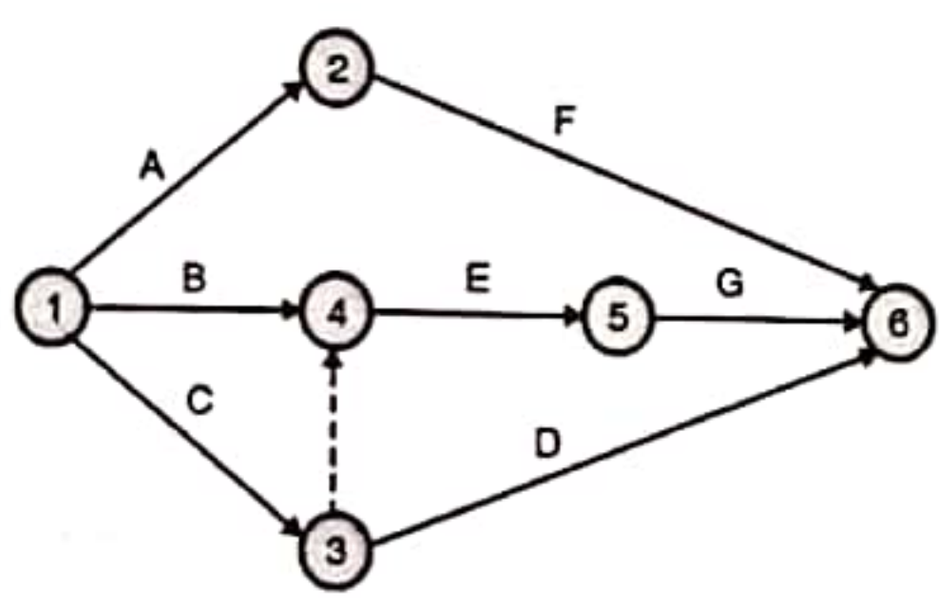

Fig. P. 3.7.6

Ex. 3.7.7

Draw a network diagram based on the following activities of a Project and their interrelationships.

Table P. 3.7.7

Activity	Description of Activity	Predecessor Activity
A	Passing of Plan	-
B	Erection of Site	A
C	Excavation	B
D	Foundation laying	C
E	Erect form Work	D
F	Erect Columns	E
G	Electrical Wiring	F
H	Install Plumbing	F
I	Plaster	F
J	Interior Work	G,H, I
K	Plaster exterior	H

Soln. :

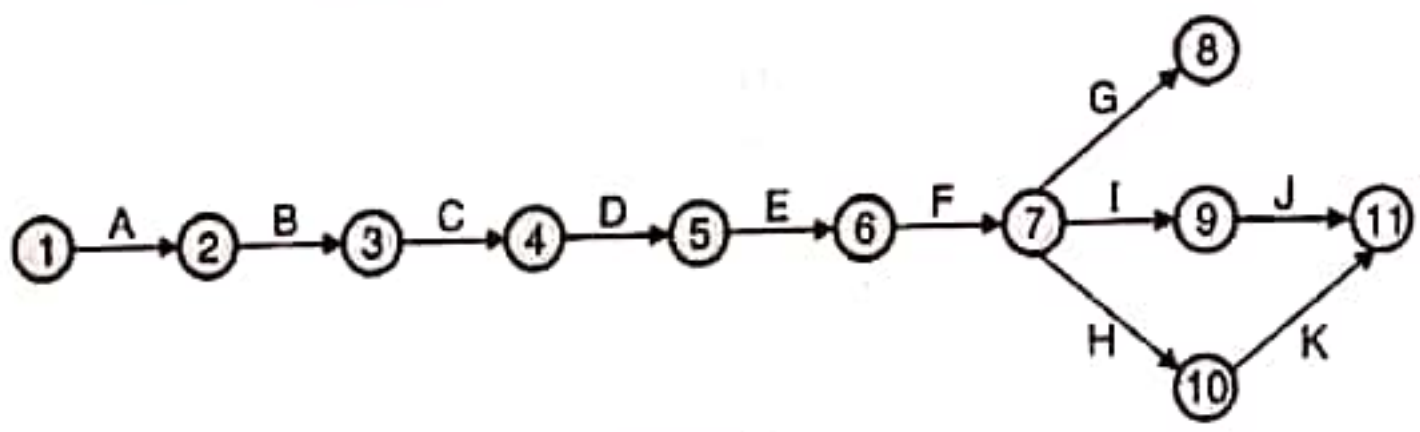

Fig. P. 3.7.7

3.8 NETWORK ANALYSIS

- In the previous section we have understood network as a graphic depiction of activities and events through which the planning, scheduling and controlling of a project becomes much easier.
- Network analysis plays an important role in project management. There are three popular network analysis techniques, namely, Programme Evaluation and Review Technique (PERT), Critical Path Method (CPM) and Precedence Network Analysis or Precedence Diagram Method (PNA or PDA).
- These techniques are used to assist project managers in planning and controlling large scale construction projects like the construction of a residential complex, construction of a dam which would involve the displacement of number of people, installation of a pipeline, construction of a new manufacturing plant, etc.
- The techniques of PERT, CPM and PDA prove extremely valuable in assisting managers in handling projects of such magnitude and complexities, discharging their project management responsibility efficiently and effectively and managing the resources allotted to the project.
- These techniques not only prove useful during the planning stage of the project but also while controlling the project.

- Planning implies developing the overall layout of the project with estimates of the time and resources, detailed scheduling and sequencing of the various activities to be performed. On the other hand, control comes in play during the actual course of the project.
- The detailed utility of the resources enables the project manager to reallocate the resources as per the requirements of the project.
- These techniques help the project manager to not only determine expected project completion dates but also the expected start and completion dates of the different activities of the project.
- In the previous section we have studied the construction of networks and the principles underlying them. In this section we shall determine which of the activities of a given project are critical and therefore on the critical path. We shall also be determining their scheduling times and the time-cost trade-off.
- Thus, a project network provides a lot of information about the project. Once, the network plan is complete and activity times are known it can be used to schedule various activities.
- Determine the time the project will take to complete and how much cushion is available for performing the activities which will assist in determining which of the activities can be delayed and by how much and which activities cannot be delayed to meet project deadlines. In this section we shall be considering the analysis of the network.

3.8.1 Scheduling Activities

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- Once the project network plan is complete and the time taken by each activity determined it is time to know how long the project would take to complete and when the activities should be scheduled. The arrow diagram with the time duration of each activity on them provides answer to these questions.
- The computation of the time duration involves undertaking a forward and backward pass through the network.
- The forward pass computations provides us with the earliest start and earliest finish times for each activity while the backward pass while the backward pass computations provide the latest start and latest times for each activity.
- The example below will help us demonstrate the calculation of earliest start, earliest finish, latest start and latest finish times of various activities of a project.

Ex. 3.8.1

From the following activities and their durations calculate the earliest start (ES), earliest finish (EF), latest start (LS) and latest finish (LF) times of each activity.

Table P. 3.8.1

Activity	Activity Node	Duration
A	1-2	4
B	1-3	14
C	1-4	16
D	2-5	6
E	3-5	12
F	3-6	20
G	3-7	8
H	4-6	12
I	5-7	4
J	6-8	10
K	7-8	12

Soln. :

Determining Forward Pass : Early Start and Early Finish

- Forward Pass provides us with the Earliest Start (ES) and Earliest Finish (EF) time of each activity.
- Earliest Start time indicates the earliest time that an activity can be scheduled while Earliest Finish indicates the earliest time that the activity can be finished.
- For this purpose the first activity in any project is assigned a value of 0 which is the first day of the beginning of the project.

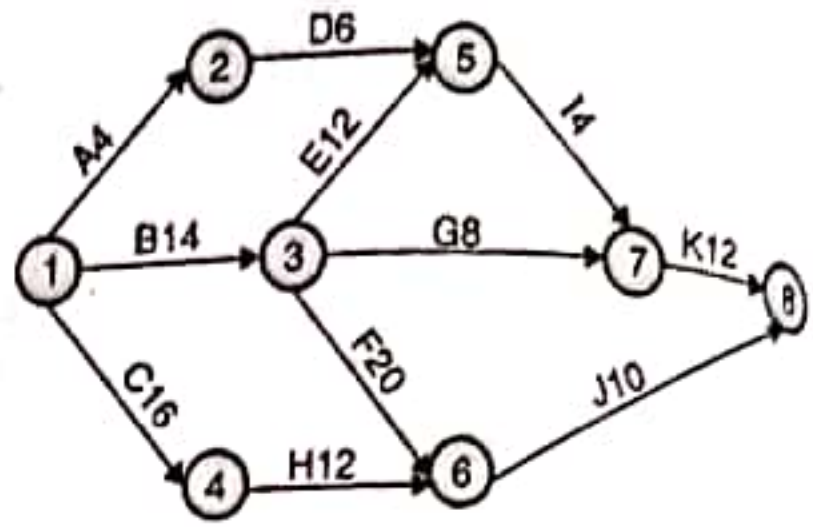

Fig. P. 3.8.1

- Now, in our above example activity A, B and C can all start on the first day and hence have been assigned 0 as the earliest time of their start. The earliest finish time of each activity can now be obtained by adding the duration of the activity to the earliest start time. So, we get the following :

(i) Activity A

Earliest Finish = Earliest Start + Duration of Activity

= 0 + 4 = 4

- So activity A's earliest finish can be on the 4th day. Similarly activity B and C who are also have an earliest start of 0 can have earliest finish of 14 and 16 respectively.
- For the subsequent activities we assume that they too will start as soon as their predecessor activity is completed and hence the Earliest start (ES) of these activities will be the earliest finish (EF) of the preceding activity.

(ii) Activity D

- Now, activity D succeeds activity A and hence the earliest finish time of 4 days acts as the earliest start of activity D. Therefore the earliest finish time of activity D is 4 + its duration time of 6 which gives us 10 days.
- The same computation can be used for other activities. However, when a succeeding activity has two or more preceding activities the activity with the maximum earliest finish time should be taken as its earliest start time.
- The earliest start and finish time are depicted in the bracket along with the activity and its duration on the arrow.
- The Fig. P. 3.8.2 below will give you a clear idea of how the network diagram will look after all the timings have been displayed on it.

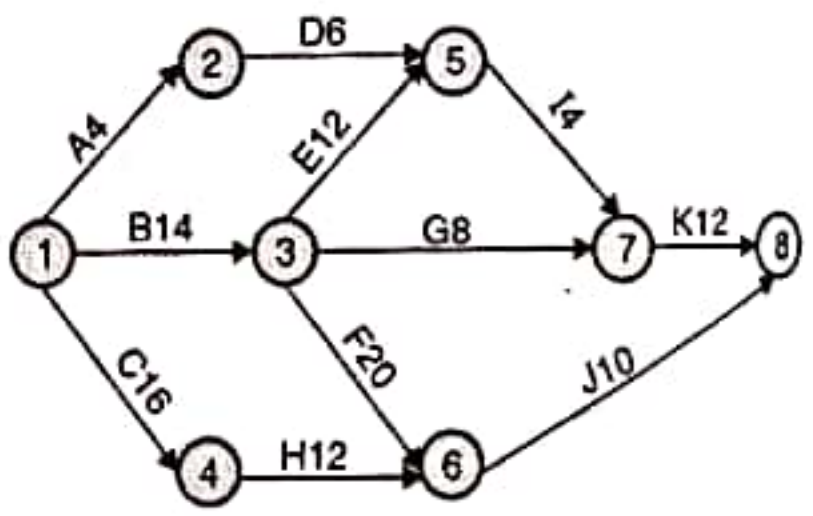

Fig. P. 3.8.2

Determining Backward Pass : Latest Start and Latest Finish

- The backward time is used to calculate the latest allowable times of starting (LS) and finishing (LF) of each of the activity of a project. The computation of the backward pass is very much similar to that of the forward pass.
- The 'latest allowable time' means the final activity of the project should occur on or before some arbitrary scheduled time or in case that is not allotted then the earliest finish time of the final activity as per the forward pass is taken as the latest finish and the computation is done backward.

- Continuing with our above example the activities 7-8 and 6-8 are our terminal activities with earliest finish times of 42 and 44 respectively. Hence, we assign a time of 44 to activity 8 which means that both these activities would have their latest finish (LF) as 44.
- Now, the latest start (LS) for any activity is latest finish time (LF) minus duration. So the latest start for activity 7-8 will be 44-12 = 32 and for activity 6-8 is shall be 44-10 = 34.
- In case an activity has two succeeding activities then the latest allowable finish time for that activity would be the smallest of the latest start time of the succeeding activity.
- The network diagram below depicts latest start and latest finish time of all the activities.

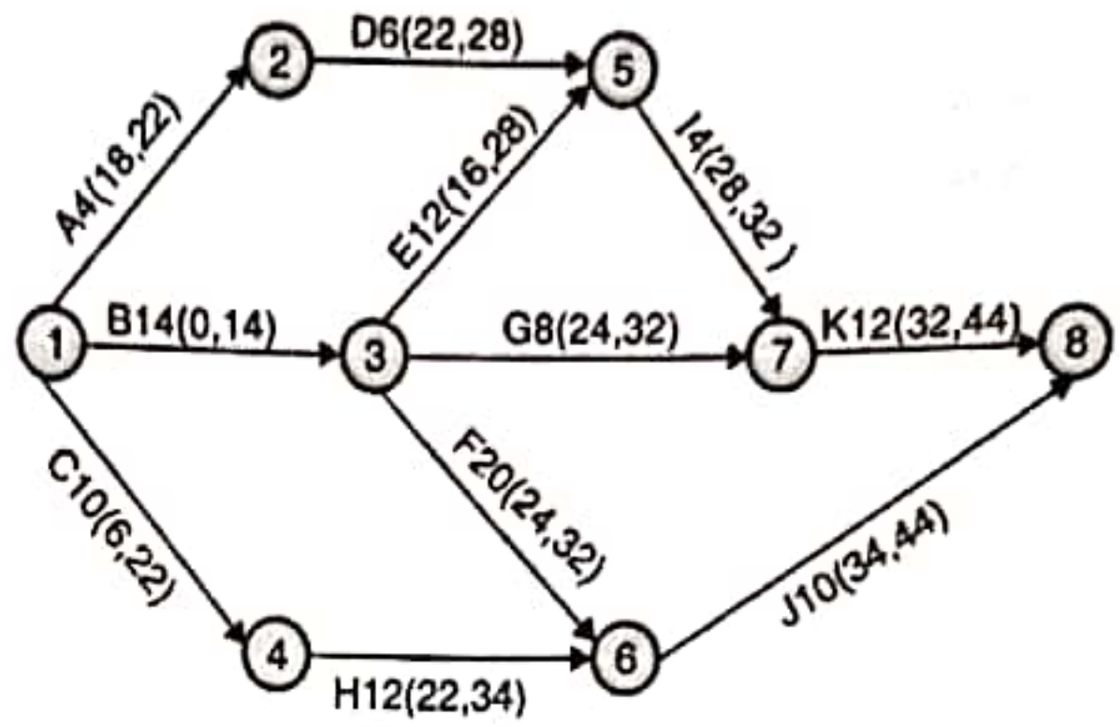

Fig. P. 3.8.3

- Depicting the earliest and latest timings of events on a network diagram
- In addition to depicting the earliest and latest timings for each activity we shall be needed to depict the earliest and latest times of various events on the network.
- These times are depicted in a circle along with the event number, its earliest and its latest times.
- In a forward pass the earliest time for the initial event of the project would be 0 and for subsequent events the earliest time would be taken as the latest of the earliest finish (EF) of the activities concluding on that event. As for the terminal event of the project it is assigned latest time equal to its earliest time.
- Once the terminal event has been assigned its latest time the process is rolled back and latest time for events that precede the terminal activity is assigned. The latest time of an event is computed by deducting the duration of the activity from the latest time of the previous event.
- So, in our example the latest time for event 7 would be the latest time of the terminal activity that is 44 – the duration of the activity which is 6 thus giving us its latest time as 16 (44-12).
- However, when more than one activity starts from the node than the lower value of the differences should be taken as the latest time for the event. In our example activity 3 has three activities starting from it now when we compute the difference.
- We find that for event 5 the value is 16 (28-12), for event 5 the value is 7 (17-10) and for event 7 the value is 24 (32-8). As we are to take the lowest value we take 14(34-20) as the latest time for event 3. The latest time for other events can be calculated similarly.

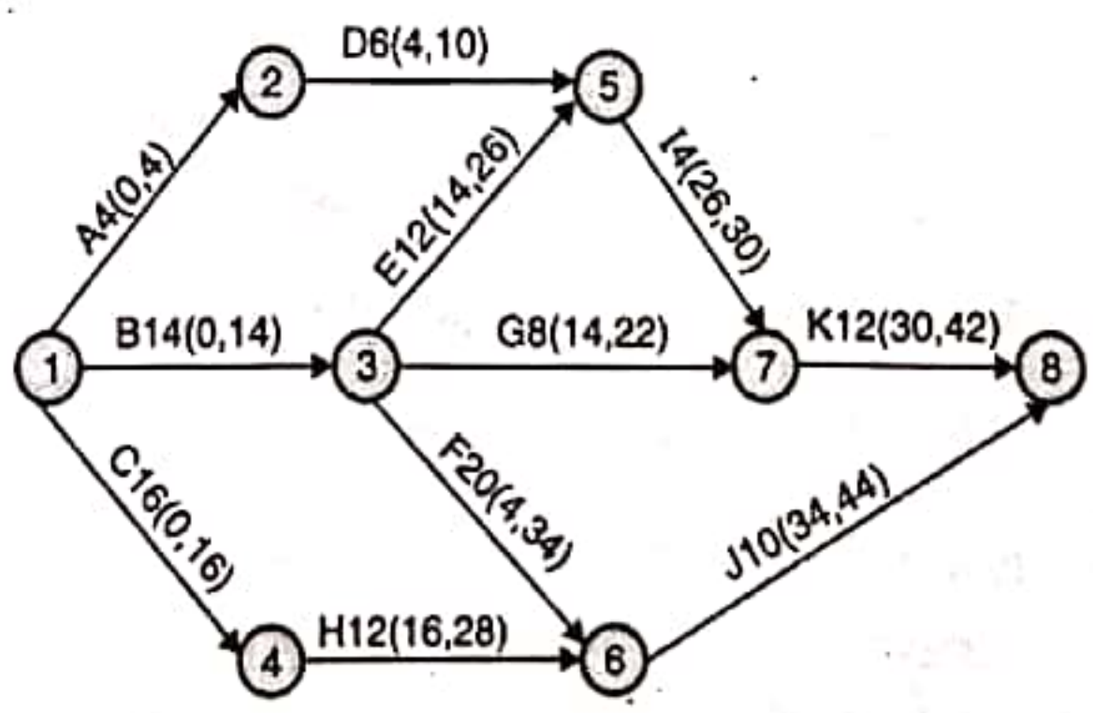

Fig. P. 3.8.4

Module 3

3.9 INTRODUCTION TO PROJECT MANAGEMENT INFORMATION SYSTEM (PMIS)

- Unlike traditional projects, modern projects are more complex in nature as they involve the sharing of resources amongst concurrent projects. The complexity of modern projects and the sharing of resources amongst concurrent projects have augmented the importance of project planning and scheduling.
- The primary objective of project planning and scheduling is the optimum utilization of resources and the timely completion of the project well within the stipulated budget.
- Project success is very much dependent on the ability of the project manager to properly sequence all the activities, allocate resources, coordinate stakeholders and identify project constraints.
- Coordination between the various activities, stakeholders and external agencies is the key to the success of the project. Failure or delay in service of activities cannot be ruled out however the skill of the project manager lies in finding alternate ways such that the project continues without much hindrance and the impact of the failed activity is nullified or minimized.
- Project planning and scheduling techniques assist project managers in effectively controlling project activities. Project planning involves the identification, grouping and sequencing of activities while scheduling involves allocating proper time frames for each activity and ensuring the timely availability of the required resources.
- Resources would be men, material, money and equipment needed for the activity. Good planning and scheduling ensures the smooth and seamless completion of projects with the minimum of bottlenecks. A good plan and schedule will ensure the optimum utilization of resources which in turn will reduce the cost burden on the project.
- Planning and scheduling are all the more important in modern construction projects as resources are shared amongst concurrent projects. This means that planning and scheduling going haywire in one project is likely to impact other projects undertaken by the company. Hence, the company can ill afford to overlook planning and scheduling.
- The ground work for project planning and scheduling starts from the design stage of the project. A detailed drawing and well defined Work Breakdown Structure (WBS) will enable the project manager to correctly estimate the quantum of work that is to be carried out in the project. The information provided by these two crucial documents can be utilized by the project manager for planning and scheduling.
- In this chapter we shall be studying the purpose of Work Breakdown Structure and the various techniques the project manager could utilize in monitoring and controlling the progress of work.

3.9.1 Project Planning and Scheduling

GQ. 3.9.1 *Describe project planning and scheduling ?*

- Projects are not undertaken for fun – there has to be a driving business need behind the decision to commit resources to a project. There is a tendency of construction projects to run late and over budget both conditions detrimental to the financial health of the company. Even the best of project managers are plagued by risks, issues, and unforeseen delays.
- Apart from the primary objective of achieving the business need for which the project has been initiated there are other inherent objectives that the project manager should strive for.

- The project should be completed with the time frame set.
- The project manager should ensure the optimum utilization of resources.
- The project should be completed within budget.

- Although, the primary objective is of completing the project, the project manager should also aim to achieve all the above objectives. A project would be deemed successful if the project manager is successful in completing the project within, the time frame allotted, the budget set, and while ensuring the optimum utilization of resources.
- For this the project manager will have to utilize project planning and scheduling techniques right from the commencement of the project. During the execution of the actual project work the project manager will have to control the activities to ensure that they go as per planned and deviations if any are identified and taken care of.

3.9.1.1 Project Planning

GQ. 3.9.2 *Write note on project planning.*

- The project planning phase is the longest and most important of the project cycle. Without proper planning, a project has a poor chance of success. Team members must decide on a budget, set timelines, and identify resources and constraints.
- The team verifies the availability of resources, materials and expertise critical to on-time project completion. Project teams should spend the necessary time planning a project and make any plan changes before moving on to the next phase. The team may put project plans in writing to clarify roles, responsibilities and project deadlines.
- Howsoever simple it may seem Project planning is not the forte of many project managers. From the project managers point of view project planning is the first step in the implementation of the project.
- A project plan is an iterative process that communicates the approach and intent of the project manager. A project plan will provide the details of the processes that will be used in the project and how the project work will be executed, controlled, and commissioned.
- The first step in Project Planning is to research the objective that the project aims to address. A good research will enable the project manager to develop a thorough understanding of the objective. The research can be done by interviewing the key stakeholders.
- The project manager needs to understand why the project is being initiated and what it aims to accomplish. The success of the project hinges on a clear understanding on the part of the project manager and key stakeholders as to the motive and end result of the project. The vision for the end result of the project should be mutually developed by the key stakeholders and project manager.
- Project planning would necessarily mean:
  - Defining and understanding the objective of the project.
  - Breaking the project into major tasks
  - Assessing the resource requirement for the completion of tasks
  - Estimating the cost to be incurred on each task
  - Estimating the duration for completion of each task within the project

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- The project manager should approach the project planning stage cautiously. He should be aware of the resources in hand, the people assisting him, and the time he should give to the planning phase.
- Although planning is an iterative process and the project manager will be revisiting it time and again during the entire course of the project implementation, he should decide in advance the time that would be spent on the planning phase. The usually practice in determining the time one should spend on planning is that it should be directly proportional to the size and relevance of the project.

3.9.1.2 Project Scheduling

GQ. 3.9.3 *Project scheduling write note on.*

- Effective Planning and analyzing the plans from different perspectives increase the chances of completing the project on time and within budget. However, before setting the plan in motion it is necessary to work out a proper project schedule and plan the procurement activities listed in the plan.
- Just as every project must have a definitive set of deliverables which mark the closure of the project; it should also have a finish date. A project with no finishing date is less likely to succeed. As far as possible the deadlines set for the project should be inflexible. The project manager should set a realistic deadline to ensure that the project meets its logical end. A project missing its deadlines is a sure shot indication of poor planning and lack of research. Therefore, for ensuring that deadlines are met, the project manager should plan and research properly.
- Thus to ensure that project deadlines are met a project schedule plan has to prepared by the project manager and the project team. The project schedule plan comprises of;
  - Project activities and the estimated duration for their completion.
  - The sequence of activities and the moment they would need to set in motion.
  - Resources needed for the activities and the moment they would be needed.
  - Measures to monitor and control the project schedule.
- The Project Scope Statement enables the creation of the Work Breakdown Statement (WBS) which in turn facilitates creation of the project schedule. A project schedule comprises of the various tasks within the project and the resources that would be needed for the completion of the task. A project schedule enables the project manager to determine the time that would be needed for the project and accordingly the timing for procurement of the resources required for the completion of the job.
- Based on the criticality of work involved in the task the time period for its completion is estimated by the project manager. While estimating the project manager may rely on previous project experience or may discuss the time frame with the people who will responsible for the completion of the task. However, when the task is undertaken it is the responsibility of the project manager to ensure that the requisite resources are made available.
- The estimation of time required for the completion of tasks should be measured in units of time such as days, weeks, or months. After the unit of time required for completion of each of the task in the project has been estimated, the project manager can estimate the time required for the completion of the project by merely adding the units of time of each task. Based on the duration estimated a deadline can be set for the completion of the project.

- However, in the real world, project deadlines are determined by management way before the actual project even commences. The delivery dates for the project are given to the project manager who then has to plan backwards. Despite the duration of the project having been decided in advance the project manager has to still undertake all the activities of work decomposition and assignment of resources to complete the tasks just as he would have done with a project with no pre-defined deadline.
- Creating a network diagram, also referred to as a logic diagram, is a great way for starting to understand and visualise how the project will proceed. It's a simple concept successfully used in applications outside of project management planning; commonly used in manufacturing industries, as well as service industries requiring mapping and understanding work flows.
- In the context of project planning, a network diagram is a sequence of tasks (activities), commonly represented by blocks, that are linked together in the logical sequence they need to be carried out. Producing a network diagram follows the completion of the project WBS.
- Once the logic diagram has been completed, a clearer picture of the required sequence of events and activities for the project emerges. The logic rules affecting activities, for example you cannot start building the house foundations until you have first prepared the ground, are evident.
- By including the project team in the development of the network diagram, the project manager obtains a consensus of understanding of how the project should be implemented, at the same time providing a forum for challenging accepted ways of doing things, which may need amending to suit the specific constraints associated with the project at hand.
- Project Schedule serves the following purpose:
  - Project schedule simplifies the project plan such that it can be understood by all those concerned and initiates prompt action.
  - Project schedule validates the time objective by verifying the deadlines set for tasks.
  - The implications of a delay in a particular task can be gauged and proper corrective action can be initiated to avoid repercussions.
  - Project schedule enables the project manager to identify and focus on those activities that could prove to be bottleneck in the future.
  - Project schedule serves as a basis for project monitoring and control.
  - Project schedule ensures the optimum utilization of resources and helps in resource levelling by working on the floats.
  - Project schedule identifies scheduling constraints and enables the project manager to work within the framework of the constraints.

3.9.2 Project Monitoring and Control

GQ. 3.9.4 *Explain project monitoring and control.*

- The Monitoring and Controlling phase of the project oversees all the tasks necessary to ensure that the approved and authorized project is within scope, on time, and on budget so that the project proceeds with minimal risk.
- This process involves comparing actual performance with planned performance and taking corrective action to yield the desired outcome when significant differences exist. Monitoring and Controlling process is and iterative process and hence continuously performed throughout the life of the project.

- According to the Project Management Body of Knowledge (PMBOK), "the Monitoring and Control Process Group consists of those processes performed to observe project execution so that potential problems can be identified in a timely manner and corrective action can be taken, when necessary, to control the execution of the project."
- The main purpose of monitoring and controlling activities is to be proactive in finding issues ahead of time and taking corrective action. Corrective action can require revisiting Planning Process Group and updating the Project Management Plan as needed with the ultimate goal of bringing the project back in line with project objectives and constraints and improving future execution to avoid repeating the same issues.

3.9.3 Monitoring and Control Processes Include

GQ. 3.9.5 *What are the steps of monitoring.*

1. **Monitoring and Controlling Project Work**

   The Monitoring and Controlling Project Work process collects, measures and disseminates performance information and assesses measures and trends to forecast potential items requiring corrective action. This includes monitoring project risks and ensuring that they are being managed according to the project's risk plans.

   - Recommended corrective actions
   - Recommended preventive actions
   - Forecasts
   - Recommended defect repair
   - Requested changes

2. **Change Control**

   The Change Control process ensures that changes as a result of project corrective actions and other controlling factors are managed across the project knowledge areas. Change control takes place throughout the project, from project initiation through project closure.

   - Approved change requests
   - Rejected change requests
   - Updates to the Project Management Plan
   - Updates to the Project Scope Statement
   - Approved corrective and preventive actions
   - Approved defect repair
   - Validated defect repair
   - Deliverables

3. **Scope Verification**

   The scope verification process ensures that project deliverables are formally accepted.

   - Accepted deliverables
   - Requested changes

- Recommended corrective actions

4. **Scope Control**

The Scope Control process ensures that changes to project scope are controlled.

- Updates to the Project Scope Statement and Scope baseline (this includes requirements)
- Updates to the Work Breakdown Structure (WBS) and the WBS Dictionary
- Requested changes
- Recommended corrective actions
- Updates to organizational process assets
- Updates to the Project Management Plan

5. **Schedule Control**

The Schedule Control process monitors and controls changes to the project schedule.

- Updates to the schedule model data and baseline
- Performance measurements
- Requested changes
- Recommended corrective actions
- Updates to organizational process assets
- Activity list and activity attribute updates
- Updates to the Project Management Plan

6. **Cost Control**

The Cost Control process monitors and controls costs and changes to the project budget.

- Cost estimate updates
- Cost baseline updates
- Performance measurements
- Forecasted completion
- Requested changes
- Recommended corrective actions
- Updates to organizational process assets
- Updates to the Project Management Plan

7. **Performing Quality Control**

The quality control performance process measures specific project results to determine whether the project is meeting quality standards.

- Quality control measurements
- Validated defect repair

- Updates to the quality baseline
- Recommended corrective and preventive actions
- Requested changes
- Recommended defect repair
- Updates to organizational process assets
- Validated deliverables
- Updates to the Project Management Plan

8. Managing the Project Team

This process tracks team member performance, provides feedback, resolves issues and coordinates changes to maintain and improve project performance.

- Requested changes
- Recommended corrective and preventive actions
- Updates to organizational process assets
- Updates to the Project Management Plan

9. Performance Reporting

The Performance Reporting process collects and distributes performance information: including status reports, progress reports and forecasts.

- Performance reports
- Forecasts
- Requested changes
- Recommended corrective actions
- Updates to organizational process assets

10. Managing Stakeholders

This process manages stakeholder communications and works with stakeholders to ensure that requirements are satisfied and issues are proactively resolved.

- Resolved issues
- Approved change requests
- Approved corrective actions
- Updates to organizational process assets
- Updates to the Project Management Plan.

Chapter Ends...

CHAPTER 4

Module 4

Planning Projects

University Prescribed Syllabus

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4.1 CRASHING PROJECT TIME

GQ. 4.1.1 *Enumerate the types of costs that go into the project budget*

- In the previous sections we have seen the effect of project constraints such as equipment, manpower and time. In this section we shall be studying the impact of another constraint on time and other resources and this constraint is cost.
- The project budget is critical as funding is based on it, project success is derived from how closely you manage it, and without it you can't perform any work on the engagement. Properly pricing the project – properly estimating the costs that go into the project – is critical for any size engagement.
- Therefore, it's always a good to examine the elements that go into the overall project budget and study the influence of the inputs to the project costs and budget. Let's examine the key types of costs that go into the project budget.

4.1.1 The People Costs

- These are the costs associated with the personnel on the project. They include salaries and the cost of benefits (such as vacation time and health insurance) if they apply.
- Employee or contractor salaries and expenses are one of the biggest budget items on any project. The people costs can either form a part of direct or indirect costs. This depends on the activity undertaken by the individual person. So if the work undertaken by a person can be directly attributed to a project activity it is a direct cost.

4.1.2 The Administrative Costs

- Administrative costs are the everyday costs that support the work of the project but are not necessarily directly related to a specific task on the project. Phone expense, copier paper, heating expenses, and support personnel are examples of administrative costs.
- Project teams have to work and meet somewhere, so that means that there is some sort of facilities expense in the form of rent, lease, or mortgage payments. If the building or facility was leased or purchased specifically for the project, it would be classified as a project cost instead of an administrative cost. Administrative costs are part of the indirect costs of the project.

4.1.3 Project Resource Costs

- Resource and project costs include things such as materials needed for specific tasks, equipment leases, travel expenses, and so on. These expenses are specific to the project. Resource costs are typically the largest expense and estimating these costs will require research by the project manager and team.
- If you as the project manager have initial budget input or responsibility for creating the initial project budget, then careful examination of each of these categories will help you come up with a reasonable budget for the project.
- If not, being aware will help you identify what may have been missed and it will certainly help you as you manage the project budget on an ongoing basis throughout the engagement.

4.1.4 Direct Costs vs. Indirect Costs

GQ. 4.1.2 *State the differences between direct costs and indirect costs.*

- The above mentioned cost categories can be grouped as either direct or indirect costs. Direct costs include costs such as salaries, equipment rentals, software, and training for team members. Any cost that can be directly attributed to a particular activity of a project is a direct cost.

Direct costs = Cost specifically related to a particular activity of a project.

- Indirect costs are not specific to the project. When your project team works with other members of the organization who are not working on the project in the same building, things like the lease cost of the building would be considered an indirect cost because it is not specifically related to the project.
- Another indirect cost would be administrative staff who will be assisting you with project activities but aren't assigned specific project tasks themselves.

Indirect costs = Costs associated with the project but not directly related to a particular activity of the project.

- Indirect costs also include the penalties for late completion of the project and benefits for early completion. Project indirect costs are a function of time i.e. the longer the project takes to complete the higher are the indirect costs associated with it.
- On the other hand, in an effort to reduce the indirect costs we may increase the direct costs as they are indirectly proportional to the duration of the project. Longer the project duration lower are the direct costs and vice versa.
- This means that longer project durations lead to higher indirect costs but lower direct costs. This creates a dilemma for the project manager as he has to strike the right balance between duration, direct and indirect costs.
- To overcome this dilemma the project manager has to undertake a time-cost trade-off.

4.1.5 Time – Cost Trade-off : Project Crashing

- The project network diagram and particularly its critical path contain valuable information about the duration of the project, the critical activities, the non-critical activities and the various floats associated with these non-critical activities.
- This information can be used to find ways to expedite the project and then study its effect on the cost of the project. The effect of expediting the project activities on its cost is referred to as time-cost trade-off.
- The primary premise here is that the duration of some activities can be cut down if some additional resources are employed in performing them. Example: the number of people required to dig a trench 20 feet deep and 200 meters in length within 5 days is 4.
- If 4 more people are assigned to the task naturally the number of days required would be fewer then the number now required let us assume this number is 3. Now the task is performed faster but the number of man-days that have expended on the digging of the trench are higher ($5 \times 4 = 20$ v/s $8 \times 3 = 24$).
- Thus, merely adding more resources to an activity does not result in expediting of the project activity. Sometimes adding more resources brings in diseconomies of scale wherein more resources means more inefficiency. Higher direct costs are associated with lower activity duration and vice versa. The act of adding more resources to expedite project activities is called project crashing.
- Although, it may be tempting to reduce the duration of the project it cannot be done indefinitely. The project crash time represents the maximum duration by which the project activity can be crashed and any attempt to further crash it will only raise the direct costs without reducing the time.
- While, crash time represents the time by which the project activity can be crashed, crash cost represents the minimum direct cost required to bring about the crash.

- The Fig. 4.1.1 shows the graphical representation of the time-cost relationship. In the graph the normal time represents the shortest time required to perform an activity under normal cost and normal cost represents the absolute minimum of the direct cost required to perform an activity.
- The line connecting the normal time-cost point to that of crash time-crash cost point indicates that as the reduction in duration increases so does the cost and at the beyond the crash time-cost point the benefits of reduction in duration are lower than the cost associated with the reduction.

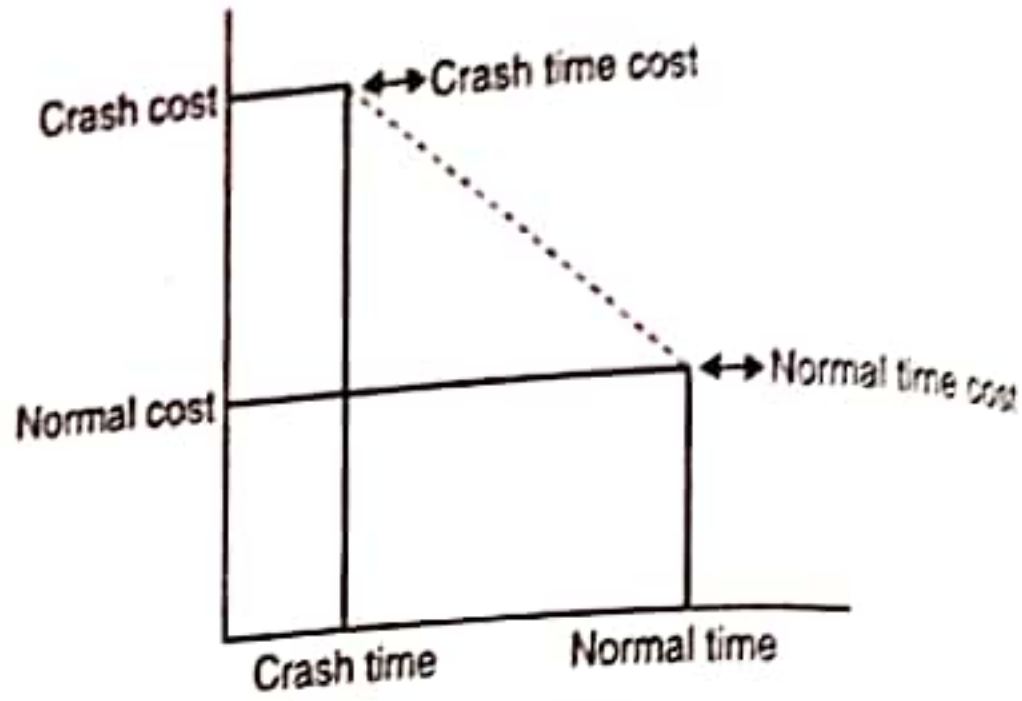

Fig. 4.1.1

- Thus, there is an incremental cost per unit of time saved under conditions of crashing and can be represented as follows:

  Incremental Cost = Crash cost – normal cost/ normal time – crash time
- So, if for an activity the crash cost and crash time is 900 Rs and 6 days respectively and normal cost and time are 700 and 9 days then the incremental cost per day is

  $= 900 - 700/9 - 6 = 67$ Rs per day

Rules for Crashing

(i) The activities on the critical path need to only be taken into consideration as they determine the project duration. Crashing of non-critical activities would not prove useful as it will not assist in reducing the project duration.

(ii) Once the critical path is crashed a new path may emerge as the critical path.

(iii) If during the course of the crashing if there are more than one critical paths then the activities that are common to them should first be taken up for crashing.

(iv) The crashing is done for one unit of time i.e. a day, week, etc.

Steps In Crashing

- **Step 1 :** The first step in crashing is to identify the critical path and then select the activity that has the minimum incremental cost of crashing.
- **Step 2 :** Once the activity with the minimum incremental cost of crashing has been crashed a new critical path may be created. The critical path is again identified and the same procedure is applied.

Ex. 4.1.1

The table below lists seven activities of a construction project along with the normal and shortest duration of completing the activity and the cost of reduction per day. The indirect cost per day is 90 Rs. The direct cost of completing all the seven activities in the given normal time is Rs 660/-.

You are required to calculate the normal duration of the project, the critical path and its cost. Also, calculate and plot the cost-time trade off on a graph and highlight the lowest cost and associated time and shortest time and associated cost.

Activity	Normal Duration	Normal Cost	Shortest Duration	Cost of Reduction per day	Maximum Possible Crashing
1-2	3	50	2	50	1
1-3	2	75	1	75	1
1-4	6	140	4	60	2
2-4	5	100	3	40	2
2-5	7	115	6	30	1
3-4	2	80	2	-	-
4-5	4	100	2	70	2

Soln. :

Step 1 : We will first be drawing the network diagram based on the data in the table. The number next to activity on the arrow denotes the duration of the activity.

