

UNIT I

CHAPTER 1

Introduction to Software Project Management

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Introduction

The aim of this book is to provide you with an insight into the world of project management. It will help you in understanding the various concepts involved, show you how to get started and get the project done. This book will introduce you to various project related concepts such as project time management, scope management, cost management, quality management, communication management, and human resource management. The book will show you how to direct a team of highly qualified people with individual objectives and goals. The book will also touch upon advanced concepts such as creating budgets, work breakdown structures, and project scheduling.

As a project manager you will be expected to lead your team rather than merely manage them. Project management is a very challenging area it stretches the thoughts and abilities of the project manager even further than ever imagined. Project managers get hitched to the project and dedicate their entire careers to it. The success of a project manager is judged by the success of the project.

Although, as students you will not be expected to immediately don the hat of a project manager, however, having an overall perspective of the project and its nitty-gritty's will help you in being a better team member.

1.1 DEFINITIONS OF PROJECT

According to the International Project Management Association

"A project is a time and cost constrained operation to realize a set of defined deliverables up to quality standards and requirements."

ISO

- "Project is a unique process consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements including constraints of time, cost and resources."

British Standard Institute

- "Project is a unique set of coordinated activities, with defined starting and finishing points undertaken by an individual or organization to meet specific objectives with defined schedule, cost and performance parameters."
- From the above definitions we can infer the basic characteristics of a project.
 - Projects have a definitive start and finish date. In fact a project that lacks a finish date is destined for failure.

- Projects are cost constrained i.e. the expenditure on the project has to be sanctioned before the commencement of the project.
- Projects are also constrained by resources. Resources include men, material and money and have to be approved before the commencement of the project.
- The finishing point of the project indicates the point when the project deliverables are achieved or when it is realized that the deliverables cannot be achieved and it is futile to persist with the project activities.
- Project deliverables are the objectives for which the project has been undertaken. The quality and standards of these deliverables have to be defined in advance.
- Project comprises of well defined and coordinated activities which are aimed at achieving specific objectives.

1.1.1 Attributes of a Project

- GQ. 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 a 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.

1.1.2 Roles

GQ. 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 a project.

- Project manager
- Project sponsor
- Subject Matter Expert (SME)
- 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.

1.2 WHAT IS PROJECT MANAGEMENT?

GQ. 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 coordinates the efforts of the multi-disciplinary team to achieve the objectives of a project to meet the client's requirements.
- 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.
- 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. For example in an IT 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, 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.
- Project management presents various organizational opportunities and challenges. The changing face of information technology has a major influence in the evolution of 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 project management it is essential to understand how project management has evolved along with information technology.

► 1.3 NEED FOR PROJECT MANAGEMENT

GQ. State and explain the necessity for project management ?

Need for Effective and Efficient Project Management

Why is SPM important?

- To control scope of project and manage change
- To deliver projects on time and within budget
- To ensure the focus of the project team
- To collect user requirement from disparate sources
- To define the critical path to optimally complete the project
- To provide a process for estimating project resources, time and costs
- To communicate project progress, risks and changes
- To explore project assumptions.
- To prepare for unexpected project issues
- To document the knowledge gained from the project.

Fig. C. 1.1

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



- (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

However, 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.

► 1.3.1 What is the Difference between Projects and Operations?

GQ. 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

► 1.4 CONTRACT MANAGEMENT

GQ. Discuss the contract management ?

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.

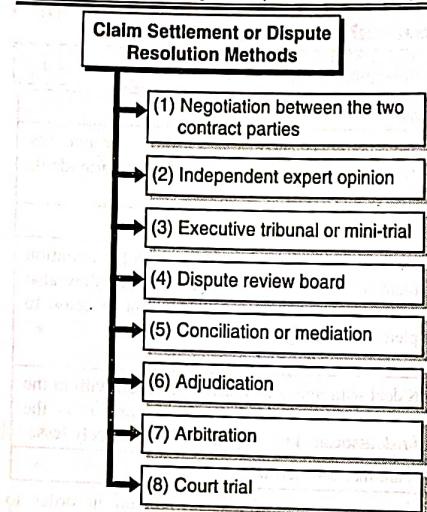


Fig. C1.2

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.

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?

► 1.5 ACTIVITIES COVERED UNDER SOFTWARE PROJECT MANAGEMENT

- 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 generic project lifecycle that comprises of phases common to most projects.

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.
- 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.

- 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.

- 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 off 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.

- Project Evaluation** – it is not possible to evaluate the true value of any 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 error 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.

1.6 PLANS, METHODS AND METHODOLOGIES

Q. Write a note on project sponsor and creating project 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.

1.6.1 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 stakeholders 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.

1.6.2 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 stakeholders.

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.

1.6.3 Project Charter

Q. Write short note on project charter.

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.

1.6.4 Purpose of the Project Charter

A project charter serves the following purpose;

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

1.6.5 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.

1.7 PROJECT PLANNING PROCESS

- Unlike traditional construction projects, modern projects are more complex in nature as they involve the sharing of resources amongst concurrent projects. The complexity of modern construction 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.

1.8 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 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.

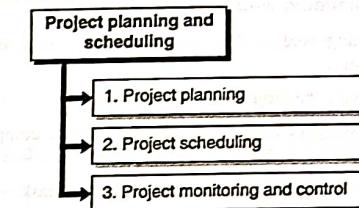


Fig. C1.3 : Project Planning and Scheduling

1.8.1 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
- 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.

1.8.2 Project Scheduling

- 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 be 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 be 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 tasks 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

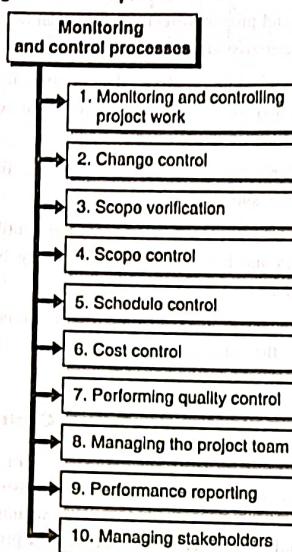
- Project schedule simplifies the project plan such that it can be understood by all those concerned and initiates prompt action.
- Project schedule validates the time objective by verifying the deadlines set for tasks.

- 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.

1.8.3 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 an 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.



Monitoring and Control processes includes**Fig. C1.4 : Monitoring and Control processes****► 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

► 1.9 THE BUSINESS CASE**GQ. 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

1.10 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 are 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**

1.11 STAKEHOLDERS AND OBJECTIVES

GQ. 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 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.

1.11.1 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 stakeholders 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.

1.11.2 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 stakeholders.

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.

1.11.3 Project Charter

GQ. Write short note on project charter.

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.

1.11.4 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.

1.11.5 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.
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- 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.

1.12 CATEGORIES OF PROJECT

Q. Write a note on Project categories.

SPPU – May 2013, 4 Marks

Q. Write a note on project categories and what are causes of project failures ?

SPPU – Nov. 2015, 8 Marks

Q. What are the different categories of project ?

SPPU – Feb. 2016 (In sem), 3 Marks

A project has been defined as an undertaking of a non-routine, non-repetitive nature having prescribed objectives in terms of scope, time, quality and cost. In this section we shall be studying the various categories of projects, but before we do that let us first study a few definitions of projects to develop a better understanding of them.

1.12.1 Definitions of Project

According to the International Project Management Association

- "A project is a time and cost constrained operation to realize a set of defined deliverables up to quality standards and requirements."
- "Project is a unique process consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements including constraints of time, cost and resources."

