PROJECT MANAGEMENT

MCOM

Semester - I

MCOM - 101

SHRI VENKATESHWARA UNIVERSITY

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SYLLABI-BOOK MAPPING TABLE

Project Management

Syllabi	Mapping in Book
Unit 1 **Project Management:** Meaning and scope, Need of project management, Life cycle of a project - conception and selection, planning and scheduling, implementation and control, evaluation and termination.	**Unit 1:** Introduction to Project Management **(Pages 3-52)**
Unit 2 **Project Analysis and Selection** Identification of investment opportunities, project initiation, Market and Demand Analysis, Technical Analysis, Economic and Financial Analysis, Social Cost and Benefit Analysis, Formulation of Detailed project report.	**Unit 2:** Project Analysis and Selection **(Pages 53-112)**
Unit 3 **Project Planning & Scheduling** Planning Resources, Planning of Physical Resources, Planning of Human Resources, Planning Financial Resources, Project organizing, Planning Time Scales-Network/PERT Analysis.	**Unit 3:** Project Planning and Scheduling **(Pages 113-148)**
Unit 4 **Implementation and Control** Project Management Information System, Monitoring and Reporting Physical resources, human resources, and financial resources-cost control.	**Unit 4:** Implementation and Control **(Pages 149-165)**
Unit 5 **Project Completion and Evaluation** Integrated Project Management Control System, managing Transition for project to operation, project completion and evaluation, project review, project termination.	**Unit 5:** Project Completion and Evaluation **(Pages 167-182)**

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INTRODUCTION

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A large number of business entities do not hire project managers on their payrolls and it is not new to set up a project team to fulfill a certain requirement. Though most of the people may not have the prescribed skills in a project methodology, being part of a project team is a wonderful opportunity to learn and can provide new dimensions to a person's career graph.

The following main points define what project management actually is:

- Project management is not a diminutive job
- It has a scheduled beginning and end
- It is not an ongoing process
- Project management employs a variety of tools to determine endeavours and keep track of project milestones
- Projects are in regular need of resources on an impromptu basis unlike organizations that have only dedicated permanent posts
- Project management lessens risk and lowers the prospect of success

The three most important factors in project management are time, cost and scope, which are collectively addressed as the triple constraint. These form the edges with quality as a chief theme.

A successful project management discipline will not get rid of all threats, flaws and shocks, but will provide benchmark methods and measures to cope up with them and help thwart the following:

- Projects crossing the deadline, going beyond the budget or failing to meet customer expectations
- Irregularity between the processes and procedures practiced by projects managers, causing a few to be favoured more than others
- Projects thriving well, regardless of lack of planning, accomplished through extreme levels of stress, goodwill and noteworthy measures of overtime
- Project management regarded as providing no value add and as a waste of time and funds
- Unpredicted in-house and/or outside events affecting the project

Project management is about building an atmosphere and situation in which a definite aim or objective can be realized in a streamlined way by a team of people.

The learning material in this book, *Project Management,* has been presented in the self-learning format, wherein each unit begins with an *Introduction* to the topic followed by an outline of *Objectives*. The detailed content is then presented in a simple, structured and easy-to-grasp style interspersed with '*Check Your Progress*' questions to test the student's understanding. At the end of each unit, *Summing Up* and a list of *Questions and Exercises* have been provided for recapitulation.

UNIT 1 INTRODUCTION TO PROJECT MANAGEMENT

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Structure

1.0 INTRODUCTION

A project is temporary. It has a defined beginning and end in time, and therefore defined scope and resources. A project is unique in that it is not a routine operation, but a specific set of operations designed to accomplish a singular goal. A project team often includes people who don't usually work together – sometimes from different organizations and across multiple geographies.

The development of software for an improved business process, the construction of a building or bridge, the relief effort after a natural disaster, the expansion of sales into a new geographic market — all are projects. And all must be expertly managed to deliver the on-time, on-budget results, learning and integration that organizations need.