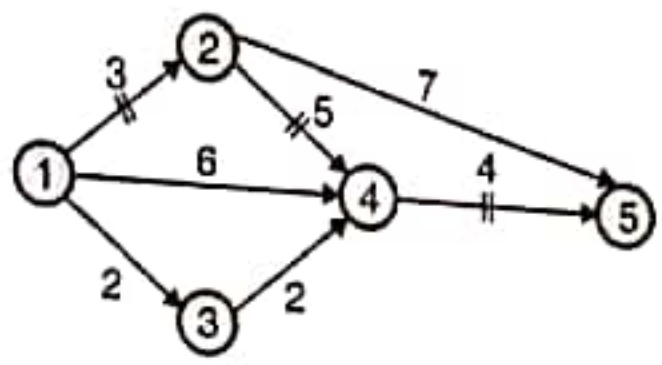

Fig. P. 4.1.1

Minimum duration and Critical Path

Path	Normal Length
1-2-4-5	12
1-2-5	10
1-4-5	10
1-3-4-5	9

- The original critical path of the project is 1-2-4-5 and the normal duration of the project is 12 days and the normal cost of the project is Rs 660/-.

Step 2 : The activities on the critical path are 1-2, 2-4, and 4-5 with the cost of reduction at Rs 50, Rs 40 and Rs 70 respectively. Since we are to select the activity with the minimum incremental cost of crashing we shall be selecting activity 2-4 for crashing. We can crash activity by 2 days since the critical path duration is 12 days and the longest non-critical path takes 10 days as also the maximum that activity 2-4 can be crashed is 2 days. The direct cost of the project has now gone up by Rs 80/- while the overall project duration has gone down to 10 days and invariably the indirect cost which is Rs 90/ - per day. The changed event times are given in the network diagram below.

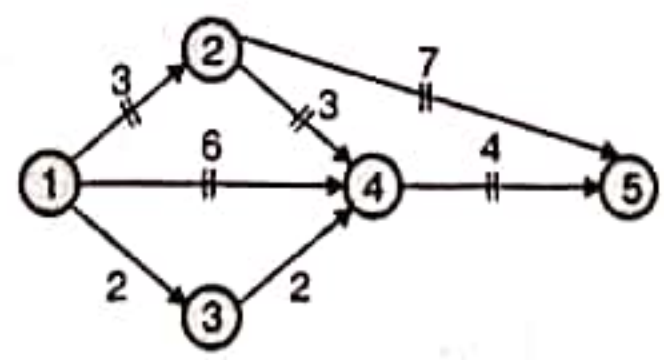

Fig. P. 4.1.1(a)

- Activities 1-4 and 2-5 which were initially on the non-critical path have now become critical on account of the changed durations. We now have three critical paths.

Path	Duration
1-2-4-5	10
1-2-5	10
1-4-5	10

▶ **Step 3**

- When there are more than one critical path, crashing of individual activity along the original critical path will not prove useful. We will have to crash parallel activities which will help in the simultaneous reduction of duration in all the critical paths. However, if an activity is common to all the critical paths its compression will prove to be a feasible alternative.
- A careful study of the critical paths in the above table provides us with two alternatives.
  (i) Crash activities 1-2 and 1-4 at a cost of Rs 50+60 = 110/- per day
  (ii) Crash activities 2-5 and 4-5 at a cost of Rs 30+70 = 100/- per day
- Going by our rule of selecting the activity with the minimum incremental cost of reduction we select the second option i.e. we crash activities 2-5 and 4-5 by a day at a cost of Rs 100/- thereby getting the project duration down to 9 days. The changed events are indicated in the network below.

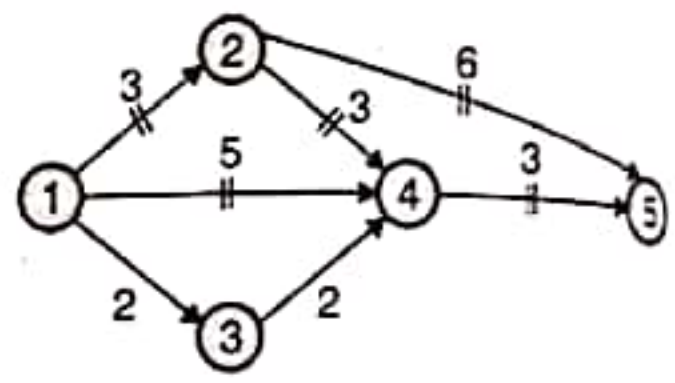

Fig. P. 4.1.1(b)

▶ **Step 4 :**

- The only option left with us now is to crash activities 1-2 and 2-4 at a cost of Rs 110/- for day. This increases the direct cost by 110/- and the duration is reduced to 8 days. Now all the activities on the three critical paths have duration equal to 8 days and no further crashing is possible.
- The network diagram below will indicate that all the three critical paths have a duration of 8 days. Thus the total direct cost of the project is now Rs 950/- while its duration is down to 8 days.
- The question that we are now faced with is that is the crashing financially beneficial to the project. For this we will have to take into account the indirect cost which as mentioned in the problem is Rs 90/- per day.

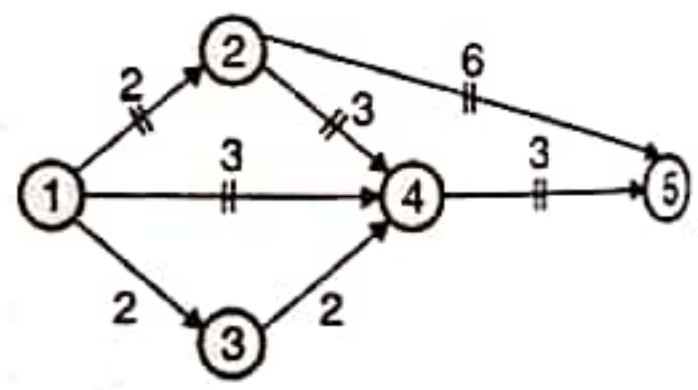

Fig. P. 4.1.1(c)

▶ **Step 5 :** The table below will give you a perfect idea of how the project will proceed financially and where the project manager has to stop with the crashing activities.

Project Duration	Direct Cost			Indirect Cost			Total
	Normal	Crashing	Total	Overhead	Penalty	Total	
12	660		660	1080	-	1080	1740
10	660	80	740	900	-	900	1640
9	660	180	840	810	-	810	1650
8	660	290	950	720	-	720	1670

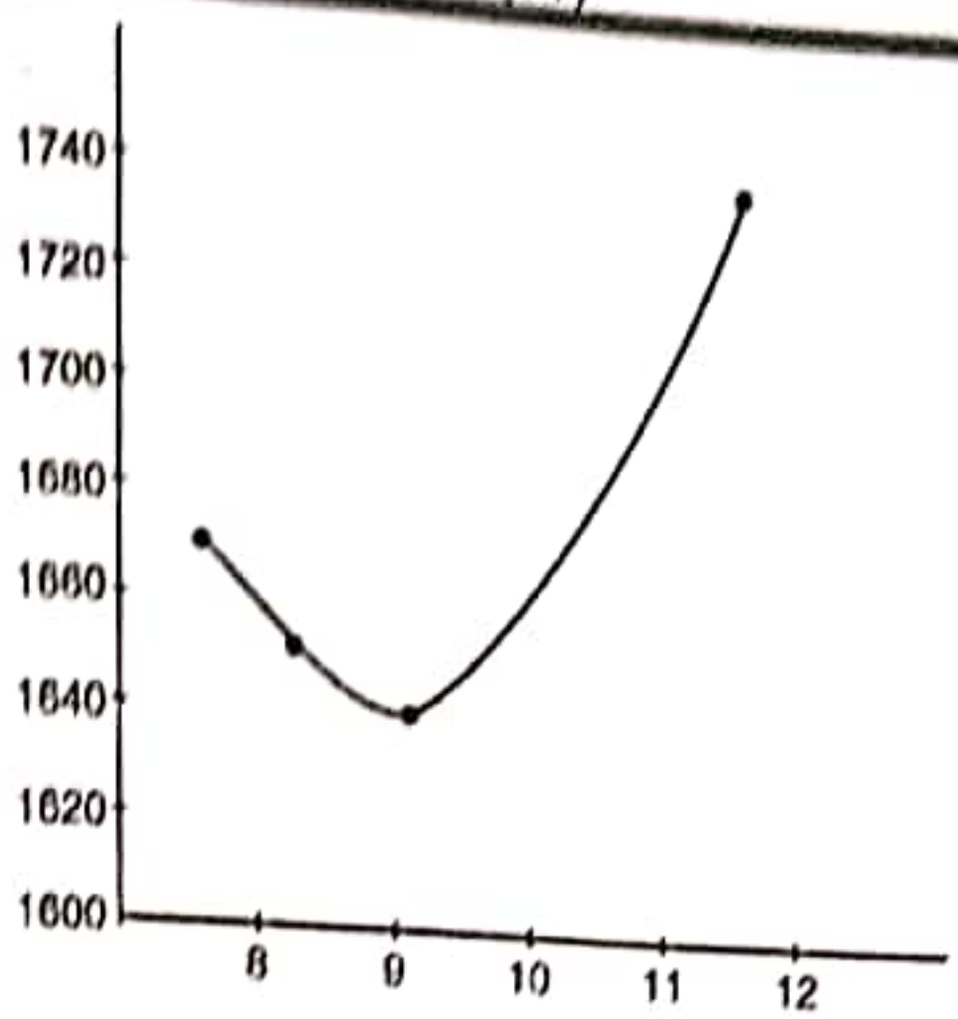

Fig. P. 4.1.1(d)

The above table indicates that the optimum duration at which the time-cost trade off takes place is 10 days. This has also been graphically represented in the graph above. So despite the possibility of further crashing it will not be financially feasible.

4.2 RESOURCE LOADING AND LEVELLING

Q.4.2.1 *Why is resource leveling important in project management ?*

4.2.1 What are Project Resources?

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- For a project to be successful it is beneficial to know in advance the resources required and the when they would be required. Resources are required to carry out project tasks and include people, capital, material, facilities, tools, and equipments.
- Lack of resources will be a constraint on the completion of the project. However, the biggest resource in any project is people. Projects require people with the right qualification, experience, and skill set to accomplish the project objectives.
- Depending on the nature of the project, deadline for its completion, and the scope of project especially WBS the project manager is able to identify the resource requirement for its success.
- The resource can then be mapped to the WBS to create a Resource Breakdown Structure. The Resource Breakdown Structure indicates the moment the resource would be required and the project deliverable it would be creating.
- As we have seen that there are various projects vying for scarce resources in an organization. The resource breakdown structure will be able to utilize these resources optimally by assigning resources to project activities. The project schedule will have to consider the availability of project resources to create deliverables.
- In case the project sponsor has set a deadline even before the project is assigned to the project manager, the project manager should verify the resource requirement based on the project deadline. Projects that fail or are delayed can usually be traced to poor planning, insufficient resources or unrealistic deadlines.
- The time taken to complete a project depends on the number of hours a resource works in a week, the number of days they will be able to work, and the time they can allocate to this project.

- The project manager's first concern during planning is to uncover which skills are needed for the project, which tasks will require the most hours and which skills are needed to complete those tasks. This will enable him to proceed assigning a resource with the right skills and the highest availability. To determine availability, first consider the resource's project availability percentage, then adjust for concurrent project demands and planned out-of-office time. Find the right balance to solve the resource equation, and the project manager will be able to shorten the project's planned duration and accelerate the finish date.

While selecting his team the project manager may rely on multiple methods to assess the skills of the proposed team member.

- **Prior Experience :** The project manager has worked with the team member on prior projects and has is very well aware of his capabilities and shortcomings.
- **Prior Track record :** Although you may not have directly worked with this team member his track record in the organization makes him a good prospect for being a part of the team.
- **Management Recommendation :** Not all members are selected by the project manager some may be in the team on recommendation of the management. Either management may feel that they are suitable for the job or wants them to get the experience of working on the project.
- **Team Member Recommendation :** Existing team members whom you fully trust may recommend others on to the team.
- The project manager might be able to hit the sponsor's initial deadline by using creative resource allocation, such as a trainer with development skills, or a desktop technician who can set up a server, when traditional resources aren't available and delaying isn't a practical option.
- The key to making these kinds of choices, and settling on the most aggressive yet realistic deadline, is to communicate with the resources' managers. Make sure they agree to commit their people to the effort and hold them accountable for their active participation on the project team and timely completion of their assigned tasks.

4.2.2 Resource Allocation

- Every project should implement a resource allocation programme with the objective of allocating available resources to activities of a project with the sole intention of ensuring the completion of the project in the shortest project duration within the limits of the resources made available to the project.
- It is but obvious that a project is most likely to be delayed if the resources required for the project are not sufficient. So the first task of the resource allocation programme is to check whether the available resources are adequate for the completion of the project.
- If the answer is yes then the project manager can proceed as per the plan. However, if they are found to be insufficient then some of the activities of the project will have to be scheduled only after their latest allowable start times thereby leading to a delay in the completion of the project.
- The programme will also have to investigate the amount of delay the non-availability of sufficient resources would cause.

4.2.3 Resource Levelling

Q. 4.2.2 *Explain briefly resource leveling.*

- It will be possible for a project manager to perform the activities within the network only when the resources i.e. men, machine, material, etc are made available. The project manager cannot expect unlimited availability of resources and therefore it is his responsibility to ensure the optimum utilization of the resources made available to him.
- As we have seen in the previous chapter, the earliest and latest start time of all the activities can be determined along with the slacks and that the objective of determining of determining the earliest start time was to ensure the early completion of the project.
- However, this is possible only when there are unlimited resources made available to the project which as we all know is never the case. Hence, the other objective of determining the earliest and latest start time is the levelling of the resources allocated to the total project.
- The project manager aims to keep the total amount of resources in use during the project as nearly constant as possible and ensure their optimum utilization during the entire course of the project.
- Thus, the project manager aims at levelling resources to ensure steady progress and expenditure. This, analysis aimed at maintaining the constancy of resource usage throughout the project is called as resource levelling.
- The primary objective of resource levelling is to reduce the peak resource requirement and smoothen the resource usage rate without altering the project duration. Thus, resource levelling involves the reallocation of resources to maintain constancy of resource requirement.
- Resource levelling can be carried out for individual resource or all the resources of the project. For complex project with multiple tasks this becomes an arduous task requiring the project manager to revisit the project network to accommodate the resources. However, arduous the task may be it is worth the effort.

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Ex. 4.2.1

The following data pertains to a small construction project. You are to draw the network diagram, find project duration, mark critical path and determine the schedule of activities such that the requirement of manpower is smooth and there is no delay in the project.

Event	A	B	C	D	E	F	G	H
Activity	1-2	1-3	1-4	2-3	2-5	3-5	4-6	5-6
Duration	2	4	3	0	1	6	5	7
Manpower	3	5	2	-	2	4	5	3

Soln. :

Step 1 : We will first be drawing the network diagram based on the data in the table. The number next to activity on the arrow denotes the duration of the activity and the one in the bracket denotes the manpower required to complete the activity. Activity D is a dummy activity and hence has no duration and manpower.

Total Project Duration = 17 days

Critical Path = 1-3-5-6

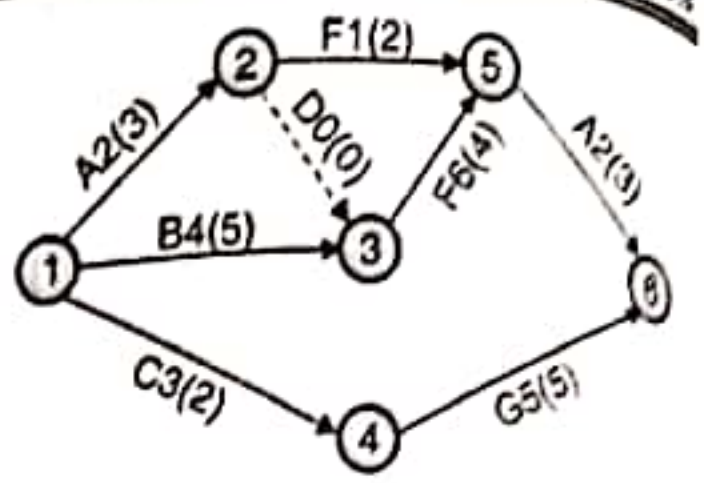

Fig. P. 4.2.1(a)

▶ **Step 2 :** The next step would be to draw a schedule graph on a time scale. This will enable us to know the ranges of time allowable for various activities. The assumption here is that the various activities are started at earliest start time (ES). On the basis of this graph the requirement of daily manpower is determined.

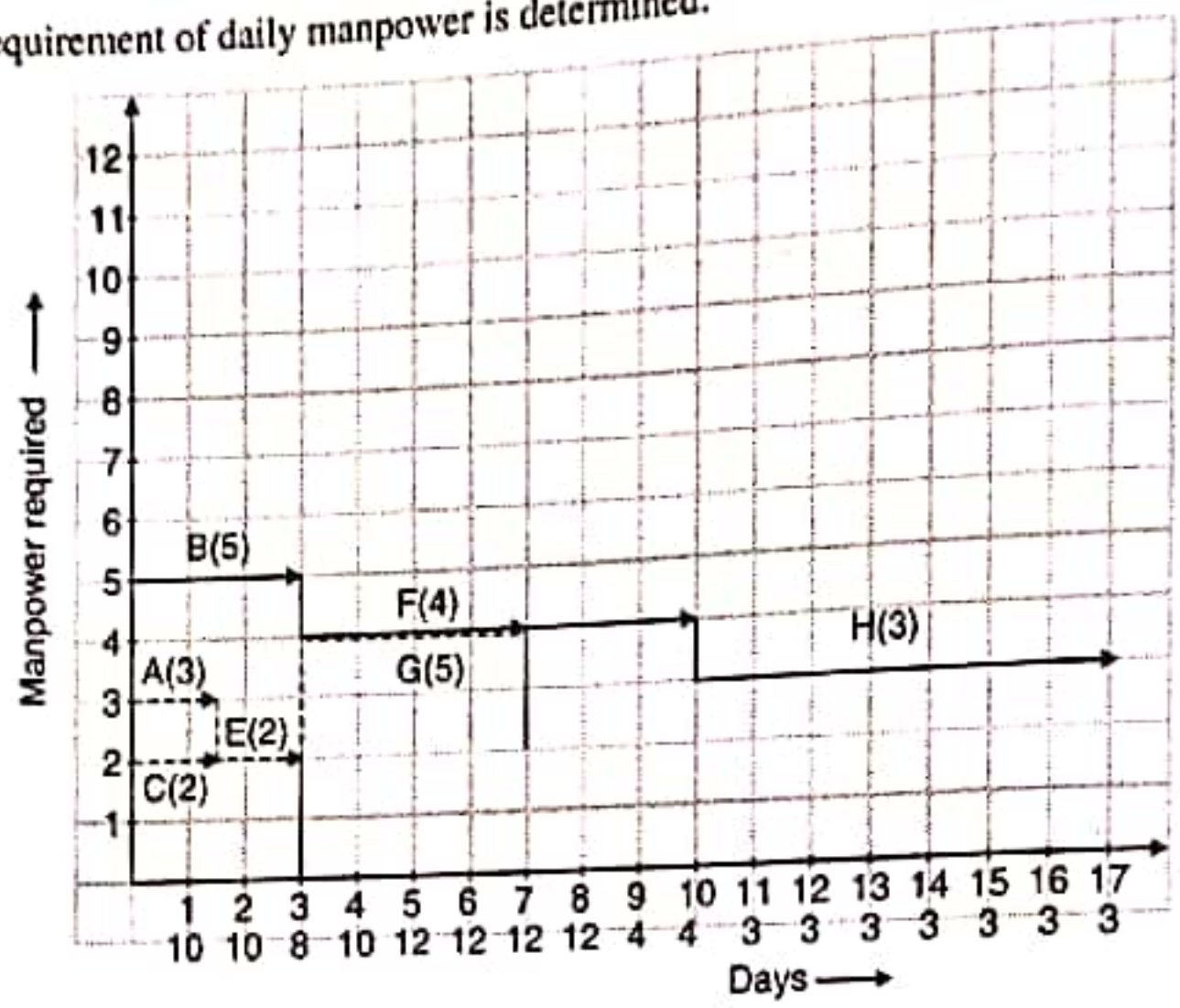

Fig. P. 4.2.1(b) : Manpower Requirement Graph

- From the Manpower Requirement Graph it is obvious that there is a large variation in the manpower requirements of the project if the network diagram were to be followed.
- The aim of the project manager is to maintain constancy in the requirement of manpower for which a few of the activities would have to be shifted to ensure that the requirement evens out.
- Going back to the time schedule graph, the continuous line represents the critical path of the project. The duration of the project is 17 days and the events B, F and H are on the critical path.

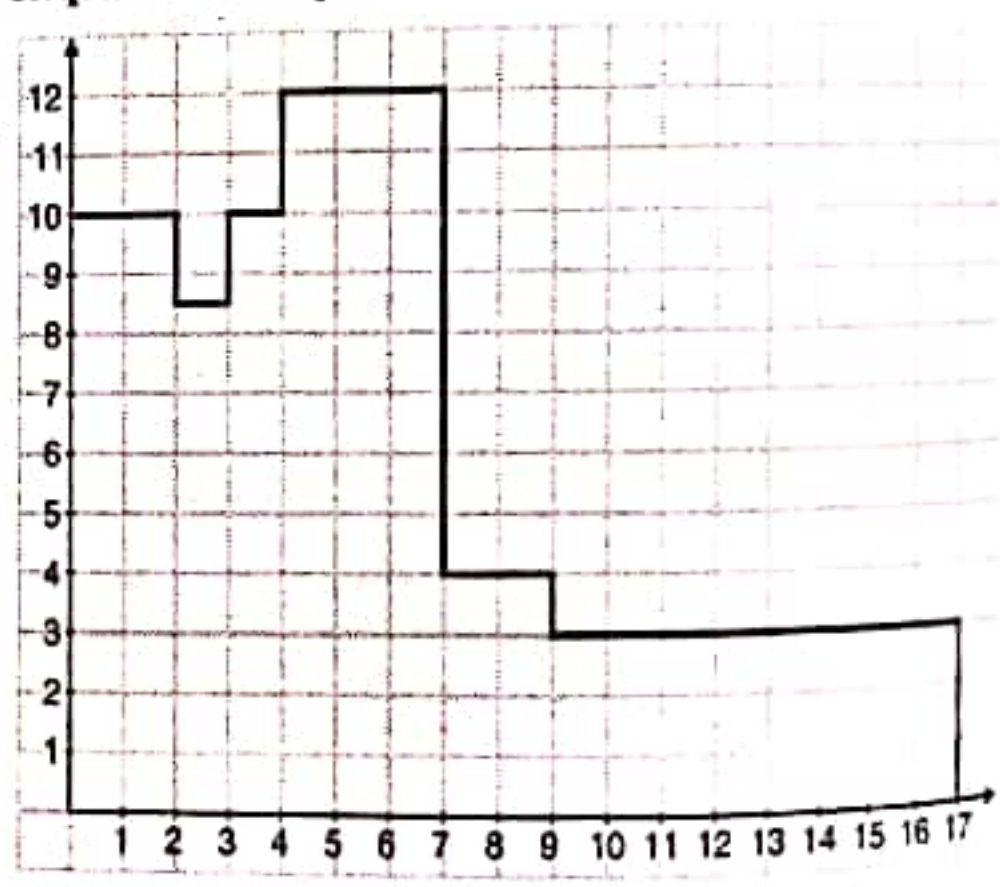

Fig. P. 4.2.1(c)

- Although, the project manager is aiming to maintain constancy in manpower requirement he may in no way tamper with the duration of the project and hence the activities on the critical path are not to be touched therefore should not be rescheduled. This leaves him with the only option of shifting the remaining activities that have slack.

Table P. 4.2.1 : Activity Scheduling Times and Float

Activity	Normal time (days)	Earliest Time		Latest Time		Total Float	Free Total
		Start	Finish	Start	Finish		
1-2	2	0	2	7	9	7	0
1-3	4	0	4	0	4	0	0
1-4	3	0	3	9	12	9	0
2-3	0	0	0	0	0	0	0
2-5	1	2	3	9	10	7	7
3-5	6	4	10	4	10	0	0
4-6	5	3	8	12	17	9	2
5-6	7	10	17	10	17	-	-

- The project manager may shift activity E to the 9th day of the project and activity G to the 12th day. The change in the manpower is depicted in the Fig. 4.2.1(d).

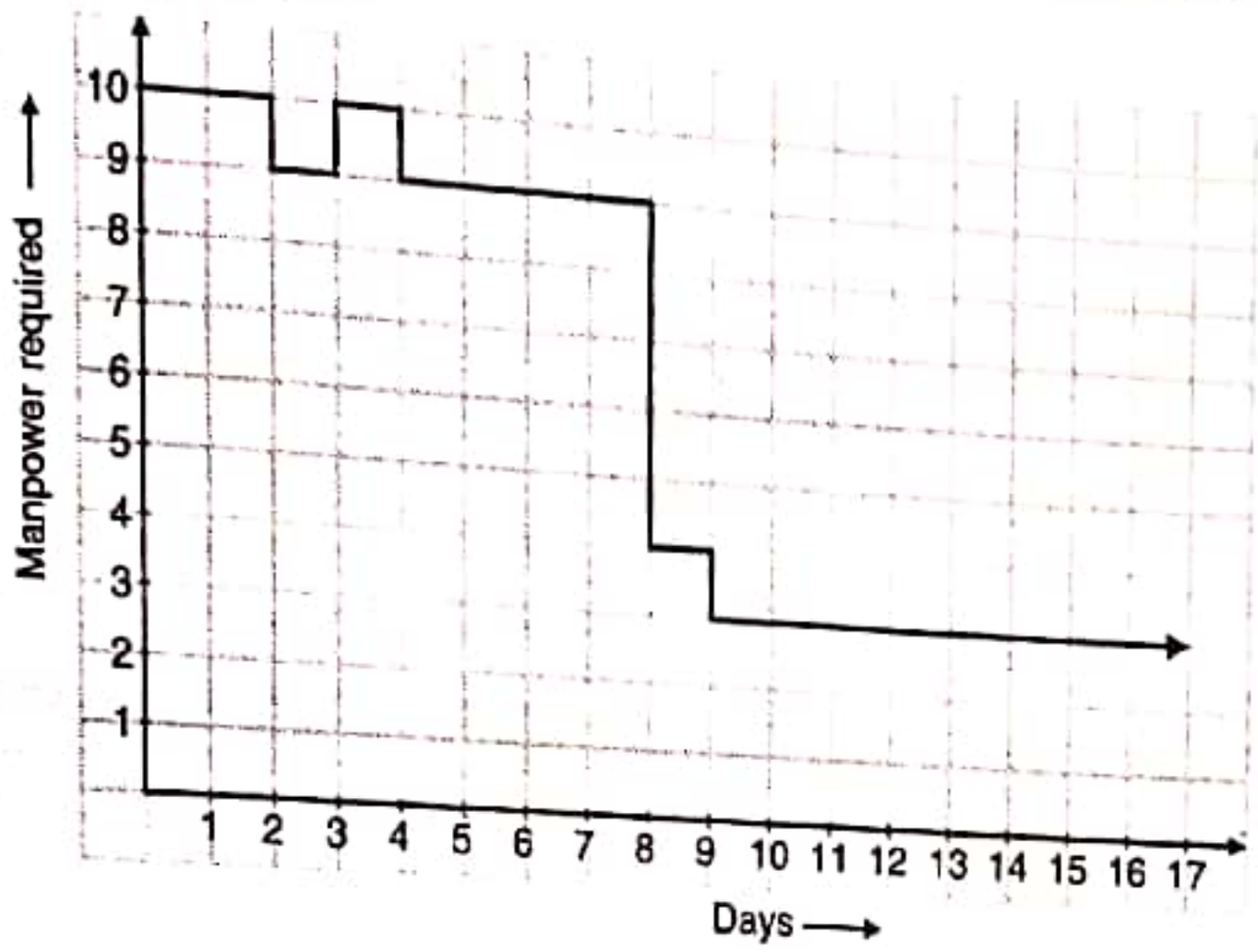

Fig. P. 4.2.1(d)

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4.2.4 Resource Loading or Smoothing

GQ. 4.2.3 *Difference between resource leveling and resource smoothing.*

- Is the analysis of the project network aimed at reducing the peak demand for resources and reallocating them among activities of a project in a manner that ensures that the project duration remains the shortest. In smaller or simpler projects, resource loading can be done by simply analysing the project network to find out the demand for resources.
- During this analysis it is assumed that all the activities will start on their respective earliest start time. We will then schedule the resource as per requirement and then observe the overlaps and the period when the demand for the resource is the highest.
- In case the resource is limited and there is an overlap then the activities will have to be rescheduled. Alternative schedules will have to be prepared as per the slack of each activity.
- Also, if the duration of a project is directly proportional to the amount of resource (e.g. labour) applied then the length of the project is a function of the number of workers assigned to the project. Thus, the project length would be shorter when more number of workers are assigned.

- Till now we had been discussing the allocation of a single resource and the determination of project duration. However, the problems in real life projects involve multiple resources and hence are more complicated.
- For allocation of multiple resources the project network will have to be analysed systematically and priorities will have to be highlighted clearly.

Criteria for Resource Smoothing

- The criteria for scheduling are the slack that the activities have and resources are allocated to the activities as per the slack that they have.
- For this the activities have to be arranged according to the float they have starting from the activity having the minimum float to the one that has the highest float.
- Also, if two activities have the same float then the one with the smallest duration should be scheduled first. The objective behind scheduling the activity with the smallest duration is that the waiting time for the other activity is reduced.
- Now, if there are two activities having identical float and duration then the activity requiring more resources should be scheduled first.

Procedure for Resource Smoothing:

- **Step 1 :** Calculate the earliest start and latest finish times of each activity and then draw a time scaled version (or squared) of the network. In this network critical path is drawn along a straight line and non-critical activities on both sides of this line. Resource requirement of each activity is given along the arrows.
- **Step 2 :** Draw the resource diagram by taking earliest star times or latest start times of activities on the x-axis and cumulative on y-axis.
- **Step 3 :** Shift start time of non-critical activities first having largest float in order to smoothen the resources.

Ex. 4.2.2

Following are the manpower requirement for each activity in a project.

Activity	Normal time (days)	Manpower required per day
1 – 2	10	2
1 – 3	11	3
2 – 4	13	4
2 – 6	14	3
3 – 4	10	1
4 – 5	7	3
4 – 6	17	3
5 – 7	13	5
6 – 7	9	8
7 – 8	1	11

(a) Draw the network and find out total float and free float for each activity.

(b) The contractor stipulates that during the first 26 days only 4 to 5 men and during remaining days 8 to 11 men only can be made available. Rearrange the activities suitably for leveling the manpower resources, satisfying the above condition.

Soln. :

The network diagram of the given project is shown in Fig. P 4.2.2.

The value of total float and free float for non-critical activities are given in Table P. 4.2.2.

Table P. 4.2.2 : Activity scheduling times and float

Activity	Normal time (days)	Earliest Time		Latest Time		Total Float	Free Float
		Start	Finish	Start	Finish		
1 – 2	10	0	10	0	10	0	0
1 – 3	11	0	11	2	13	2	0
2 – 4	13	10	23	10	23	13	0
2 – 6	14	10	24	26	40	16	16
3 – 4	10	11	21	13	23	2	2
4 – 5	7	23	30	29	36	6	0
4 – 6	17	23	40	23	40	0	0
5 – 7	13	30	43	36	49	6	6
6 – 7	9	40	49	40	49	0	0
7 – 8	1	49	50	49	50	0	0

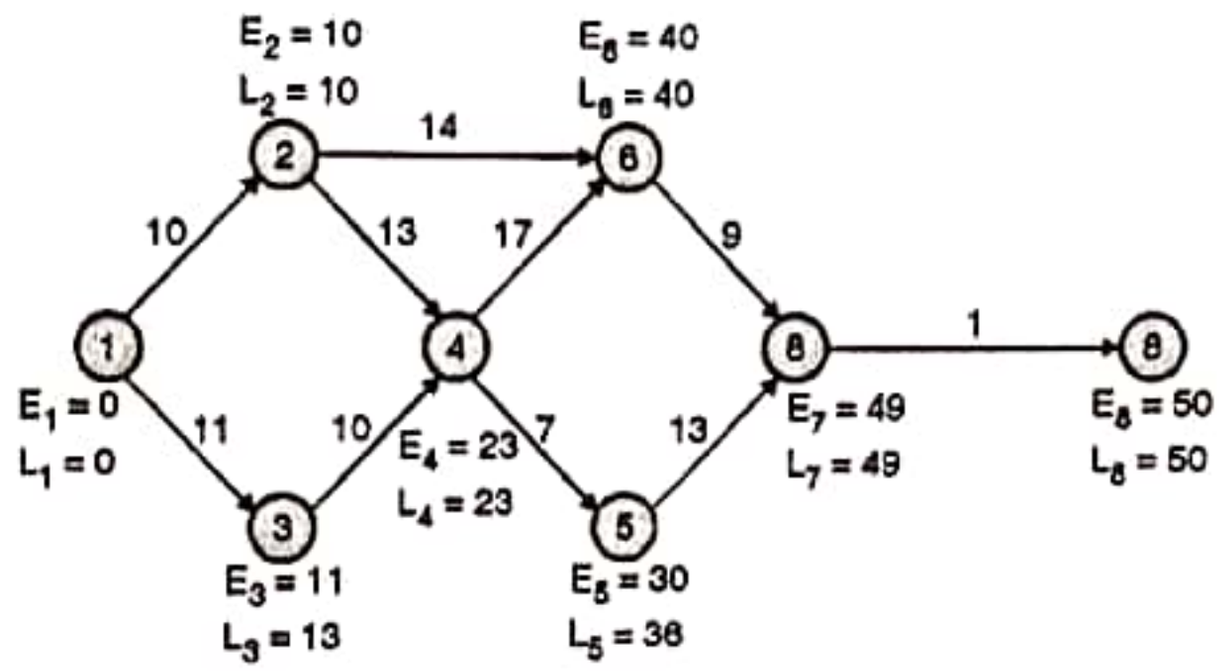

Fig P. 4.2.2

- The total project duration is 50 days. Now it is required to rearrange activities so that they can be performed within 50 days (project duration) with the available manpower at different intervals.
- The critical activities 1 – 2, 2 – 4, 4 – 6, 6 – 7 and 7 – 8 are scheduled first. Since non-critical activity 1 – 3 is scheduled at t = 0 followed by the non-critical activity 3 – 4, therefore, on 11th day (earliest finish time of 1 – 3) the manpower requirement would rise to 7, which is more than the available on 11th day. The total float of activity 1 – 3 is more than its free float, even than rule (b) is not applicable because its earliest start time as well as free float are both zero. Thus it has to be scheduled otherwise it would result in a delay of the project.
- Starting time of non-critical activities 2 – 6 and 4 – 5 can be delayed both to t = 26 (rule a) because more men would then be available (activity 4 – 6 can also be delayed up to t = 29). The last non-critical activity 5 – 7 is scheduled at t = 33 (rule a).
- The total daily requirement of men is shown in table and manpower requirement of various activities is shown in bracket in Fig. P. 4.2.2(a).

Table P. 4.2.2(a) : Manpower requirement

Interval	Day(s)	Men
0 – 10	1 to 10th	5
10 – 11	11th	7
11 – 21	12th to 21st	5
21 – 23	22nd to 23rd	4
23 – 26	24th to 26th	5
26 – 46	27th to 46th	11
46 – 49	47th to 49th	8
49 – 50	50th	11

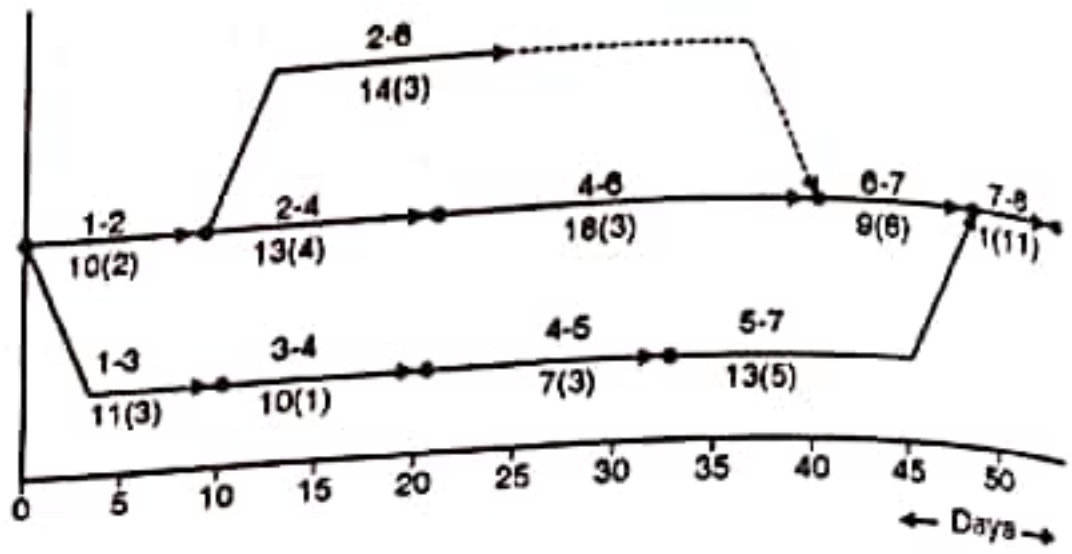

Fig. P. 4.2.2(a) : Time scaled graph

Ex. 4.2.3

The network for a small construction project along with the duration in days is given. The earliest and latest event times are given under the respective event number. You have been asked to schedule the activities with a view to smoothing out daily manpower requirements.

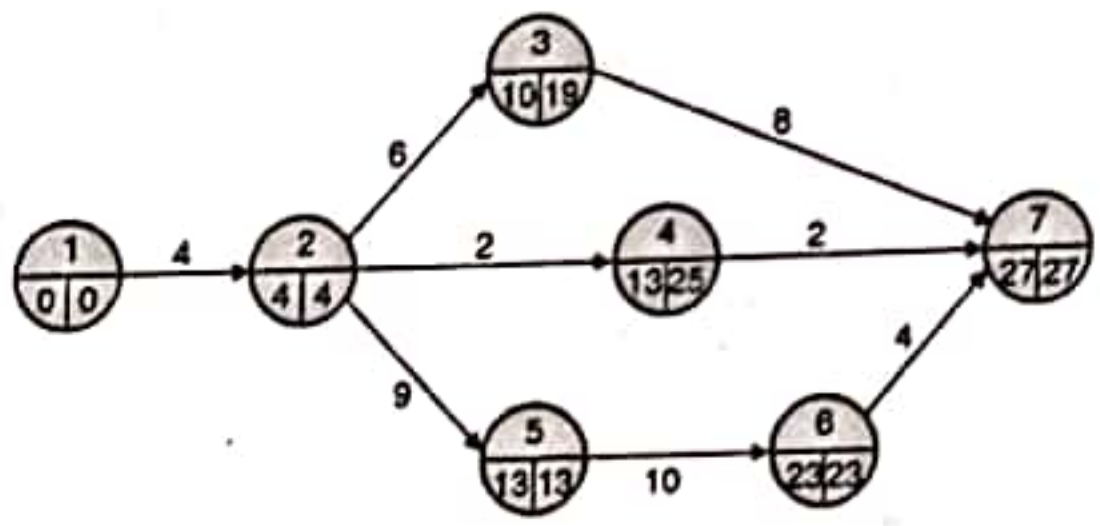

Fig. P. 4.2.3

The manpower requirements for each activity are as follows:

Activity	Manpower Required
1-2	2
2-3	3
2-4	4
2-5	4
3-7	4
3-4	3
4-7	1
5-6	2
6-7	2

Soln. :

The table below will give us the earliest start, latest start and the total float.

Activity	Earliest Start	Latest Start	Total float
1-2	0	0	0
2-3	4	13	9
2-4	4	23	19
2-5	4	4	0
3-7	10	19	9
3-4	10	22	12
4-7	13	25	12
5-6	13	13	0
6-7	23	23	0

- To calculate the latest start we need to add the total float to the earliest start. So the latest start for activity (3-7) is its earliest start which is 10 + 9 (total float) = 19 which is its latest start.
- Based on the time-workforce diagram of earliest start times, the minimum and maximum daily manpower requirements work out to 2 and 11 respectively and a similar time-workforce diagram based on latest start times the minimum and maximum daily manpower requirements work out to 2 and 13.
- Now for smoothing out the daily manpower requirement we move activity (2-4) to start on the 18th day, activity (3-4) to start on the 20th and activity (4-7) to start on the 23rd day. The effect of this is shown in the histogram below.