British Standard Institute

- "Project is a unique set of coordinated activities, with defined starting and finishing points undertaken by an individual or organization to meet specific objectives with defined schedule, cost and performance parameters."
- From the above definitions we can infer the basic characteristics of a project.
 - Projects have a definitive start and finish date. In fact a project that lacks a finish date is destined for failure.
 - Projects are cost constrained i.e. the expenditure on the project has to be sanctioned before the commencement of the project.
 - Projects are also constrained by resources. Resources include men, material and money and have to be approved before the commencement of the project.
 - The finishing point of the project indicates the point when the project deliverables are achieved or when it is realized that the deliverables cannot be achieved and it is futile to persist with the project activities.

- Project deliverables are the objectives for which the project has been undertaken. The quality and standards of these deliverables have to be defined in advance.
- Project comprises of well defined and coordinated activities which are aimed at achieving specific objectives.

1.12.2 Project Categories

- Projects vary in size, complexity, and risk; therefore, a one-size fits all approach to project management is unsuitable. Hence, a project ranking system has been defined to group projects by category based primarily on level of complexity and risk.
- The categorization of projects allows for a consistent approach to scheduling and to ensure that the appropriate scheduling provision is applied.
- This is necessary to ensure that the appropriate level of scheduling efforts needed to establish and maintain schedule control on the project is applied.

- The project ranking system consists of six categories representing varying levels of complexity and risk ranging from very low to very high.
- Category I is the lowest, which represents typical maintenance projects and schedule type work. Categories II through VI represent typical construction projects ranging from simple to very complex. Characteristics of each project category are described as follows :

Category I

- The lowest level of the project ranking system, which represents typical maintenance contracts and seasonal schedule type work of very low complexity and risk. For such projects, specific timeframes for accomplishing the work is not a major constraint.
- Generally, a full construction season is given to allow for flexibility in planning and scheduling the work. Therefore, Category I projects do not require the level of scheduling efforts typically needed for other construction projects.
- Examples are: minor repairs, pavement asphalt overlaying, painting, rumble strip overlaying, concrete repair, retaining wall, etc.
- The Criteria for these projects are;
- Typical seasonal maintenance and schedule type work generally with contract duration of one construction season or less.

Category II

- Category II is the second lowest level of the project ranking system for typical construction projects, which represents small, simple, low risk, and short duration construction projects. Such projects involve limited and straight-forward operations with limited project constraints.

The Criteria for these projects are

- Short duration projects
- Limited items of work
- Does not include utility adjustments or relocations
- Value is low

Category III

- Category III represents slightly complex and relatively small to medium size construction projects that are typically completed in one or two construction seasons.
- Category III projects typically involve a limited number of straightforward contiguous, linear, or repetitive operations with typical project constraints.

Category IV

- Category IV represents moderately complex, medium risk, and medium-size projects that are typically completed within two or three construction seasons.
- Category IV projects typically involve a limited number of concurrent operations with typical project constraints. Category IV projects may also include certain medium to large size multi-season low risk projects of relative complexity.

Category V

- Category V represents complex, high risk, and medium to large size projects that are typically completed within three or more construction seasons.
- Category V projects typically involve multiple concurrent operations with substantial project constraints.
- Such projects include, but are not limited to new, reconstruction, extension, or widening/improvements of medium to large roadway/bridge projects with substantial constraints.

- Category V projects may also include certain mid-size high-risk projects of relative complexity that include provisions for special time-related constraints or conditions.

Category VI

- Category VI is the highest level of the project ranking system for typical construction projects, which represents very complex and very costly mega-projects that are typically completed within four or more construction seasons.
- Category VI projects typically involve very large multiple multi-phased contracts with substantial project constraints. Such projects typically involve major roadway/bridge construction/widening, very complex multiple-span bridges, tunnels, or major interchange work on major corridors.

1.13 PROJECT SUCCESS AND FAILURE

UQ. "Poor planning for implementation results in project failure" justify enlist any four causes of project failure. **SPPU - Feb.2015 (In sem) 6 Marks**

UQ. Write a note on different project categories and what are the causes of project failure.

UQ. Which are the factors affecting failure of construction project. **SPPU - Dec.2015, 6 Marks**

Although no project manager wants to end up a loser not all projects are successful, some projects can make the project manager, the project team, and all those associated with the project feel like failures. There are many projects that are initiated, stopped and then rearranged, only to complete the cycle again and again but to no avail, the project just fails to go anywhere near the projected deliverables.

For a project to be successful it must include the following :

- A proper vision of the project deliverables.
- A project manager with adequate skills.
- A project team with all the requisite skills required for the success of the project.
- Adequate finance to provide for all the resources required for implementation of the project.
- Adequate time to complete the project implementation work to produce the deliverables.

Project planning and scheduling techniques assist project managers in effectively controlling project activities.

- Commitment from the project manager, project team and organization management.
- Appropriate strategies to manage change in the project scope and deliverables.

These elements are a prerequisite for success of a project, without them the project is doomed. At some stage in a project lacking some or all of the above stated elements, the project manager, project team and management may become disgusted with the lack of progress that they may just call off the project and declare it a failure. Although, the project manager may feel very bad about the failure he has to seek the reasons for it.

The project manager has to evaluate project requirements, finances, skills of team and available time. He will also have to get a third party review of his own performance.

A dispassionate evaluation will enable the project manager to identify problem areas. Such an evaluation will help guide future projects.

1.14 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.

1.14.1 Project Planning and Scheduling

GQ. Write note on project planning.

GQ. 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.

1.14.1.1 Project Planning

GQ. 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
- 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 usual 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.

1.14.1.2 Project Scheduling

GQ: 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 be 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 be 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 tasks 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.

1.14.2 Project Monitoring and Control

GQ: 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 an 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.

1.14.3 Monitoring and Control Processes Include

GQ: 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

<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Updates to organizational process assets • Updates to the Project Management Plan <p>► 7. Performing Quality Control</p> <p>The quality control performance process measures specific project results to determine whether the project is meeting quality standards.</p> <ul style="list-style-type: none"> • 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
<p>► 3. Scope Verification</p> <p>The scope verification process ensures that project deliverables are formally accepted.</p> <ul style="list-style-type: none"> • Accepted deliverables • Requested changes • Recommended corrective actions 	
<p>► 4. Scope Control</p> <p>The Scope Control process ensures that changes to project scope are controlled.</p> <ul style="list-style-type: none"> • 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 	
<p>► 5. Schedule Control</p> <p>The Schedule Control process monitors and controls changes to the project schedule.</p> <ul style="list-style-type: none"> • 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 	<p>► 6. Cost Control</p> <p>The Cost Control process monitors and controls costs and changes to the project budget.</p> <ul style="list-style-type: none"> • Cost estimate updates • Cost baseline updates • Performance measurements • Forecasted completion • Requested changes • Recommended corrective actions
	<p>► 10. Managing Stakeholders</p> <p>This process manages stakeholder communications and works with stakeholders to ensure that requirements are satisfied and issues are proactively resolved.</p> <ul style="list-style-type: none"> • Resolved issues • Approved change requests • Approved corrective actions • Updates to organizational process assets • Updates to the Project Management Plan.

UNIT II**CHAPTER 2****Project Design**

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The Requirements, Design and Implementation

Architecture of UML consists of five views. These views are used to represent different aspects of the system. The five views are:

- 1. Requirements View: This view represents the requirements of the system. It is represented by the 'Requirements' circle in the diagram.
- 2. Design View: This view represents the design of the system. It is represented by the 'Design' circle in the diagram.
- 3. Implementation View: This view represents the implementation of the system. It is represented by the 'Implementation' circle in the diagram.
- 4. Use Case View: This view represents the use cases of the system. It is represented by the 'Use Case' circle in the diagram.
- 5. Deployment View: This view represents the deployment of the system. It is represented by the 'Deployment' circle in the diagram.