Project management, then, is the application of knowledge, skills and techniques to execute projects effectively and efficiently. It's a strategic competency for organizations, enabling them to tie project results to business goals — and thus, better compete in their markets.

Project management is concerned with achieving a specific goal in a given time by using the resources available for that specific period. In order to achieve success with project management, the essential requirements are— adequate project formulation, availability of resources, proper implementation planning before commencing the actual implementation, effective monitoring of the emerging problems and taking corrective measures. All these measures need to be undertaken to get the project ready on time.

1.1 OBJECTIVES

After going through this unit, you will be able to:

- Explain the concept of project management
- Discuss the need of project management
- Describe the phases involved in the life cycle of a system
- Discuss the process involved in project planning
- Explain the concept of project implementation and control

1.2 PROJECT MANAGEMENT: MEANING, SCOPE AND NEED

Project management is the art of directing and coordinating human and material resources throughout the project by using modern management techniques. The main purpose of project management is to achieve the predetermined objectives of scope, cost, time, quality and the satisfaction of the participant.

Project management includes developing and implementing a plan for the project while considering the available resources such as manpower, material and cost in the organization. Project management involves the following activities:

- Planning and analysing the objectives of the project
- Measuring and controlling the risk-involved in the project
- Estimating the organizational resources required in the project
- Assigning tasks to the employees related to the project
- Directing and motivating employees to improve their performance
- Organizing project activities
- Formulating the project
- Forecasting trends in the project
- Completing the project on time
- Keeping up the quality of the project

1.2.1 Characteristics of Project Management

Project management requires attention for goal-oriented systems, the environment, sub-systems and their relationships. This is what makes project management a 'systems approach' to the management.

The application of principles and practices from the classical and behavioural and systems viewpoints to the unique requirements of projects has led to a new set of concepts

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which may be called the 'project viewpoint'. Cleland and Kind have identified the following characteristics of project management:

- The project manager is the single focal point for bringing together all the necessary resources for achieving the project objectives. He/she formally heads the project organization and operates independently the normal chain of commands. The project organization reflects the cross-functional, goal-oriented nature of the project.
- Since each project requires a variety of skills and resources, many functional areas may perform the work in a combined form. The project manager is responsible for integrating the people from different functional disciplines working on the project.
- The project manager will negotiate directly with the functional managers for support. The functional managers are responsible for the activities of the individuals and for the personnel coming under the scope of their functional groups. However, the project manager has to concentrate on integrating all the project activities and overseeing the activities from the beginning to end.
- The project manager focuses on delivering a particular product or service at a certain point of time and cost to the satisfaction of the technical requirements. In contrast, the functional units must maintain an ongoing pool of resources to reach the ultimate organizational goals instead of the limited project goals. Thus, conflicts may often arise between the project and functional managers over the optimum allocation of resources to a project.
- A project in an organizational structure has two chains of command. One is the vertical, functional reporting relationship and the other is the horizontal, project reporting mechanism.
- For rewarding incentives and distributing responsibilities, the decision making, accountability, outcomes and rewards should be shared among all the members of the project team and the supporting functional units.
- Though the project organization is temporary, the functional units from which it is formed are permanent. Thus, when a project ends, the project team is scattered and the project personnel either return to their functional units or they are reassigned to new projects. Projects may originate from different areas of the organization. Product development and related projects tend to emerge from marketing whereas technological applications originate in Research and Development (R&D).
- Project management sets into motion numerous other support functions such as personnel evaluation, accounting and information systems.

1.2.2 Successful Project Management

In order to reduce the cost of constructing a project, organizations should consider various factors such as cost and time for the successful competition among projects. Following are the key factors essential for a successful project management:

- **Adequate project formulation**: Project formulation is the process of converting project ideas into project proposals in a structured manner. Generally, project formulation suffers from the following shortcomings:
  - o Use of informal methods for estimating the costs and benefits, such as maintaining paper records instead of using computers
  - o Deliberate overestimation of benefits and underestimation of cost of constructing a project
  - o Faulty judgements due to lack of experienced managers and employees

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It is essential for an organization to avoid these shortcomings in order to have adequate and meaningful project formulation.