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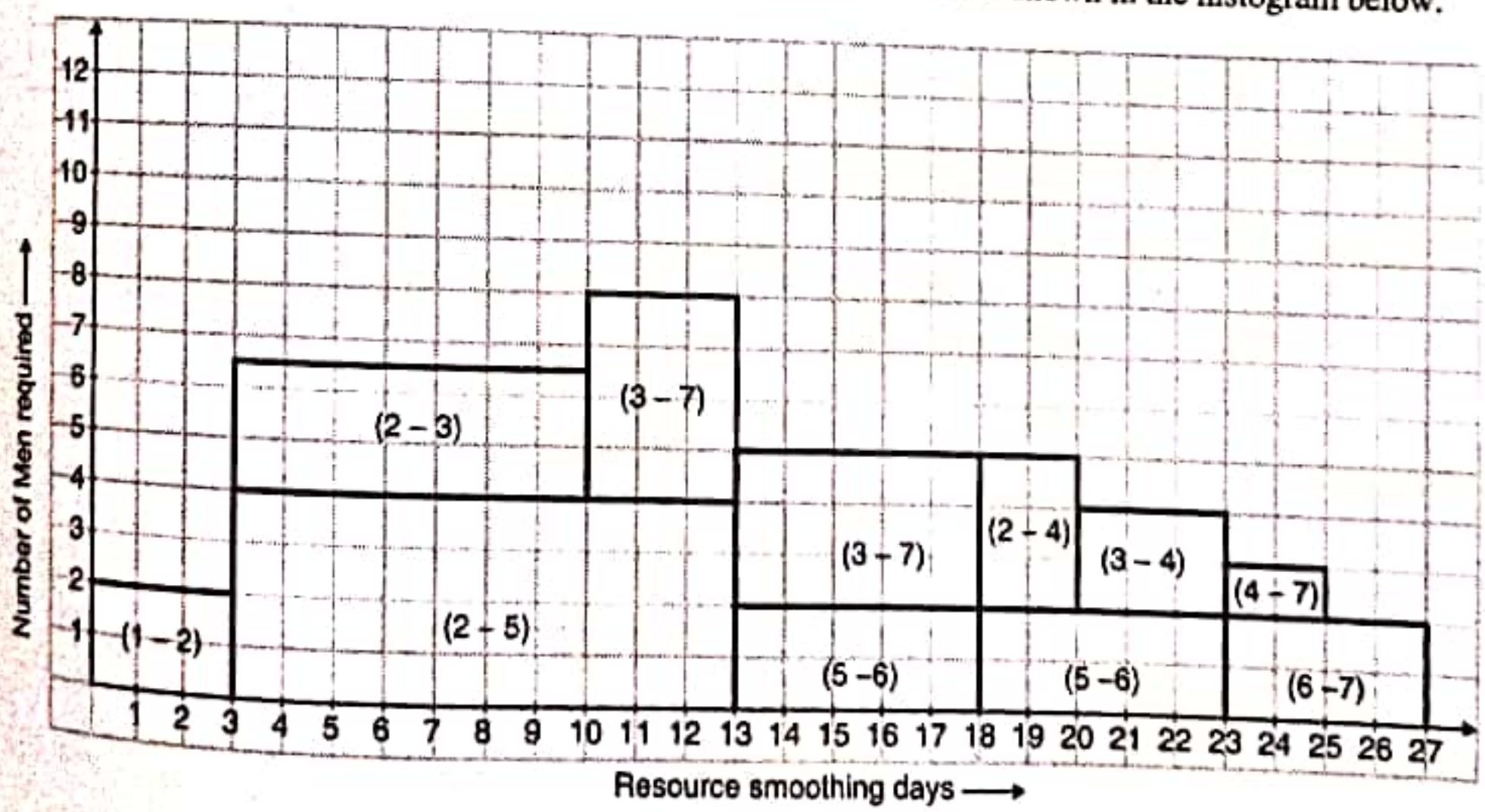

Fig. P. 4.2.3(a)

Ex. 4.2.4

Determine the aggregate resource requirements, periods by-period for the Network given below. The number over the arrow indicates the requirements of Mason and the number below the arrow are the durations of the activities for the project. Smoothen out the requirements of the resource and indicate the resulting revised schedule.

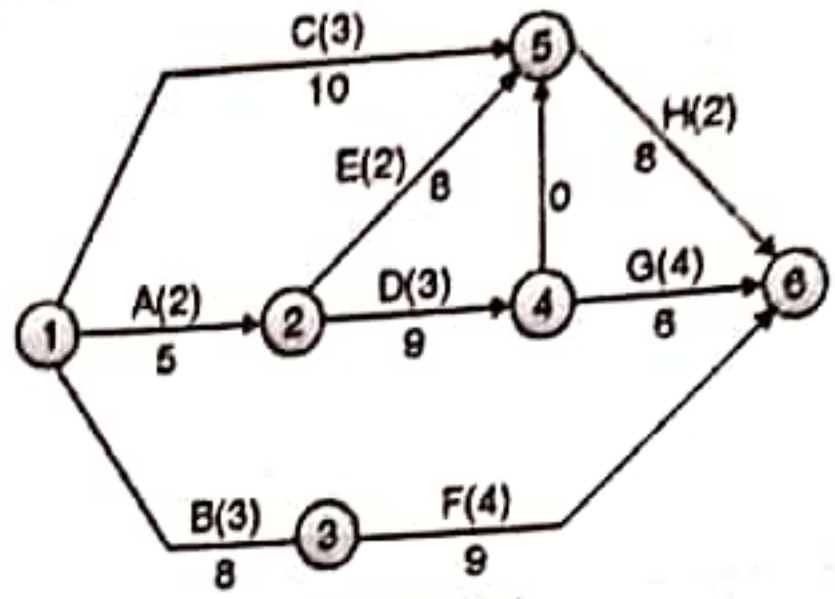

Fig. P. 4.2.4

☑ **Soln. :**

- In the first step we shall calculate the earliest and latest start and finish time along with the total and free float.

Activity	Normal time (days)	Earliest Time		Latest Time		Total Float	Free Total
		Start	Finish	Start	Finish		
A	5	0	5	0	5	0	0
B	8	0	8	5	13	5	0
C	10	0	10	4	14	4	4
D	9	5	14	5	14	0	0
E	8	5	13	6	14	1	1
F	9	8	17	13	22	5	0
G	6	14	20	16	22	2	0
H	8	14	22	14	22	0	0

Duration in Days	Activity	Total Days
1-5	A,B,C	8
6-8	B,C,D,E	11
9-10	C,D,E,F	12
11-13	D,E,F	9
14	D,F	7
15-17	F,G,H	10
18-20	G,H	6
21-22	H	2

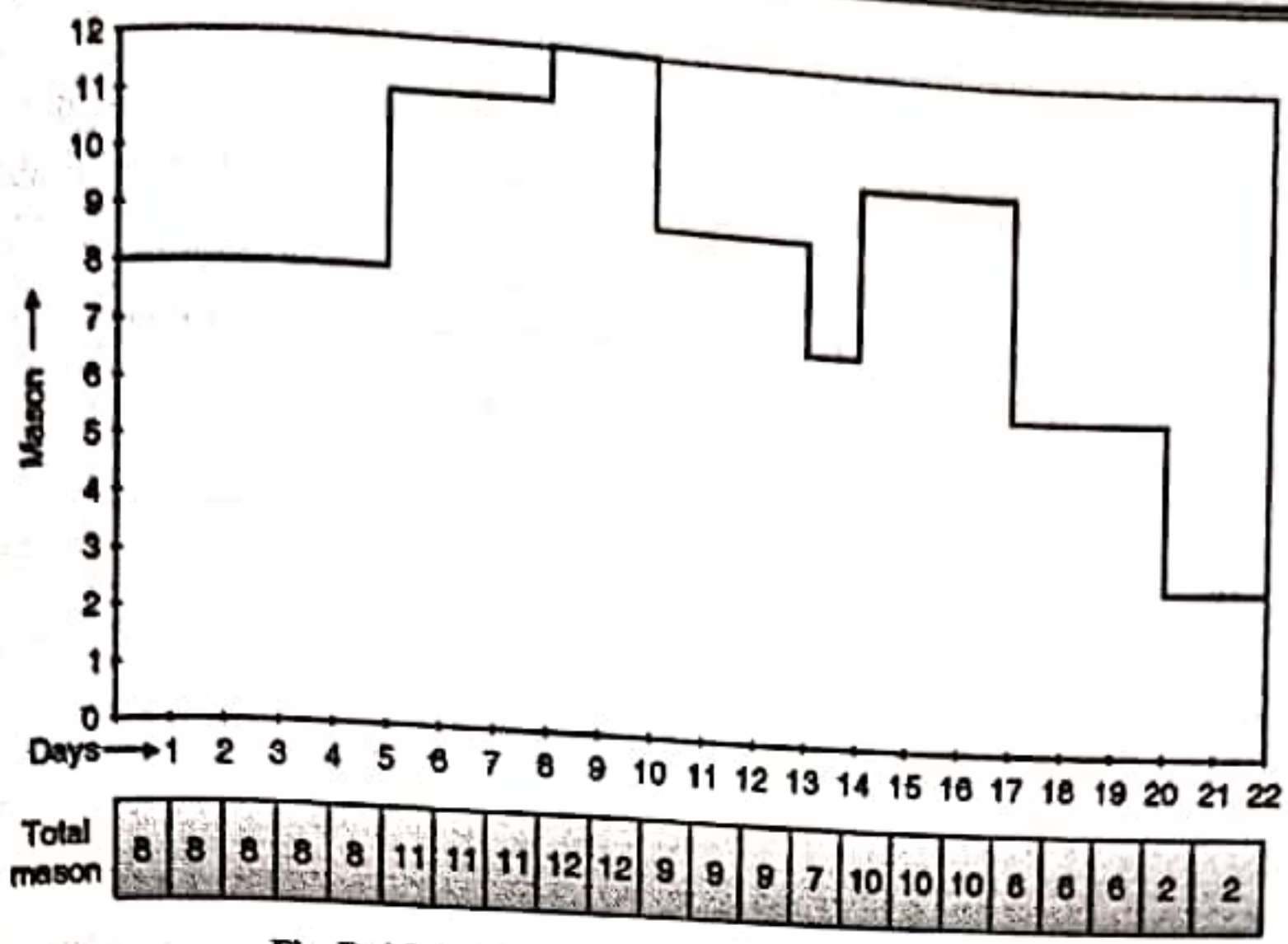

Fig. P. 4.2.4(a) : Manpower Requirement Histogram

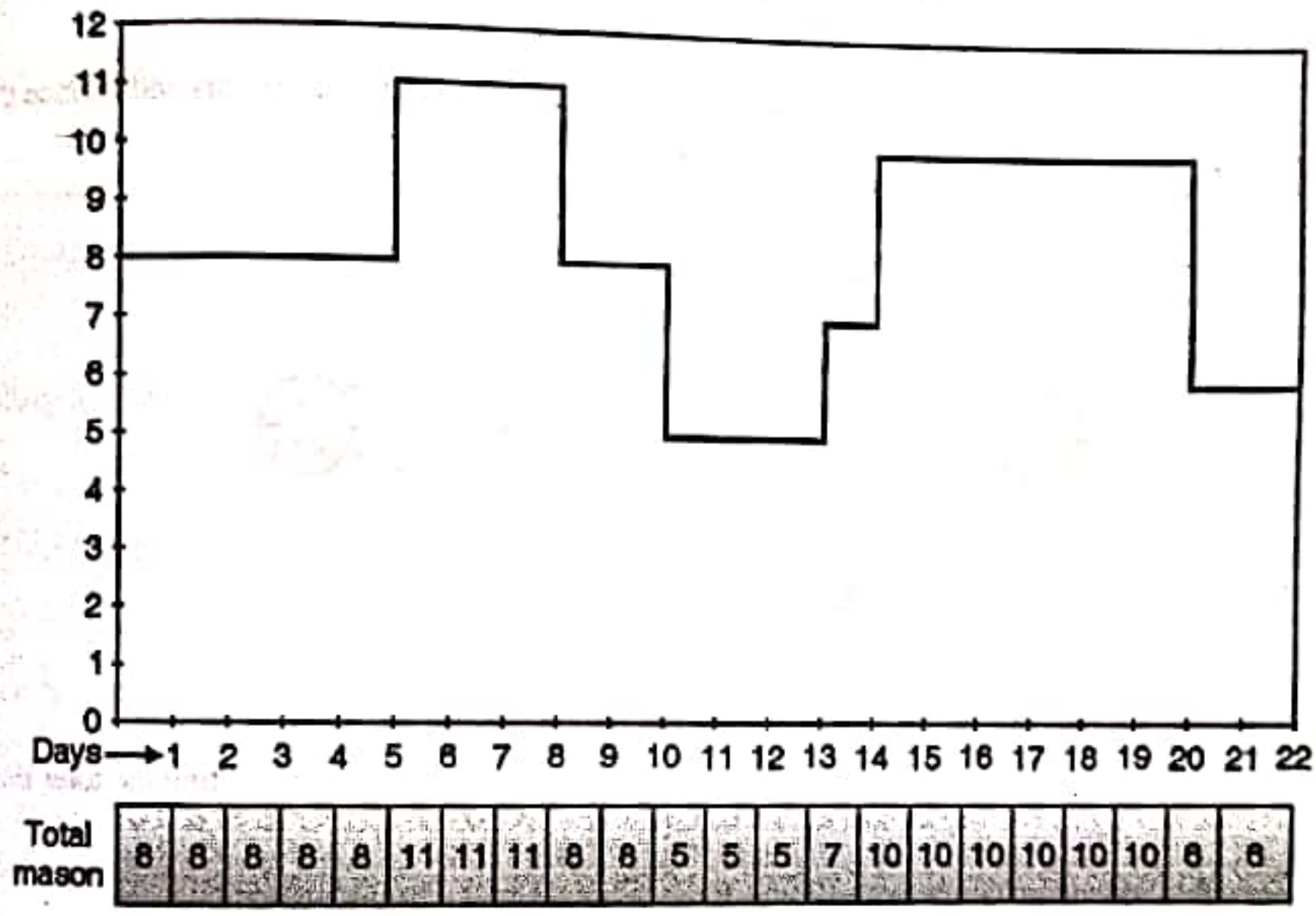

Fig. P. 4.2.4(b)

Ex. 4.2.5

A construction project has the following requirement for equipment and manpower for 8 activities. You are given the duration of each activity and are supposed to calculate the project completion time based on the availability of manpower and equipment.

Activity	Equipment Required	Manpower Required	Duration
1 – 2	X	30	4
1 – 3	Y	20	3
1 – 4	Z	20	6
2 – 4	X	30	4
2 – 5	Z	20	8
3 – 4	Y	20	4
4 – 5	X	30	6

Project Constraint : Only one set of equipment is available and maximum manpower available is 50.

☑ **Soln. :**

▶ **Step 1:** Let us first construct a network diagram without taking into account the constraints and include the earliest and latest time for each event.

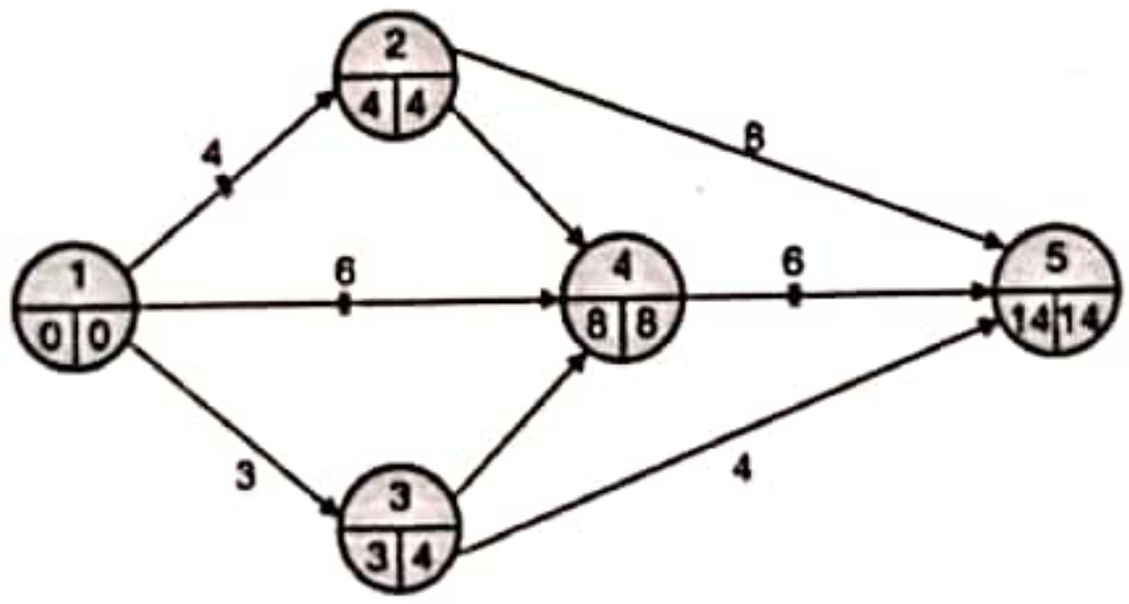

Fig. P. 4.2.5

▶ **Step 2:** in the 2nd step we shall be identifying the critical step for which we shall be calculating the total float.

Activity	Total Float
1 – 2	0
1 – 3	1
1 – 4	2
2 – 4	0
2 – 5	2
3 – 4	1
3 – 5	7
4 – 5	0

Based on the above the critical path is 1-2-4-5 and the duration of the project is 14 days.

Step 3: in this step we shall consider the effect of resource constraints on the activities. We shall be first be allocating resources to the activities on the critical path, then to the sub critical activities and finally to the balance activities. While allocating resources we shall have to take into account the logical interdependence of activities. Also, whenever an activity is complete its status is reviewed.

The resource allocation table below will give you a complete idea as to how the resources are to be allocated within the given constraints.

Review Date	1st	4th	5th	9th	10th	13th	18th	21st
Equipment X activity schedule	1 – 2	1 – 2	2 – 4			4 – 5	4 – 5	
Required Manpower								
Days Completed	30	30	30			30	30	
	4	4	8			18	18	
Equipment Y activity schedule	1 – 3			3 – 4	3 – 4		3 – 5	3 – 5
Required Manpower								
Days Completed	20			20	20		20	20
	3			12	12		21	21
Equipment Z activity schedule		1 – 4	1 – 4	1 – 4	2 – 5	2 – 5		
Required Manpower								
Days Completed		20	20	20	20	20		
		9	9	9	17	17		
Total Number of Men	50	50	50	40	40	50	50	20

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From the table above it is evident that due to project constraints of equipment and manpower the project duration will get extended to 21 days.

4.3 GOLDRATT'S CRITICAL CHAIN

- Goldratt's Critical Chain Project Management was developed and publicized by Dr. Eliyahu M. Goldratt in response to many projects being dogged by poor performance manifested in longer than expected durations, frequently missed deadlines, increased costs in excess of budget, and substantially less deliverables than originally promised.
- The Goldratt's Critical Chain Project Management (CCPM) is a methodology for planning, executing and managing projects in single and multi-project environments. This methodology of Project Management is an alternative to the established standard of Project Management as advocated by PMBOK and other Standards of Project Management that we have studied in the due course of this book.

4.3.1 Problems with Traditional Project Management Techniques

- When planning for an upcoming project, estimates for task durations are required. In order for the plan to be treated as realistic, much time is spent ensuring estimates are accurate.
- Accurate estimates give us increased probability and high-confidence in the task completing on time. This allows additional safety time beyond the work content time required to be embedded within the task duration.
- The more safety in a task the more there is a tendency to behave in the following ways:
  - Not starting the task until the last moment (Student's syndrome)
  - Delaying (or pacing) completion of the task (Parkinson's Law)
  - Cherry picking tasks
- As a result, the safety which was included at the planning stage is wasted and, if problems do occur, tasks over-run.
- In addition Management force people to work on more than one task at once – creating multitasking. This drives people to switch between tasks leading them to elongate time estimates in planning and further waste the embedded task safety in execution.
- Resources working on tasks also naturally resist reporting any early finishes. If an early finish is reported, the estimate for the task is recognised as too long. When a similar task on a different project is estimated, the initial response will be to again use a worst case duration. This will inevitably be challenged as the similar task was finished early last time. Increased pressure will be placed on the resource to accept a shorter estimate this time.
- The risk is that this, shorter estimate will not offer sufficient safety to the project should a problem occur. Hence resources ensure that sufficient safety is always embedded in each task estimate and the entire safety is used in execution of the task.
- In summary, delays to tasks are passed on to the entire project however; benefits from tasks finishing early are rarely passed on to the same project.
- The traditional tools used to manage projects; Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), Gantt, etc, do not address the misuse of embedded safety and consequently the behaviours they drive.

4.3.2 Critical Chain Project Management Method (CCPM)

Q. 4.3.1 Write short note on CCPM.

- The Critical Chain Method has its roots in Dr. Goldratt's "The Theory of Constraints" (TOC). This Project Management Method comes into force after the initial Project Schedule is prepared, which includes establishment of the task dependencies.
- The Critical Chain is defined as the longest chain (not path) of dependent tasks. In this case, 'dependent' refers to resources and resource contention across tasks/projects as well as the sequence and logical dependencies of the tasks themselves. This differs from the Critical Path Method.
- The evolved Critical path is reworked based on the Critical Chain Method. To do so, the methodology suggests and assumes constraints related to each task. Some of these constraints are as follows:
- There is a certain amount of uncertainty in each task.
- The task Durations are overestimated by the Team Members or Task Owners. This is typically done to add a safety margin to the task so as to be certain of its completion in the decided duration.
- In most cases, the tasks should not take the time estimated, which includes the safety margin, and should be completed earlier.
- If the Safety Margin assumed is not needed, it is actually wasted. If the task is completed earlier, it may not necessarily mean that the successor task can start earlier as the resources required for the successor task are not available until their schedule time. Hence the saved time cannot be passed on to finish the Project early.
- On the other hand, if there are delays over and above the estimated schedules, these delays will most definitely get passed on, and in most of the cases, will exponentially increase the Project Schedule.
- With the above assumptions, the Critical Path Methodology of Project Management recommends the use of safety 'Buffers' to manage the impact of variation and uncertainty around projects. The safety at a task level is aggregated and moved to strategic points in the project flow.
- There are three types of buffer/strategic points necessary to ensure the project has sufficient safety:

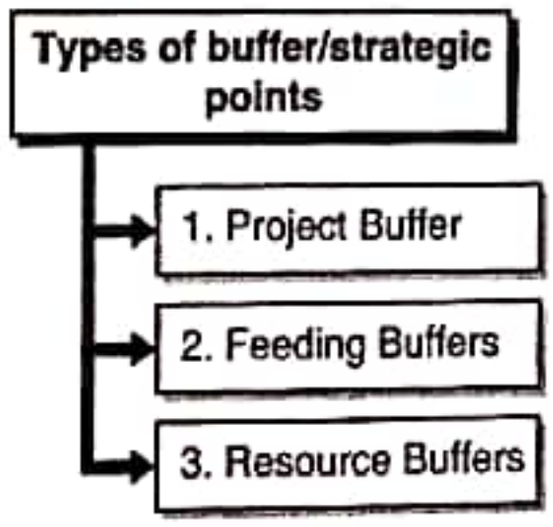

Fig. C4.1 : Types of buffer/strategic points

1. Project Buffer

- A project buffer is inserted at the end of the project network between the last task and the completion date. Any delays on the longest chain of dependant tasks will consume some of the buffer but will leave the completion date unchanged and so protect the project.

- The project buffer is typically recommended to be half the size of the safety time taken out, resulting in a project that is planned to be 75% of a "traditional" project network.

2. Feeding Buffers

- Delays on paths of tasks feeding into the longest chain can impact the project by delaying a subsequent task on the Critical Chain.
- To protect against this, feeding buffers are inserted between the last task on a feeding path and the Critical Chain.
- The feeding buffer is typically recommended to be half the size of the safety time taken out of the feeding path.

3. Resource Buffers

Resource buffers can be set alongside of the Critical Chain to ensure that the appropriate people and skills are available to work on the Critical Chain tasks as soon as needed.

Execution

1. Priorities

- All resources on a project are given clear and aligned priorities relating to the 'health' of the Critical Chain relative to its associated buffer and hence the project as a whole.
- A resource with more than one task open should normally be assigned to complete any task jeopardising any projects Critical Chain before completing any feeding path task.

2. Completion

- Resources on a task are encouraged to follow the 'roadrunner' approach. When there is work available it should be progressed at the fastest possible speed (without compromising quality) until completed.
- Tasks are not left partially complete to remove the temptation to multitask. As task duration estimates have reduced safety they drive resources to meet the more "aggressive" durations and limit the behaviours of Student Syndrome and Parkinson's Law.

Review

1. Buffer Management

- The amount each buffer is consumed relative to project progress tells us how badly the delays are effecting our committed delivery date. If the variation throughout the project is uniform then the project should consume its project buffer at the same rate tasks are completed.
- The result is a project completed with the buffer fully consumed on the day it was estimated and committed.
- Project Managers determine the corrective actions necessary to 'recover' buffer time at points in the project where the buffer consumption is occurring faster than the project is progressing.

2. Remaining duration

- Tasks are monitored on their remaining duration, not their percentage complete.
- Resources report upon tasks in progress based on the number of days they estimate until the task will be complete.

- If the remaining duration stays static or increases, then Project Managers and Resource Managers "watching the buffers" know exactly where a blockage or potential delay is occurring and can take decisive action quickly to recover.

4.4 PROJECT STAKEHOLDERS AND COMMUNICATION

Q. 4.4.1 Why is it essential to communicate with the project stakeholders

Project Initiation is the first official step in the Project Management Lifecycle and marks the commencement of the project. Project Initiation is based on the business needs that justify the allotment of resources and the expenses that will be incurred on it. The primary idea behind Project Initiation is to ensure that the business need is properly understood by the project manager and is kept in mind throughout the lifecycle of the project. Remember, the business need drives the project hence deviation from it is not acceptable. The business need is the direct outcome of the objectives and goals of the organization.

The Project Initiation stage enables the creation of the project charter that is the official document authorizing the project manager to undertake the project within the organization. As everyone who is party to the project or who is likely to be affected by it is part of the project initiation stage it is easy for the manager to identify the stakeholders.

The business need which drives the project could vary from organization to organization. While some organizations may feel the need to increase productivity others may feel the need to reach out to more customers or to increase efficiency. The project manager needs to understand the business need that is driving the project and also how the project will help the organization in meeting this business need. As stated earlier the organizational objectives, goals and mission are behind the business need hence the project manager should understand the objectives and goals of the organization to understand its business needs better. The project manager also needs to understand how the outcome of the project will be used by its stakeholders.

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4.4.1 The Stake Holders

The stakeholders of the project are those people who have some interest in the outcome of the project. Hence, it is imperative that the project manager identifies all the stakeholders and establishes the project requirement with them. The stakeholders may a single person, a group, entire department or the entire organization. The stakeholders will be able to provide valuable inputs to the project requirement that will prove useful in ensuring the success of the project. However, not all stakeholders influence the projects outcome there are some key stakeholders who have a major influence on the outcome of the project. The project manager should identify these key stakeholder's and get inputs from them on their specific requirements from the project.

The stake holders to the project are;

- End users – are the people who will actually be using the project
- Project In charge/ Project Sponsor – the person in the organization who has the authority to grant the resources and sign the charter.
- Project team – people actually working on the project.
- Functional managers – managers in charge of the various functional departments of the organization.
- Project Manager – the person in charge of the project.

- Business Partners – suppliers, customers, and vendors

Along with the specific requirements from the key stakeholders the project manager should also gather information on the time frame for the completion of the project, cost criteria and any other technical constraint that may come in way of the success of the project. Once all the project requirements have been gathered the project manager can go to the next stage of project planning.

4.4.2 Project Communication Plan

GQ. 4.4.2 *Explain project communication plan.*

Although, communication in an organizational setup is pretty much similar, there is an important difference between project communication and organizational communication. Projects are temporary in nature and a one-time endeavor and are undertaken to create unique product or services with an objective of adding value. On the other hand, organizational processes are permanent operations aimed at creating the same product or service. Therefore, the communication of these two systems requires varied skills and warrants the development of a separate communication management plan.

Most of the project manager's time is spent in communicating. Communication is the heart of project management. For effective and efficient management, the project manager will have to build strong communication lines with all those who are concerned with the project. This may include team members, internal as well as external stakeholders, project sponsor, etc.

The project manager will have to create a communication management plan to communicate with all those interested in the project be it the project team, project sponsor, stakeholders, vendors, customers, business analyst, etc. Communication among all project stakeholders is one of the main factors for the project success. It is a prerequisite of getting the things done in the right way and in the right time. Information is power: sharing information is reciprocal empowering amongst project stakeholders.

Project communication management is the management of processes required to ensure timely and appropriate generation, collection, distribution, storage, retrieval, and ultimate disposition of project information. Information about the project will be exchanged in these interactions and will be the key to the success of the project.

Project communication management comprises of:

1. Communications Planning
2. Information Distribution
3. Performance Reporting

4.4.3 Communication Planning

Prior to the execution phase, it is also necessary to identify how each of the stakeholders will be kept informed of the progress of the project. The communications plan identifies the types of information to be distributed to stakeholders, the methods of distributing the information, the frequency of distribution, and responsibilities of each person in the project team for distributing the information. There is no point in distributing information to stakeholders that they do not need. The communication plan should define which people need what information, when they would need the information, and how they would get the information. Hence, the project manager could adopt a policy that makes it necessary for any information

that is to be disseminated to flow through him. This will provide him access to all the information that is being distributed. It would also give him control over the flow of information.

The communication plan also identifies the communication technologies and forms that could be used. It also states when the communication should take place and the form it should adopt. Joint project reviews serve as a good tool to bring visibility to all areas of the project. Joint Project Reviews provide an opportunity to discuss pressing issues and make crucial decisions on the project. These reviews involve the project manager, team members, stakeholders, and project sponsor. The communication plan will also define the frequency of the meetings, the topics to be discussed, and the means of communication.

Hence, the communication plan should organize, document, select, and finalize the expectation of communication.

The communication management plan provides;

- A system to gather, organize and disseminate information to the people for whom the information is intended.
- The system states the channels that should be adopted and the form of communication.
- The communication channels state the origins of information and its destination and the modality the information will be acceptable to the recipient.
- The system also states the procedures that should be adopted to rectify and update information that may have been disseminated.
- The communication plan provides guidelines on the organization of information, level of details required, the time it should be made available, and the terminology. These factors are influenced by the nature of the recipient and the action expected from him.
- The communication plan should provide the period when a particular type of communication should occur. There are meetings which are carried out on a regular basis while some are arranged for extraordinary conditions.

Module 4

The project manager's main job is to communicate with team members, key stakeholders, project sponsor, vendors, business analyst, customers, etc. The project manager has to gather and provide information as per requirement. Most of the communication that takes place in an IT Project is non-verbal. This was expected as the whole team is tech savvy and is more likely to depend on e-mails, text mails and other forms of web messaging to convey and receive messages. However, the project manager should insist on face-to-face communication as many a times it has been observed that non-verbal forms of communication fail to deliver the right message. Hence, periodic meetings and other informal meetings should be promoted by the project manager.

4.4.4 Information Distribution

The primary goal of information distribution is to ensure that the right persons get the right information at the right time, as defined in the communication management plan and includes the art of managing stakeholder's requirement.

Therefore, to prepare and distribute the right information at the right time to the right stakeholders in the right format, the communication manager needs to:

- Analyze the communication needs of each stakeholders
- Identify the information for fulfilling the information needs of each stakeholder
- Identify the format, method and effort required

- Prioritize the communication option

It is the responsibility of the sender to ensure that the information sent is clear and complete such that it proves useful to the receiver. On the other hand, it is the responsibility of the receiver to ensure that the information is received in its entirety and understood correctly.

Communication takes various forms in projects:

- Communication could be oral or written.
- Communication could involve listening or speaking.
- Usually, formal communication is in the form of written communication and includes reports etc, while informal communication is in the form of oral communication such as ad hoc conversation.
- Communication could be vertical or horizontal. Vertical communication would involve reporting to higher-ups in the organization while horizontal would involve communicating with peers.

4.4.5 Information Distribution Methods

Project related information can be gathered using various methods such as manual filing systems, electronic databases, project management software, etc. Information collection, sharing and distribution come under the ambit of Information distribution.

The various methods for project distribution are :

1. Project meetings, hard-copy document distribution, manual filing systems, and shared-access electronic databases
2. Electronic communication and conferencing tools, such as email, fax, voice mail, telephone, video and Web conferencing, and Web publishing
3. Electronic tools for project management, such as Web interfaces to scheduling and project management software, meeting and virtual office support software, portals and collaborative work management tools.

4.4.6 Performance Reporting

Information distribution includes Project Performance Reporting. Project Performance Reporting involves the collection of all data and distribution of performance information to stakeholders. Primarily, performance reporting focuses on reporting of the utilization of project resources, information on project scope, schedule, cost, and quality. In addition reports on risks and procurement may also be required. Reports may be either comprehensive or prepared on exception basis i.e. only cases related to matter which do not confirm to the prescribed norms are reported.

Tools and Techniques of Performance Reporting

There are various Tools and Techniques of Performance Reporting :

1. **Tools for Information Presentation :** Information presentation tools include software packages like spreadsheet or software's with graphic capabilities that can be used to create images for presentation.
2. **Tools for Performance Information Gathering :** Project performance information can be gathered and compiled from a variety of sources like manual filing systems that facilitate the production of performance reports.
3. **Status Review Meetings :** These meetings are held regularly to collect performance information and share project information.

4. **Time Reporting Systems :** Time is of essence on a project and hence it is essential to keep a proper tap of it. Time reporting systems keep a proper log of the time expended on the project. A variance report comparing the actual performance with the baseline performance provides accurate information on progress being made on the project.

5. **Cost Reporting System :** Like the time reporting system, the cost reporting system will keep a log of the expenditure on the project and make a variance report after comparing the actual with the baseline.

4.4.7 Outputs of Performance Reporting

The outputs of performance reporting are:

1. **Performance Reports :** The primary output of performance reporting is the information collated and presented in performance reports. The information collected is compared to the baseline performance and a report is generated in a format that it easy to decipher. Performance reports provide information on the current status and the progress made so far in as much detail as required by the stakeholders and as documented in the communication management plan. Some of the common formats for performance reporting are bar charts, histograms and tables.

2. **Forecasts :** Forecasts of the most likely impact of the current performance of the project on the future of the project are assessed, updated and represented.

3. **Change Requests :** An analysis of the current position of the project and likely forecasts enables the project manager to design some changes that would get the project back on track. These changes are processed through the project's change control mechanism.

4. **Report on the lessons learnt (Organizational Process Assets)** – every project teaches various lessons; problems encountered and corrective action chosen. These lessons need to be documented so that they could be referred to in case a similar problem is encountered in future projects. The lessons become part of the database for the organization.

Chapter Ends...

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CHAPTER 5

Module 4

Risk Management in Projects

University Prescribed Syllabus

Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix, Risk response strategies for positive and negative risks.

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5.1 INTRODUCTION

- Experience has taught us that any project can fail and the reasons for failure are aplenty; lack of effective management, lack of proper engineering, or occurrence of some unforeseen events.
- A risk is any condition or event whose occurrence in not certain, but if were to occur it would have a negative impact on the outcome of the project. From this explanation of risk we can derive the following;
  Occurrence is a probabilistic condition.
  Will have a negative impact on the project were the event to occur.
- Risks are those events that may or may not occur, but if they were to occur they would have a negative impact on the project.
- One may confuse risks with those events that are likely to occur, but whose exact nature is not known in advance. However, such events are not risks; these are normal events that are likely to happen during the course of the project the only problem is that their exact nature is not known in advance. Example : there are bound to be some problems in programming which need to be identified and dealt with in the project itself.
- Risks are probabilistic events which everyone is hopeful that they would not occur. However, is the risk events were to materialize they would surely harm the project.
- Risks are a natural accompaniment of projects; on the other hand projects are themselves a risk, as technology change may make the project redundant before it were even to be completed.
- The positive side is that risks are foreseeable events that the project management team can plan for. Hence risk management plan is an important necessity for managing large projects and is included in the project management plan.
- The project management plan provides details as to how the risks will be identified, analyzed and controlled.
- Consider that you are planning to host a computer programming contest in your campus for which uninterrupted power supply is an absolutely necessity. So the one clear risk that you have identified is power outage.
- Power failure is a probabilistic event that may or may not happen. However, if there were to be a power failure the project would be affected. Therefore, to overcome the risk each computer has to be provided with uninterrupted power supply.
- The above example tells us that risk management entails additional cost. The cost of providing UPS backup to each computer is an additional cost. Hence, risk management can be considered to be cost effective if the cost incurred on risk management is lower than the cost incurred in case the risks were to materialize.
- Another feature of risk management that one needs to understand is that it is difficult to measure the value of risk management.
- Continuing with the example, if the power does not fail does it mean that extra expenditure on providing UPS backup was a total waste. No one can say so; there was no guarantee that the power would not fail.
- As risks are probabilistic events there is likelihood that the risk management system may not be used at all. In such a scenario the value provided by risk management system is defined in terms of the potential value provided which can only be estimated.
- Primarily risk management has two components, namely, risk assessment and risk control.

Risk assessment involves risk identification, analyses, and prioritization while risk control involves risk management planning, resolution, and monitoring.

5.2 RISK MANAGEMENT PLANNING

Once the risk has been identified and analyzed the project manager can decide on the manner in which the risk can be dealt with.

The response to risk depends on the type of risk. However, all risk should be documented alongwith the chosen response and its outcome in the risk register for future reference.

The response to riskdependsonitstypei.e.negativeriskorpositiverisk.Thethreemostcommonresponsestonegativeriskare:

1. Avoidance

The first natural response to any risk to find ways to avoid it. This would mean creating work arounds, adjusting project objectives, or changing the project schedule, in short whatever required to avoid the risk.

2. Transference

The risk is transferred to a third party that is in a better position to manage the risk. Thus, instead of trying to manage the risk in-house the risk is transferred to a third party.

3. Mitigation

Here the project manager is left with no alternative but to tackle the risk in-house. This would means pending extra time and money to reduce the probability and impact of the risk.

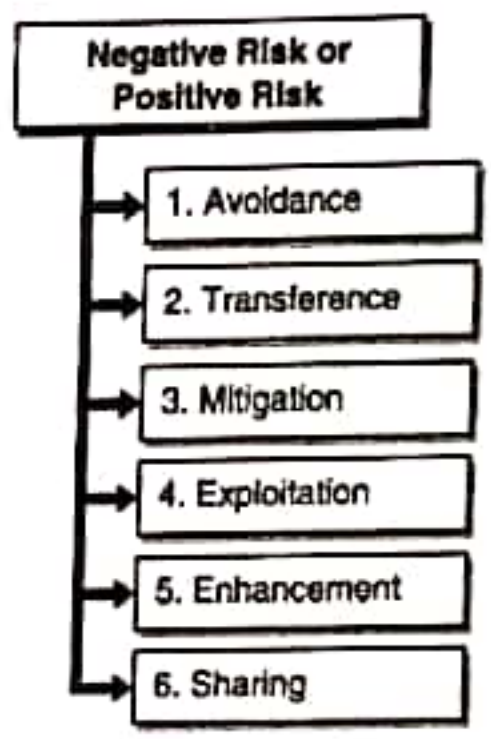

Fig. C5.4 : Negative risk or positive risk

The three most common responses to positive risks are :

4. Exploitation

The project manager tries to gain maximum benefits from the positive risk. The idea here to utilize the risk to maximum.

5. Enhancement

The project manager creates an environment that is ideal for the positive risk to happen.

6. Sharing

- The positive risk is shared by the project team with another entity to gain maximum benefits from the risk. The project team may not be capable of level again maximum benefits from the risk and hence feels that by bringing in a third party it may be able to derive maximum.
- In addition to the above given responses there is another response that is suitable for both positive as well negative risk and this is the response of Acceptance.
- Positive as well as negative risks with very low impact should be accepted as it is.

Module 4

5.2.1 Risk Management

GQ. 5.2.1 *Explain briefly the process of risk management.*

▶ **1. Risk identification**

- Risks identified in the planning phase will evolve over time.
- Some risks may be eliminated while some new ones may be added to the list. Resolved risks should be struck of the list and new ones should be added.

▶ **2. Risk assessment**

The risk management process is created, base lined and kept ready in the project planning phase for the execution phase.

Fig. C5.5 : Risk management

▶ **3. Evolution of risks**

- Though the likely risks have been identified in the project planning phase they become more definitive during the execution phase.
- The project manager is in a better position to define and specify the risk items. This permits the development of action plans to resolve the risks.