The five views are interconnected and work together to provide a complete picture of the system. The 'Requirements' view provides the requirements for the system. The 'Design' view provides the design of the system. The 'Implementation' view provides the implementation of the system. The 'Use Case' view provides the use cases of the system. The 'Deployment' view provides the deployment of the system.

2.1 AN OVERVIEW OF THE UML

Q. What do you mean by UML? Explain in brief.

- UML is an acronym for Unified Modeling Language.
- The Unified Modeling Language is a visual modeling language used for design and modeling of software systems with object oriented methodology.
- The software systems can be best modelled graphically with the help of UML.
- The UML is an open standard managed and controlled by Object Management Group (OMG), an open association of companies and was formed to design standards for the object oriented modeling and design.
- UML is intended for the purpose of communication by means of different graphical symbols since UML is simply a set of graphical symbols meant for representing the proper communication and coordination amongst the modules involved within a particular software system framework.
- The main motive of UML is to manage, summarise and design the software systems with best practices in software engineering.
- So, UML provides support to software process models during design and development of a software system and plays a vital role in modeling software system frameworks.
- The rules and vocabulary of UML offers the platform for theoretical and physical representation of a software system.
- Ultimately; we can say that, UML delivers the comprehensive blueprint of a proposed software system.
- The vocabulary and graphical symbols in UML helps software designers to generate and read attractive software system models.
- But, the vocabulary of UML do not guide us regarding what model should we design and when it should be designed because it's a part of software development process and software developers are responsible for scheduling the software modeling tasks.
- The UML is not explicitly meant for a particular software development methodology or life cycle. It can be used with all kind of software development methodologies and life cycles and is universally accepted by the software trades and industries.

- As far as the structure of UML is concerned, the UML can be considered as a visual language.
- The UML structure comprises of :
 - Building blocks of UML.
 - Common UML mechanisms.
 - UML Architecture.
- The UML is mainly useful for software intensive systems and can be efficiently and effectively used in various domains such as telecommunication, banking, and finance, aerospace, medical field, transportation, enterprise information systems and many more.
- In conclusion, UML is a visual language for imagining, identifying, building and detailing the proposed software system framework.

2.2 CONCEPTUAL MODEL OF UML

Q. Explain the conceptual model of UML in brief.

(SPPU - May 2018)

- As we have already discussed in previous section that, the UML structure consists of :
 - Building blocks of UML.
 - Common UML mechanisms.
 - UML Architecture.
- Let us have a brief discussion on conceptual model of UML in this section.
- From the viewpoint of UML structure, UML consists of three types of building blocks namely :

(1) Things (2) Relationships (3) Diagrams

- Fig. 2.2.1 depicts the building blocks of UML.

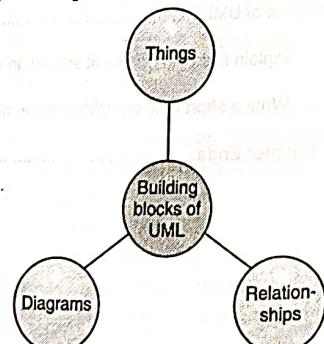


Fig. 2.2.1: Building Blocks of UML

2.2.1 Things

- Things in UML are nothing but the basic components of UML modeling.
- The UML things are of four types :
 - Structural Things
 - Behavioral Things
 - Grouping Things
 - Annotational Things

2.2.1.1 Structural Things

- Structural things are the nouns involved in the UML model. The structural things constitutes the static part of the UML model and represents the theoretical and physical elements of model.
- There are seven types of structural things namely :

- (A) Class (B) Interface
 (C) Collaboration (D) Use case
 (E) Active class (F) Component (G) Node

(A) Class

- A class is a collection of objects those are having common characteristics.
- For any object oriented system, classes are the essential building block.
- A class depicts a collection of objects that have common state and behavior.
- In an object oriented system, a class is considered as a blueprint of the objects.
- A class can be defined as a detailed explanation of a group of objects that share the equivalent attributes, relationships and operations.
- A class itself is not a specific object however, it is a complete set of objects.
- A well-organized class consists of three blocks: Name of a class, Attributes of a class and Operations of a class.
- Typically, a class can be represented as follows :

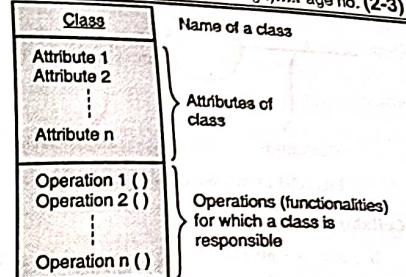


Fig. 2.2.2 : Notation of a class

- Every single class inside a system must be given a name for unique identification of that class in a system.
- A name of a class is a textual string. A name of a class may comprise of numbers, letters and some punctuation marks.
- Practically, name of a class is a small noun or noun phrase drawn from the terminology of a system that we are designing.
- An attribute is simply a characteristics or property of a class that defines a set of instances and range of values involved in a system.
- The name of an attribute roughly corresponds to the name of a particular field in a programming language.
- An operation is simply nothing but a procedure or a function that can be applied to or by objects in a class.
- The similar operations are jointly shared by all objects of a certain class. Operations are features of a class that identify how to invoke a specific behavior.

(B) Interface

- An interface is a collection of operations which are used for postulating a service of a particular component or a class.
- The relationship among interface and component is quite important.
- The interfaces are used as a glue for binding components altogether.
- Graphically, interface is depicted with the help of notation shown in the Fig. 2.2.3.

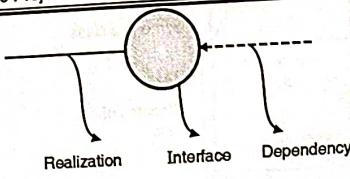


Fig. 2.2.3 : UML notation of Interface

(C) Collaboration

- In static as well as dynamic aspects of the software system scenario, collaboration plays a vital role and is dedicated for defining the functionality of a particular module or piece of a software system.
- Collaboration is used for documenting the implementation of a particular module involved within a software system.
- A conceptual piece or module of software is determined and defined with the help of collaboration.
- So, the grouping of elements to comprehend their behavior in a software system as a whole is called as collaboration.
- The main objective behind design of collaboration is to describe the working and implementation style of a particular module in a software system.
- Collaboration can be considered as a group of classes, interfaces or other building blocks of a system that take efforts altogether to deliver supportive behavior in the implementation of a software system.
- Graphically, collaboration can be represented as an ellipse. For instance, refer Fig. 2.2.4.



Fig. 2.2.4 : Collaboration

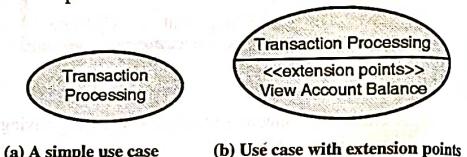
(D) Use case

- In UML, the system requirements and functionality of the system are depicted with the help of use cases.
- Use cases are meant for specification of the interaction between the system itself and end users of the system which are termed as actors in UML.

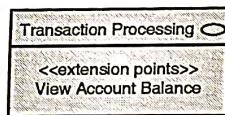
(Project Design)...Page no. (2-4)

- Basically, use case offers a detailed description of how the system is used.

- A use case is defined as a set of scenarios that collectively work to achieve a common user goal. It outlines a sequence of interactions amongst one or more actors and the system itself.
- Each use case comes with its primary actor who is responsible for certain tasks involved in the scenario. More details of the actor are discussed in subsequent section of this chapter.
- Each use case should clearly mention the exact interaction between the actors and the system itself.
- Each use case should be named uniquely and use case name should describe the desired functionality of that particular use case. We can describe the use case in more detail by making partition inside the oval shape and details of the respective use case can be given in the second partition. The contents of the second partition are called as extension points. Use case can be depicted as a classifier also.