▶ **4. Risk management an iterative process**

- Risk management is an iterative process which is initiated in the project planning phase and then continues right through the entire lifecycle of the project.
- In the execution phase a better idea of the likely risks is developed enabling the project manager to devise action plans to deal with them.

▶ **5. Risk meeting**

- Risk meeting contribute to the process of risk identification and development of action plans to tackle the risk.
- Collective minds enable better and faster identification and resolution of risks, hence should be encouraged. Risk identification meetings are not a onetime process they will have to be held time and again.

▶ **6. Risk resolution**

- Not all risk have the same impact on the project while some may cause grave damage others may cause mild bruises.
- Hence, risks are graded according to their ability to impact the project and resolution strategies are developed.

5.2.2 The Inputs to Risk Management

1. Project scope baseline

The project scope, WBS and WBS dictionary prove vital in identifying risk events. The enable the project manager in identifying and planning for critical project deliverables.

2. Project cost and schedule

- Risks have a negative impact on both project cost and schedule. A special reserve, outside the project budget, will be needed to bear the brunt of the impact of the risk on the cost plan.
- Risks have an impact on the schedule of the project and some projects are extra sensitive to schedule.
- In such projects the project manager needs to identify those events which can hinder the progress of the project.

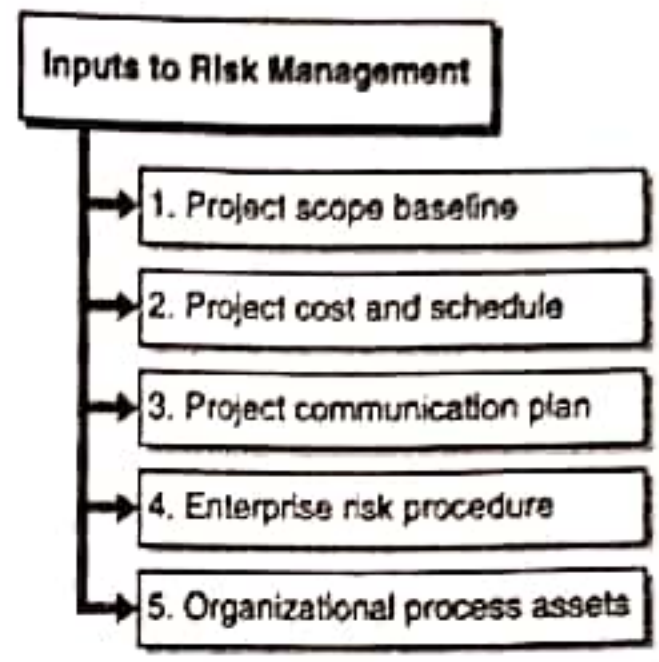

Fig. C5.6 : Inputs to Risk Management

3. Project communication plan

Risks status needs to be communicated to all those concerned. The identification, analysis and action needs to be communicated.

4. Enterprise risk procedure

- Organizations may devise their own rules, procedures and policies when it comes to dealing with risks.
- In such cases the project manager will be required to follow these rules.

5. Organizational process assets

- There are chances that the organization may have implemented a similar project in the past. In such case, the project plan back then may prove to be useful in identifying and managing risks.
- Along, with these inputs the project manager will be required to work with the project team, stakeholders and consultants to manage and mitigate risks. The key to successful risk mitigation is to identify the risks early, analyse correctly and create a plan to deal with the risk.

Module 4

5.2.3 Risk Categories

GQ. 5.2.2 *What is Risk?*

GQ. 5.2.3 *Explain risk categories.*

- Risks are defined as the various uncertain events that happen due to change in the various factors in the software development.
- Risks are conditions, which may or may not arise, that can have a positive or negative effect on the project's ability to reach its set objective.
- Although, every project has some degree of risk, the risk quotient identified with IT projects is even higher given the speed with which IT technology changes. New technology may come along and outdate the technology used in the project even before the project has been implemented.

- However, most risks can be identified and planned for. Thus most risks are foreseeable events which make it possible for the project team to make adequate arrangements to neutralize the negative effect they may have on the project.
- The risk management plan is an integral component of the overall project management plan.
- During the development of the risk, the major event is the identification of risk and its management.
- The risk analysis process starts with detailing the risks under the various risk analysis factors as mitigate, monitor, and manage.
- The best strategy to overcome risk is to anticipate risks in the project at the earliest so that the effect of the risks on the project is minimized by the risk management plan. To identify risks it is necessary to categorise them. There are primarily three categories of risk:

▶ **I. Project Risks**

Project risks concerns various forms schedule, resources, budgetary and user requirement related issues.

▶ **II. Technical Risks**

Technical risks concern various forms of design risk, implementation risk, interfacing, performance, and maintenance problems.

▶ **III. Business Risks**

Business risks are various, project being redundant on completion, exceeding budgetary provisions, etc.

Fig. C5.1 : Risk categories

5.2.4 Risk Management Approaches

- Creating a central database for all information related to risks, documentation of all risk items and the resolution strategies then adopted. Such a database proves useful to future projects which may encounter similar risks. They may refer to the process that was adopted to resolve the risk.
- Summarizing risk information and including it in regular status meeting.
- Continuously evaluate risk and develop strategies to resolve them.

5.2.5 Frame work for Dealing with Risk

- The Risk Management Framework specifies accepted best practice for the discipline of risk management.
- The framework is implementation independent-it defines key risk management activities, but does not specify how to perform those activities. In particular, the framework helps provide a foundation for a comprehensive risk management methodology basis for evaluating and improving a program's risk management practice
- The Risk Management Framework can be applied in all phases of the system development life cycle (e.g., acquisition, development, implementation).
- In addition, the framework can be used to guide the management of many different types of risk.
- The primary objective of the Risk Management Framework, henceforth referred to as the framework, is to specify the sequence of activities that must be performed while performing risk management.

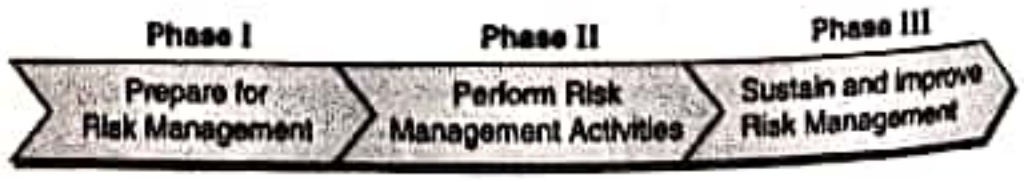

Fig. 5.2.1

As risk management is conducted within a much broader framework the framework also specifies the activities required to prepare for risk management i.e. the 1st phase as well as to sustain and improve risk management practice over time i.e. 3rd phase.

5.2.5.1 The Three Phases of Risk Management Framework

The three phases of the framework are:

1. Phase I: Prepare for Risk Management
2. Phase II: Perform Risk Management Activities
   - Assess Risk
   - Plan for Risk Mitigation
   - Mitigate Risk
3. Phase III : Sustain and Improve Risk Management

- The first phase, Prepare for Risk Management, of the framework lays the groundwork for the other two phases and hence should be completed before executing the other two phases.
- The second phase, Perform Risk Management Activities, specifies the activities that are to be used for managing risk. This phase is performed continually till the overall risks to the key objectives of the project are eliminated.
- The third phase, Sustain and Improve Risk Management, is performed on a periodic basis to ensure that the risk management practice remains effective over the entire course of the project. Activities of this phase are used to identify improvements to risk management practice. Phases 2 and 3 are executed concurrently.
- In the first phase preparation activities for risk management are performed. This phase determines who is sponsoring the risk management, plan for conducting risk management, and the resources required to effectively conduct risk management.
- In the second phase risk management activities are performed as planned. First and foremost the phase identifies the risks that could affect the achievement of the key program objectives. This phase also specifies how each risk will be addressed and the action needed to ensure that each risk is maintained within tolerable limits over the entire duration of the project. This phase also determines whether the mitigation plan is having the desired effect.
- In the third phase activities are performed to sustain and improve risk management effort over the entire duration of the project.
- This phase specifies the risk management assets and work products that need to be under configuration, lessons learnt while preparing for risk management and conducting risk management and how the entire risk management exercise can be improved.

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5.3 RISK IDENTIFICATION

5.3.1 What is risk identification.

- Risk is an integral part of projects and therefore risk identification at the earliest becomes all the more critical.
- Risk identification is an iterative process, wherein the project manager and his team are always on the lookout for risk that may sneak into the project or may have already sneaked in.

- Risk identification needs to be done throughout the project lifecycle, because as the project develops new risk is likely to emanate and pose a threat to the project.
- An idealistic situation would be one in which all the likely risks could be identified before the execution of the project but the reality is that new risk emanate as the project progresses and hence the project manager and his team have to always be alert and identify risk and nub them in their bud.
- To identify the risks are always the biggest and the toughest task in project management.

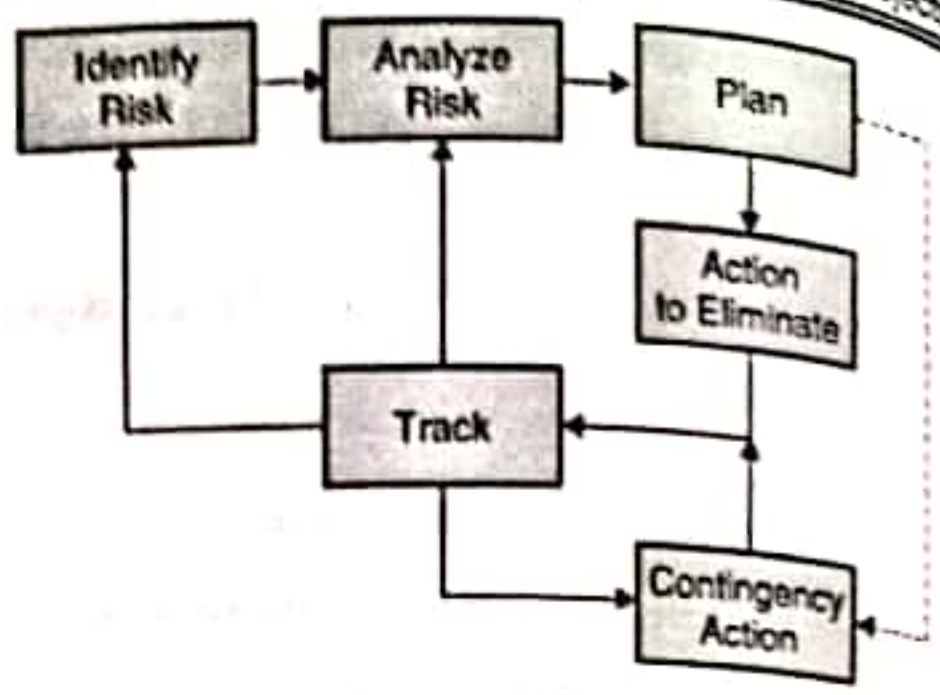

Fig. 5.3.1 : Process of Risk Management

- The risk can be categorized on the basis of the size of the project, and the software development, the risk identified is then modified.
- The risks which create a business impact due to the constraints imposed by management or the market place during the development phase till the deployment phase.
- As the customer played the critical role in the project development being the end user, the various characteristics related to the customer for communication are very important.
- The exact requirement gathering and the analysis to be done for the development of the project at the Development Life Cycle has to be determined to avoid the risks.
- Good quality tools should be used and made available for the developers.
- The major risks are associated if the staff and the team are not as per the required project.

There are several tools available that can help the project manager in identifying risks :

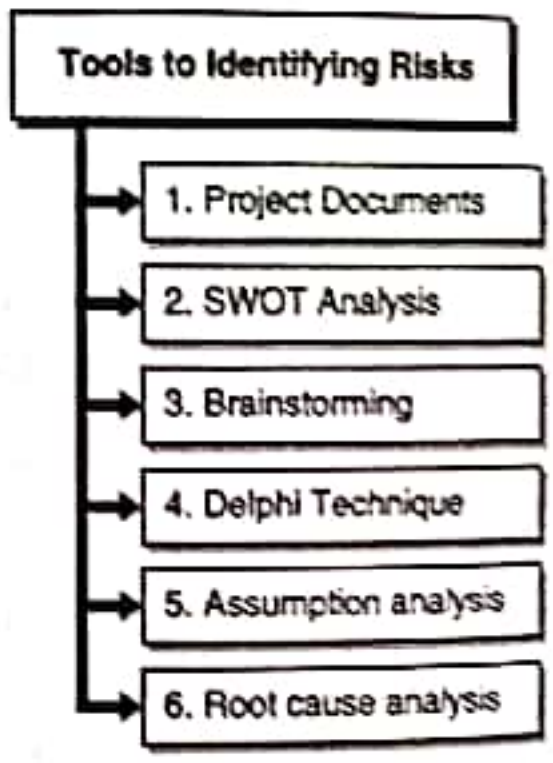

Fig. C5.3 : Tools to identifying risks

▶ **1. Project Documents**

- Project documents is the first place to start looking for project risks.
- The project scope statement, WBS, project plan, resource requirement, etc will help identify many risks associated with the project.

▶ **2. SWOT Analysis**

- Similar to an organizational SWOT, the project is examined in terms of its strengths, weaknesses, opportunities and threats and areas are identified where the project could fail and where the project could improve.
- SWOT is a great technique when it comes to resources and requirements not used before.

3. Brainstorming

- A brainstorming session is one in which the project team sits together and thinks up with as many risks as possible.
- A brainstorming session is one in which the participants can let their imagination go wild, there is no restriction on the number of risks to be identified on the other hand the team is encouraged to anything that remotely resembles a risk.

4. **Delphi Technique**

- Although brainstorming sessions do manage to identify the likely risks, a few participants may shy from identifying risks on account of personal reasons. Therefore, to overcome these limitations the Delphi Technique is adopted.
- The Delphi technique comprises of anonymous surveys conducted amongst team members to build consensus on risk events.

5. **Assumption analysis**

- Every project is based on certain assumptions. However, these assumptions need to be tested to ensure their validity.
- Assumptions not tested have the potential to become risk in the future. Therefore, these assumptions need to be tested, researched and the results confirmed as to how they would be affecting the project. An assumption log should form a part of the project documents.

6. **Root cause analysis**

- This analysis examines an effect that the project is experiencing and then goes to the root of the effect to identify its cause.

All the identified risks need to be entered into a risk register. The risk register will contain a log of all the risks and its impact on the project.

5.3.1 Risk Components and Drivers

GQ. 5.3.2 State and explain the risk components.

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The risk components are defined and identified on the criteria of the performance, support, cost and the schedule of the project :

1. **Performance risk**

If the specifications don't meet the final requirements of the project.

2. **Support risk**

Thesupporttheapplicationdeveloperprovidesafterdeploymentoftheproject

3. **Cost risk**

To maintain the time and the cost of the project.

4. **Schedule risk**

The schedule and the parameters of deliverable should be maintained

Fig. C5.2 : Risk components

5.4 RISK REGISTER

GQ. 5.4.1 *Explain the purpose of risk register.*

The risks identified through the risk identification process are entered in a risk register and hence is a continuous process as new risks tend to emerge as the project progresses. A risk register also known as risk log is an important component of the overall risk management framework. A risk register is created during the early stages of project planning and is an important tool for the project manager as it assists the project manager in tracking issues and addressing them as they arise. A risk register is used to identify, assess, and manage risks down to acceptable levels through a review and updating process.

5.4.1 Purpose of a Risk Register

The purpose of a risk register in project management is to record the details of all risks that have been identified along with their analysis and plans for how those risks will be treated.

Basically, it's a log that identifies risks along with their severity and the actions and steps to be taken to mitigate the risk. The risk register database can be viewed by project managers as a management tool for monitoring the risk management processes within the project. It is the responsibility of the project manager to ensure that the risk register is updated whenever necessary. The task of updating the risk register is usually delegated to the project control function.

5.4.2 Qualitative Risk Analysis

In the Perform Qualitative Analysis process, details are added to the existing list of risks in the risk register including the priority of risks, the urgency of the risks, the categorization of risks, and any trends that were noticed while performing this process. Risks that have been managed, avoided, or are no longer relevant can be removed from the risk register. The associated risk action plans can also be deleted from the risk register.

5.4.3 Quantitative Risk Analysis

In the Quantitative Risk Analysis process, the risk register is updated with the probabilities associated with each identified risk and the probability of meeting the cost and time projections. Additionally, risk priorities are updated and trends that have been observed are also noted.

5.4.4 Risk Response

In the Plan Risk Response process, a specific response plan is created to manage each risk. These risk response plans are updated in the risk register as an output of this process.

While managing risks, remember that not all risks are negative-positive risks are opportunities. Accordingly, a project manager should devise strategies for managing negative risks or threats as well as positive risks or opportunities.

5.4.5 Monitor and Control Risk

In the Monitor and Control risks process, plans are re-assessed and re-evaluated. The risk register is updated with information on new risks as an output of this process. This information should be regularly updated in the risk register, whether it is changing to the risk estimates or actual numbers such as costs related to weather damage.

5.4.6 Components of Risk Register

The components of the Risk Register are :

1. Date – date when the risk has been identified or modified needs to be noted.
2. Reference number – reference number of the key element
3. Key element – brief description of the key element. The key element helps in identifying the risk better.
4. Risk Group – the group to which the risk belongs.
5. Brief description of the risk
6. Unique Identity number of the risk
7. Existing controls available to mitigate the risk
8. Likely consequences if the risk is not mitigated
9. Probability of occurrence

5.5 QUALITATIVE AND QUANTITATIVE RISK ASSESSMENT - PROBABILITY AND IMPACT MATRIX

GQ. 5.5.1 *Describe the process of qualitative risk analysis*

- The next step in the risk management plan is to analyze the identified risks.
- The identified risks need to be analysed to determine the probability of their occurrence and the quantum of impact they would be having on the project.
- The procedure for analysis is to conduct the qualitative analysis and once the risk qualifies then a quantitative analysis is carried out.

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5.5.1 Qualitative Risk Analysis

- Qualitative risk analysis does not involve a detailed analysis of the risk. It is fast and subjective approach to risk analysis. Usually the probability and quantum of impact of the risk is based on past experience or merely gut feeling.
- The purpose of qualitative risk analysis approach is to decide whether the risk qualifies for further analysis.
- Qualitative risk analysis is carried out using a risk matrix also called as a probability-impact matrix.
- Probability and Impact Matrix is a tool for the project team to aid in prioritizing risks. As you know, there may be several risks in any project. Depending on the size and complexity of the project in hand, the risks may vary somewhere from double digits to triple digits. It is necessary to find a way to identify those critical risks which needs the most attention from the project team.
- Probability and Impact Matrix uses the combination of probability and impact scores of individual risks and ranks/ prioritizes them for easy handling of the risks. In other words, the probability and impact matrix helps to determine which risks need detailed risk response plans. It is vital to understand the priority for each risk as it allows the project team to appreciate the relative importance of each risk.
- For example, a risk with a high probability/ likelihood of occurring and which will have a high impact on the project

objectives will likely need a response plan.

- A risk is "rated" for its Probability and Impact on a scale to understand where on the Risk Matrix it lies. Which Risks in the process move forward into the Risk Management process will depend on the project and people. Some are by nature more risk tolerant than others.
- For example, we can have a project where the team agrees that any risk that is in the moderate, high or extreme cell can move forward in the Risk Management process.
- There stream in the watch list and are "accepted". Another project could have different criteria.

Impact →	1	2	3	4	5
Probability ↓	Negligible	Minor	Moderate	Significant	Severe
(81-100)%	Low Risk	Moderate Risk	High Risk	Extreme Risk	Extreme Risk
(61-80)%	Minimum Risk	Low Risk	Moderate Risk	High Risk	Extreme Risk
(41-60)%	Minimum Risk	Low Risk	Moderate Risk	High Risk	High Risk
(21-40)%	Minimum Risk	Low Risk	Low Risk	Moderate Risk	High Risk
(1-20)%	Minimum Risk	Minimum Risk	Low Risk	Moderate Risk	High Risk

5.5.2 Quantitative Risk Analysis

- Once the risk has passed the qualitative test it is time to take it more seriously and research the risk events to gauge their true potential and probability of impact.
- The risk in quantitative risk analysis is subject to detailed analysis that takes time and has a budget associated with it.
- The probability of the risk happening and quantum of its impact is gauged in a controlled environment.
- A ranking of risks based on their probability and quantum impact is created.

5.6 RISK RESPONSE STRATEGIES FOR POSITIVE AND NEGATIVE RISKS

GQ. 5.6.1 *Explain in briefly positive and negative risks.*

- A risk is an unplanned event that may or may not occur, but if it does, it will impact your project objectives such as scope, cost, quality or schedule. The impact can be positive or negative.
- A positive risk has a positive impact while the impact of a negative risk is negative. You would like to realize a positive risk while avoiding a negative risk. If avoidance is not possible, you will try to reduce the impact or the probability of a negative risk.
- You will identify these risks during the planning phase and develop a plan to manage them.
- Strategies to manage negative and positive risks are different.

5.6.1 Negative Risk Response Strategies

According to the PMBOK Guide, 6th edition, we have five strategies to manage negative risks:

1. Escalate 2. Mitigate 3. Transfer
4. Avoid 5. Accept

Ideally, you want to avoid risks, but it is not possible in most cases.

1. **Escalate**

- You use the escalate risk response strategy when you cannot manage risk on your own because you lack the authority, resources, or knowledge required for a response.
- You contact your PMO or management to take responsibility for managing the risk. Once management accepts, you won't take any further action except recording it in the risk register.
- For example, the government announces a regulation that could impact your project negatively. You have no resources to manage this risk, so you approach management.

2. **Mitigate**

- This risk response strategy helps you lessen the impact or probability of the risk. Put simply, this strategy decreases the severity of the risk.
- For example, a team member may leave during the peak of your project. To reduce the impact of his absence, you find another employee with similar qualifications in your organization and inform his boss that you may need him for your project.
- The new employee may not be as capable, but he can cover.

3. **Transfer**

- You use this strategy when you lack skills or resources to manage the risk, or you are too busy to manage it.
- In this strategy, you transfer the responsibility to a third party. If the risk occurs, the third party will manage it and you will be safe from the impact. Please note that transferring does not eliminate the risk; it only shifts the responsibility of managing the risk to a third party.
- Transferring a risk can cause a secondary risk. For example, although you have given a third party the responsibility, you are responsible for the project from the client's point of view.

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4. **Avoid**

- Here, you try to eliminate the risk or its impact. You do this by changing your project management plan, changing the project scope, or by changing the schedule.
- You use this strategy with critical risks. This is the best technique for risks, but you cannot use it at all times.
- Using this technique is easy if you identify the risk in an early stage, as changing the scope or plan in later stages is difficult and costly.
- You will have to convince the client or your management to change the scope or schedule to use this strategy. You can only use the avoid risk response strategy after their approval.
- For example, you find that there is a chance of rain during certain periods and you have work planned outdoors at that time. Therefore, you move these activities to a few days later to avoid the risk.

5. **Accept**

- You can use this risk response strategy with positive and negative risks. Here you take no action to manage the risk other than acknowledging it.
- You use this strategy with non-critical risks when it is not possible or practical to respond to the risk using other strategies, or if the importance of the risk does not call for a response.

- You can accept the risk either by actively or passively acknowledging it. In an active acceptance strategy, you keep a separate reserve to manage the risk, and in passive acceptance, you do nothing except record to the risk register.
- For example, you are digging for construction works, and there is a risk of finding artifacts, though the chances are low. So you record this \ in the risk register and take no action because a response plan is costly with no guarantee of finding an object of interest.

5.6.2 Positive Risk Response Strategies

- This risk is also known as an opportunity. They have a positive impact on your project, so you will always want them to happen. The most desired strategy for an opportunity is "exploit," which ensures that you realize the opportunity, although it is not possible to do all the time.
- Accept is the least desired strategy in which you take no action and hope the risk is realized on its own.

1. Escalate

- You use this strategy when you cannot realize an opportunity, as you lack the authority to take the necessary steps to make it happen.
- You approach top management and ask them to take the responsibility of managing the risk. Once they review and accept the risk responsibility, you are no longer responsible for it; however, you will record it in your risk register for further monitoring.
- In the escalate risk response strategy, you entrust top management to manage the risk, and it limits your job of monitoring it.

2. Enhance

- In the enhance risk response strategy, you try to increase the chance of a risk happening so you can realize the risk. In this case, you try to realize the opportunity. The enhance risk response strategy is the opposite of the mitigate strategy.
- For example, let's say you will complete your project in three months and the government is about to float a similar project in two months. You can bid for a new project if you complete your project in two months.
- This is an opportunity for you.

3. Exploit

- In the exploit risk response strategy, you ensure that the opportunity is realized. Here, you do not try to realize the opportunity, you ensure you realize it.
- For example, let us consider that your project will be completed in three months. You learn that the government is about to float a similar project in two months and you can bid for it if you can complete your project before two months.
- You have an opportunity here if you complete the project ahead of time: you will get a chance to bid for your next project.
- Now you have to ensure that you realize this opportunity. You take every possible measure to ensure that the project is completed ahead of time so you can bid for the new project. You bring in new resources, compress the schedule, allow overtime, etc.
- Exploit is the opposite of the avoid risk response strategy.

4 Accept

- In the accept risk response strategy, you take no action to realize the opportunity. You leave the opportunity as is, and if it happens on its own, you will benefit from it.
- You use this strategy when the cost of the response is high and there is a low chance of it occurring, or the benefit does not outweigh the effort involved.
- For example, suppose you may get skilled workers from another project at a lower rate if you convince them to join you. However, you do not pursue this matter and instead, let them decide whether or not they are interested in your project.
- You can use this strategy for both types of risks, positive or negative.

5 Share

- You use the share risk response strategy when you cannot realize the opportunity on your own. So, you team up with another company and work together to realize it.
- For example, suppose that because of a lack of technical capabilities, you cannot bid for a project but your company wants the project. Therefore, you team up with another company capable of doing this task and jointly bid for the project.
- Here, you are using the share risk response strategy because the profit will be shared between both parties. A teaming agreement is an example of the share risk response strategy. Let us revisit the key points:
- You will use the escalate strategy so top management can handle it if you are not capable of realizing the opportunity.
- If the opportunity is not very important or you are not very interested in it, you will go for either the enhance or accept risk response strategy.
- You will choose the exploit risk response strategy if the strategy is too important to miss.
- If you want to realize the opportunity and you cannot do so on your own, you will try the share risk response strategy.

Chapter Ends...

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CHAPTER 6

Module 5

Executing Projects

University Prescribed Syllabus

Planning, monitoring and controlling cycle, information needs and reporting, engaging with all stakeholders of the project, team management, communication and project meetings.

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6.1 INTRODUCTION

After having developed the project-management plan and set appropriate project baselines, it's time to get to work and start executing the project plan.

Project execution or implementation is the phase in which the plan designed in the prior phases are put into action. The purpose of project execution is to deliver the project deliverable and other direct outputs. Typically, this is the longest phase of the project management lifecycle, where most resources are applied.

During the project execution the execution team utilizes all the schedules, procedures and templates that were prepared and anticipated during prior phases. Unanticipated events and situations will inevitably be encountered, and the Project Manager and Project Team will have to deal with.

6.2 PROJECT EXECUTION

GQ. 6.2.1 *Write short note on project execution.*

During the project execution phase the project plan is implemented. In the project execution phase the project team will undertake the creation of components defined in the Work Breakdown Structure and follow the sequence of activities in the Project Network Diagram.

6.2.1 Responsibilities of the Project Manager in the Execution Phase

- The responsibilities of the project manager don't end with the project plan he has to now shift his focus from the project planning activity to participating, analyzing, and observing the work being done in the execution phase.
- With the project plan in place and the budget for the project approved it is time to move to the execution phase of the project. The execution phase is the time to get the project plan rolling. Although, the project plan lays a solid foundation for the project, the project manager will have to follow the project plan through the execution phase to ensure that it is implemented in the right earnest and that it emerges victorious.
- The project manager is responsible to internal and external stakeholders, the project team, vendors, and project sponsor. He has to interact with the team leader and members and ensure that they complete their tasks successfully.
- The project manager will have to keep the interested parties updated on the current status of the project. The project manager will have to increase the communication between team members and stakeholders. The project manager will have to deal with procurement and contract administration issues, help manage quality control and monitor project risk.
- Monitoring the cost of the project and comparing the actual to the budgeted is another key responsibility of the project manager. The project manager will have to track the implementation against the project network diagram, cost and time estimates, and then take corrective action if needed to keep the project on course.
- Another very critical responsibility of the project manager is to document all the activities of the project. Through regular meeting and one-on-one interactions the project manager will have to mould and motivate his team into a reliable and interdependent collection of professionals.

6.2.2 Project Execution Plan

The project execution plan ensures that project activities are carried out as per the plan. Without a project execution plan in place, each team member would undertake activities as per their own practice and experience. This may jeopardise the complete project.

Project execution depends on the plans developed in the planning phase. In the project execution phase the project manager has to monitor the execution of other plans such as the communication plan, risk management plan, and procurement plan via daily interaction with the project team and stakeholders.

- **Information Distribution :** ensuring that right information is available at the right place at the right time is very crucial for the success of the project.
  - **Status Reviews :** The project communication plan is an important factor in the execution plan. The communication plan should define which people need what information, when they would need the information, and how they would get the information.
  - Joint project reviews serve as a good tool to bring visibility to all areas of the project. Joint Project Reviews provide an opportunity to discuss pressing issues and make crucial decisions on the project. These reviews involve the project manager, team members, stakeholders, and project sponsor.
  - The communication plan will also define the frequency of the meetings, the topics to be discussed, and the means of communication.
- **Project Administration :** Project administration is a part of the project planning phase and is implemented and modified as necessary during the project execution phase. Modification may be needed because of;
  - Changes in scope arising out of changes in the functionality of the deliverables.
  - New estimates of work to be completed arising out of revelation of new or additional information.
  - Changes in resource arising out of change in the project scope.
  - Project administration also involves monitoring the various activities of the execution phase, risk management, and authorizing project changes.
- **Procurement :** In case there is a need to purchase products outside the resource pool of the organization the procurement plan is set into motion. Every organization has devised its own set of guidelines and policies for purchasing which should be integrated in the purchase plan. The project manager should follow these guidelines and policies while undertaking procurement of new products or services that were not planned for in the planning phase. The project manager will be responsible for vendors meeting their contractual agreements.
- **Scope Verification :** Scope verification is the responsibility of the project manager. He will have to ensure that the products created during the execution process are as per the stated requirement in the baseline scope with agreed upon tolerance limits. Scope verification is achieved through formal reviews of the deliverables.
- **Documentation :** Information on the work status of the project deliverables needs to be collected and regularly updated for effective management. The information documented includes the current status of the work on the deliverables, quality standards, and the cost that is incurred.

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- **Work Authorization :** The work authorization is the formal procedure for sanctioning project work. Work authorization is a written document stating the commencement and completion time and the sequence that is to be followed.

6.3 PROJECT MONITORING AND CONTROLLING CYCLE

GQ. 6.3.1 *Briefly describe the monitoring and Controlling Cycle*

- The Monitoring and Controlling phase of the project oversees all the tasks and metrics necessary to ensure that the approved and authorized project is within scope, on time, and on budget so that the project proceeds with minimal risk.
- This process involves comparing actual performance with planned performance and taking corrective action to yield the desired outcome when significant differences exist. Monitoring and Controlling process is and iterative process and hence continuously performed throughout the life of the project.
- According to the Project Management Body of Knowledge (PMBOK), "the Monitoring and Control Process Group consists of those processes performed to observe project execution so that potential problems can be identified in a timely manner and corrective action can be taken, when necessary, to control the execution of the project."
- The main purpose of monitoring and controlling activities is to be proactive in finding issues ahead of time and taking corrective action. Corrective action can require revisiting
- Planning Process Group and updating the Project Management Plan as needed with the ultimate goal of bringing the project back in line with project objectives and constraints and improving future execution to avoid repeating the same issues.

6.3.1 Monitoring and Control Processes

1.	Monitoring and Controlling Project Work	2.	Change Control
3.	Scope Verification	4.	Scope Control
5.	Schedule Control	6.	Cost Control
7.	Performing Quality Control	8.	Managing the Project Team
9.	Performance Reporting	10.	Managing Stakeholders

1. Monitoring and Controlling Project Work

- The Monitoring and Controlling Project Work process collects, measures and disseminates performance information, and assesses measures and trends to forecast potential items requiring corrective action.
- This includes monitoring project risks and ensuring that they are being managed according to the project's risk plans.
  - Recommended corrective actions
  - Recommended preventive actions
  - Forecasts

- Recommended defect repair
- Requested changes

Change Control

- The Change Control process ensures that changes as a result of project corrective actions and other controlling factors are managed across the project knowledge areas.
- Change control takes place throughout the project, from project initiation through project closure.
  - Approved change requests
  - Rejected change requests
  - Updates to the Project Management Plan
  - Updates to the Project Scope Statement
  - Approved corrective and preventive actions
  - Approved defect repair
  - Validated defect repair
  - Deliverables

3. Scope Verification

- The scope verification process ensures that project deliverables are formally accepted.
  - Accepted deliverables
  - Requested changes
  - Recommended corrective actions

4. Scope Control

- The Scope Control process ensures that changes to project scope are controlled.
  - Updates to the Project Scope Statement and Scope baseline (this includes requirements)
  - Updates to the Work Breakdown Structure (WBS) and the WBS Dictionary
  - Requested changes
  - Recommended corrective actions
  - Updates to organizational process assets
  - Updates to the Project Management Plan

5. Schedule Control

- The Schedule Control process monitors and controls changes to the project schedule.
  - Updates to the schedule model data and baseline
  - Performance measurements
  - Requested changes

- Recommended corrective actions
- Updates to organizational process assets
- Activity list and activity attribute updates
- Updates to the Project Management Plan

▶ **6. Cost Control**

– The Cost Control process monitors and controls costs and changes to the project budget.

- Cost estimate updates
- Cost baseline updates
- Performance measurements
- Forecasted completion
- Requested changes
- Recommended corrective actions
- Updates to organizational process assets
- Updates to the Project Management Plan

▶ **7. Performing Quality Control**

– The quality control performance process measures specific project results to determine whether the project is meeting quality standards.

- Quality control measurements
- Validated defect repair
- Updates to the quality baseline
- Recommended corrective and preventive actions
- Requested changes
- Recommended defect repair
- Updates to organizational process assets
- Validated deliverables
- Updates to the Project Management Plan

▶ **8. Managing the Project Team**

– This process tracks team member performance, provides feedback, resolves issues and coordinates changes to maintain and improve project performance.

- Requested changes
- Recommended corrective and preventive actions
- Updates to organizational process assets
- Updates to the Project Management Plan

9. Performance Reporting

- The Performance Reporting process collects and distributes performance information: including status reports, progress reports and forecasts.
  - Performance reports
  - Forecasts
  - Requested changes
  - Recommended corrective actions
  - Updates to organizational process assets

10. Managing Stakeholders

- This process manages stakeholder communications and works with stakeholders to ensure that requirements are satisfied and issues are proactively resolved.
  - Resolved issues
  - Approved change requests
  - Approved corrective actions
  - Updates to organizational process assets
  - Updates to the Project Management Plan

6.4 INFORMATION NEEDS AND REPORTING

6.4.1 Describe the information needs and communication process in projects

The primary goal of information distribution is to ensure that the right persons get the right information at the right time, as defined in the communication management plan and includes the art of managing stakeholder's requirement.

- Therefore, to prepare and distribute the right information at the right time to the right stakeholders in the right format, the communication manager needs to:
  - Analyze the communication needs of each stakeholders
  - Identify the information for fulfilling the information needs of each stakeholder
  - Identify the format, method and effort required
  - Prioritize the communication option.

It is the responsibility of the sender to ensure that the information sent is clear and complete such that it proves useful to the receiver. On the other hand, it is the responsibility of the receiver to ensure that the information is received in its entirety and understood correctly.

Communication takes various forms in projects :

- Communication could be oral or written.
- Communication could involve listening or speaking.

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- Usually, formal communication is in the form of written communication and includes reports etc, while informal communication is in the form of oral communication such as ad hoc conversation.
- Communication could be vertical or horizontal. Vertical communication would involve reporting to higher-ups in the organization while horizontal would involve communicating with peers.

6.4.1 Information Distribution Methods

Project related information can be gathered using various methods such as manual filing systems, electronic databases, project management software, etc. Information collection, sharing and distribution come under the ambit of Information distribution.

The various methods for project distribution are :

- Project meetings, hard-copy document distribution, manual filing systems, and shared-access electronic databases.
- Electronic communication and conferencing tools, such as email, fax, voice mail, telephone, video and Web conferencing, and Web publishing.
- Electronic tools for project management, such as Web interfaces to scheduling and project management software, meeting and virtual office support software, portals and collaborative work management tools.

6.5 COMMUNICATION AND PROJECT MEETINGS

GQ. 6.5.1 *Explain communication plan and project meetings.*

- Communication is the heart of project management. For effective and efficient management the project manager will have to build strong communication lines with all those who are concerned with the project.
- This may include team members, internal as well as external stakeholders, project sponsor, etc. Hence, the project manager will have to create a communication plan to communicate with all those interested in the project.
- Prior to the execution phase, it is also necessary to identify how each of the stakeholders will be kept informed of the progress of the project. The communications plan identifies the types of information to be distributed to stakeholders, the methods of distributing the information, the frequency of distribution, and responsibilities of each person in the project team for distributing the information.
- There is no point in distributing information to stakeholders that they do not need. The communication plan should define which people need what information, when they would need the information, and how they would get the information.
- Hence, the project manager could adopt a policy that makes it necessary for any information that is to be disseminated to flow through him. This will provide him access to all the information that is being distributed. It would also give him control over the flow of information.
- The communication plan also identifies the communication technologies and forms that could be used. It also states when the communication should take place and the form it should adopt. Joint project reviews serve as a good tool to bring visibility to all areas of the project.
- Joint Project Reviews provide an opportunity to discuss pressing issues and make crucial decisions on the project.

These reviews involve the project manager, team members, stakeholders, and project sponsor.

The communication plan will also define the frequency of the meetings, the topics to be discussed, and the means of communication.

Hence, the communication plan should organize, document, select, and finalize the expectation of communication.

The communication management plan provides :

- A system to gather, organize and disseminate information to the people for whom the information is intended.
- The system states the channels that should be adopted and the form of communication.
- The communication channels state the origins of information and its destination and the modality the information will be acceptable to the recipient.
- The system also states the procedures that should be adopted to rectify and update information that may have been disseminated.
- The communication plan provides guidelines on the organization of information, level of details required, the time it should be made available, and the terminology. These factors are influenced by the nature of the recipient and the action expected from him.
- The communication plan should provide the period when a particular type of communication should occur. There are meetings which are carried out on a regular basis while some are arranged for extraordinary conditions.

- The project manager's main job is to communicate with team members, key stakeholders, project sponsor, vendors, business analyst, customers, etc. The project manager has to gather and provide information as per requirement. Most of the communication that takes place in an IT Project is non-verbal.
- This was expected as the whole team is tech savvy and is more likely to depend on e-mails, text mails and other forms of web messaging to convey and receive messages.
- However, the project manager should insist on face-to-face communication as many a times it has been observed that non-verbal forms of communication fail to deliver the right message. Hence, periodic meetings and other informal meetings should be promoted by the project manager.
- Communication within workgroups and also with colleagues from others within the organization and outside is essential for a project. Communication is keeping informed all those concerned with the project.
- The communications planning process concerns defining the types of information you will deliver, who will receive it, the format for communicating it, and the timing of its release and distribution. In this section we shall be examining communication media in a structured way.
- Communication genres refer to the types of communication and the ground rules for when and how such communication should be carried out. Communication genres are communicative actions habitually used by project members to achieve some purpose.

Example : In software projects, meetings and reviews are used at various stages of the software development lifecycle to approve or provide feedback to the subject under consideration.

- So even for the simple email which we take for granted, a advanced email based application be developed wherein a pre-structured preformed can be used by all those concerned with the project to fulfil a standard process. This structured email application can be viewed as communication genres.

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- One influence on communication genres is that of time and place. Time and place are perhaps the biggest constraint on communication when it comes to software projects especially with these projects crossing the barriers of time and place. Therefore, modes of communication can be categorised by a combination of two opposites, namely, same place/different place, same time/different time.

	Same Place	Different Place
Same Time	Meetings, Intercom, One to One Chats, etc. This form of communication genres are preferred during the early stages of the project when the team members are getting to know each other and there is a need to build trust and confidence.	Telephone, Video Call, Conference Call, SMS, etc It is possible to use this form of communication genres during the intermediate stages of the project when the overall architecture of the project has been developed and further development can take place at different locations.
Different Time	Notes, Messages, Notice boards, etc	Email, Voice mail, etc This form can be used during the implementation stage of the project when the project design has been clarified and everyone is aware of their roles.

- In addition to the time and place the communicator should also consider the nature of information that is to be conveyed to select the communication genres.
  - Telephone call can be used for conveying quick and non-complex information but cannot be used for communication large amounts of information.
  - Face-to-Face communication is preferred for conveying personally sensitive information.
  - For complex information which will require further clarifications a two way form of communication should be used.
  - For official communication a more official medium of communication such as company email should be used.

Chapter Ends...

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CHAPTER 7

Monitoring and Controlling Projects

Module 5

University Prescribed Syllabus

Monitoring and Controlling Projects : Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit

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7.1 INTRODUCTION

Till now the entire focus of our work had been on the planning and the various aspects of the planning of the project. In this section we shall be turning our attention to the other important aspect of project management which is monitoring and control. Despite the meticulous planning that goes in Civil Project Management its monitoring and control are very crucial.

Planning of projects is very tricky because what you actually plan to do never happens and you will need to make changes and adapt to the changing project scenario. You will have to monitor and make changes in the plan as you go along the project. So, planning-monitoring and control is an iterative process. Things are never going to go as per plan and as project manager you will have to monitor the plan and apply control. At the end of the day you may not have followed exactly the same plan as you had originally planned but you need to monitor and control to get the project going.

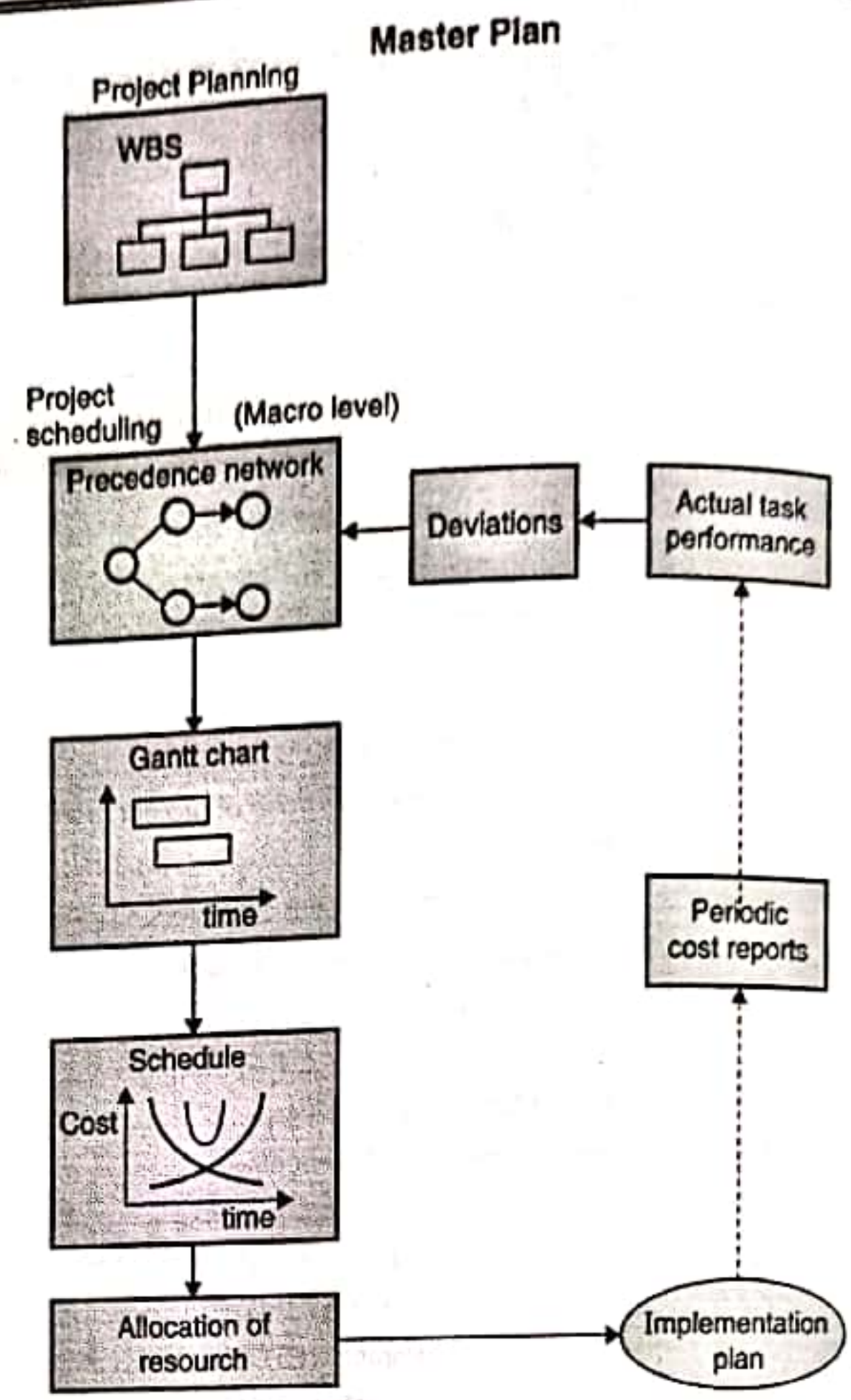

Fig. 7.1.1

7.2 MONITORING AND CONTROLLING PROJECTS

GQ. 7.2.1 *What are the main purpose of project monitoring and control.*

- The flowchart above represents the formal manner in which the monitoring of the project is to be done. This flowchart has been adapted and is a part of IS 15883.
- The flowchart is based on the primary assumption that the project planning process has been completed and includes all that we have studied in the previous chapters in this book, namely the Gantt Chart and WBS. Based on these plans the actual construction work at the site starts and as is progresses it starts generating reports. These reports are generated on a regular basis maybe weekly or even in some cases daily.
- Based on these reports MIS reports are generated and the schedule is updated. Comparison between the planned and actual helps in resource deployment and management and measurement of performance and productivity.

The information collected through the ground reports forms the base on which the project manager compiles a report status that is presented to the people in-charge of the actual work to take stock of the situation and take preventive action in case of variances between the planned and actual.

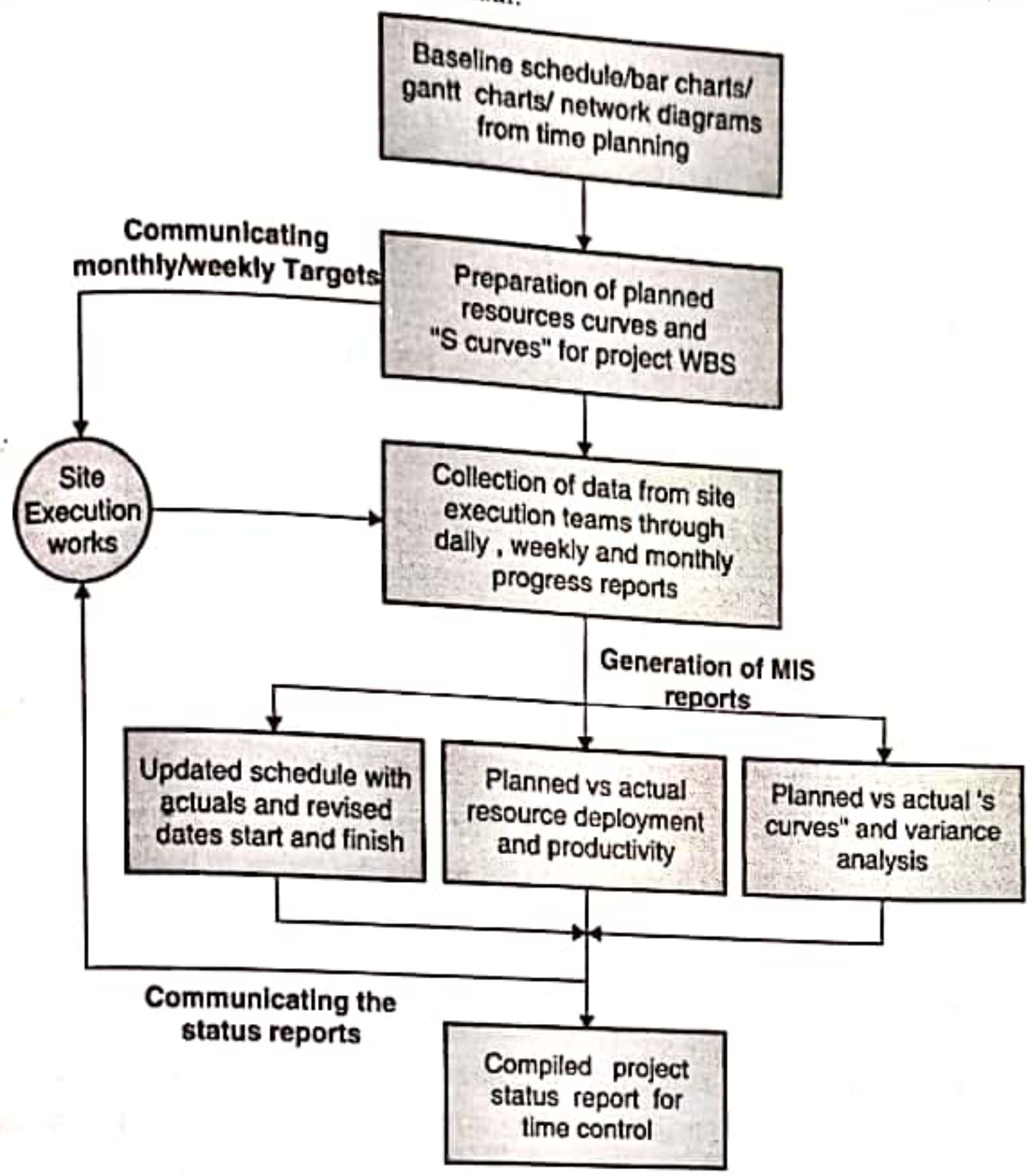

Fig. 7.2.1

- The baseline plan is the key document against which the actual performance is compared to identify deviation. The baseline plan acts as a benchmark for monitoring the progress of the project. The baseline plan may also undergo change on request from the project stakeholders.
- Although, the planning process comprises of various levels of planning for the sake of understanding we have divided them into three levels, namely, master plan, macro plan and the micro plan.
- The master plan as the name suggests, comprises of the major milestones, key resources and project constraints. The macro plan comprises of the completion of major project activities and usage of resources while the micro plan defines the activity completion at the daily or weekly level.
- In this and the previous chapters we have been studying network planning which is a part of the macro level planning of the project.
- Once the project commences data starts coming out in the form of daily reports and based on these reports the micro plan is updated.

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- The micro level plan provides feedback to the macro plan which in turn updates the network. Planning at the micro level comprises of spreadsheets that report the daily and weekly project progress. Planning at the macro level comprises of network analysis and earned value measurements that will help the project manager monitor the project.
- The question that arises next is who to report. The project manager's summary report presents a complete picture of current status of the project to all levels of management.
- To the top management it covers the highlights of the project and to those at the actual work site it contains the work packages.

7.2.1 How Often to Report

- The frequency of reporting depends on the size of the project. For fairly large projects such as the construction of large housing complexes or infrastructure projects, which may extend over two to three years, review interval is often chosen as one month. This is the interval for complete survey of the project. This will usually be supplemented by a fortnightly report on the key figures. The facility to impose a weekly check in case of emergency or when a critical activity is being undertaken is built in the system.
- On the other hand, even the largest of maintenance projects will only take a few weeks or months at the most and hence will require daily reporting. The project manager must consider the size of the project based on the network at the macro level, the complexity and the types of individual activities involved and their range of duration, reliability of estimates and extent to which authority has been delegated to the supervisors.
- When all this has been decided the nearest convenient administrative cycle be it a week, day, month is decided on. However, there is one golden rule of monitoring that to not restrict the review to beginning and end events only and is especially true when it comes to the critical activities in the network.

7.2.2 What and How to Report - Feedback Control System

(i) **Negative Feedback Control System :** in this type of control system the performance achieved is compared with the target and the difference in performance is measured. The difference, if any, is reported to the person in charge of that particular activity. The process is repeated again till it forms a loop. The positive value of the difference between actual performance and targeted causes the person in charge to reduce the actual performance and therefore this technique is called as negative feedback control system.

(ii) **Difference Monitoring Chart :** in this type of monitoring system instead of showing the difference between the target and actual performance a chart is used which presents the difference. An example is shown in the figure below which displays the extent to which the project is ahead or behind of schedule.

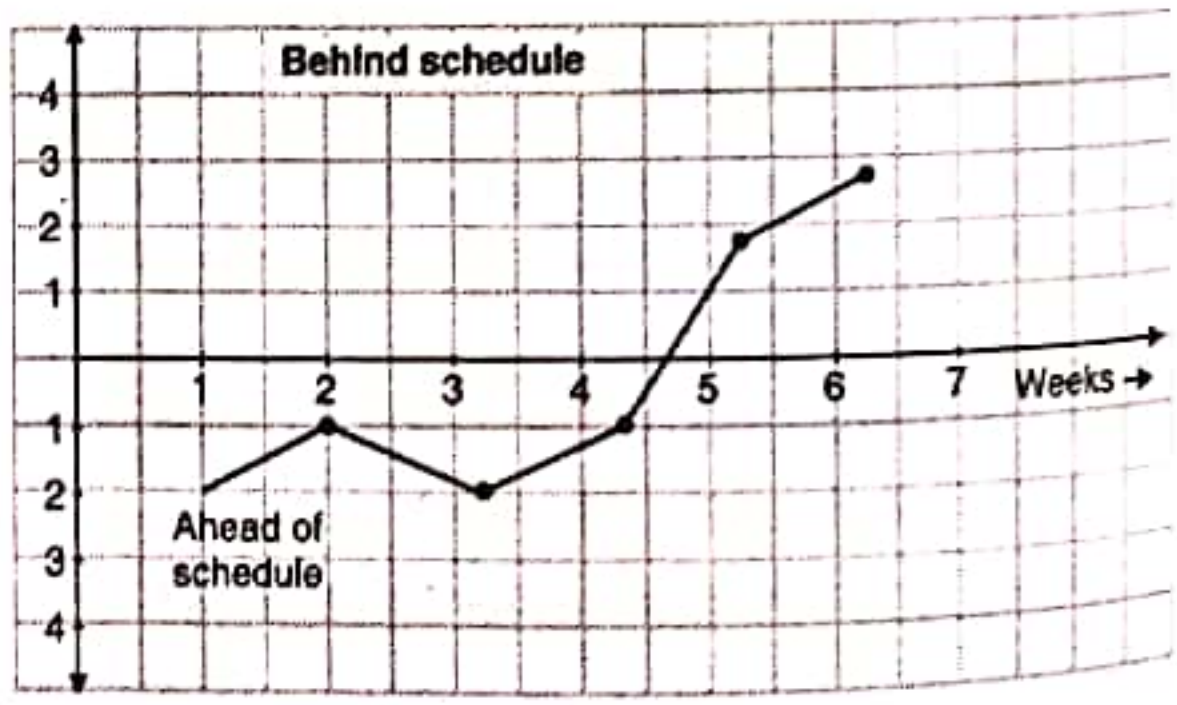

Fig. 7.2.2

(iii) **Cumulative Cost Curves :** cumulative cost curves of expenditures are used on large construction projects as a means of monitoring time and cost simultaneously. The graph below represents the cash requirement of the project as a percentage of the total project period. This information will enable the person in charge to ensure that the project progresses smoothly and that the project doesn't face bottlenecks on account of the non-availability of funds.

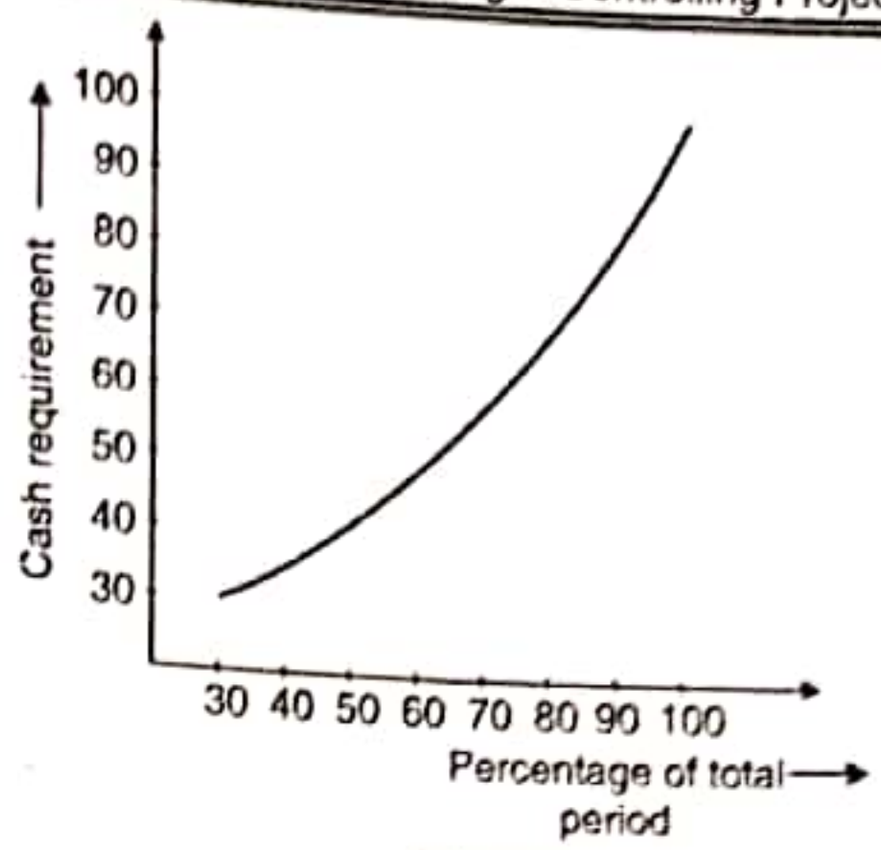

Fig. 7.2.3

(iv) **The EL Envelope** – the figure below shows two cumulative cost curves for the same project. The upper curve E represents the cost when all the project activities have begun as early as possible and L represents the cost when the activities have started as late as possible. The shaded area between the curves is then proportional to the potential saving and is called as the EL Envelope.

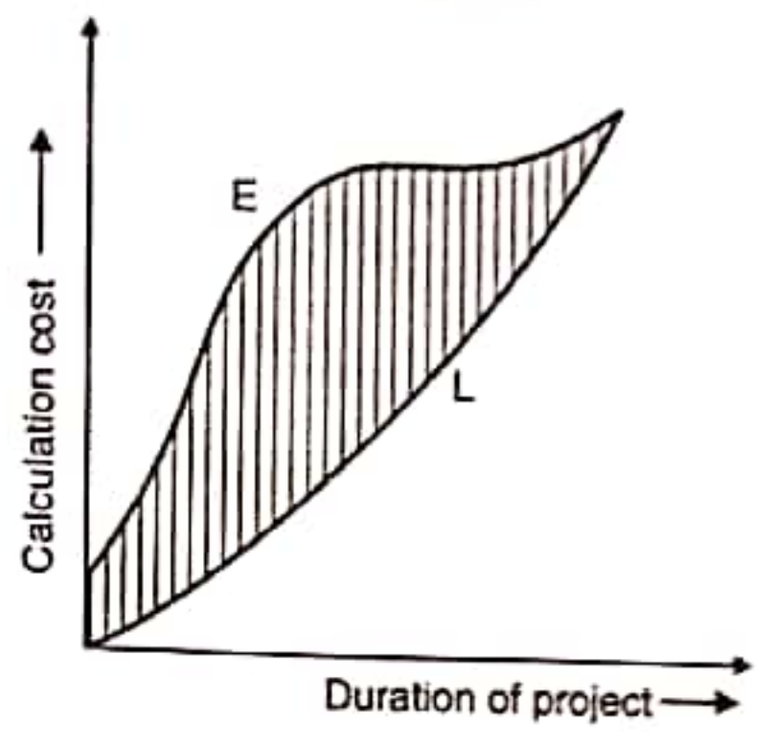

Fig. 7.2.4

(v) **Direct Methods** – monitoring is often done on the network diagram itself. Among the methods in use are:

- Ticking off the completed jobs and marking those in progress.
- Blackening out completed events.
- Inserting actual completion times at the events.
- Using pin and coloured thread to link the completed portion of the jobs.

In case the network diagram has been converted into a bar chart, then a second bar to represent the actual work completed is drawn underneath each original bar.

7.3 EARNED VALUE MANAGEMENT (EVM) TECHNIQUE

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The parameters of EVM that are used to measure the project cost & schedule performance are categorized as shown in Fig. 7.3.1. These parameters are categorized into four groups: basic elements, measurement of variance, efficiency indices and forecasting parameters. Individual parameters are defined and explained in the following sections and illustrated graphically.

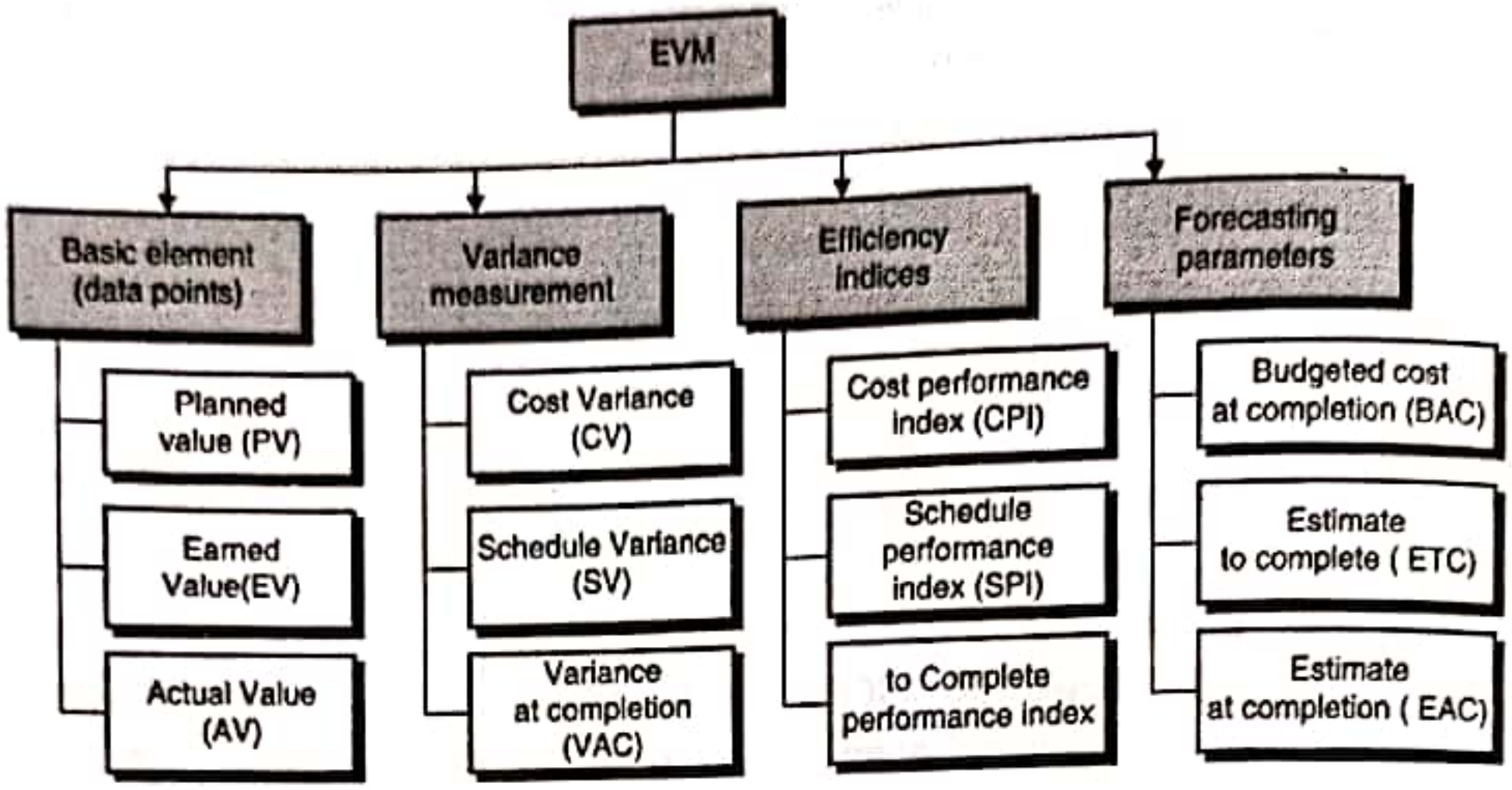

Fig. 7.3.1 : Performance Measurement Parameters of EVM

7.3.1 Planned Value (PV)

- The first step in the application of EVM methodology is to develop the project baseline cost curve called planned value curve.
- It is the plot of cumulative budgeted cost of activities (defined in the project work breakdown structure) at the periodic intervals (for example, monthly) of the project duration.
- The cumulative costs at various project intervals are obtained from the month-wise summary of cost incurred on the activities. Since this baseline cost curve is obtained based on the 'budgeted cost of activities and as per planned' project schedule, This planned value curve is also termed as budgeted cost of work as scheduled (BCWS) (see Fig. 7.3.2).

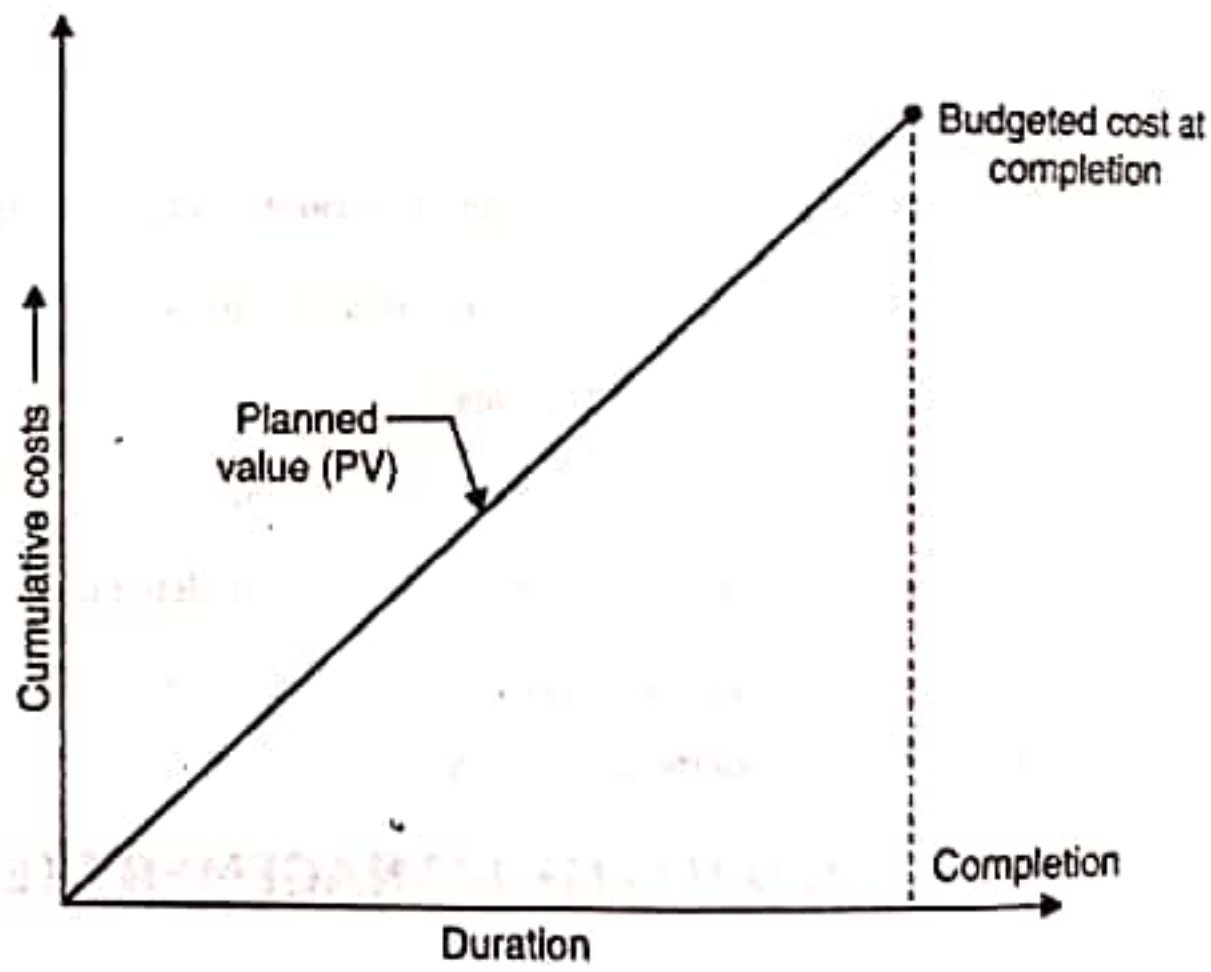

Fig. 7.3.2 : Planned Value (PV)

7.3.2 Earned Value (EV)

- The term earned value (EV) indicates the value of work earned and this is obtained as the cumulative values of the quantum of the work actually executed in the activities multiplied by the corresponding budgeted unit costs of the respective activities.
- The quantum of the work executed in the activities at any given point of time (review date) could be as per planned quantity or at variance from the planned quantity.

The earned value increases cumulatively as the activities gets completed along the project duration. This earned value plot is also called 'budgeted cost of work performed' (BCWP) (see Fig. 7.3.3).

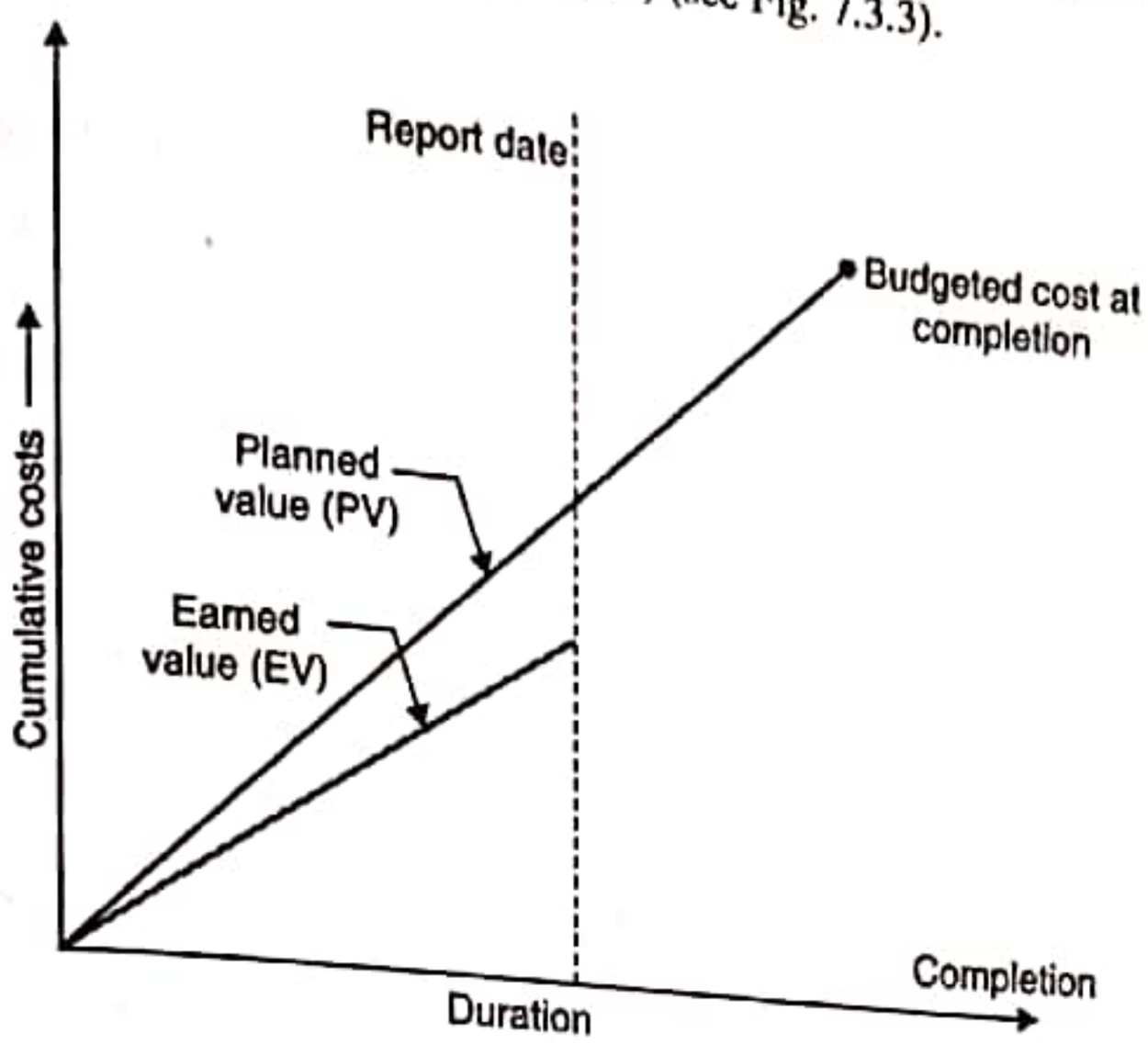

Fig. 7.3.3 : Earned Value (EV)

7.3.3 Actual Cost (AC)

- The actual cumulative cost of activities at any given point of time (review date) is obtained from the quantum of work actually executed in the activities multiplied by the actual unit costs of the work in respective activities.
- For well controlled project situations, the actual quantum of work and their actual unit cost shall adhere to the planned quantum of work and their budgeted unit cost.
- Otherwise they may be at variance with respect to the planned quantum of work and their budgeted unit price indicating favourable or unfavourable project situations.
- Major effort in the EVM methodology is to continuously compile the actual cost from the data collected on the cost of various resources utilized (manpower, material, equipment, etc) in the activities.
- The actual cumulative cost curve is developed progressively with the completion of activities during the course of project implementation. This actual cost curve is also termed as actual cost of work performed (ACWP) (see Fig. 7.3.4).

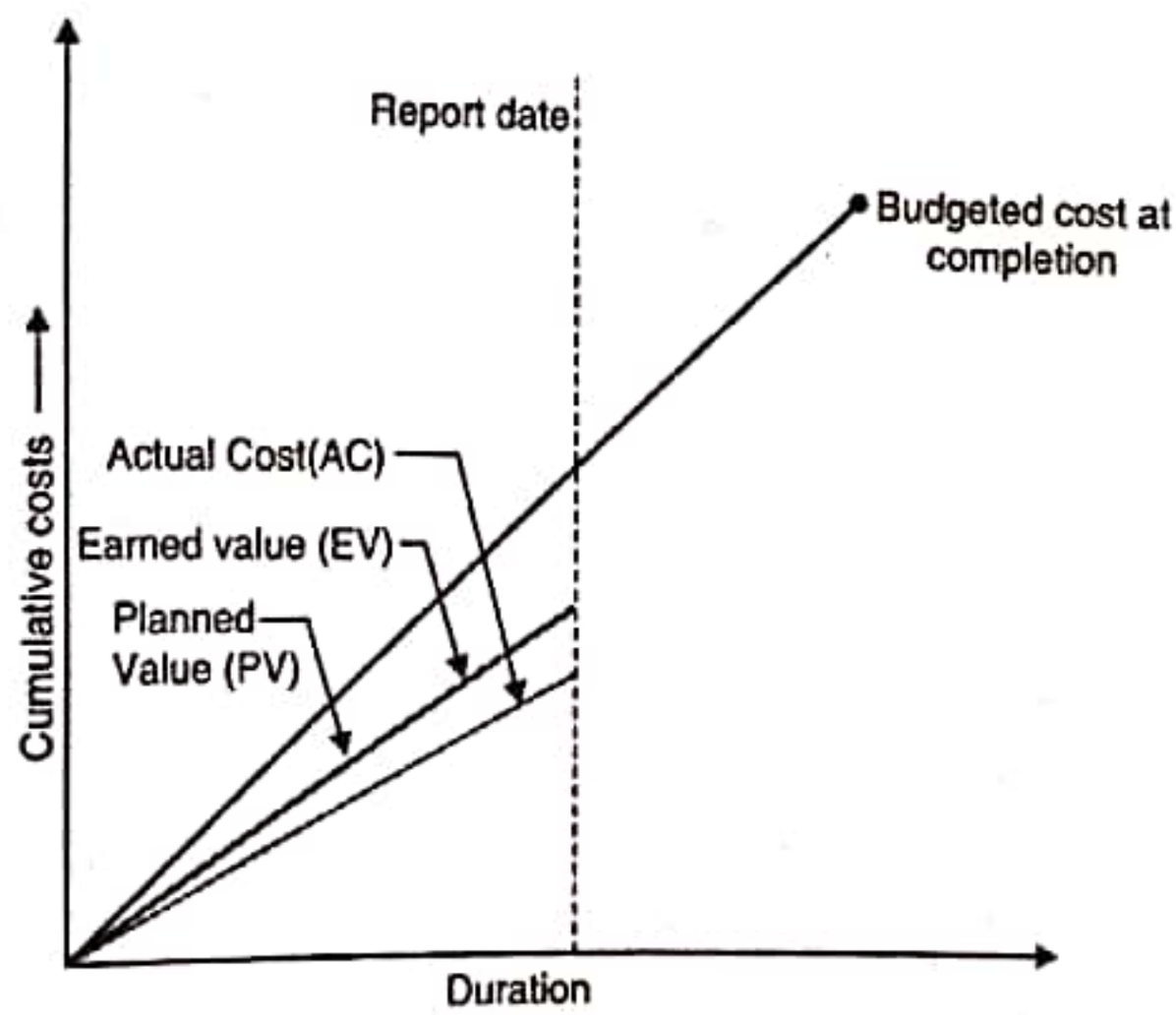

Fig. 7.3.4 : Actual Cost (AC)

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7.3.4 Measurement of Variances

7.3.4.1 Cost Variance (CV)

The cost performance of the project is measured in terms of cost variance which is the difference between the earned value and the actual cost of the work carried out.

$$CV = EV - AC$$

$$\text{Cost variance percentage} = \frac{CV}{EV} \times 100$$

- When EV and AC are equal, the project is on the budgeted cost. A negative and positive value of CV indicates the project cost over-run and cost under-run respectively.
- The cost overrun could be on account of lower productivity of labour and equipment and over consumption or wastage of materials.
- Negative CV could also be attributed to the inaccuracy of the original budget costs. Cost variance percentage indicates the cost over-run and cost under-run as the percentage of earned value.
- Negative and Positive cost variance % indicates percentage cost over-run and cost under-run respectively (see Fig. 7.3.5).

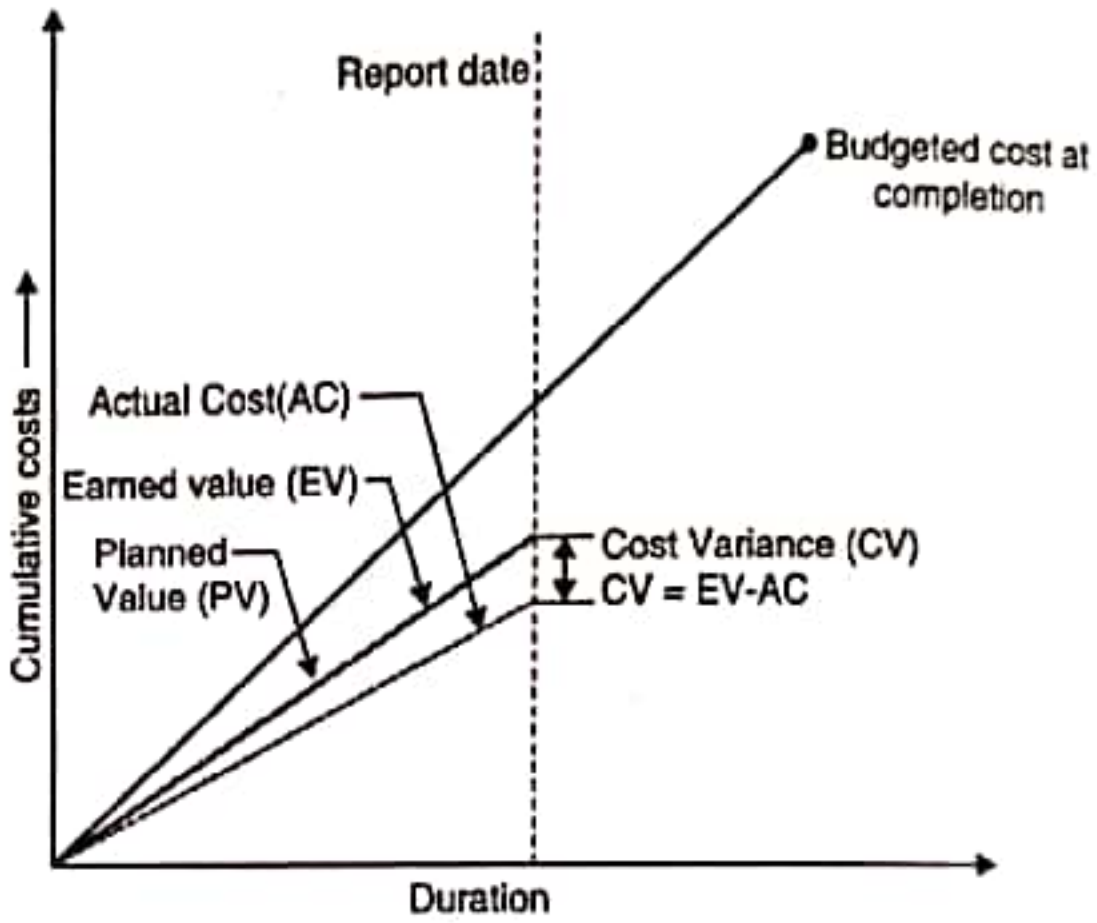

Fig. 7.3.5 : Cost Variance (CV)

7.3.5 Performance Indices as a Measure of Efficiency

- The cost and schedule variances are project specific values. However, the cost performance and schedule performance are expressed as indices to serve as common basis for comparison with other projects besides usage in forecasting calculations. The cost performance Index and schedule performance index are also expressed as percentage to indicate the percentage efficiencies of cost and schedule performance (see Fig. 7.3.6).
- Cost performance index (CPI) measures the value of work completed compared to the actual cost incurred on the project. It measures the cost efficiency of the work completed.