(a) A simple use case (b) Use case with extension points



(c) Use case as a classifier

Fig. 2.2.5 : Use Case notations in UML

(E) Active Class

- The class whose objects own one or more processes or threads is known as an active class.
- An active class is quite similar to a normal class except that, the objects of an active class represent elements whose behavior is synchronized with other elements involved within a software system scenario.
- Graphically, an active class can be represented as shown in Fig. 2.2.6.

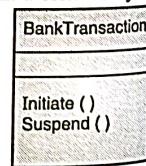


Fig. 2.2.6 : Active Class

(F) Component

- A component is a physical and expendable part of a system that offers the realization of a set of interfaces.
- Graphically, it is represented as a rectangle with tabs.
- Each component involved within a system should be given a name (textual string) in order to identify a particular component uniquely from other components.
- The UML notation for component is depicted in Fig. 2.2.7.

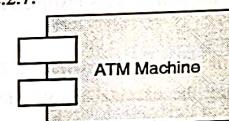


Fig. 2.2.7 : UML notation of Component

(G) Node

- Node in a deployment diagram is an important building block in forming the physical facets of a software system.
- Nodes are used to design the topology of the hardware on which a proposed software system executes.
- A solitary node basically represents a device or a processor on which components might be deployed.
- Fig. 2.2.8 depicts a UML notation of a node in deployment diagram.

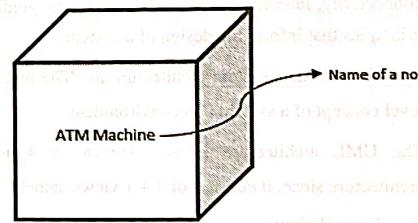


Fig. 2.2.8 : UML notation of a node

2.2.2 UML Diagrams

- Diagrams in UML refers to the representation of things and relationships as a whole and complete UML model.

- (Project Design)...Page no. (2-5)
- UML Diagrams merely represents the set of things (elements) and relationships graphically. Note that, the UML diagram itself cannot be a model.
 - Basically, there are nine UML diagrams which are listed below :

- | | |
|--------------------------|-----------------------|
| 1. Class diagram | 2. Object diagram |
| 3. Use case diagram | 4. Sequence diagram |
| 5. Collaboration diagram | |
| 6. Statechart diagram | 7. Activity diagram |
| 8. Component diagram | 9. Deployment diagram |

1. Class diagram

- Class diagram is the common diagram in object oriented modeling and design.
- Class diagram represents a group of classes, interfaces, their interrelationships and collaborations of classes.
- Class diagram effectively shows how things are organized collectively in the given system scenario.

2. Object diagram

- A special type of diagram which depicts a group of objects and their interrelationships with each other at a particular instance of time, is known as an object diagram.
- It is simply a collection of objects in a system at a specific point of time.
- Since object diagram represents instances instead of classes, it is also called as an instance diagram.

3. Use case diagram

- The elementary functional requirements of the software system are explained with the help of use case diagram.
- Use case diagrams are used in primary phase of the software system design in order to define input to and output from the proposed software system.
- The use case diagram depicts functional requirement of the proposed system by means of the use cases and the actors.

4. Sequence diagram

- The sequence diagram is a type of interaction diagram that primarily focuses on time ordering of messages.
- The objects in the sequence diagram are not only the instances of class but they can be instances of elements like nodes, components and collaborations involved in the scenario.

- The sequence diagram uses the object timeline in order to specify the time ordering of the messages between objects.

5. Collaboration diagram

- A collaboration diagram is a kind of interaction diagram that highlights the structural organization of objects involved within a software system scenario.
- An interaction diagram is meant for showing communication and coordination between two or more objects but, data manipulation is not shown.
- To understand the functionality of each of the component, an interaction diagram mainly emphasizes on specific messages communicated amongst objects.

6. Statechart diagram

- Statechart diagram in UML depicts the behavior of a software system and can be used to model the behavior of different elements like a class, a subsystem or entire software system.
- We use state diagram for designing the dynamic aspects of a software system.
- Well organized state diagram are simple, easily understandable and just like a well-planned and well-controlled algorithms.

7. Activity diagram

- The activity diagram simply models the flow of an object since an object moves amongst different states in the flow of the control.
- The activity diagram is basically devoted for making step by step executable systems.
- Activity diagram focuses on flow of control from activity to activity and are widely used in workflow modeling.

8. Component diagram

- A component diagram is basically meant for exhibiting the physical characteristics of the object oriented systems.

- It is also used for modeling the static implementation view of the software system.
- The physical belongings such as documents, tables, libraries, files, etc. that exist in a node are modelled with the help of a component diagram.

9. Deployment diagram

- A deployment diagram is the subsequent diagram meant for depicting the physical aspect of an object oriented system.
- It shows the configuration of run time processing nodes and the components involved in the software system.
- A deployment diagram provides a framework for constructing the executable software systems and applications by means of forward and reverse engineering.

2.3 ARCHITECTURE OF UML

UQ. Explain five (4+1) views of system in UML.

(SPPU - May 2012)

GQ. Write a short note on: UML Architecture Model.

- The UML Reference Manual (Rumbaugh) defines the system architecture as "The organizational structure of a system including its decomposition into parts, their connectivity, interactions, mechanisms and the guiding principles that inform the design of a system."
- The IEEE defines system architecture as "The highest level concept of a system in its environment."
- The UML architecture is also known as 4 + 1 architecture since, it consists of 4 + 1 views namely :
 - Logical view
 - Process view
 - Implementation view
 - Deployment view
 - Use case view

focus is given on active classes since, active classes are used for representation of processes and threads involved in a software system scenario.

- The implementation view illustrates the components along with the interdependencies amongst the components.
- As far as UML is concerned, the static aspect of a software system for this view can be represented with the help of component diagram whereas the dynamic aspect of a software system comprise of Statechart diagram, activity diagram and interaction diagrams.
- The deployment view of UML architecture comprise of the nodes which are nothing but the physical components that forms the hardware topology of a software system. Basically, this view talks about the deployment aspect of a software system.
- As far as UML is concerned, the static aspect of a software system for this view can be represented with the help of deployment diagram whereas the dynamic aspect of a software system comprise of Statechart diagram, activity diagram and interaction diagrams.
- The use case view consists of use cases involved within a system which are dedicated for representing behavior of the system. The use case view does not depict the overall organization of the software system. But, it shows the basic requirements of the software system by means of use cases.
- All of these views interact with each other in order to provide the overall static and dynamic models of a particular software system with the help of UML.



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UNIT II

CHAPTER 3

Project Evaluation

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Introduction

- Every company has a range of alternative projects that will enable it to meet its goals, so some form of evaluation must be carried out to select the most appropriate project to take forward.
- The evaluation criteria usually include political, economic, environmental, technical, techno-legal and social appraisal of the project as well as the challenges the project will be presenting.
- In this chapter we shall be studying the analytical tools that are used to carry out effective appraisal of projects using both economic and non-economic criteria.
- Under economic and financial appraisal we shall be studying techniques such as net present value, internal rate of return, payback period and break even analysis.

3.1 PROJECT EVALUATION - IMPORTANCE AND TYPES

A project involves a complete cycle of activity, which includes planning, appraisal (as a pre-project construction assessment), implementation, evaluation (as post-project construction assessment) and monitoring; it also includes termination (i.e. when the project is closed down).

- Project evaluation 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 evaluation 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.