  Cost performance index (CPI) = EV/AC
- CPI less than one and more than one indicates cost over-run and cost under-run respectively.

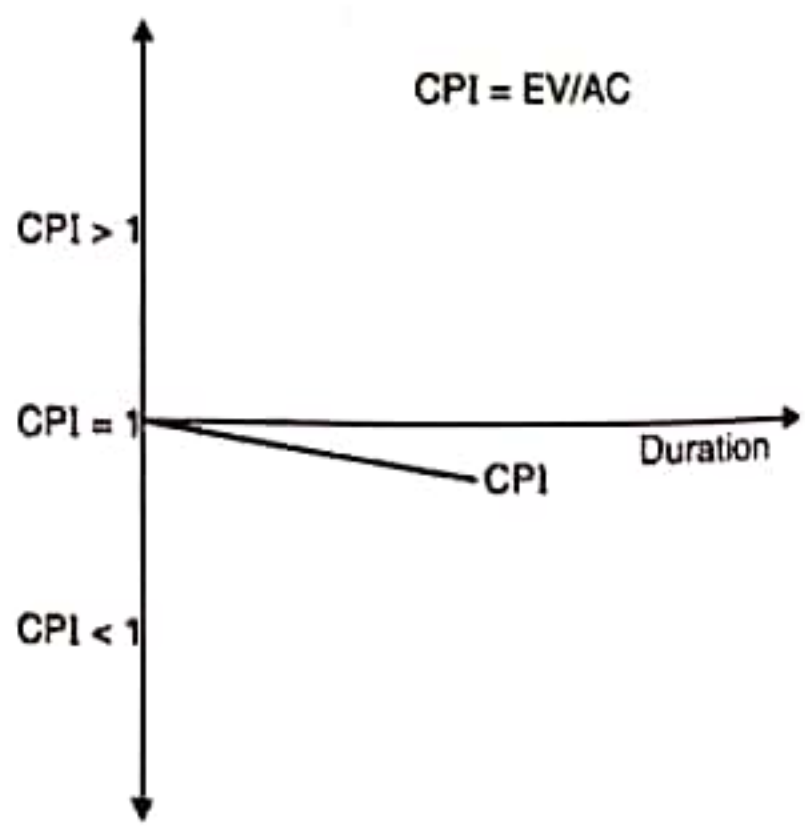

Fig. 7.3.6 : Cost Performance Index (CPI)

Forecasting Parameters

There are three basic forecasting parameters in the EVM relating to completion costs. These are budget at completion (BAC) estimate to complete (ETC) and estimate at completion (EAC).

The other parameters are variance at completion (VAC), planned percentage complete (PPC), actual percentage complete (APC), to complete cost performance index (TCPI) and to complete schedule performance index (TSPI).

7.3.6 Budget at Completion (BAC)

Budget at completion is the total cumulative planned cost of all the project activities as per the planned schedule. It is the total base line cost and is the end value of the planned value curve (see Fig. 7.3.7).

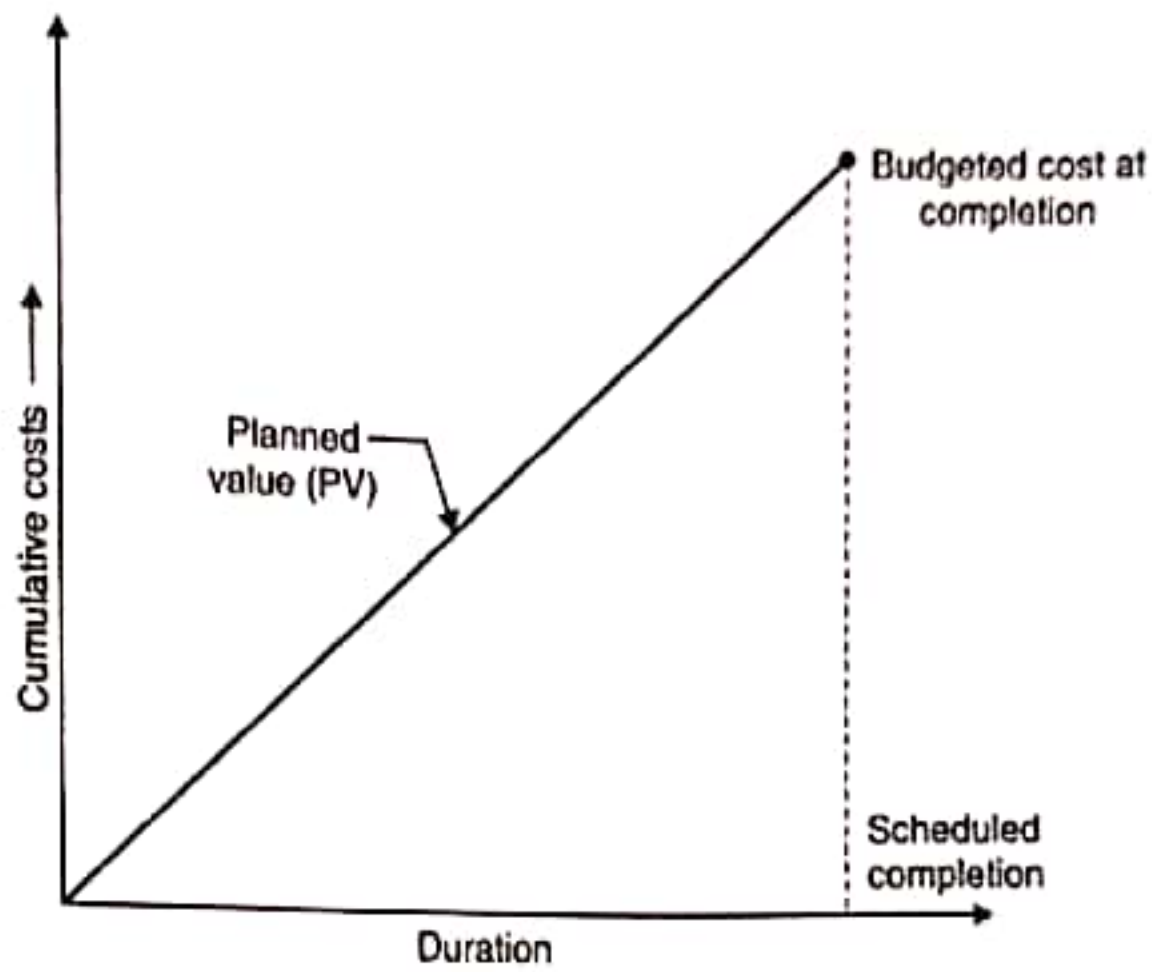

Fig. 7.3.7 : Budget at Completion (BAC)

7.3.7 Estimate to Complete (ETC)

- The cost estimate to complete the balance work as on review date is termed as ETC and shall be based on realistic new estimate worked out for the completion of the balance work incorporating the allowances for the risks.
- ETC to complete the balance work could be assessed on the basis of CPI achieved up to the review date. ETC is used for the calculation of EAC (see Fig. 7.3.8).

$$ETC = \frac{BAC - EV}{CPI}$$

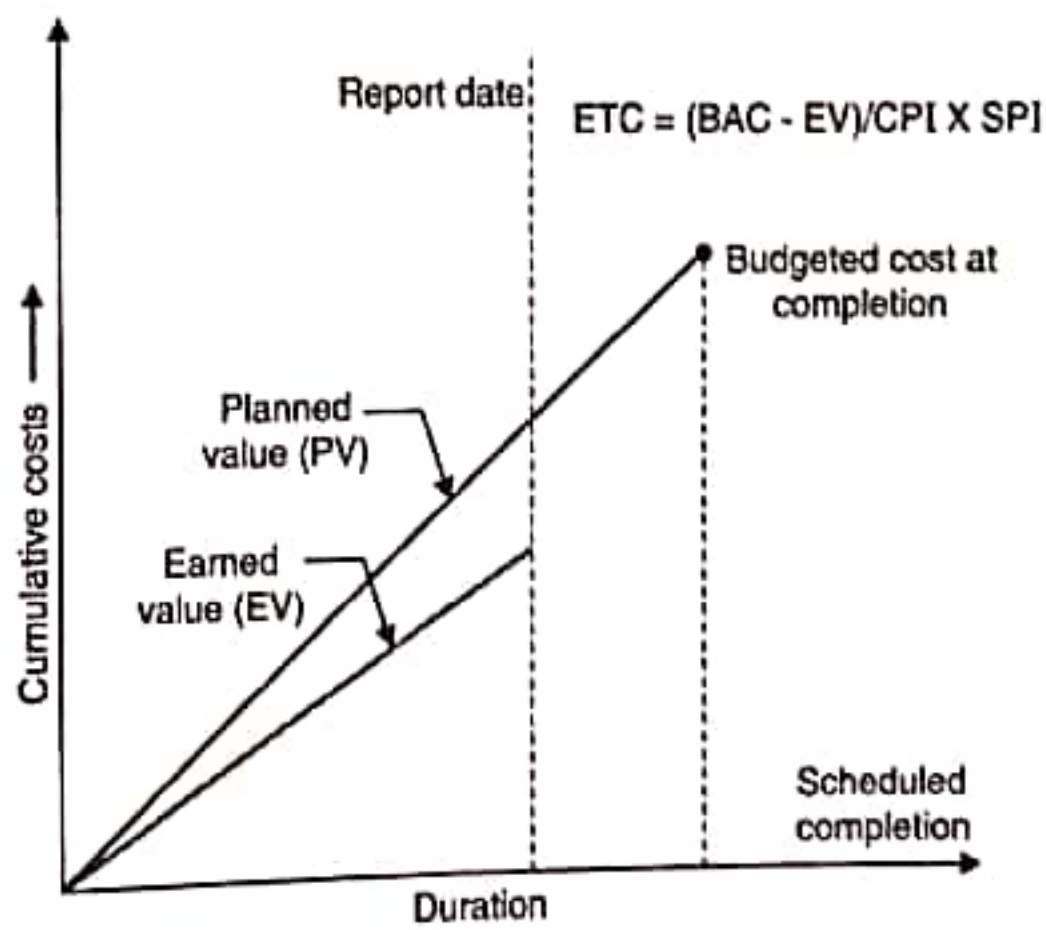

Fig. 7.3.8 : Estimate to Complete (ETC)

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7.3.8 Estimate at Completion (EAC)

EAC is a new revised cost estimate at completion. EAC is determined based on one of the following considerations.

a) EAC is calculated considering that the current cost performance index (CPI) will continue till project completion

$$ETC = \frac{BAC}{CPI}$$

Here EAC is a new revised cost estimate at completion.

b) EAC is calculated as the sum of the actual cost incurred as on report date and the balance work controlled and completed at the original budgeted rates.

$$EAC = AC + (BAC - EV)$$

c) EAC is calculated as the sum of the actual cost incurred as on report date plus the cost to complete the balance work on realistic revised estimates (ETC)

$$EAC = AC + ETC$$

7.4 USING MILESTONES FOR MEASUREMENT

Progress being made on the project can be made using:

1.	Gantt Chart	2.	Slip Chart
3.	Ball Chart	4.	Timeline Graph

1. Gantt chart

- We have studied the Gantt Chart in great detail in the previous chapters. In a progress Gantt chart, tasks are shaded in proportion to the degree of their completion. In other words, a task that is 60% complete would be 60% shaded, starting from the left.
- A vertical line is drawn at the time index when the progress Gantt chart is created, and this line can then be compared with shaded tasks.
- If everything is on schedule, all task portions left of the line will be shaded, and all task portions right of the line will not be shaded. This provides a visual representation of how the project and its tasks are ahead or behind schedule.

2. Milestone Slip Chart

- A milestone slip chart is a simple but very effective progress report.On a weekly or monthly basis milestones are plotted on a grid to show when they are scheduled to occur.
- In the example 0 represents the start of the project. In the baseline schedule milestone M1 is due to occur in week 2; M3 in week 5 and M3 in week 7.
- At the end of the first week of work, all three milestones are on schedule, by the end of week two they are all running a week late.

At the end of week three M1 finishes a week late and the other milestones are still running one week late. In week four M2 is back on schedule but M3 is still running a week late. M2 finishes on time in week five but by week six M3 has been delayed a further week.

The progress dates can be easily transferred from a detailed schedule to this simple report which will be perfectly adequate for many stakeholders who only require high level progress information.

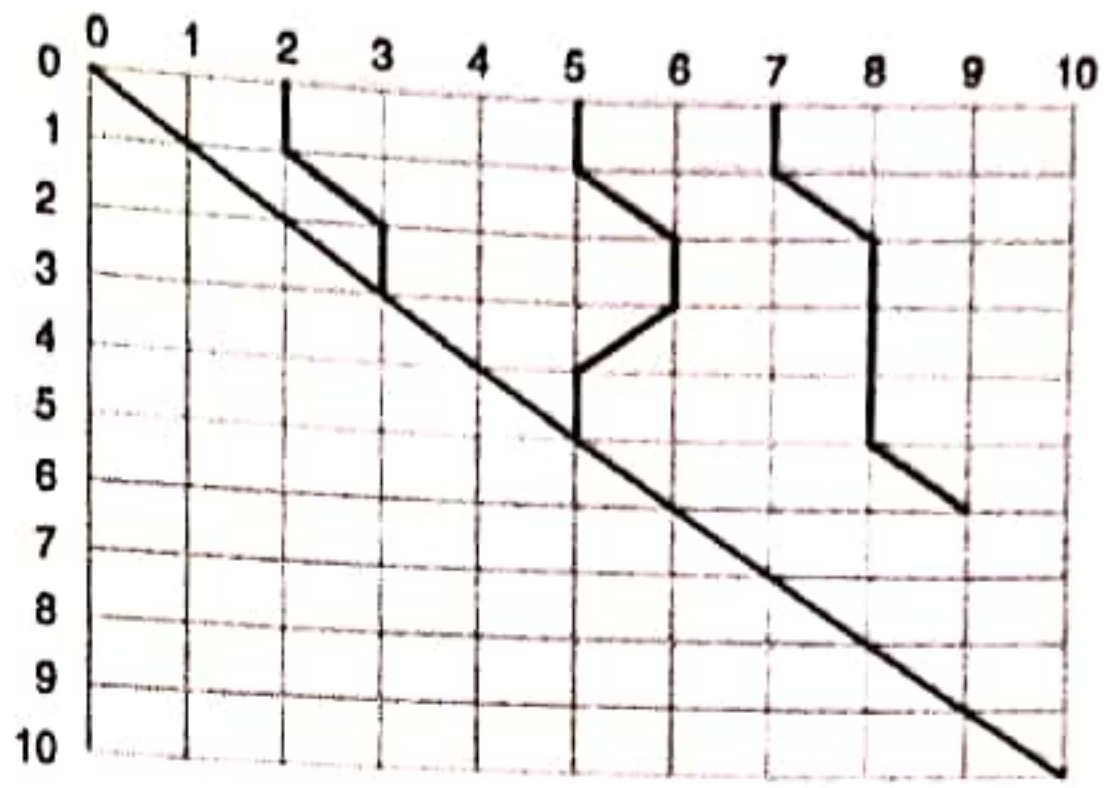

Fig. 7.4.1

3. Ball Chart

The circles in ball chart contain the date on which the particular task or activity in the project will start and end and the sequence that will be followed for each activity.

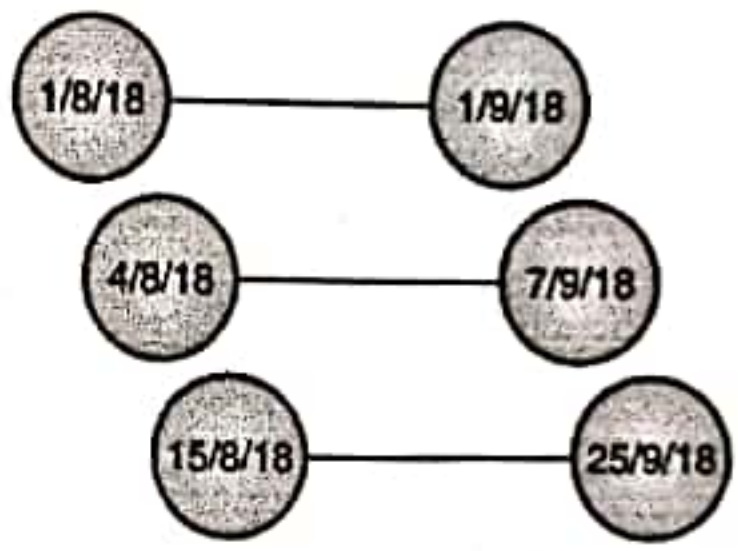

Fig. 7.4.2

4. Timeline Graph

- Timeline Graphs provide an easy way to report big picture progress to executives and stakeholders can be a life saver when it comes to managing large projects.
- At the same time, the project manager needs to drill down into the details of milestones and dependencies and see how the project stands as a whole and pinpoint any tasks and deadlines in danger of slipping.

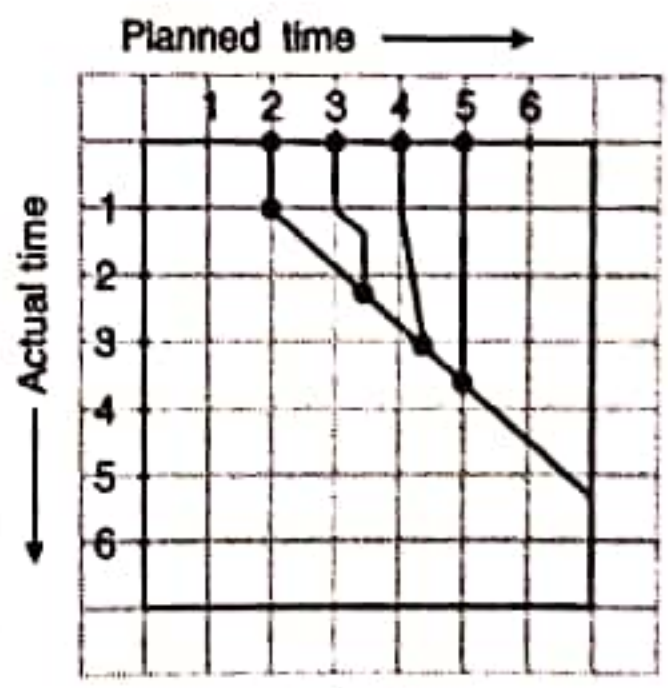

Fig. 7.4.3

Module 5

7.5 CHANGE REQUESTS AND SCOPE CREEP

- Project scope management includes the processes required to ensure that the project includes all the work required, and only the work required, to carry out the project successfully.
- Project scope management is primarily concerned with defining and controlling what is and is not included in the project.

- As per the Project Management Body of Knowledge (PMBOK), the knowledge area of Project Scope Management comprises of five processes, namely, scope initiation process, scope planning, scope definition, scope verification, and scope change control.

▶ **1) Project Scope Initiation Process**

- In this process the project sponsor gives the project manager the authority and resources to define the project scope.
- The authority to commit time and resources to defining the project scope is given when the project plan and charter are being developed.

▶ **2) Project Scope Planning Process**

- The project scope planning process identifies what work is and is not part of the project work. It primarily settles the boundaries of the project work.
- It is essential to also identify what is not a part of the project work to avoid future problems.
- As Old Curmudgeon has stated, "Failure to define what is part of the project, as well as what is not, may result in work being performed that was unnecessary to create the product of the project and thus lead to both schedule and budget overruns."

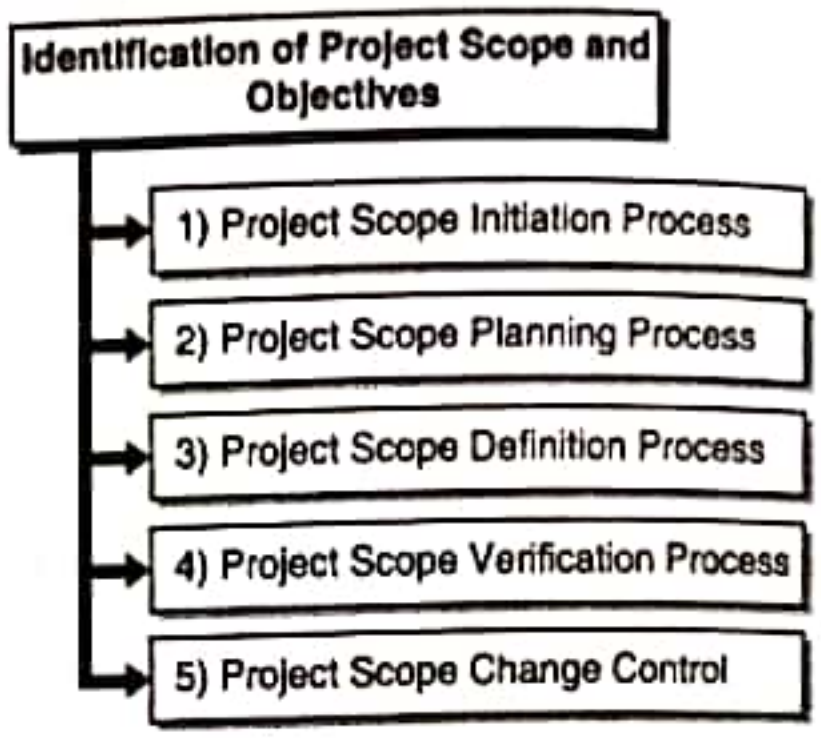

Fig. C7.1

▶ **3) Project Scope Definition Process**

- The project scope definition process identifies the project deliverables and the product deliverables.
- Project deliverables is the work that needs to be accomplished to deliver a product with specific features and functions.
- Product deliverables are the features and functions that characterise a product. The boundaries and deliverables defined by scope planning and definition facilitate the development of the project charter and plan. The requirements of the project define its boundaries.

▶ **4) Project Scope Verification Process**

- The scope verification process checks the scope for accuracy and completeness.
- The scope boundaries and deliverables should be agreed upon by the project sponsor and project manager.

▶ **5) Project Scope Change Control**

- Although, the project scope has been set with great deliberation and thought, changes to it are bound to arise as the project progresses and new information or need emerges. This warrants the need for project scope change control to manage these changes. The change control process has to approve the change to initiate amendments in project schedule and budget.
- The project scope change control process also protects the scope boundaries from expanding unnecessary due demands of additional features and functions to the project scope.

- There is a direct relationship between project scope, budget and schedule. An increase in the scope i.e. expansion of scope boundaries leads to a direct increase in the project's budget and schedule and vice versa. Hence, such change demands need to be properly scrutinized before being approved.
- These five processes make up the project scope management plan. The size of the project determines whether the scope management plan has to be a separate document or a part of the project charter.
- In case the project is large in size and complexity a separate scope management plan document can be created and a summary of it can be included in the project charter. The cardinal rule for defining the project scope is that it should be aligned to the project's MOV.

7.5.1 Project Scope Initiation

- The project scope initiation is the first step in the project scope management process and commences when the project sponsor authorizes and provides resources to the project manager to develop the project scope management plan.
- Although, the primary concept or idea of the project, as presented in the business case, describes the project, its MOV, risks and assumptions, it is to a certain extent very raw and needs to be further developed before actual commencement of the project plan.
- Therefore, the authorization to develop the project scope management plan, as per IT project methodology, is given after the project's business case has been formally accepted and resources have been committed to the development of the project charter and plan by the project sponsor.

7.5.2 Project Scope Planning

- The project scope planning defines all the project's work, activities, and deliverables that enable it to accomplish the project's MOV.
- It is not possible to prepare the project plan without the project's scope as it contains information on the work, activities and deliverables that are to be accomplished and without knowledge of them the team will not be in a position to estimate the schedule, budget and resources required.

7.5.3 Defining the Project Scope Boundary

- In the game of cricket the boundary indicates the area of play. So, when the ball crosses the boundary it is out of play, and even if someone catches it outside the boundary it has no consequence on the game.
- Hence, the boundary plays a critical role in establishing what is in and what is not. Similarly, in project management, the work, activities and deliverables within the boundary of the project scope are considered to be relevant for the project team and anything outside the boundary is of no relevance to the team.
- The work, activities, and deliverables within the boundary should be supporting the project's MOV. The project team should expend all its resources in accomplishing the works within the boundary.
- On the other hand, the project team will be wasting its resources in accomplishing work that is outside the project's scope or boundary. The project's MOV plays a critical role in defining and managing the scope boundary.

7.5.4 Developing the Project Scope Statement

- The needs and expectations of the project's sponsor or client help in creating the project scope statement. Although, the business case provides the project manager with the scope of the project, it needs to be refined further.
- Remember, the business case is sent to the project sponsor for selection of the project and hence it lacks the quantum of groundwork that would actually be required to prepare a full scale project plan.
- However, after the project has been selected, authorized and resources granted for development of the project charter and plan, the project manager has to delve further in identifying the needs and expectations of the project sponsor or client. The project team has to set up several meetings with key stakeholders before creating the scope statement.
- The project scope statement has to also clarify the work that is not to be included or is outside the boundaries of the project.
- During the course of meetings and interviews with stakeholders, various ideas may emerge, although some may be adopted many may have to be overlooked despite being interesting, as they may not be feasible in the current scenario. It is critical that the project manager defines clearly what is and is not part of the project scope.
- Not only should the project scope statement clearly state the boundaries, it should be agreed upon by both the project sponsor as well as the project manager. A mutually agreed upon project scope statement leaves little space for disagreement later on.
- Setting the project boundaries not only settles expectations of stakeholders but also defines project's constraints.
- Project boundaries also enable the project manager to identify how the new system will integrate with the organization's existing system.
- However, the project scope statement presents a superficial view of the project and does not dig deep into the scope of the project. As more information emerges the scope gets more detailed.

7.5.5 Project Scope Definition

- Settling the project scope boundaries and developing a project scope statement prepares the groundwork for defining the project scope.
- The project scope defines the deliverables that the project team aims to accomplish. The development of a detailed project scope is critical to the success of the project.
- A detailed project scope definition builds on the project boundaries, major deliverables, assumptions, and constraints that are documented during the project scope statement.
- During the definition stage the project scope is defined and described with greater specificity because more information is now available with the project manager on account of increased interaction with the various stakeholders of the project.
- Also, stakeholders needs, wants, and expectations, are analysed and converted into project deliverables while ensuring that they do not cross the boundaries of the identified project scope.
- The assumptions and constraints are analysed for completeness with additional assumptions and constraints added if felt necessary. The project team members and other stakeholders who have additional insight into the preliminary project scope statement should analyse and develop the project scope definition.

There are two types of deliverables or scope, project-oriented deliverables/scope and product-oriented deliverables/scope.

Bifurcation of the deliverables enables the project team to clearly define each deliverable, assign time, resources, and responsibility for its accomplishment. Such a bifurcation and allotment of work leads to better coordination amongst the team member and enables them to identify the place of each deliverable in the larger picture of the project.

This facilitates the assigning of resources, estimation of time, and the calculation of cost of completing the work. Bifurcation of deliverables also lays to rest any ambiguity on the project's deliverables and expectations on the part of the stakeholders.

7.5.6 Project-Oriented Scope Definition

- Project-oriented scope defines all the work that needs to be accomplished to deliver an information system with specified features and functions.
- Project-oriented scope or deliverables support project management and project development processes that are defined in the project methodology.
- The business case, project charter, project scope statement, and project plan are all part of the project scope.
- The project-oriented scope defines the work outputs at the various phases of the project.
- The project-oriented scope also includes the study of the existing system, analysis of stakeholder's requirements, and the design of the proposed information system.
- The objective of the project-oriented deliverables is to ensure that project processes are able to produce the desired project's products and are aligned with the project's MOV and objectives.
- Project-oriented deliverables enable monitoring of the project's progress and quality at each phase. All the project deliverables should be clearly defined and should have a purpose in the project. It is also essential to define the structure of the project deliverables to ensure that the output is as per the standard provided.
- Each project-oriented deliverable should be approved by either the project manager or the project sponsor. The project team is not supposed to commence work on the next deliverable until the previous deliverable has been verified and approved.
- Also, the requirements of each deliverable in terms of time, cost and resources should be defined. Once all the deliverables have been defined and the time, cost and resources required for each of them identified, a detailed work package can be prepared to estimate the total project schedule and budget.
- Once all the deliverables have been defined, they can all be clubbed in the Delivery Definition Table (DDT) as per their sequence of delivery.
- The DDT can be used to create a Deliverable Structure Chart (DSC) to create work packages which can be further used to create a Work Breakdown Structure (WBS). The WBS helps in creating the project plan.

7.5.7 Product-Oriented Scope Definition

- The product-oriented scope definition focuses on the features and functions that characterize an information system that is to be developed.
- A context level data flow diagram (DFD) is a useful modelling tool for refining the scope boundary and defining what the system must do.

- The Data Flow Diagram is a graphical aid for designing the inputs, processes and output screen of the system. It is in the form of diagrams (DFDs) which reveal relationships among the various components of the system.
- The use of DFD's provides an overview of what data flows in a system, what transformations are done on the data, what files are used and where results flow etc.
- The use of DFD's as modelling tool was popularized through their structures system analysis methodologies. It acts as a good documentation aid which is easily understood by both the developer of the system and the end user of the system.
- As DFD's specifies only what processes are performed and not how they are performed it is easily understood by the end user.
- It can provide a high level system overview, complete with boundaries and connections to other systems. It also provides a detailed representation of system components.
- A context level DFD has one process, represented by a circle, and a depiction of all the inflows and outflows of data and information between the system and external entities.

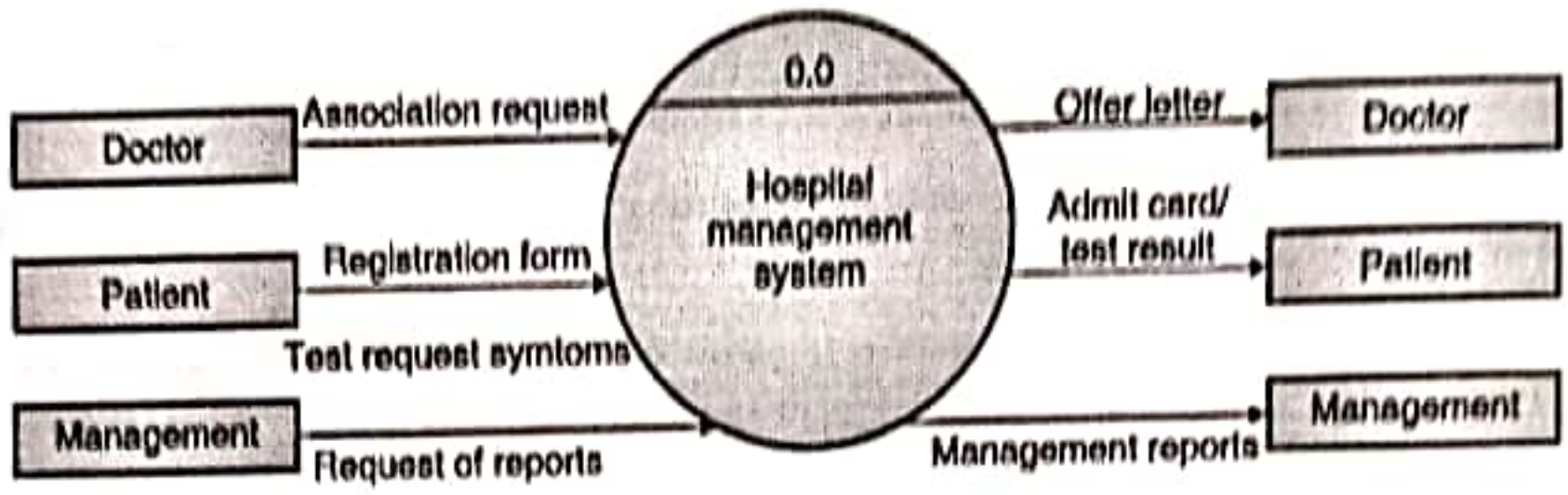

Fig 7.5.2 : Context Level DFD

- Another useful tool for product scope defining is the use case diagram. The use case diagram is a software development tool that provides a high level model for defining the product scope.
- The use case diagram can provide a high level diagram in the early stages of the project which can be refined as more information on the requirement emerges.
- The use case diagram provides an effective overview of the functions and interactions between the use cases and the actors. Actors are the users, customers, or even an external system that interacts with the system.
- Also, a box separates the use cases from the actors and acts as a scope boundary that defines the project scope. The use cases within the box are considered to be within the scope of the project and those outside are outside the project scope.

7.5.8 Project Scope Verification

- The project scope defined needs to be verified. Scope verification is the process of obtaining the stakeholders formal acceptance of the completed project scope and associated deliverables.
- Scope verification ensures that the project deliverables are completed as per the standards laid in the delivery definition table (DDT). Scope verification includes the review of each deliverable and comparison with the standards specified in the DDT.

In the event of the project being terminated early, the project scope verification should document the level and extent of completion.

One may tend to relate project scope verification with quality control, however they differ. While project scope verification is concerned with the acceptance of the deliverables, quality control is concerned with meeting the specified quality requirements of the deliverables.

Also, quality control is performed before scope verification although both can be performed simultaneously.

7.5.8.1 Inputs for Project Scope Verification

The inputs or checklist for project scope verification ensures that deliverables completed are as per specifications provided in the DDT. The various inputs for project scope verification are:

1) Deliverables

- Deliverables are those that are fully or partially completed and are an output of the project execution process.
- The deliverables should be tangible and verifiable and should support the project's measurable organizational value (MOV).

2) MOV

- The project's MOV should be clearly defined and agreed upon. In case the project's MOV has not been agreed upon it could lead to changes in the project's scope which may adversely impact the project's schedule, budget and resources.

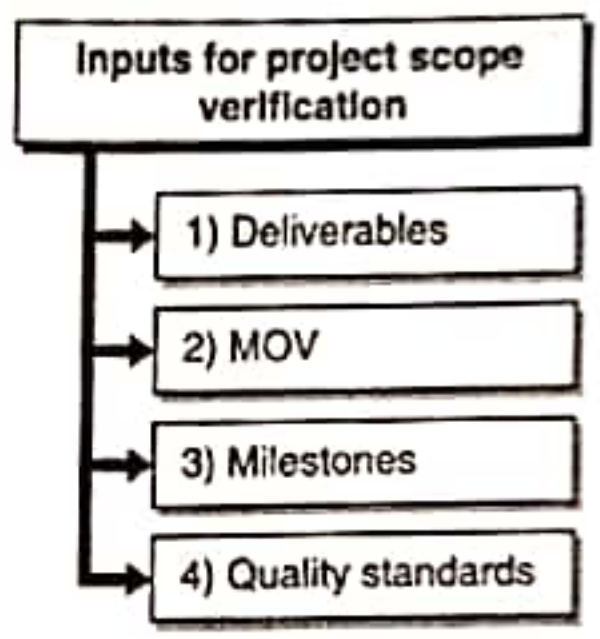

Fig. C7.2

3) Milestones

- Milestones are significant events which mark the completion and acceptance of the deliverables and authorize the project team to proceed to the completion of the next deliverable.
- Milestones for each deliverable should be defined so that on reaching the milestone the team will know that the deliverable was not only completed but verified and accepted.

4) Quality standards

Although quality control measures are performed before scope verification, in some cases they could be performed in parallel. The project manager will have to ensure that the work complete is as per the quality standards specified.

Module 5

Scope Verification Tools

- **Inspection** – includes activities like measuring, examining and verifying to ensure that deliverables meet requirement and product acceptance criteria. Inspections are also called reviews and are carried out by the project stakeholders.
- The project team, stakeholders and project sponsor should be clear on the expectations. The project team should be clear on what it has to deliver.

Outputs for Project Scope Verification

▶ **1) Accepted Deliverables**

The deliverables accepted are documented and those rejected are also documented along with the reasons for rejection.

▶ **2) Change Request**

Change request are generated from the scope verification process and are sent for review to the integrated change control process.

▶ **3) Recommend Corrective Action**

Corrective actions are recommended to bring change in future project performance into conformance with project management plan.

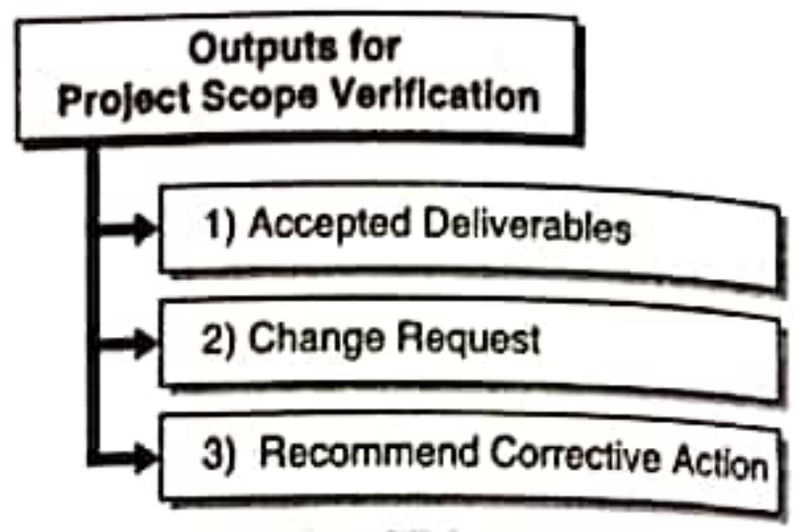

Fig. C7.3

7.5.9 Project Scope Change Control

- Project scope change is like an unwelcome but unavoidable guest who barges his way into your home just as you are busy with your daily chores or about to leave for a movie. Change is an unavoidable part of IT project management. No matter how much planning goes into the project, the future is unpredictable.
- Need for change in project scope may arise due to various reasons; way into the project manager may discover a better method or a new feature, a request from management or customers to change the deliverables, or in some cases the cause for change is the manager himself. Whatever, be the reason for the change, if not managed properly can derail the entire project.
- Although, change in IT project management is a difficult process to incorporate it is almost a regular feature in every project due to the very nature of the industry.
- Changes in stakeholder's requirements, new software, security issues, bugs, etc warrant a change in the project scope.
- However, a request for change in the project's scope must be evaluated for cost, time, risk and other repercussions.
- Also, each change request must be documented, tracked, reviewed, implemented or rejected, and conveyed to the stakeholder. Whether the change request has been accepted or rejected should be recorded in the change log as it helps in the final scope verification with stakeholders who would also not be puzzled as to why certain change requests have not been implemented.
- Not all change requests are unjustified; on the other hand, some change requests add more value to project, though they may cause some initial drawback and discomfort.
- Therefore, change requests should be managed with utmost care as it may lead to a decline in the morale of the team and the manager may lose control over the project.
- Before we go over to study the process of scope change control let us see what scope control is supposed to address:

▶ **1) Scope Grope**

- A scope grope describes the project's team inability to define the project's scope.
- This situation is experienced early on in the project when the goals and objectives of the project are vague and the project team and sponsor have trouble understanding what the project is supposed to accomplish.

Ambiguity and subjectivity while defining goals and objectives causes scope grope. Scope grope occurs due to miscommunication and misunderstanding, unrealistic expectations on the part of the client and overselling by the project team.

Hence, while developing the project scope the participants should clearly define the goals, objectives and the MOV of the project.