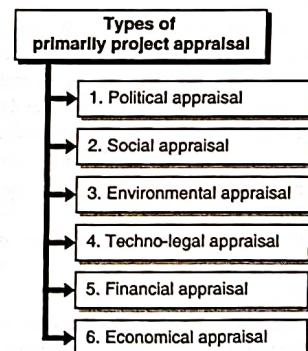
Primarily project appraisal includes

Fig. C3.1 : Types of Primarily Project Appraisal



- Political, Social and Environmental factors may not have a huge bearing on software projects hence we will not be focussing on them.

3.1.1 Techno-Legal Appraisal

Q.U. Write a short note on technical appraisal.

SPPU – April 2015, 3 Marks

- In any 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 statute 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 & 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 occasions 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.

3.1.2 Financial Appraisal

- The financial appraisal remains crucial as part of the overall approach to project appraisal. Commercial sector investors provide a significant part of funding for many projects and sometimes 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.

3.1.3 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

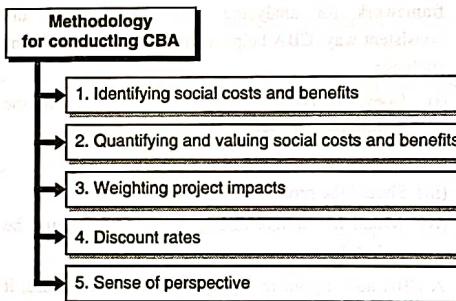


Fig. C3.2 : Methodology for conducting CBA

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 labor 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.

► 3.2 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 sometimes 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.

► 3.2.1 Cash Flows

- A cash flow statement is one of the most important financial statements for a project or business. A cash flow statement is a listing of the flows of cash into and out of the business or project. Think of it as your checking account at the bank. Deposits are the cash inflow and withdrawals (checks) are the cash outflows. The balance in your checking account is your net cash flow at a specific point in time.
- A cash flow statement is a listing of cash flows that occurred during the past accounting period. A projection of future flows of cash is called a cash flow budget.
- A cash flow statement is not only concerned with the amount of the cash flows but also the timing of the flows. Many cash flows are constructed with multiple

time periods. For example, it may list monthly cash inflows and outflows over a year's time. It not only projects the cash balance remaining at the end of the year but also the cash balance for each month.

► 3.2.2 Cost Benefit Analysis

Q. Write a short note on : Benefit cost ratio

SPPU – May 2013, 4 Marks

Q. Write a short note on concepts of benefit cost analysis.

SPPU – April 2015 (2012 Pat.), 4 Marks

- 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.

► 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.

► Cost-Benefit Analysis Process

- The purpose of a CBA is to provide information that will materially assist decision-making. The basic steps for conducting a CBA are discussed below.
- 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.

► Basic steps for conducting cost-benefit analysis

1. Determine scope and objectives
2. Assess the constraints
3. Consider the alternatives
4. Identify, quantify and value the costs and benefits of each alternative
5. Calculate net Present value
6. Sensitivity analysis and dealing with uncertainty
7. Equity and distributional Implications
8. NPV, BCR and IRR

Fig. C3.3 : 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 labor, 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:

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

Where:

B_t is the benefit at time t ;

C_t 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 weights 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 analysis 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 shows 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. 3.2.1 : 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.3.2.1

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	80	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:

$$\begin{aligned} \text{BCR} &= \text{NPV of Benefits} / \text{NPV of Costs} \\ &= 162.86 / 125.91 = 1.29 \end{aligned}$$

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

Ex. 3.2.2 SPPU - April 2012, 8 Marks

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.3.2.2

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 :

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

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

$$= [178571.42 + 478316.32 + 569424.19 + 127103.61] - 1000000 = 353415.54 \text{ Rs.}$$

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

3.2.3 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.

- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- 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 occurs 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. $\text{NPV} > 0$, accept and $\text{NPV} < 0$, 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.

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.

Merits

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

Limitations

- It is difficult to calculate as well as understand and use in comparison with the payback method.
- 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.

- This method may not give satisfactory results in case of projects having different effective lives.

Ex. 3.2.3 : 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 of and annuity of 5 payments of Rs. 11,000 each at 12 percent, the NPV is calculated as follows:

$$\begin{aligned} \text{PV of Cash inflows} &= 11,000 (\text{PV } 1 - 5 \text{ years} @ 12\%) \\ &= \text{Rs. } 39,634 \end{aligned}$$

Less : Present Value of Cash outflows 35,000

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.3.2.4 : 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. :

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

Where

$$\begin{aligned} B_t &= \text{Benefit at time } t \\ h &= \text{Life of project} \\ r &= \text{discount rate} \\ t &= \text{year} \end{aligned}$$

$$\begin{aligned} &= \frac{25,000}{(1+0.12)^1} + \frac{25,000}{(1+0.12)^2} + \frac{25,000}{(1+0.12)^3} + \frac{25,000}{(1+0.12)^4} \\ &\quad + \frac{25,000}{(1+0.12)^5} - 11,00,000 \\ &= 22,321 + 19,936 + 17,857 + 15,923 + 14,204 - 1,00,000 \\ &= 90,241 - 1,00,000 = - 9759 \end{aligned}$$

As NPV < 0 the project is not acceptable

Ex. 3.2.5 : 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 annum.

Soln.:

Table P.3.2.5

	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

$$\begin{aligned} NPV &= \frac{1,25,000}{(1+0.12)^1} + \frac{1,50,000}{(1+0.12)^2} + \frac{1,00,000}{(1+0.12)^3} + \frac{90,000}{(1+0.12)^4} \\ &\quad + \frac{80,000}{(1+0.12)^5} - 3,00,000 \\ &= 111607 + 1,19,617 + 71,428 + 57334 + 45454 - 3,00,000 \\ &= 4,05,430 - 3,00,000 = 1,05,430 \end{aligned}$$

Project B

$$\begin{aligned} NPV &= \frac{1,50,000}{(1+0.12)^1} + \frac{1,70,000}{(1+0.12)^2} + \frac{1,25,000}{(1+0.12)^3} + \frac{1,00,000}{(1+0.12)^4} + \frac{90,000}{(1+0.12)^5} - 4,00,000 \\ &= 1,33,928 + 1,35,566 + 89285 + 63694 + 51136 \\ &= 4,73,609 - 4,00,000 = 73,609 \end{aligned}$$

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.

UEX. 3.2.6 SPPU - Oct. 2011, 10 Marks

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

Table P.3.2.6

Particulars	Project X	Project Y
Investment in Rs.	110000	110000
Cash inflow in Rs	31000	71000
Year 1		
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

$$NPV = 1,31,899 - 1,10,000 = 21,899.88 \text{ Project}$$

UEX. 3.2.7 SPPU - Oct. 2011, 12 Marks

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.3.2.7

Particulars	Project A	Project B
Initial Investment (Rs.)	4,00,000	3,50,000
Annual Income (Rs.)	1,50,000	1,00,000
Year 1		
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

Y = Rank II

 Soln.: Calculation of net present value**Project A**

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

$$\begin{aligned} &= \frac{1,50,000}{(1+0.1)^1} + \frac{2,00,000}{(1+0.1)^2} + \frac{80,000}{(1+0.1)^3} + \frac{1,00,000}{(1+0.1)^4} \\ &\quad + \frac{20,000}{(1+0.1)^5} - 4,00,000 = 44,477 \text{ Rs.} \end{aligned}$$

Project B

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

$$\begin{aligned} &= \frac{1,00,000}{(1+0.1)^1} + \frac{3,00,000}{(1+0.1)^2} + \frac{50,000}{(1+0.1)^3} + \frac{90,000}{(1+0.1)^4} \\ &\quad + \frac{60,000}{(1+0.1)^5} - 3,50,000 = 1,25,135 \text{ Rs.} \end{aligned}$$