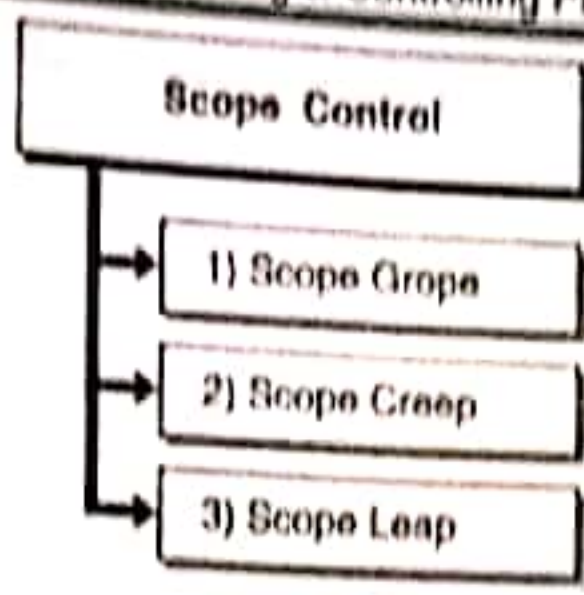

Fig. C7.4

2) Scope Creep

- Scope creep also called as requirement creep, function creep or feature creep refers to small uncontrolled continuous changes in the project's scope even after the project scope has been approved.
- The project sponsor may try to add various decorative features to the project which were not approved in the project scope.
- Sometimes even the project team may be responsible for the scope creep, as it members while executing the project may come up with some novel ideas of some add-on features.
- However, the project team has to bear in mind that even a small changes in the project scope has a spiralling effect on the project's schedule and budget.
- Project creep can be attributed to; poor requirement analysis on the part of the client and project team, not involving the user early on in the project, underestimation of the complexity of the project, adding features not approved in the scope, and lack of scope change control.
- Scope creep should be identified and controlled throughout the project as it leads to unnecessary pressure on the budget and schedule.

3) Scope Leap

- As the title itself suggests it is a complete change in the scope, objective and focus of the project.
- Scope leap demands an entire change in the project scope and focus of the project.
- Scope leap can be attributed to a drastic change in the business environment of the industry.
- Scope leap requires a change in the MOV of the project and if the change is inevitable the organization would be better off in closing the current project and starting afresh.

7.5.9.1 Scope Change Control Procedure

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- Although, scope change control comes into picture once the execution of the project has commenced the procedure to manage such scope changes should be planned and mentioned in the project charter and explained to all stakeholders and team members.
- The change control should be an internal process of the project team and should be used to block any stakeholder from changing the deliverables of a project without following proper procedure and justification.
- The procedure should identify and handle all scope change requests without prejudice.
- The procedure should assess the impact of the change on the various facets of the project before arriving at a decision to accept or reject the scope change can be made. The requestor should have a legitimate reason to attempt a change.

- The scope change control system is a formal, documented process that includes a change request form on which the requestor should make his application for change in the project scope.
- The requests are reviewed for their value, costs, schedule impact, risks and feasibility and above all their overall ability to add value to the project and compatibility with the project's MOV.
- The change request form requires the requestor to clearly define the change as well as provide justification for requesting the change and alternative course if any.
- This will enable the project team to understand the nature and reason for the scope change and study the impact of the change as well as the alternative courses offered on the scope, schedule, budget and resources.
- The alternatives include compromising on some functionality elsewhere in the project to offset the unbudgeted expenditure here, extending the project deadline, and adding more resources. The project sponsor is required to approve the changes as impacts of change will have to be adjusted accordingly.

Change Request Form
Request Date -
Requestor's Name -
Official Title -
Request Description -
Justification -
Alternatives -
Impacts : i. Scope
ii. Schedule
iii. Cost
iv. Time
Risk
Recommendation:
Authorized by:

- Despite thorough planning and following the procedure to the "T", change in project management is inevitable. Hence, when a scope change request is made to the project manager it should be reviewed for its impact on the entire project.
- An integrated change control mechanism should be activated to study the impact of the change request on the scope, schedule, cost, quality, human resources, communication, risk, and procurement.
- If a change request by-passes the mechanism the project in all likelihood will be weakened. Hence, irrespective of who is making the request the set procedure for change control has to be followed.
- Another very critical aspect of change control is treating all requests equally. Every request should be taken notice off, assessed and responded to officially.
- A project scope control log should be maintained to register each request received and the response given to it. Such a procedure creates a healthy environment and the requestor is not aggrieved even if his request is declined.

Although, no change is welcome and the first inclination of the project manager and his team is to decline any change request, some requests can prove beneficial and justified as the project progresses.

The question that arises here is that what the criteria should be for accepting or declining change request. The criterion is simple, any change request if accepted should bring the project closer to achieving its MOV else it will prove to be an additional burden on the projects resources.

The project change control procedure keeps the project manager firmly in saddle and enables him to control and manage the project schedule and budget.

7.6 PROJECT AUDITS

7.6.1 Write short note on : Project Audits

The final activity within a project is the review of its success or failure by an independent party or by the project manager himself. An audit of the success or failure of the project should be undertaken. An audit should be undertaken irrespective of the success or failure of the project. The purpose of the audit is to analyze the effectiveness of the project team, the value of the deliverables, and the reaction of the client. By auditing a failed project the project manager and all those get to understand where the project went wrong and how these mistakes can be avoided in the future. This audit can serve as a lessons learnt document and can prove useful in other projects.

Success of a project is determined by how well it performed against the defined objectives and conformed to the management processes outlined in the planning phase. To determine how well it performed, the following types of questions are answered:

Did the project succeed in achieving the project vision? – We have seen every project is conceptualized with a vision. Though the vision evolves as the project progresses it is necessary to understand whether the project succeeded in accomplishing what it originally intended.

Did it result in the benefits defined in the business case? – In the business case the utility of the project for the achievement of the objectives and goals of the organization had been advocated. The audit will be able to justify the business case.

- Did it achieve the objectives outlined in the project scope statement?
- Did it operate within the scope of the project?
- Did the deliverables meet the criteria defined in the quality plan?
- Was it delivered within the schedule outlined in the project plan?
- Was it delivered within the budget outlined in the financial plan?

To determine how well the project conformed, an assessment is made of the level of conformity to the management processes outlined in the quality plan. These results, as well as a list of the key achievements and lessons learnt, are documented within an audit review and presented to project sponsor for approval.

Chapter Ends...

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CHAPTER 8

Project Contracting

Module 5

University Prescribed Syllabus

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8.1 PROJECT PROCUREMENT MANAGEMENT

The first step in project procurement in projects is forecasting the requirement of materials based on the WBS.

8.1.1 Need for Forecasting

QQ. 8.1.1 *Explain necessity of forecasting ?*

Modern business is a complex web of men, machine and material. All these inputs are expensive and therefore need to be handed very carefully. To put these resources to optimum use one must plan the construction process effectively. Forecasting is primarily intended to meet project's order at least cost.

Various activities depend on the sales forecast and they are as follows :

1. project activity can be scheduled as per orders and stock orders can be replenished with the objective of optimum utilization of plant and machinery.
2. schedules can be converted into material schedules to enable the procurement process.
3. Capacity requirement of shop can be anticipated and arrangement can be made.
4. Vendors can be selected and requirements given to them to meet future needs of materials.
5. Manpower requirement can be planned and the recruitment procedure can be initiated.

8.1.2 The Material Requirement Planning Process

- The second step in Materials Management Process is the Material Requirement Planning (MRP) Material Requirement Planning is the technique of planning the ordering and usage of material at the various levels of construction. MRP also monitors the stock during the various transaction that take place during the construction process.
- Thus MRP is both Inventory Control and Scheduling of the inventory as per the requirement of the Master Schedule.
- The Master Schedule will indicate the quantity of construction during that period, the structure i.e. the sub constructions, components and raw material, the lead time in procurement in case of vendors or in case of in-house manufacturing and the present status of the inventory.
- The Material Requirement Planning Process starts when the project requirements are forecasted and the construction schedule is decided. MRP is particular useful when the project is complex and made up of several level of sub-projects having many common parts.

Terminology used in MRP

1. **Master Schedule :** Master Schedule states the quantum of work along with its schedules.
2. **Bill-of-Material :** Bill-of- material describes the composition of the project. It states the components a project is made up of.
3. **Level Coding :** Codes are assigned to the components in the Bill-of-material according to their level in project.
4. **Lead Time :** Lead time is the time taken between the issuing of replenishment order and the receipt of the material in stores.

8.1.3 Purchase Procedure and Purchase Documentation

Q. 8.1.2 Explain the purchase procedure and purchase documentation ?

- Purchasing is a specialized activity frequently carried on by a separate department under the control of a buyer or purchase manager.
- Purchasing is of extreme important particularly to a concern because it has its bearing on every vital factor concerning the construction i.e. quantity, quality, cost, efficiency, prompt delivery, volume, etc. it is by the purchasing department that much money can be saved or lost.
- Purchasing is the function of buying raw materials, general supplies, tools, office stationery and other items. The essentials of efficient purchasing are right quantity, right quality, right time, right price, right source and delivery at the right place.

8.1.3.1 Procedure for Purchasing

- The procedure of purchasing starts from the stage of indenting for materials and ends with the payment of bills for supply of materials, after materials have been received.
- This activity is being completed through various different stages. The different stages in which this activity is completed may differ from concern to concern.
- This is due to nature of business and different ideas of different persons involved in this activity. However, the following are the important stages which are prominently used, in almost all the organisations.

8.1.3.2 Steps in Purchase Procedure and Purchase Documentation

Fig. 8.1.1 : Purchase Procedure

- Although the details of a purchase procedure may differ from firm to firm, the important steps in purchasing and receiving of materials are as follows, assuming that purchases are centralized:
- Initiation of purchase procedure by means of a Purchase Requisition.
- Inviting tenders and selecting suppliers.

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- Preparation and execution of purchase orders.
- Receipt of materials.
- Inspection and testing of materials.
- Debit note to the supplier in case of rejected materials.
- Checking invoices for payment.

8.1.4 Raising Purchase Indents

The purchase procedure begins with the purchase department receiving a purchase indent. The purchase indent provides the authority to the purchase department to initiate the purchase procedure. The purchase indent is received from :

- Store keeper in case of stock items.
- Particular construction department in case of an item that is specific to the project in hand.
- Maintenance department in case of spares required for construction equipment.
- Generalized office supplies received from the administrative department.

Purchase indents are prepared in triplicate, one copy is kept by the originating department, one copy is sent to the stores and the original copy is sent to the purchase department. Every purchase indent received by the purchase department has to be scrutinized to ensure that;

- Indent is signed by authorized personnel.
- Routed through the stores.
- Material requisitioned is properly described or coded.
- Quantity is properly stated.

8.1.5 Receiving Material

- When the material arrives it is received at the stores and its contents are physically checked against the details provided in the purchase order.
- The details of the material received are entered in the Goods Received Report (GRR) Register and a Goods Received Note (GRN) is prepared.
- A goods received note is a type of document used in companies as proof that the company has received a delivery. This note plays an important role because it contains a list and description of the goods that have been received, including the number and quantity. It simplifies the processing of such goods through the various departments in the company.
- This especially applies to the accounts or financial department, which has documents to make a comparison of the goods that have been supplied in relation to the order that was placed by the company.
- Usually, when companies place an order for specified items to a manufacturer or supplier, the company will produce a detailed list of the items that were ordered.
- When the supplier or manufacturer supplies the goods to the company, the only way for the company to ensure that the supplier sent the exact requirements is by comparing the goods received note to the purchasing order that was produced when placing the order.

Normally, the two documents have to match in order to assure the company that the goods it received are exactly what it ordered from the supplier.

This process serves the further purpose of allowing both the supplier and the company to identify when all of the goods did not arrive together, where there may shortages, and where the goods might exceed what the company ordered.

Such scenarios occur due to factors that include computer glitches, human errors, and, more uncommonly, the attempt by one party to take advantage of the other. For instance, the supplier might try to supply something inferior to the specifications of the company or a quantity of goods that is less than what the company ordered.

The goods received note in conjunction with the purchase order helps to clarify the situation by revealing the exact order.

Other ways in which the goods received note can help in the resolution of disputes arising from human error can be seen in a situation where the supplier and company both kept up their part of the bargain, but the delivery person mixed up the orders. For instance, if the delivery person was supposed to deliver 100 bags of cement to Company A and 50 bags to Company B, a mix-up could result in the delivery of cement to the wrong recipients. When this is the case, the goods received note, in addition to the purchase order, will help clear up the problem.

8.1.6 Inspection of Material

The material that has been received has to be inspected and tested. However, branded material need not be tested; their quantity and packing need to merely be conformed before accepting them.

Material received needs to be inspected for;

1. **Conformance to dimension :** The dimensions of the material should be checked against component drawings. In case no such specifications have been provided the material should be checked for damages and quality of finish. However, where specifications and drawings had been provided the material needs to go through thorough checking using measuring instruments.
2. **Conformance to material specifications :** Critical material should undergo metallurgical tests in laboratories.
3. **Conformance to performance :** The material received should be tested to ensure that it conforms to the specified performance.

The inspection report should be stated in the GRN.

8.2 INTRODUCTION OF PROJECT CONTRACTING

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- It is not always that the project manager is a permanent employee of the organization. Many a times, we find organizations availing of the services of independent IT professionals for the implementation of specific IT projects.
- These IT professionals are selected on the basis of their technical expertise, experience as well as the proposal that they submit to the organization. Once the proposal has been accepted by the organization, both the parties enter into a contract which is legally binding on both.
- Howsoever, keen the external IT professional may be in clinching the deal he should never over commit to the client on the project.

- The IT professional should properly take into account all the aspects of the project and its nuances and then commit to the completion date and price.
- If the IT professional over promises and fails to deliver he will be held liable and may eventually lose the contract and a permanent blot on his image.
- From the organizations point of view, the biggest advantages of working with an outside professional is that apart from bringing in the required technical expertise and fresh perspective they are totally into the project all the time.
- An in house project manager has various other activities to cater to and hence may not be able to dedicate himself totally to the project.

8.2.1 Organization Demands for External Project Manager

- While dealing with an external project manager the organization demands the following;

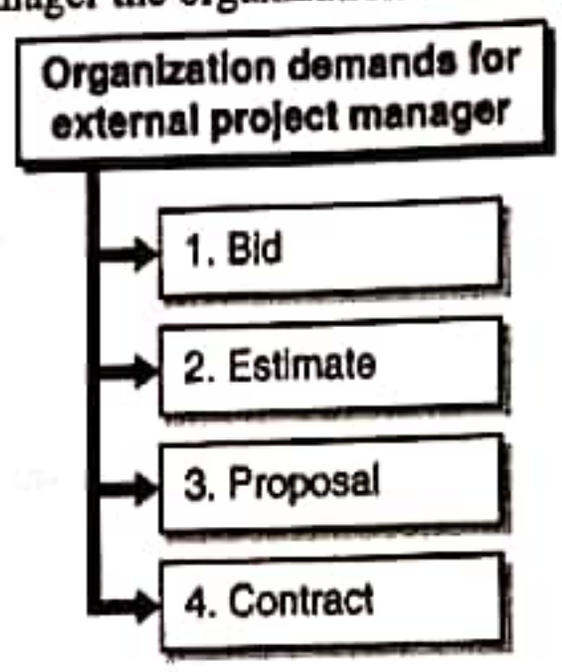

Fig. C. 8.1

1. Bid

An indication of how much the IT professional would charge the client to carry out the potential project when competing with other freelancers/businesses.

2. Estimate

An approximation of the overall project costs based on past projects of similar scope or extrapolating on whatever information is available.

3. Proposal

An interpretation of the client's specific needs and how the IT professional plans to execute and charge for it.

4. Contract

- A legally binding agreement between the IT professional and the client that includes any contract provisions.
- Project proposals and contracts may seem interchangeable, however, in reality they are two very different things, and one never exists without the other.

8.2.2 Elements of a Contract

After the proposal has been finalized and agreed upon, it is time for the contract. Some of the very essential elements of a contract are;

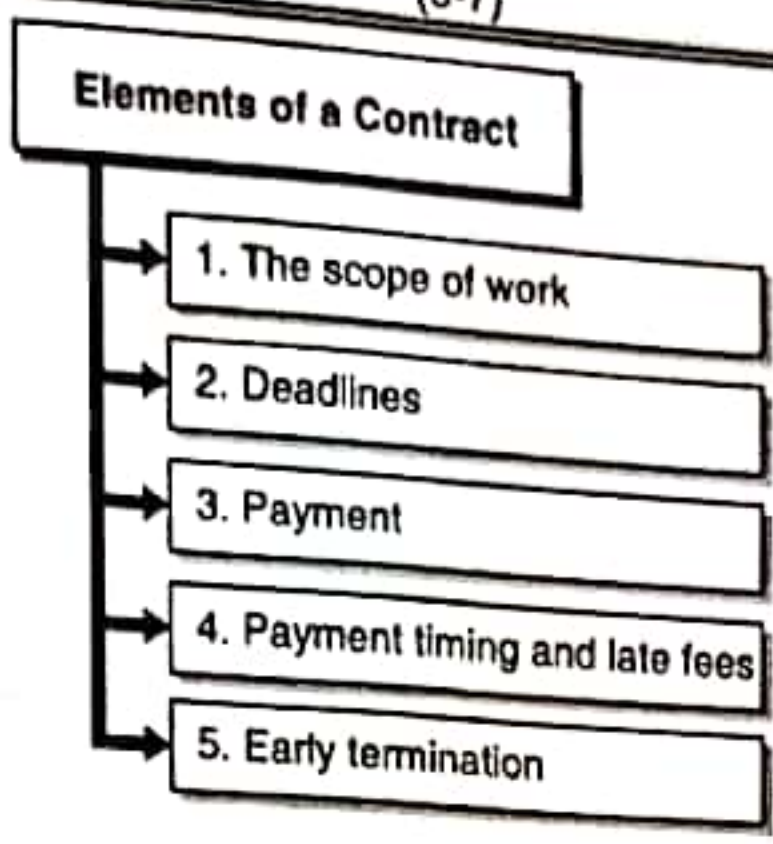

Fig. C. 8.2

1. The scope of work

The Scope of Work should describe in detail what the freelancing IT professional is expected to do for the organization.

A vague or incomplete Scope of Work is a recipe for problems down the road, with the client claiming that the work doesn't meet their specifications.

So, clarity in Scope of Work is of utmost importance. The client should know exactly what to expect before the work starts.

2. Deadlines

Few things cause more disruption in a freelancer's life than a client suddenly moving up a deadline. Make sure the contract states when the work is due.

If the project is broken up into phases, assign a deadline to each phase. It can't hurt to say in the contract that if the scope of work changes, the deadline is also subject to change, and vice versa.

3. Payment

The IT professional can be paid by the hour, by the project, or whatever other arrangement the two parties devise.

But whatever the arrangement it has to be clearly mentioned in the contract.

4. Payment timing and late fees

The timing of the payment is as important as the amount that is being paid.

In some cases payment is made against the delivery of the work while in some cases time is given to the client to make the payment. If an advance is expected the freelancer should mention so.

5. Early termination

Clients sometimes change their minds and cancel projects. If the work has already commenced and the client pulls the plug, the freelancer is likely to suffer.

In contract-speak this scenario is known as "early termination," and it's important that the freelancer and the client have a plan in place should it happen.

The freelancer might agree that the client will pay him a pre-determined amount of money, if they terminate the agreement early. Or, may be they agree that the client will pay him for the work you've completed as of the termination date, an amount that will have to be determined in the future.

In any event, it's a good idea to make sure the contract provides that the freelancer gets paid for partially completed work.

8.3 TYPES OF CONTRACT

GQ. 8.3.1 State and explain types of contract.

- In the world of business, contracts are used for establishing business deals and partnerships. The parties involved in the business engagement decide the type of the contract.
- Usually, the type of the contract used for the business engagement varies depending on the type of the work and the nature of the industry.
- The contract is simply an elaborated agreement between two or more parties. One or more parties may provide products or services in return to something provided by other parties (client).
- The contract type is the key relationship between the parties engaged in the business and the contract type determines the project risk.
- Let' have a look at most widely used contract types.

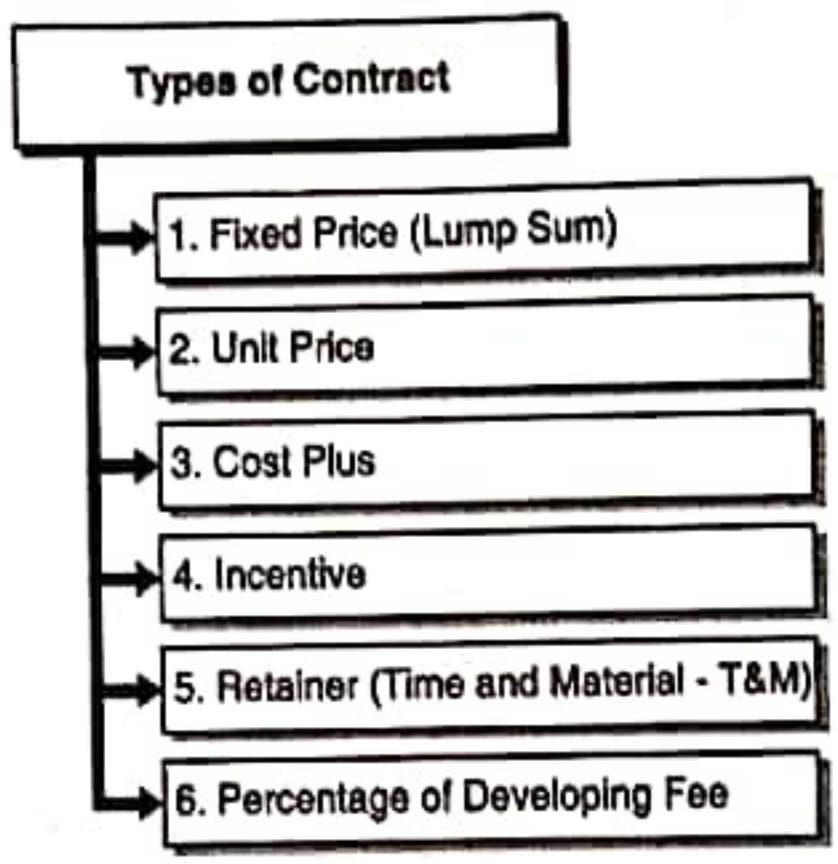

Fig. C. 8.3

▶ 1. Fixed Price (Lump Sum)

- This is the simplest type of all contracts. The terms are quite straightforward and easy to understand.
- To put in simple, the service provider agrees to provide a defined service for a specific period of time and the client agrees to pay a fixed amount of money for the service.
- This contract type may define various milestones for the deliveries as well as KPIs (Key Performance Indicators). In addition, the contractor may have an acceptance criteria defined for the milestones and the final delivery.
- The main advantages of this type of contract is that the contractor knows the total project cost before the project commences.

▶ 2. Unit Price

- In this model, the project is divided into units and the charge for each unit is defined. This contract type can be introduced as one of the more flexible methods compared to fixed price contract.
- Usually, the owner (contractor/client) of the project decides on the estimates and asks the bidders to bid of each element of the project.

After bidding, depending on the bid amounts and the qualifications of bidders, the entire project may be given to the same service provider or different units may be allocated to different service providers.

This is a good approach when different project units require different expertise to complete.

3. Cost Plus

- In this contract model, the services provider is reimbursed for their machinery, labour and other costs, in addition to contractor paying an agreed fee to the service provider.
- In this method, the service provider should offer a detailed schedule and the resource allocation for the project. Apart from that, all the costs should be properly listed and should be reported to the contractor periodically.
- The payments may be paid by the contractor at a certain frequency (such as monthly, quarterly) or by the end of milestones.

4. Incentive

- Incentive contracts are usually used when there is some level of uncertainty in the project cost. Although there are nearly-accurate estimations, the technological challenges may impact on the overall resources as well as the effort.
- This type of contract is common for the projects involving pilot programs or the project that harness new technologies.
- There are three cost factors in an Incentive contract; target price, target profit and the maximum cost.
- The main mechanism of Incentive contract is to divide any target price overrun between the client and the service provider in order to minimize the business risks for both parties.

5. Retainer (Time and Material - T&M)

- This is one of the most beautiful engagements that can get into by two or more parties. This engagement type is the most risk-free type where the time and material used for the project are priced.
- The contractor only requires knowing the time and material for the project in order to make the payments. This type of contract has short delivery cycles, and for each cycle, separate estimates are sent of the contractor.
- Once the contractor signs off the estimate and Statement of Work (SOW), the service provider can start work.
- Unlike most of the other contract types, retainer contracts are mostly used for long-term business engagements.

6. Percentage of Developing Fee

- This type of contracts is used for engineering projects. Based on the resources and material required, the cost for the construction is estimated.
- Then, the client contracts a service provider and pays a percentage of the cost of the project as the fee for the service provider.
- Selecting the contract type is the most crucial step of establishing a business agreement with another party. This step determines the possible engagement risks.
- Therefore, companies should get into contracts where there is a minimum risk for their business. It is always a good idea to engage in fixed bids (fixed priced) whenever the project is short-termed and predictable.
- If the project nature is exploratory, it is always best to adopt retainer or cost plus contract types.

8.4 STAGES IN CONTRACT PLACEMENT

GQ. 8.4.1 *Describe the stages of contract management.*

- Contract management is the process of managing contract creation, execution and analysis to maximize operational and financial performance at an organization, all while reducing financial risk.
- Organizations encounter an ever-increasing amount of pressure to reduce costs and improve company performance.
- Contract management proves to be a very time-consuming element of business, which facilitates the need for effective and automated contract management system.

8.4.1 Fundamentals of Contract Management

- When two companies wish to do business with each other, a contract specifies the activities entered into by both organizations and the terms through which they will each fulfil their parts of the agreement.
- Contracts affect business profitability in a very large way due to the emphasis on revenue and expenses. When a contract is phrased poorly, one organization might lose countless money over a simple technicality they lacked the resources to identify.
- Effective contract management can ultimately create a powerful business relationship and pave the road to greater profitability over the long-term, but only when managed correctly.

8.4.2 Stages of Contract Management

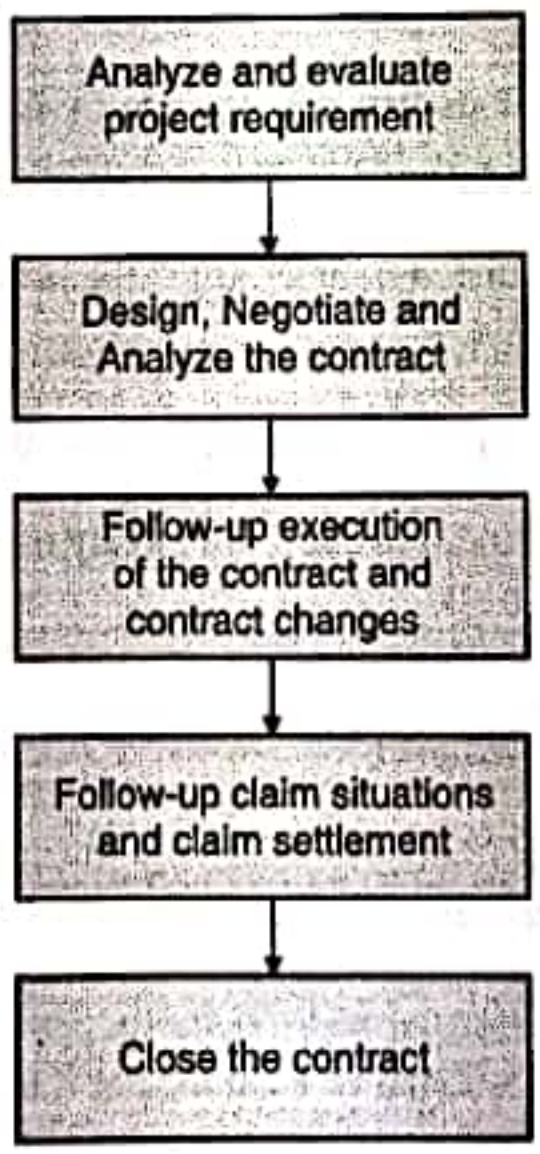

Fig. 8.4.1 : Stages of Contract Management

- Contracts play a significant role in the end-of-quarter crunch and are broken up into stages to organize efforts and structure the typical contract process.

If done manually, creating a contract can prove quite time consuming. The process includes the following steps :

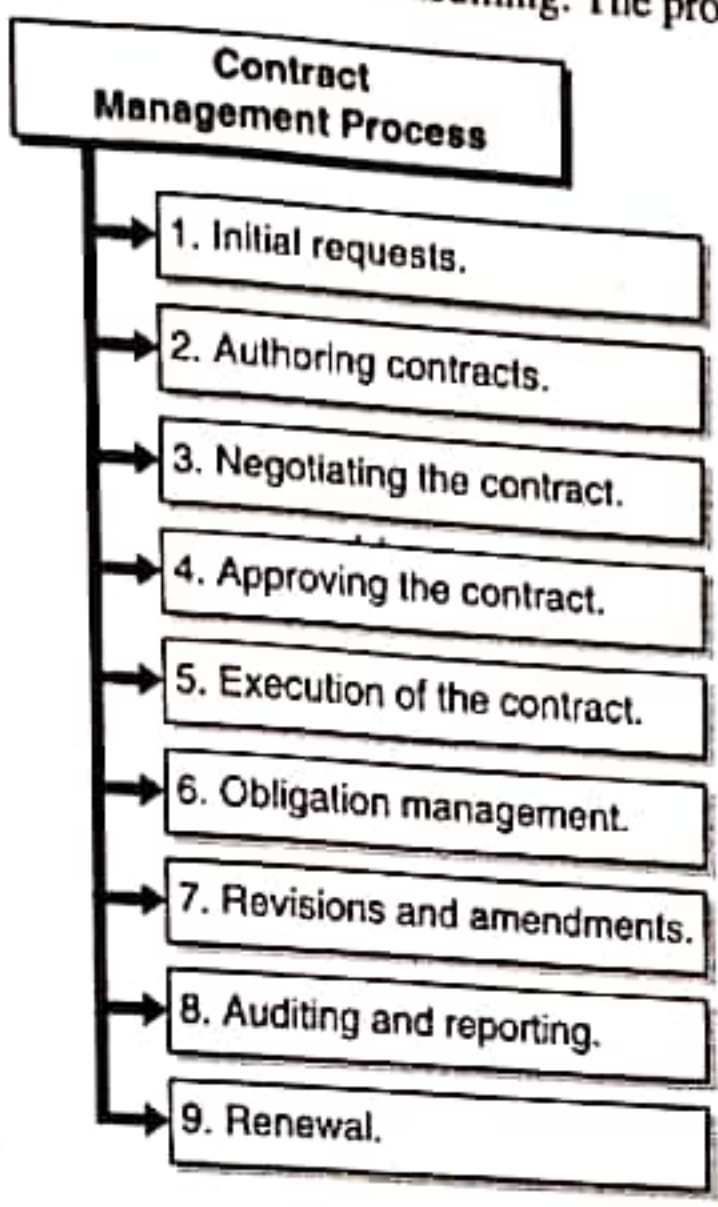

Fig. C. 8.4

1. Initial requests

The contract management process begins by identifying contracts and pertinent documents to support the contract's purpose.

2. Authoring contracts

Writing a contract by hand is a time-consuming activity, but through the use of automated contract management systems the process can become quite streamlined.

3. Negotiating the contract

Upon completion of drafting the contract, employees should be able to compare versions of the contract and note any discrepancies to reduce negotiation time.

4. Approving the contract

The instance in which most bottlenecks occur is getting management approval. Users can preemptively combat this by creating tailored approval workflows, including parallel and serial approvals to keep decisions moving at a rapid pace.

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5. Execution of the contract

Executing the contract allows users to control and shorten the signature process through the use of e-Signature and fax support.

6. Obligation management

This requires a great deal of project management to ensure deliverables are being met by key stakeholders and the value of the contract isn't deteriorating throughout its early phases of growth.

7. Revisions and amendments

Gathering all documents pertinent to the contract's initial drafting is a difficult task. When overlooked items are found, systems must be in place to amend the original contract.

8. Auditing and reporting

- Contract management does not simply entail drafting a contract and then pushing it into the filing cabinet without another thought.
- Contract audits are important in determining both organizations' compliance to the terms of the agreement and any possible problems that might arise.

9. Renewal

- Using manual contract management methods can often result in missed renewal opportunities and business revenue lost.
- Automating the process allows an organization to identify renewal opportunities and create new contracts.

8.5 TYPICAL TERMS OF A CONTRACT

- Contracts are legally binding documents that should not be approached lightly. It's important to be organized and prepared with the right resources.
- Properly identifying the needs, reasons, and ultimate goals that require a contract makes any decisions down the line much easier.
- Contracts should seek to define and mitigate risk in a relationship, looking ahead to any potential scenarios that could occur over the lifetime of the document and accounting for them in the contract.
- Contract shall contain :
  - Type of Contract,
  - Schedule
  - Terms & Conditions (T&C)
  - Change management clause
  - Penalty clause for under-performance
  - Scope
  - Price
  - Termination clause
  - Incentive clause for higher performance
- Contract is legally enforceable i.e., If any party (seller or buyer) feel cheated on the agreement by other party, they can approach court of law. But it is highly suggested to try all means like negotiation, mediation and arbitration before taking legal step.

8.6 CONTRACT MANAGEMENT

GQ. 8.6.1 *Discuss the contract management ?*

- A contract is any agreement between two or more parties where one party agrees to provide certain products or services, and the other party agrees to pay for those products or services.
- Once, the parties to the contract have signed on the dotted line they are bound by its clauses as a contract is a legal document and the aggrieved party can take the other to the court of law.
- Hence, it becomes essential to manage the contract professionally. However, contract management starts even before the parties to the contract have signed the document.
- Contract management is a continuous process, starting with analysis and evaluation of the customer's inquiry, and carrying on until contract closure, upon fulfilment of all contractual obligations.

Although, contract management activities seem to be the sole purview of the project manager in larger projects where we have large contracts it is best practice to involve a full-time contract manager who brings in his professional experience, takes responsibility for that process, and ensures the contribution of all team members.

Contract preparation is a critical step in contract management and comprises of analysis and evaluation of the other parties' requirements, a clear statement of our own requirements, and negotiation in order to reach agreement between the involved parties.

After signing the contract, upon handover, the implementation team needs to analyze the contract in order to ensure that they understand what has been signed and needs to be implemented.

The party responsible for implementing the project while signing the contract anticipates how they would want to implement the required project results. This means that project planning is based on assumptions on how the project environment will develop over implementation and closure phase.

However, these assumptions can turn out to be wrong: certain conditions can change, or certain events can happen so that changes or deviations of the plans and of the contract become necessary. Thus, it would be helpful to prepare the project plans and the contract in a way so that those necessary changes can be implemented with mutual agreement of all involved parties.

Change Management Process is an essential component of contract management. A change is executed into a contract upon successful negotiation and mutual agreement of a change order.

Under certain circumstances (e.g. different interpretations of technical, commercial, or other contractual requirements) this mutual agreement cannot be reached, but the execution of a change takes place anyway, in order to be compliant with higher prioritized project requirements or goals. This we call a claim situation, and we need to integrate a claim management process as a second tool for contract management into the contract.

The following picture reflects the general claim management process.

Obviously, claim settlement is the tricky part and needs further explanation.

There are several steps of escalation which we can integrate into the contract as a third tool of contract management. These are the claim settlement or dispute resolution methods.

(1) Negotiation between the two contract parties

In most claim situations, we will be able to settle the case after negotiating with the other party.

(2) Independent expert opinion

The contract parties agree to call a neutral third party for determination of specific contract elements, their interpretation, and an expert opinion on the case.

(3) Executive tribunal or mini-trial

This is a process, sometimes called 'mini-trial', in which the parties make formal but abbreviated presentations of their best legal case to a panel of senior executives from each party, usually with a mediator or expert as neutral chairperson.

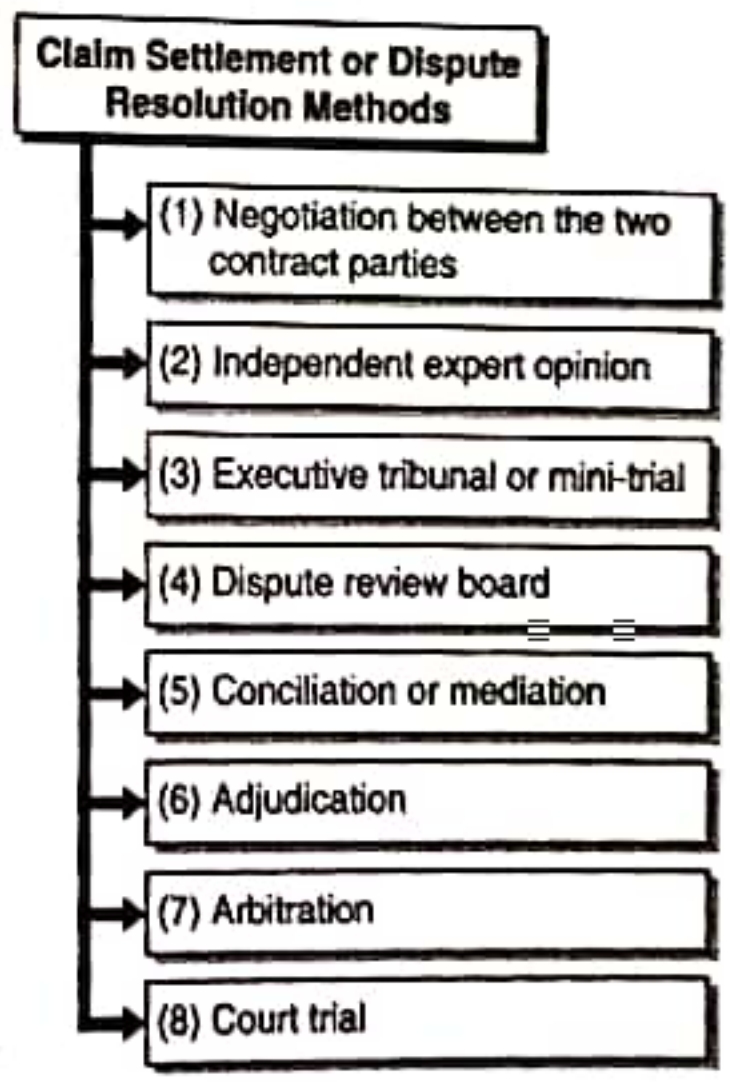

Fig. C. 8.5

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Following the presentations, the executives meet (with or without the mediator or expert) to negotiate a settlement on the basis of what they have heard.

(4) Dispute review board

- The dispute review board is a 'standing' adjudication panel used in major construction contracts.
- This board is normally appointed at the beginning of the project and stays in close touch with it, adjudicating disputes as they arise.

(5) Conciliation or mediation

- Conciliation and mediation are similar. Conciliation refers to a process in which the third party takes a more activist role in putting forward terms of settlement or any opinion on the case between the two parties.
- While in mediation, the third party provides support to the parties during their negotiation but does not interfere with the content of the case or its settlement.

(6) Adjudication

In this process a neutral third-party, the adjudicator, makes summary binding decisions on contractual disputes without following the procedures of arbitration.

(7) Arbitration

This is a formal process, agreed by the parties, regularly with three arbitrators who are neutral and independent. They make a final and binding decision as first instance.

(8) Court trial

After arbitration as first instance, we usually can go for a formal court trial as second and then third instance.

- The situation of claim settlement can be avoided if the change management process is followed for most of the deviations which we cannot avoid.
- This requires a common understanding of the contract and the underlying project planning between the contract parties. However, as mentioned above, there might still remain some claim situations.
- For a successful claim, the contractual basis is essential.
- The second building block consists of the records of events and their analysis in terms of impact.
- In order to define the claim strategy the following questions can be helpful:
  - What relationship to our contractual partner do we want to keep?
  - What are the policies of our other involved or affected business units?
  - How does the claim correspond to the project goals?
  - How does the claim correspond to our general business goals?
  - Who needs to be involved?

8.7 ACCEPTANCE

- contract there may be a number of different times when testing and acceptance may be required. For example:
- In an agreement that had major milestones there may be acceptance and test requirements for the completion of the milestone.
- For production of an item in volume they may be an acceptance and test of the "first article" produced to ensure that meets the expected requirements.
- Prior to the completion of performance there may be a formal acceptance and test required to prove the item meet all the requirements of the agreement.
- There can be performance testing that occurs after installation of a software program of piece of capital equipment as part of final acceptance that the item performs as committed. Whenever there are an acceptance and test requirements several things be included :

1. The party whose work is subject to test and acceptance needs to either delivery to the other party or provide notice to the other party that it is ready and available for testing and acceptance.
2. The parties should have agreed in advance upon where and how such testing will be performed.
3. For any discrepancies found in testing they parties should have agreed in advance what the impact will be. How long do they have to correct it? Does the test start from the beginning or from some forward point? Who pays the cost of any subsequent tests?
4. The party who has the acceptance and test rights will usually have a time period imposed during which the test and acceptance must be performed. That period should be extended by any discrepancies and retesting required.