∴ 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 trial and error method.

$$IRR = 15.18 \%$$

Project B

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

Thus, by using trial and error method.

$$IRR = 25.66 \%$$

UEX. 3.2.8 SPPU - Oct. 12, 8 Marks. Dec. 15, 6 Marks

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.3.2.8

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**

$$\begin{aligned} NPV &= \frac{12,000}{(1+0.8)^1} + \frac{1,25,000}{(1+0.8)^2} + \frac{78,000}{(1+0.8)^3} + \frac{80,000}{(1+0.8)^4} \\ &\quad + \frac{75,000}{(1+0.8)^5} - 4,00,000 = -9956.5 \text{ Rs.} \end{aligned}$$

Project B

$$\begin{aligned} NPV &= \frac{1,40,000}{(1+0.8)^1} + \frac{1,45,000}{(1+0.8)^2} + \frac{76,000}{(1+0.8)^3} + \frac{65,000}{(1+0.8)^4} \\ &\quad + \frac{60,000}{(1+0.8)^5} + \frac{90,000}{(1+0.8)^6} - 4,50,000 = 9602 \text{ Rs.} \end{aligned}$$

Thus, project B is to be selected.

Calculation of benefit lost ratio

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

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

Thus, project B is to be selected.

UEX. 3.2.9 SPPU - May 2013, 8 Marks

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 IRRThe 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.

UEEx. 3.2.10 SPPU - April 2014, 8 Marks

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. 3.2.10

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.

UEEx. 3.2.11 SPPU - April 2014, 6 Marks

The data pertaining to project A and B given below.

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

Table P. 3.2.11

Project	Initial Investment (Rs.)	Annual Benefits (Rs.)		
		1 st Year	2 nd Year	3 rd 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.

UEEx. 3.2.12 SPPU - April 2015, 8 Marks

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

$$NPV = \left[\frac{30,000}{(1+0.12)^1} + \frac{30,000}{(1+0.12)^2} + \frac{30,000}{(1+0.12)^3} + \frac{30,000}{(1+0.12)^4} \right] - 80,000 \\ = [26785.71 + 23915.81 + 21353.40 + 19065.54] - 80,000 = 11120.46$$

UEEx. 3.2.13 SPPU - Oct. 12, 8 Marks, Dec. 15, 6 Marks

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.3.2.13

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 NPV

Project A

$$NPV = \sum_{t=1}^n \frac{C_t}{1+k^t} - \text{Initial Investment} \\ = \frac{5,50,000}{(1+0.1)^1} + \frac{7,00,000}{(1+0.1)^2} - 10,50,000 \\ = (500000 + 578512.39) - 10,50,000 = 28512.39 \text{ Rs}$$

Project B

$$NPV = \sum_{t=1}^n \frac{C_t}{1+k^t} - \text{Initial Investment} \\ = \frac{7,50,000}{(1+0.1)^1} + \frac{5,00,000}{(1+0.1)^2} - 12,75,000 \\ = (681818.18 + 413223.14) - 12,75,000 = 179958.68 \text{ Rs}$$

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 $i = 10\%$

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

Trial 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

$\therefore IRR = 11.95$

Thus, Project A is selected

3.2.4 Internal Rate of Return

- UQ.** Write a short note on: IRR method
SPPU – May 2013, 4 Marks
- UQ.** Write short note on IRR method
SPPU – May 2016, 4 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

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

- Like NPV, IRR too considers the time value of money.
- IRR is easier to understand and relate to, hence is readily adopted by businesses.
- 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

- It involves tedious calculations as it produces multiple rates which are confusing.
- 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:

$$NPV = 0; \text{ or}$$

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

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

Ex. 3.2.15 : 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

$$NPV = \left[\frac{65,200}{(1+0.10)^1} + \frac{96,000}{(1+0.10)^2} + \frac{73,100}{(1+0.10)^3} + \frac{55,400}{(1+0.10)^4} \right] - [59272 + 79,338 + 54962 + 37,945] - 2,13,000 \\ = 2,31,517 - 2,13,000$$

$$NPV = 18,517$$

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 to zero at 14% value of r. We can safely assume the IRR to be 14%.

UEx. 3.2.16 SPPU – April 2011, 8 Marks

Find IRR for the project with following details.

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

Soln. : Calculation of IRR**Trial 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

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

Thus at $i = 41.17$, RHS = 0

$$\therefore IRR = 41.17\%$$

UEx. 3.2.17 SPPU – April 2012, 10 Marks

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. 3.2.17

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**

$$NPV = \left[\frac{70,000}{(1+0.1)^1} + \frac{50,000}{(1+0.1)^2} \right] - 1,00,000 \\ = [63636.36 + 41322.31] - 1,00,000 = 4958.6$$

Project B

$$NPV = \left[\frac{90,000}{(1+0.1)^1} + \frac{85,000}{(1+0.1)^2} \right] - 1,50,000 \\ = [81818.18 + 70247.93] - 1,50,000 \\ NPV = 2066.11$$

Thus, project A is to be selected.

UEx. 3.2.18 SPPU – Dec. 2015, 6 Marks

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 $i = 30$

$$0 = \left[\frac{40,000}{(1+0.3)^1} + \frac{40,000}{(1+0.3)^2} + \frac{40,000}{(1+0.3)^3} + \frac{40,000}{(1+0.3)^4} + \frac{40,000}{(1+0.3)^5} + \frac{40,000}{(1+0.3)^6} \right] - 1,00,000 \\ = 1,05,714.39 - 1,00,000 = 5714.39$$

Trial 2

Let us consider the discount Rate $i = 40$

$$0 = \left[\frac{40,000}{(1+0.4)^1} + \frac{40,000}{(1+0.4)^2} + \frac{40,000}{(1+0.4)^3} + \frac{40,000}{(1+0.4)^4} + \frac{40,000}{(1+0.4)^5} + \frac{40,000}{(1+0.4)^6} \right] - 1,00,000 \\ = 86,712.22 - 1,00,000 = -13280.78$$

Thus, at $i = 32.7$, RHS = 0

$$IRR = 32.7\%$$

3.2.5 Differentiation between NPV and IRR

As seen in the previous sections NPV and IRR are both used in the evaluation process for capital expenditures. While NPV discounts the stream of expected cash flows associated with a proposed project to their current value, which presents a cash surplus or loss for the project, internal rate of return (IRR) calculates the percentage rate of return at which those same cash flows will result in a net present value of zero. The two capital budgeting methods have the following differences:

Basis for Differentiation	NPV	IRR
Outcome	NPV method results in a rupee value that the project will be able to generate.	IRR method generates the percentage return that the project will be able to generate.
Purpose	The NPV method focuses on the project surpluses	IRR focuses on the breakeven cash flow level of a project.
Decision Support	Since NPV is represented in rupee terms it forms the foundation of an investment decision.	Since IRR generates the percentage return it does not tell the investor the amount on money that can be made from the project and hence does not form the foundation for investment decision.
Re-investment rate	Under the NPV method the presumed rate of return for the re-investment of intermediate cash flows is the firms cost of capital.	Under the IRR method the presumed rate of return for the re-investment of intermediate cash flows in the firms internal rate of return.
Discount rate	NPV uses discount rate which is difficult to derive and is based on the management's assessment of risk.	Such a difficulty is not face under the IRR method since the rate of return is simply derived from underlying cash flows.

NPV is the preferred method as it assists in the decision making process while IRR is calculated as the capital budgeting process and supplied as additional information.

3.2.6 Payback Period

UQ. Write a short note on : Payback period

SPPU – May 2013, 4 Marks

UQ. Explain Pay back period method with the help of suitable example

SPPU – 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.