- Contract managers would be seldom involved in the actual testing and acceptance of the item delivered.
- Their role is to manage the documentation that surrounds the process and making sure people are aware of times required to complete acceptance and test activity.
- You retain copies of notices for the test to commence and verify that those meet the requirements of the contract.
- You notify individuals that the time period for test and acceptance has commenced and when it needs to be completed by.
- You manage documentation highlighting and problems or discrepancies and advise the other party of your rights to have the period extended in accordance with the terms of the agreement. Upon final test and acceptance being complete, you provide a formal notice that it has been completed or provide a list of requirements that must be completed with any conditional acceptance.

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It is the other party's responsibility to manage their actions that may be triggered by acceptance such as invoicing for milestone, progress or final payments. The two most important things the contract manager does during this activity is:

1. Ensure that your right to test and accept the item has not lapsed by failing to act within the committed time frame.
2. The contract manager must document when final acceptance has occurred. That is because final acceptance is frequently a trigger for when the warranty period commences.

8.8 OUTSOURCING

GQ. 8.8.1 *What is outsourcing and explain in briefly ?*

- Outsourcing is the business practice of hiring a party outside a company to perform services and create goods that traditionally were performed in-house by the company's own employees and staff.
- Outsourcing is a practice usually undertaken by companies as a cost-cutting measure. As such, it can affect a wide range of jobs, ranging from customer support to manufacturing to the back office.
- Outsourcing was first recognized as a business strategy in 1989 and became an integral part of business economics throughout the 1990s. The practice of outsourcing is subject to considerable controversy in many countries.
- Those opposed argue it has caused the loss of domestic jobs, particularly in the manufacturing sector. Supporters say it creates an incentive for businesses and companies to allocate resources where they are most effective, and that outsourcing helps maintain the nature of free market economies on a global scale.
- Outsourcing can help businesses reduce labor costs significantly. When a company uses outsourcing, it enlists the help of outside organizations not affiliated with the company to complete certain tasks.
- The outside organizations typically set up different compensation structures with their employees than the outsourcing company, enabling them to complete the work for less money. This ultimately enables the company that chose to outsource to lower its labor costs. Businesses can also avoid expenses associated with overhead, equipment, and technology.
- In addition to cost savings, companies can employ an outsourcing strategy to better focus on the core aspects of the business.
- Outsourcing non-core activities can improve efficiency and productivity because another entity performs these smaller tasks better than the firm itself.
- This strategy may also lead to faster turnaround times, increased competitiveness within an industry and the cutting of overall operational costs.

Chapter Ends...

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CHAPTER 9

Module 6

Project Leadership and Ethics

University Prescribed Syllabus

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9.1 INTRODUCTION TO PROJECT LEADERSHIP

GQ. 9.1.1 Describe the project leadership

- Conventionally management is referred to as activities which execute five managerial functions like planning, organizing, staffing, leading and controlling. Managers execute and integrate these functions and thus manage the organization. There is confusion that management and leadership are similar, but that is not the fact.
- Leading is not just being first, biggest or most powerful. It is much beyond that. Leading in the organization carries much importance and is having different and meaningful definition. The leadership is an art of motivating a group of people to act towards achieving a common goal. Emerging trends in management has brought a different meaning to leadership.
- According to traditional theories, leaders in business lead and manage the business. It states that there is no sharp distinction between leadership and management. Leaders occupy positions of authority and it is a formal role. It even predicts that leaders make strategic decisions. They are good at managing people. New discovered role of manager in contemporary era state that leader gives the direction to the organization.
- A study of leadership is diverse in nature and multiple definitions have been offered. Nevertheless, leadership style can be defined broadly as the manner and approach of providing direction, implementing plans, and motivating people.
- Leadership can be defined as a process by which one individual influences others toward the attainment of group or organizational goals. Three points about the definition of leadership should be emphasized.
- Leadership is a social influence process. Leadership cannot be there without a leader and the followers. Key aspect of leadership is it elicits voluntary action on the part of followers. Because of voluntary nature of compliance, leadership is different from other types of influence based on formal authority.
- Leadership results in followers' behavior that is focused and goal-oriented in some sort of organized setting. Most of the studies of leadership concentrate on the nature of leadership in the workplace.
- There is distinction between leader and leadership. Leader is an individual who exercises the leadership. Leadership is an activity of leading people towards organizational goal is executed by this individual.
- The word manager and leader are interchangeably used. The managers are called as leaders because of the formal authority, inspire of observing whether they really exercise leadership in their job or not.
- Harvard's John Kotter says that management is coping with the business complexities and leadership on other hand is coping with the change. According to him leadership is the part of management. Leadership produces the change. So for organization strong management as well as effective leadership is required.
- In short, in a business enterprise, several activities like setting of the objectives of organization, designing methods to achieve them, directing and coordinating the activities of various departments can be successfully managed if there is proficient leadership.
- Tata Iron and Steel Company and Reliance Industries are some of the best examples of leadership in India. These companies would have not achieved great success without leaders like J.N. Tata and Dhirubhai Ambani respectively.

9.1.1 Definition of Leadership

9.1.2 Define leadership

- The different leadership thinkers have different definitions from their own perspectives.
- **Encyclopaedia of Social Sciences** states that "Leadership refers to the relation between an individual and a group around some common interest and behaving in a manner directed or determined by time (i.e. leader).
- **Chester. L. Bernard** defined leadership as "It refers to the quality of the behavior of the individual whereby they guide people on their activities in organized efforts.
- **George R. Terry** stated that "Leadership is the activity of influencing people to strive willingly for mutual objectives".
- **Peter F. Drucker** "Leadership is the lifting of man's visions to higher rights, the raising of man's performance to higher standards, the building of man's personality beyond its normal limitations."
- **R.T. Livingston** holds "Leadership is the ability to awaken in other the desire to follow a common objective"
- **Allen** says "Leader is one who guides and directs other people. He must give effective direction and purpose."
- **Robert C. Appleby** opines "Leadership is a means of direction, is the ability of the management to induce subordinate to work toward group ideals with confidence and keenness.

9.1.2 Attributes of a Leader

9.1.3 State the attributes of leader

- As discussed earlier, the leader is a person who motivates the employees to work to attain the goal of an organization. It is very important to get the right leader who works in the positive direction and enhances organizational standards and ensures organizational growth. According to many management thinkers leaders are not born they are made.
- Leaders earn the trust and respect from their group members. This is the reason why followers follow the leader. To be leader is not as easy as it is to become a manager. It is long process where person has to take lot many experiences and needs to learn many skills.
- These competencies of the leader are depend on a variety of factors :

1. The number of people following the leader
2. The extent of the leader's leadership skills
3. The leader's basic nature and values
4. Organization's background, such as whether it's for profit or not-for- profit, new or long established, large or small etc.
5. The particular culture (or values and associated behaviors) of whomever is being led
6. The leadership is totally dependent on the situation. So it is really difficult to list exact and all leadership skills.

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Following are the major leadership attributes :

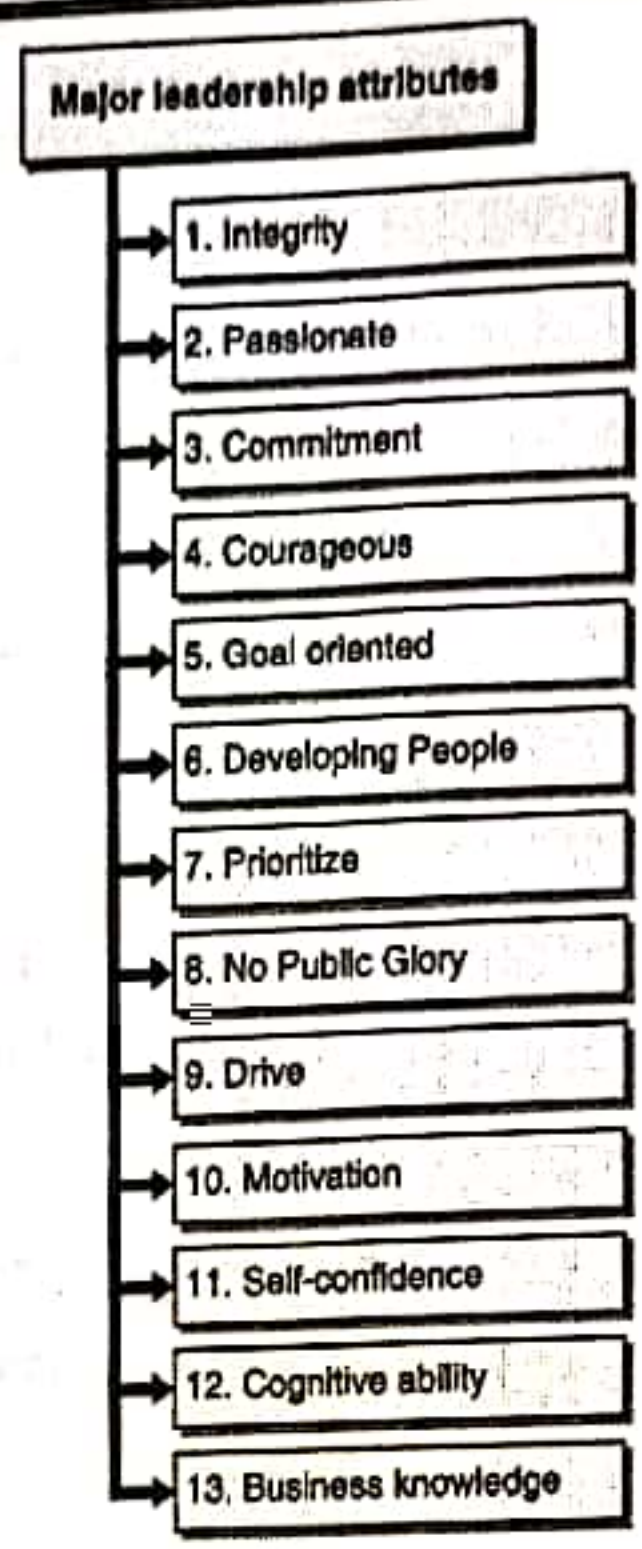

Fig. C.9.1

1. Integrity

- One of the important attributes of the leadership is integrity. Leaders have high ethics and they are honest. Because of this they gain people's trust and respect.
- This creates a positive response in the group of followers. Leaders never play the blame game, they always take the responsibility of the action and its consequence.

2. Passionate

- Passion is very important ingredient of success. Leaders are passionate.
- They are enthusiastic about their work and they even have the ability to emit this energy to the followers.

3. Commitment

- Commitment in any work is important. Leaders are committed throughout the work. Once they take the responsibility of one task, they complete it in the given time and available resources.
- They follow the strong discipline while executing the tasks and same is applicable to their followers.

4. Courageous

- Leaders handle many risky and uncertain situations. Their decision makings are very important as it directly impacts the organization's future. So they need to have courage to handle any type of situation.
- They should be able to speak up whenever appropriate time comes.

5. Goal oriented

- Everyone who works for the organization contributes to the organizational goal. The leaders need to be very focused on the objectives of the organization as they lead the whole team.
- They need to be very much focused and develop the strategic plans to ensure the organization's benefit.

6. Developing People

- An organization can grow if the employees grow and develop. The development of people can be done by giving the training, coaching or may be teaching.
- This is one of the key traits of a leader. Leader alone cannot achieve the organizational goal. So his responsibility is to develop the human resource available to him.

7. Prioritize

- In case of multiple responsibilities on one person, a person has to prioritize the activities or actions. Leaders are the people who need to fight on many fronts and so need to decide the preliminary and secondary activates they need to find out the most urgent and important things first regardless of their interest in them.

8. No Public Glory

- Leaders know that they cannot achieve anything alone. So they always share the credit of success with the team.
- They do not expect public glory or any awards or accolades. Leaders understand that at best they will get private credit for their work.

9. Drive

Leaders are ambitious and take initiative.

10. Motivation

Leaders want to lead and are willing to take charge of the activity.

11. Self-confidence

- One of the most important factor which affects leadership is self confidence. Leaders are assertive and decisive. They enjoy taking risks.
- They admit mistakes and foster trust and commitment to a vision. Leaders are emotionally stable rather than irresponsibly adventurous.

12. Cognitive ability

- Leaders are conceptually skilled, intelligent and perceptive.
- They need not be necessarily geniuses. They have analytical ability, good judgment, and the capacity to think strategically.

13. Business knowledge

Leaders tend to have technical expertise in their businesses.

9.1.3 Leadership Styles

GQ. 9.1.4 What is Leadership Styles

- No matter what their traits or skills, there are different leadership styles. Few leaders are autocratic.
- Some are democratic and others are participatory, and may be others are hands off. In general the leadership style depends on the situation and organization's life cycle. Leadership styles could be :

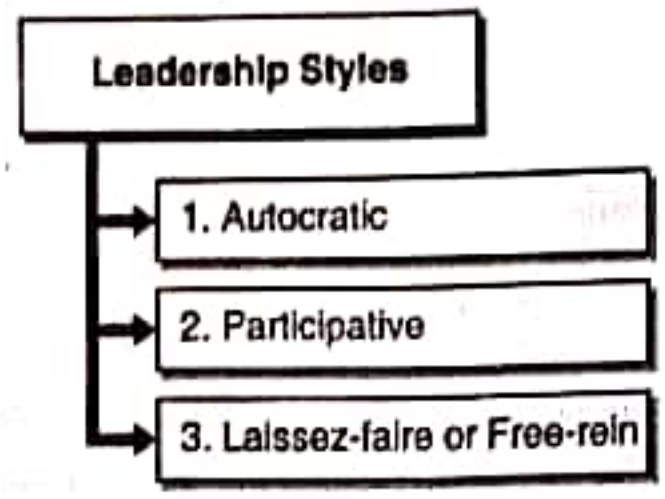

Fig. C.9.2

1. Autocratic

- This type of leader makes all the decisions and dominates team members. The result of this approach is passive resistance from team members.
- This style keeps continuous pressure on the subordinates and gives the direction to get the work done. Generally, this approach is not a good way to get the best performance from a team.
- But this style may be appropriate when urgent action is to be taken and if subordinates actually prefer this style.

2. Participative

- Participative leadership involves the subordinates in decision making by consulting team members in a controlled manner.
- This encourages employee ownership for the decisions and they feel that they are also one of the major parts of the team. A good participative leader encourages participation and delegates work wisely, without forgetting the fact that sight of the fact that he or she bears the crucial responsibility of leadership.
- The leader gives importance to group discussions and input from team members. The leader maximizes the members' strong points in order to obtain the best performance from the entire team. Participative leader motivates team members by empowering them to direct themselves.
- The drawback of this leadership style is that a participative leader may be seen as unsure. And even the team members may feel that everything is a matter for group discussion and decision.

3. Laissez-faire or Free-rein

- This is hands-off approach. This type of leader encourages team members to function independently and work out their problems by themselves, although he or she is available for advice and assistance.
- In this style of leadership the leader has little control over team members, leaving them to sort out their roles and tackle their work assignments. Leader does not personally participating in these processes.
- In short this approach leaves the team floundering with little direction or motivation. This style is appropriate when the team is highly motivated and skilled, and has a record or history of producing excellent work.

9.2 ETHICS IN PROJECTS

GQ. 9.2.1 Write short note on ethics in projects

- The word "ethics" has originated from the word "ethos" meaning character or manners. Ethics is considered to be the source of morals; recognized rules of conduct; source of character of a person expressed as right or wrong conduct.
- The character of a person is decided by his conduct that is reflected through his actions (good/bad, right/wrong, moral/immoral) and judged with social moral standards.
- In the common parlance, Ethics refers to a system of moral principles, a sense of right or wrong, good or bad. Ethics would involve learning what is right or good and doing exactly that.
- Ethics has been related to morals, treating of moral questions, moral choices. Ethics focuses on standards, rules and codes of conduct that govern the behaviour of individuals and groups.
- There are various ethical problems that one encounters in personal and professional life. In this section we shall be studying ethics in project management.

9.2.1 Ethics In Project Management

- The recent sudden meltdown of many multinationals has brought the subject of "ethics in business" to the forefront once again. The questionable ethical behaviour by many organizational leaders is being highlighted by the media.
- This not only brings disrepute to the individual involved but also the organization he represents. Keeping this in mind many organizations are investing in ethical training for their employees.
- The relevance of ethics has also been recognized by the colleges who have introduced many courses addressing this particular subject.
- Ethics as we have seen are a set of moral principles and values. Ethical dilemmas arise when these morals and values come into conflict. To help overcome such dilemmas employers develop policies and code of conduct for a whole range of employee activities.
- These policies and code of conduct are communicated to the employees through various training programs.
- At this juncture the questions that may come to your mind are :
  - i) Can business and ethics coexist?
  - ii) Is it worth investing time and money in ethics?
- The answer is simple, unethical business activities and behaviour cost organization in terms of money, jobs, reputation and goodwill.
- Also, unethical business activities could mean violation of the law which in some countries would not only attract heavy penalties but also jail term. Therefore, acting ethically is in the best interest of the individual as well as the organization.
- However, easy as it may sound, ethical decisions are not always crystal clear. Some decisions in the business domain may abide by the law but may still be unethical while some maybe illegal but still ethical. Such decisions are hard to make and create dilemmas in the mind of decision makers.
- The role of the project manager is critical from the point of establishing an ethical culture within the project organization. Such culture will help guide the behaviour of the entire project team and can be spread through training programs.

- As a person the project manager should possess personal traits such as honesty, integrity and trustworthiness. As a project manager he should project the right image and should be able to inculcate right values and morals amongst his team members.
- The image of the project manager should be such that the team members should look upto him for ethical guidance.
- The project manager should establish relevant ethical principles in order to identify the ethical issues associated with IT project management.
- IT project management is concerned with the delivery of an output by the project team to a customer under an agreement.
- Here, the customer may be in-house or an independent organization. The agreement is concerned with output quality and moral liability.

9.2.2 Some of the ethical issues with projects are

i) The project manager should avoid conflict of interest and relationships that question his impartiality.

ii) Project team members should ensure the confidentiality of the information trusted on them.

iii) Ensure full disclosure to mitigate any risk of impropriety.

iv) Maintain a strong sense of confidence with respect to issues such as confidentiality, product reliability and commitment to stakeholders and customers.

v) Corporate resources should be used judiciously and only for official purposes. Team members should refrain from using them for personal purposes.

vi) Personal opinion and corporate opinion should always be in synch.

vii) Results should not be fudged to make them appear better than what they are.

Managing ethical values in the projects legitimizes managerial actions, strengthens the coherence and balance of the organization's culture, improves trust in relationships between individuals, supports greater consistency in standards and qualities of products, and cultivates greater sensitivity to the impact of the organizations values and messages.

9.2.3 Dispersed and Virtual Teams

- Software projects require that its team members coordinate with each other for which communication is essential. This in turn means that the entire team has to work in one location. However, this would lead to the requirement of large space capable enough to hold the entire team and still give them peace to work.
- Such diverse requirements of software projects has lead to the development of dispersed and virtual teams which has also been facilitated by multiple communication tools such as emails, fax, video chats, conference calls, VPN networks, wireless internet, etc.
- High-performing teams are a must in this world of high competition and higher expectations. Virtual teams are a fact of life.
- They are increasingly common in all organizations, given the common use of shared resources, increasing number of cross-organizational projects, partnering, and outsourcing, and the increase in the number of people who telecommute or have flexible hours.

This has prompted project managers to prefer that their team works from home. Working from home—for the right people-can increase productivity and decrease stress. Research also suggests companies that encourage and support a work-from-home protocol actually save money in the long run—an added bonus on the employer side.

Software project is well known for its flexible schedules and telecommuting opportunities, which makes sense, considering most tech companies are web-based and technology is the greatest resource when working from home. With video chats, conference calls, VPN networks, and wireless Internet, we can constantly stay connected as though we were sitting in our office, rather than at home.

Software project is also experiencing a shortage of talent for a number of jobs, and hiring remote workers opens the talent pool. Boris Kontsevoi, founder and president of Intetics Co says, "In the tech sphere, the majority of the work happens on the computer and online. As a result, the location of the person is no longer as important, as long as they have a reliable Internet connection."

9.2.4 Nature of Software Projects

While remote workers can be found in a number of different industries, it's more prevalent in the software project-sphere. It could be due to the nature of the jobs that require a strong attention to detail and long hours of focus. Working from home can reduce the amount of distractions these workers face, allowing them to get more done during work hours.

"As a programmer, I need large chunks of time to really make progress on a project," states Ann Gaffigan, CTO of Land Pros Systems, Inc., "In an office, there are so many potential distractions, with people knocking on the door or customers stopping in. This way I can control when I answer calls and emails and when I 'go silent' to get some work done."

For employees who can't afford to be distracted a number of times a day, having a controlled environment can be key to their productivity. Working from home can allow workers to minimize distractions and increase the time they spend focused on a project. It stands to reason that, in the end, companies benefit from these remote employees by getting projects completed faster with fewer mistakes.

1. Employer Benefits

- Employees aren't the only ones who benefit from working from home; a company can benefit just as greatly from a remote employee. "For employers telecommuting can limit absences, increase productivity, and save money.
- This is most common in the tech sphere because tech companies have the infrastructure to maintain remote workers. With telecommuting the idea of the office space is changing but many are saying that it is for the better," says Ari Zoldan CEO, Quantum Networks, LLC.
- Simon Slade, CEO and co-founder of Affilorama has experienced firsthand the benefits of having remote workers at his company, "By allowing employees to work remotely," he says, "you can hire the best of the best while not limiting yourself by geographical restrictions.
- At Double dot Media, 19 of our 28 employees work remotely, and I have seen no difference in job satisfaction or work performance. If anything, my remote employees' production rate is higher because they are better equipped to avoid distractions."

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- The benefits also extend to his bottom line, "telecommuting saves me money because they pay for their own computer, electricity and other utilities."
- In fact, opening the talent pool seems to be one of the biggest employer benefits when it comes to a work from home policy.
- Jessica Greenwalt, Founder of Pixelkeet and Co-Founder of CrowdMed says, "Pixelkeet has been able to attract very talented designers and developers who want to live the freelance lifestyle without having to fish for work on their own.
- It's also been easy for us to work with clients from around the globe because we have a team member in a time zone convenient for communicating with most clients."
- For some companies, working from home can be a matter of more hours in the day. This is especially true for small businesses and new companies where they can't afford to waste even one minute of the workday.
- "Being a small start-up, every hour of the day is important," says Tim Seagraves, co-founder and CTO of Revaluate, "If we all spent an hour of day commuting, that would be almost 20 hours a week that would go to commuting instead of building out our product and business."

2. Health Benefits

- People who work from home have an easier time eating healthy and striking a manageable work-life balance. Eating healthier and having more time to spend with your family can help you feel less stressed, which will make for a happier more productive workday.
- Cofounder of SimpleTexting, Felix Dubinksy, notes the health benefits of being at home, "It's much easier to keep a healthy diet while eating at home. You save a lot of stressful hours that would have been spent commuting. You can construct a comfortable work environment for yourself. Spend more time with family."
- It's a common answer when you ask people why they like to work from home. Most will respond that their flexible work environment relieves the amount of stress in their lives and gives them a healthier work-life balance.
- Today, our offices are constantly on, it isn't the same as it was decades ago, when you left the office and work actually ended. Today, most of us can work at any hour wherever we are located, so it makes sense that the line is starting to blur between work and life. But it stands to reason that working from home can help redefine—or at the very least, rebalance—that line.
- Alessandra Ceresa, Marketing Director of Greenrope, finds he can balance his work and life much easier when he works remote, "Because much of what we do is not constrained within the hours of 9-5, I am able to go to the gym in the middle of the day, take a walk, do errands.
- When I take these sorts of breaks, the moment I sit back down to work, I am focused. My life is balanced because I get all of my work done and have time to actually live my life."
- Maybe you have a commute that makes you frustrated before you even hit your desk, and all you can do while you drink your morning coffee is fantasize about what you could buy with all that gas money.

9.3 MULTICULTURAL AND VIRTUAL PROJECT MANAGEMENT

GQ. 9.3.1 Describe the multicultural projects

- Any project where people bring different assumptions about working norms (either in product development or team behavior) is a multicultural project.
- Even when all project participants are from one country, the project manager (PM) may still have to deal with multiple cultures and those cultures' expectations and behaviors.
- Some of the team differences are strictly cultural, while others stem from varied management styles and strategies, but all these differences will eventually show up during the project.
- Some project managers try to manage those differences by mandating common practices and techniques across the project. Instead of trying to get everyone to work in lock step, I've found it useful to get people to agree to major milestones and what they mean and to use complementary practices to achieve project success.
- Complementary practices are those techniques and agreements that help each team get their jobs done. For example, one team might perform nightly builds and smoke tests.
- Another team might do weekly builds and full regression tests. These practices are complementary–they are not the same–but the practices work to achieve the same result: easy integration of multiple teams' work. Each team determines what makes the most sense for them to do, as long as they meet their agreed-upon deliverables.

9.3.1 Problems of Multicultural Projects

In my experience, any strictly technical (product) problem solving is secondary to managing the people interaction issues. When managing multicultural projects, I expect problems in these areas :

1. Different definitions of milestone and handoffs

- Leading project teams to misunderstand their commitments and handoffs to other groups. Sometimes the different definitions are due to a lack of understanding of the actual words.
- Sometime people differ on their meaning of commitment- is a commitment a best effort agreement or will the team do whatever it takes to meet the commitment?
- Whatever the cause, different meanings for milestones can be overcome with complementary product development practices, especially in project planning, project scheduling, and technical review.

2. Uneven project communications and reporting of project state

- This frequently leads to lack of trust in other teams. If you don't know what other people are doing, you may not feel you can trust them.
- Especially when geography and culture separate teams, this lack of trust can be a huge obstacle to project success. You might know what other people are doing, but you might not know what they are saying.
- Language differences, and everyone's relative ability to use one common language can create many problems in a project. What language are you using as the default language?

- What kinds of ambiguities do you have in that language? How fluent are all the project participants in the project's language? Is everyone willing to talk to everyone else, or are there cultural mores that make some people uncomfortable talking to certain teams or team members?
- Make sure that the language you use for written and spoken communications is adequate for everyone.
- There can also be communications problems with regard to holidays, vacations, and overtime. Be specific about what vacations mean, the impact of everyone's national holidays on the project's schedule, and general expectations about overtime – these will all affect how the project participants work with each other and report on project state.

3. Uneven ability to use common tools, including the project's intranet

- This leads to inability to share designs, source code, tests, and any other project information. When some members of the project team can't use the project resources, they may resent the people who can use the project resources.
- In addition, they may stop trying to share their work with the rest of the project team.

To have a chance of success, the PM of a multicultural project must address these problem, for himself or herself and for the rest of the project staff.

Chapter Ends...

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CHAPTER 10

Module 6

Closing the Project

University Prescribed Syllabus

Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.

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10.2 Reasons for Project Termination 10-2

GQ. 10.2.1 Give reasons for project termination 10-2

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GQ.10.3.1 Describe various types of project terminations. 10-3

10.3.1 Types of Project Termination 10-3

10.4 Project Closure Process 10-4

GQ. 10.4.1 Explain in brief project closure process. 10-4

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10.1 INTRODUCTION

- Project Closeout includes all the processes used to formally terminate all the activities of a project or a project phase. In case the project has been successfully completed the project team should ensure that all deliverables have been completed to the satisfaction of the stakeholders and that the project sponsor accepts the project's products.
- The project team should also ensure that the final product has been successfully integrated into the day-to-day operations of the organizations. In case the project has failed the project team has to document all the relevant information with the project sponsor and then close the cancelled project.
- This stage when completed indicates that all the processes within the project have been completed and the project or project phase is ready to be closed.
- There are primarily two types of closures; contract closure and administrative closure.
  - Contract closure indicates that all agreed upon project deliverables and agreed upon terms have been completed and that the project can now officially end. It also paves the way for all the specifically assigned resources to be reassigned to new projects and dues under the contract to be paid.
  - On the other hand, administrative closure involves documenting of all project related information that would prove valuable for future projects. Although each phase has a closing process, the major emphasis is during the final project closure process.

10.2 REASONS FOR PROJECT TERMINATION

GQ. 10.2.1 *State the reasons for project termination.*

- As seen throughout the book, project consists of a life cycle with different phases, customarily starting with project initiation, planning, execution, and termination.
- The final task of project closure comprises; closing financial records, distribute resources, reassign project personnel, and produce a final report that incorporates a discussion about the project's successes and shortcomings to be given to the senior management.
- The planning for project closure should be top priority and should be planned for in the inceptive stages of a project as it elevates the chances of a successful completion.
- The importance accorded to the closure stage of the project can be gauged when organization employ a specific manager, who possess an appropriate set of skills and knowledge of project closure, to overlook this phase of the project.

Few of the reasons for project closure are

- Project is closed when it has reached its stated objectives i.e. it has been successfully implemented and been handed over to its user. A successful project is simply deployed to its customer.
- A project may be closed when it is transferred to another organizational division to take the work forward. Such a decision maybe taken if the management feels that the current project team is not in a position to reach the project objectives.

- Another reason for project closure or rather premature project closure is when the project manager reaches the conclusion that the project is unfeasible and that the objectives are out of reach, resulting in a prematurely closed down project.
- A project on perfect course may face closure on changed requirements of the user making the project redundant and forcing to call of the project.
- Crises within the organization or customer may force the closure of a project.
- Sudden and unanticipated changes in technology may force the closure of a project.
- Budgetary issues may force the closure of a project.
- Absence of key project personnel may force project closure.

10.3 TYPES OF PROJECT TERMINATIONS – EXTINCTION, ADDITION, INTEGRATION AND STARVATION

GQ.10.3.1 *Describe the different types of project terminations.*

- Termination rarely has any impact on the technical success or failure of the project. On the other hand, termination has a major impact on other areas such as :
  1. Residual attitudes towards the project
  2. Success of subsequent projects
- Therefore, it is necessary that the termination activity is caefully planned and executed.
- The most common reasons for the termination of a project are :
  1. Low probability of the project attaining success
  2. Less market potential
  3. Changes in market requirements
  4. Technical problems beyond resolution
  5. Other projects having more priority
  6. Schedule delays

10.3.1 Types of Project Termination

1. **Termination by Extinction** – in this case the project may have been a success or may have failed either way the project ceases to exist.
2. **Termination by Addition** – project becomes a formal part of the organization.
3. **Termination by Iintegration** – project assests are abosrbed by the parent organization and distributed.
4. **Termination by Starvation** – resources to the project are stopped thereby it starves to its end.

10.4 PROJECT CLOSURE PROCESS

QQ. 10.4.1 *Explain in brief project closure process.*

Project Closure includes the following tasks :

1. Release of the resources along with the complete staff associated with the project group.
2. Closure of any financial issues like contracts, loans if any, procurement of products, clearing all the dues.
3. Collection and Completion of All Project Records from the client, document completion plan from the external organization.
4. Documenting all the project records for the future references.
5. Documenting the various issues faced in the project and the solutions derived at along with lesson learned from the same. This helps other projects to plan for such type of issues in the Project Initiation Phase itself.
6. The lessons learned are recorded for the future reference and the improvement in the other projects as the guideline.

Fig. C10.1

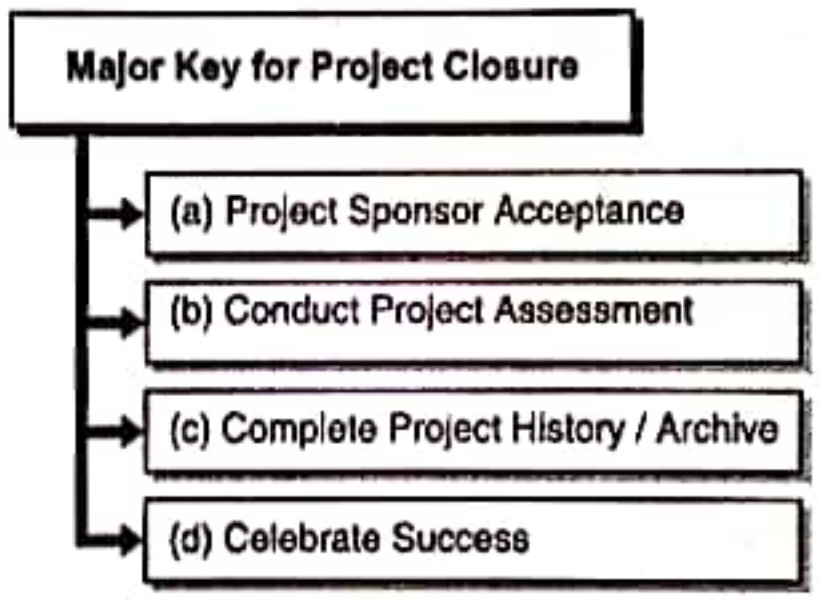

Fig. C10.2

1. The closure should be defined clearly the beginning of the project.
2. The closeout processes can be carried out as they occur during the development of the project, rather than waiting till the end for task accomplishment.
3. The closeout should be checked by the project development team, so that nothing is missed out.

The major key areas for the project closure are defined below :

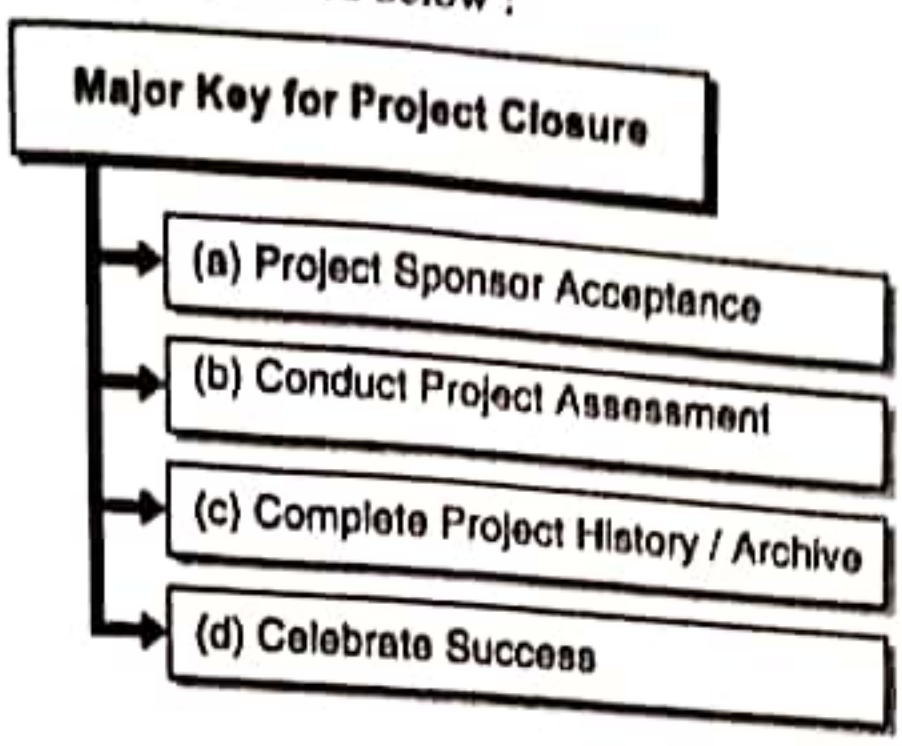

Fig. C10.3

(a) Project Sponsor Acceptance

- For any project closure the acceptance of the project sponsor is very crucial and important. It is always wise to involve the people from the sponsor's team and to provide them with regular updates.
- Surprise changes and disclosures in the end could lead to failure of the project.

(b) Conduct Project Assessment

- To complete the project after development and final closure, feedback plays an important role. Take the feedback from all the stakeholders including the research and the development team.
- The criteria can be defined how good and satisfying is the project with respect to the requirements and what could be done better for the future. Feedback relates to the development and the quality of the product.

(c) Complete Project History / Archive

- Documentation plays an important in project development and deployment.
- The supporting documents during the closure plays an important role, as it describes the complete functionality of the project starting from requirements, installations and the working structure of the product.

(d) Celebrate Success

- To work on the future projects, to create the impact of the success for the stakeholder is important. To appreciate the work done always adds as a motivating factor for the working team.
- All the stakeholders should be appreciated for the complete work done and the efforts taken to deploy the product on time.

10.5 PERFORMING A FINANCIAL CLOSURE

GQ. 10.5.1 *Briefly explain the process of performing a financail closure*

- Financial closure is the process of completing all project-related financial transactions, finalizing and closing the project financial accounts, disposing of project assets and releasing the work site.
- It is a prerequisite to project closure and the post-implementation review. A project cannot be closed until all financial

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transactions are complete, otherwise there might not be the authority or funds to pay outstanding charges and invoices.

- Financial closure establishes final project costs for comparison against budgeted costs as part of the post-implementation review. Finally, financial closure ensures proper disposition of all project assets.
- As the project reaches the final stage and is all set for closure the project manager should initiate the following steps with respect to financial closure of the project:
  - Announce the closure date to the staff and all vendors and ask them for the completion of all financial transactions and closing of financial accounts.
  - Verify that all acceptance criteria in the statement or work have been met prior to payment of vendor and consultants outstanding dues.
  - Before final closure verify that there are no outstanding invoices or unresolved obligations.
  - Close financial accounts according to applicable organizational policy
  - Comply with all applicable funding source requirements for record retention and financial reporting.
  - Notify top management that all final payments with respect to the project have been processed.
  - Transfer or dispose all assets acquired for the project as per organizational policy.
  - Release the project space according to the agreement with the management.
  - File financial records with the appropriate authorities and ensure that they are in accordance with the requirement.

10.6 PROJECT CLOSEOUT REPORT

GQ. 10.6.1 *Discuss the project close out report.*

- As with every other phase of the project, at the project closure phase too documentation is required. However, this document need not be elaborate as with the other phases.
- The project manager has to document his work at each phase of the project and hence the report at the final phase is a mere collection of all the cumulative reports.
- The project closeout report is the final report in the long list of project reports and includes:
  - Project vision statement that introduced the project
  - The project proposal that was used by the project manager to prompt the management to sanction the project.
  - The scope statement
  - The statement of work
  - The project schedule
  - The work breakdown statement
  - Project change request forms that were approved as well as those that were not approved
  - Variance reports
  - Communication relevant to the project deliverables
  - Total cost of the project
  - Total value added by the project
  - Scope verification agreement
  - Audit report

10.6.1 Project Audit

10.6.2 State the need for conducting a project audit

1. An independent and important factor for any organization performed by any external agency.
2. Its main purpose of the project audit is to discuss and uncover the issues related to risks and challenges delivered by internal elements & external factors, which can affect and impact the completion of the project, and to provide specific advice and suggestions on how to bring the project back on track.
3. The audit process implements the methodology of analyzing project matters and elements to disclose reasons and discuss the underlying problems causing technical issues during the development and the implementation in project management.
4. Project audit is an important financial check for the status of the project to capture with a purpose of detecting and rectifying issues, while they still can be fixed smoothly and economically.
5. The methods like meeting and interviewing all project team members project sponsor, project stakeholders, and representatives of the organizational management who supervises the project team are important.
6. Audit in project management helps the project manager, project sponsor and project team along with the procurement management and the financial department to get an adequate review of the project in order to identify what elements of the project were managed successfully and what were mismanaged, also what was poorly established and can be improved to avoid mistakes in the future, and to develop a better manageability.

a) Project Management Key Matters

- The major factor in the project key management includes the project scope in the work breakdown structure, project outcomes, objectives, clearness and completeness of the project requirements that include the quality, cost, and time.
- The milestone should include the working progress along with project plan reviews, changes and updates of the project. The working progress should be reported and the complete project financial plan to be prepared.
- The various logs have to be prepared along with the risk, issue and the change log. The efficiency of the decision making along with the strategy and planning plays vital role.

b) Project Organization, Staffing and Resources

The efficiency of organizational unit and its functional units and sub-teams with internal and external communication comprising of the relationships between the organization and the external agency along with the clearness in the working role and responsibilities.

c) Project Business Processes

- The importance of allocation of tasks, controlling, monitoring the progress of the project.
- The efficiency of handling and recording the changes along with the issues and the issues resolved with project documentation and management. To closure the project with industry certification.

d) Field work

- Discussion and the detail reporting of the audit team along with team lead, project managers and the procurement department is an important field work.
- It also includes to study the projects background along with various other documents that are available with the project vendor.
- Conducting various face to face communication and the review meetings including the stakeholders are necessary.

Chapter Ends...