Ex. 3.2.19 : 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. :

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

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

Merits

- 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.
- 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.

- 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

- The method does not give any considerations to time value of money. Cash flows occurring at all points of time are simply added.
- This method becomes a very inadequate measure of evaluating two projects where cash inflows are uneven.
- It stresses capital recovery rather than profitability. It does not take into account the returns from a project after its payback period.

Therefore, this method may not be a good measure to evaluate where the comparison is between two projects one involving a long gestation period and other yielding quick results only for a short period.

Conclusion :

Since Project B breakeven in 3rd year whereas Project A breakevens in 3 year and 8 months. We suggest the company to invest in Project B

3.2.7 Break Even Analysis

UQ. Write detailed note on Break Even Point analysis. SPPU – April 2011, 6 Marks

UQ. Define "Break - Even Analysis". Explain the principles and uses of Break-Even Analysis

SPPU – April 2012, 6 Marks

UQ. Explain the principles of Break Even Analysis.

SPPU – Oct. 2012, 4 Marks

UQ. Explain with neat sketch Break Even Analysis.

SPPU – April 2015(2012 Pat.), 4 Marks

UQ. Write a short note on Break even analysis.

SPPU – May 2013, 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
 - Reducing the fixed costs
 - Reducing variable costs
 - 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.

Year	Project A	Project B
Year 1	1,80,000	2,50,000
Year 2	1,10,000	1,50,000
Year 3	2,50,000	1,00,000
Year 4	1,80,000	1,10,000

You are required to evaluate both the projects by payback period method and suggest the best suitable to invest if company can invest anyone of the two.

Soln. :

Step 1 : Calculate Cumulative Cash flow :

Year	Project A	Cumulative
1	1,80,000	1,80,000
2	1,10,000	2,90,000
3	1,50,000	4,40,000
* 4	1,80,000	6,20,000

* Breakeven Year is the year in which Cash inflows = Cash flows. Since in the year 4 Cash inflow of 6,20,000 > Cash outflow of 5,00,000. Year 4 is the breakeven year.

Step 2 :

$$\text{Payback period} = \text{Year previous to B.E.P} + \frac{\text{Cum.Cash Flow of B.E.P} - \text{Total Cash Outflow}}{\text{Cash flow during breakeven year}} \times 12 \text{ months}$$

$$= 3 \text{ Years} + \frac{6,20,000 - 5,00,000}{1,80,000} \times 12 \text{ months}$$

$$= 3 \text{ Years} + 8 \text{ months.} = 3 \text{ years and 8 months.}$$

Options II

Step I : Construct Cumulative cash flow

Year	Project B	Cumulative
1	2,50,000	2,50,000
2	1,50,000	4,00,000
* 3	1,00,000	5,00,000
4	1,10,000	6,10,000

* Since in the 3rd year Cash inflows = Cash outflow 3rd year is breakeven year.

- 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

$$\text{i.e. } TR = TC$$

- 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

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

$$\therefore TR - TC = 0$$

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

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

$$\therefore \text{BEP} = FC / (P - VC)$$

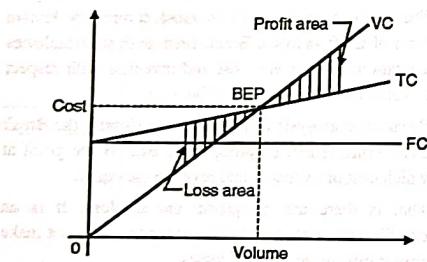


Fig. 3.2.1 : Graphical representation of Break even analysis

Assumptions of Break Even Analysis

Break even analysis is based on the following assumptions

- 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.
- Break-even analysis assumes that average variable costs are constant per unit of output atleast in the range of probable quantities of sales.
- 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
- To Measure profit and losses at various levels of production.
 - To Measure profit and losses at various levels of sales.
 - To predict and calculate the effect of changes in price of sales.
 - To study the relationship between fixed cost and variable cost.
 - To forecast the effect on profitability when cost and efficiency changes.

UEX. 3.2.21 SPPU - April 2015; 10 Marks

Nirmiti associates has following details

$$\text{Fixed cost} = \text{Rs. 50 Lakh}$$

$$\text{Variable cost per unit} = \text{Rs. 200}$$

$$\text{Selling price per unit} = \text{Rs. 400}$$

Find 1. Break even quantity

2. Break even sales

3. Contribution of actual production quantity is 80,000

4. Represent graphically BEU and sales costs.

Soln. :

$$\text{Fixed cost} = \text{Rs. 50 Lakhs}$$

$$\text{Variable cost per unit} = \text{Rs. 200}$$

$$\text{Selling price per unit} = \text{Rs. 400}$$

(i) Break even quantity

$$\begin{aligned} \text{Fixed cost} &= \text{Selling price per unit} - \text{Variable cost per unit} \\ &= 400 - 200 = 25,000 \text{ units} \end{aligned}$$

$$(ii) \text{Break even sales} = 25,000 \times 400 = 10,00,000$$

$$(iii) \text{Actual production quantity} = 80,000$$

$$\therefore \text{Contribution per unit} = 400 - 200 = 200$$

$$\therefore \text{Contribution} = 200 \times 80,000 = 16,00,000$$

UEX. 3.2.22 SPPU - April 2015 (2012 Pat.), 8 Marks

Surya associates have following details

$$(i) \text{Fixed cost} = \text{Rs. 30 Lakhs}$$

$$(ii) \text{Variable cost per unit} = \text{Rs. 150}$$

$$(iii) \text{Selling price per unit} = \text{Rs. 300}$$

Find (i) Break even quantity

(ii) Break even sale

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

Soln. :

$$\text{Fixed cost} = \text{Rs. 30 Lakhs}$$

$$\text{Variable cost} = \text{Rs. 150}$$

$$\text{Selling price per unit} = \text{Rs. 300}$$

$$(i) \text{Break even quantity} = \frac{\text{Fixed cost}}{\text{Price per unit} - \text{Variable cost per unit}} = \frac{30,00,000}{300 - 150}$$

$$= 20,000 \text{ units}$$

$$(ii) \text{Break even sale} = 20,000 \times 300 = 60,00,000$$

$$(iii) \text{Actual quantity} = 80,000$$

$$\text{Contribution per unit} = 300 - 150 = 150$$

$$\therefore \text{Contribution} = 150 \times 80,000 = 12,00,000$$

- Product is resultant of process. Quality of product is somehow related to quality of process used to develop it.

- Process quality means effectively controlling parameters of process by which required software or product is produced.

Main elements of process quality

GQ. What are the elements of process quality? (2 Marks)

- Monitoring of process** : There must exist a management system for process which helps to monitor performance of that process.
- Repeatability of Process** : It refers to the degree up to which process can be repeated by using its documentation.
- Evaluation and review of process** : This guarantees process performance improvement and quality of data in system over time. It intends to timely evaluation of a process and review it for the feedback.
- Clarity of Process** : Clarity of process means a degree up to which process for developing software product meets existing documentation which describes actual development process.

3.3.2 Process Classification

GQ. Explain Process Classification.

- Process classification helps to select appropriate process for the development of software product under consideration.
- Process Classification also identifies that the product quality depends on process.

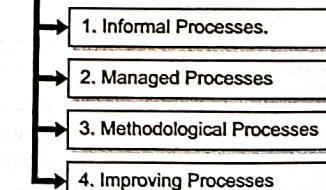
Classification of process

Fig. C3.4 : Classification of Process

Processes can be classified into following different types:

1. Informal Processes

- If there does not exist any predefined process model for developing process then developing team selects any process randomly for the developing product such a process is known as informal process.
- In informal processes all the procedures and linking among them is defined by development team as per their requirements. They are mainly used to develop short lifetime systems or small sized systems.

2. Managed Processes

- If an already defined process model is used for the development then is called managed process. In this case all the required procedures and relationship among them is defined by process model itself.
- They can be used to develop large sized system having long life span.

3. Methodological Processes

- If an already defined development method is used to develop software product then is called methodological process. For example use of some standard CASE tools to develop system.
- Such processes help in design and analysis of software system under development. They are mainly used to develop system for well understood application domain.

4. Improving Processes

- Processes which are used with the objective of improving the existing process are called improving processes.
- They have predefined budget and procedures to enhance or improve the process quality. They are always used to enhance the quality of existing process.

3.3.3 Process Measurement

Q.Q. What is process measurement?

Q.Q. List Process Metrics.

- Data that can be measured about the software process are called process measurements. Process measurement is an important factor for enhancing the quality of process.

- By enhancing the process quality we can control various process metrics.
- For example improvement in design process should reduce efforts and time metrics required for designing of a system.

Types of process metrics that can be measured

Q.Q. What are the types of process metrics?

- Time :** It can be measured as a total time required for completion of process. Time devoted to a particular process by development team is called time metric, it can be a calendar time also.
- Resources :** Resources are the components required or used in development of process. It can be technical, non-technical, monetary etc.
- Occurrence of an Event :** Event is a thing that can happen with a process during its development. Number of occurrences of particular even can be measured as a process metric. For example number of times changes are required by customer in particular design area etc.
- Time and resource metrics for a particular process helps to check whether modification in process has really improved the quality of process or not. For example by comparing time and resource utilization of a system in handling particular even before modification to it and after modification we can easily identify whether there is an improvement or not.
- Third process metrics that is number of occurrence of particular even is also more directly proportional to process improvement. For example consider occurrence of defect as an event then we can directly say whether there is improvement in process or not by measuring this even before and after modification to process.

3.3.4 Process Analysis and Modeling

Q.Q. Write note on process analysis and modelling.

- Process analysis means to work upon existing processes identify relationship between them and compare them with other processes.
- Process analysis have number of closely related objectives :
 - To interpret the series of steps involved in the process and locate the relationship among them.

- To interpret relationship among the process activities and process measurements.
- To interpret relationship among process that is under analyzed and other comparable process used in software development process.

Techniques widely used for process analysis are :

- Questionnaires and Interviews :** Questionnaires are designed or structured according to need of process analysis or team members involved in process development are interviewed personally in order to analyzed the process.
- Ethnographic Studies :** This technique involves observation of process participants when they are working and interpret nature of software development process.
- Process Modelling** means documenting the process which describes activities, entities and responsibilities handled in software system.
- Process model** consists of following elements :
 - Activity :** It is an action performed by system on the reception of some input or occurrence of an event. Each activity has certain outcome and is followed by next subsequent action.
 - Process :** A number of activities performed by the system which have common goal is collectively known as process.
 - Deliverable :** An outcome of activity is called as deliverable.
 - Condition :** Condition means a criteria that must be satisfied for the successful evaluation of activity.
 - Exception :** Exceptions are un expected conditions. Such a exceptions must be handled by a system for successful evaluation
 - Communication :** Activities of a system must be communicate with each other to accomplish particular task effectively.

3.3.5 Process Change

Q.Q. What is process change?

- Each and every software process suffers from the changes which are unavoidable and are essential for enhancement of quality of process.
- Required changes to the respective process can be easily applied by using a technique called Process Change Management.

- This technique identifies objectives of process improvement and evaluates changes made and implements them in standard business process.
- PCM techniques uses methodology with following steps :

- Process improvement request proposal** must be submitted which should specify objectives of process improvement and suggestions for software process evaluation.
- The process improvement request proposal** must be evaluated in order to decide whether it should be implemented or not. Corresponding decision is then documented.
- Advantages obtained from process improvements** like quality of product, end user satisfaction, etc. are identified.
- If there are many changes requested in process then priority for changes are assigned and then implemented them accordingly.
- The status of each process improvement request proposal in an organization is maintained.
- Process improvements are reviewed by the end users in order to estimate its effect on quality of product.

3.3.6 CMMI Process Improvement Framework

Q.Q. Explain CMMI process improvement framework.

- Capability Maturity Model Integration (CMMI)** is a capability maturity model.
- CMMI framework consists of a collection of computer programs based on knowledge, system engineering, software engineering, integrated product and process development and provider sourcing.
- CMMI framework has three groups as :
 - CMMI for Development (CMMI - DEV)**
 - CMMI for Service (CMMI - SVC)**
 - CMMI for Acquisition (CMMI - ACQ)**
- These three groups forms model components which are uniquely designed for particular business process and they may contain some core processes as a part of them which will be same among these groups.
- It is also possible to extend CMMI framework by making addition of model component to it.

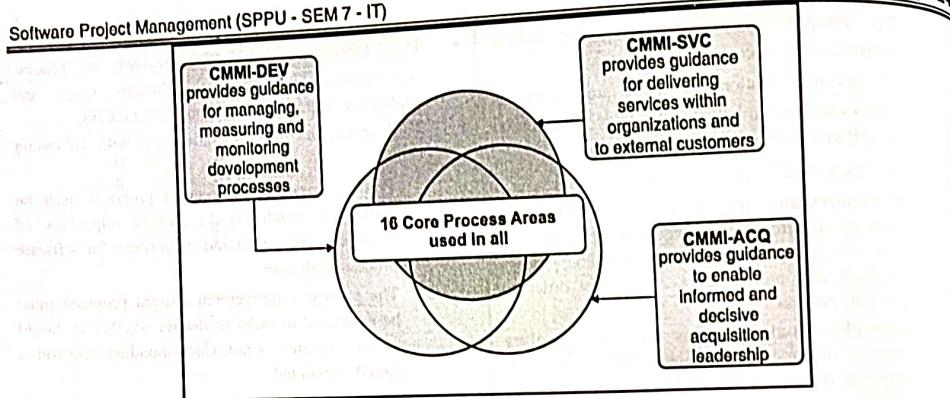


Fig. 3.3.1

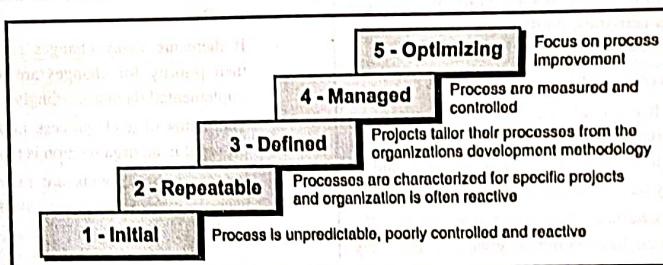


Fig. 3.3.2

- In general CMMI has following maturity levels :

- Initial
 - Managed
 - Defined
 - Quantitatively managed
 - Optimizing
- At Initial stage processes are created for particular purpose and chaotic. Environments in organization are unstable. Thus organizational success is only because of skills and engagements of team members instead of well defined processes.
 - At managed level of maturity an organization have all processes as well defined and executed according to rules and guidelines defined by customers or stakeholders. All processes achieves their goals

- At level defined an organization have well defined & well structured processes which gives detail information about standards, procedures, tools and methods.
- At quantitatively managed maturity level some processes are selected from well defined processes and are analyzed for performance by using various process measurement techniques.
- At the last level of maturity that is optimizing level an organization is continuously improving its processes to make them best in order to improve the efficiency of process.

Chapter Ends

UNIT III

CHAPTER 4

Activity Planning & Risk Management

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