- **Project organization**: A sound organization possesses the following characteristics:
  - Proper working environment for employees
  - Well-defined working methods and systems
  - Proper rewards and penalties to employees for their performances and faults
- **Implementation planning**: After taking investment-related decisions, it is necessary for an organization to do proper implementation planning before commencing the actual implementation. Proper implementation planning includes the following steps:
  - Developing a plan for various activities such as land acquisition, tender evaluation, recruitment of the staff, construction of buildings and creation of an industrial plant
  - Estimation of the resource requirements such as manpower, materials and money in project
- **Availability of funds on time**: It is important to have funds on time for taking advanced actions in the project activities. Timely availability of funds facilitates the organization to negotiate the cost of the project with suppliers and contractors.
- **Effective monitoring**: In order to have a successful management of the project, a project monitoring system must be established in the organization. This is because effective monitoring helps in analysing the emerging problems and taking corrective actions for the project activities. Following are the factors that should be kept in mind while developing an effective system of monitoring:
  - It should emphasize on the critical aspects such as the finance of the project management.
  - It should be simple and not overcomplicated as it may result in a lot of documentation and wastage of resources.

1.2.3 Principles of Project Management

Successful project management can be achieved by proper application of principles instead of implementing different kinds of techniques. Following are the seven principles of project management:

- To identify the project type that is suitable for the business. One needs to select the projects that are good for business.
- To understand the needs and expectations of the customers.
- To prepare the reasonable plans which defines the scope, cost and approach of the project. This helps in reducing unplanned areas in the project.
- To establish a good team with a good leader. This principle conveys that there should be proper working environment and communication flow between the project managers and team members.
- To define the status of the project. This helps improving the project quality and recognizing the various problems in it.
- To make a proper assumption for the project. This principle focuses on the verification of the critical items used in the project in order to reduce the risk.
- To take proactive actions in the problems of the project. This is because the problem usually gets worse over time which in turn increases the chances of risk.

1.2.4 Project Management: Scope and Importance

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The scope of a project is determined by using product scope and project scope. Product scope explains all the functions and features that are to be included in a product or service of the project. On the other hand, project scope deals with the deeds to be done for delivering the needed product. The tools and techniques to manage the product scope change with the nature of the project.

The project manager uses various tools and techniques such as product and cost-benefit analysis for developing the scope of a project. Once the project has been selected, the project manager and the client jointly prepare the scope of the project and deliverables.

Importance

Organizations have to manage their projects effectively in order to create and maintain their reputation in the market. Many organizations fail to manage their projects properly due to the following reasons:

- Project is completed late or without fulfilling the demands of the client
- Project is not giving any valuable information
- Project lacks proper planning and organization of the activities
- The techniques and standards used are not advanced

A good project management offers various techniques and guidelines to manage employees and workloads. Project management provides the following benefits in an organization:

- **Saving cost**: Project management offers a common methodology for managing the project, i.e., if the processes and procedures are planned once, then they can be used in all the future projects again. Consequently, it helps in saving the cost and time required in completing the project.
- **Improving working conditions**: If the projects are successful, the client will be more involved in the projects. This helps in improving the working environment of the organization, which in turn encourages the morale and confidence of the project team.
- **Improving financial management**: Better estimation of the actual costs involved in the project helps in managing the budget of the organization. This results in better financial predictability and cost control.
- **Resolving problems**: Team members in a project spend a lot of time and energy in dealing with project problems. This is because the project team members do not know how to resolve the project problems. If the project is properly managed and planned, then the process of project management helps in solving the project problems quickly.
- **Determining risk**: The process of project management helps in identifying and managing risks in the near future.
- **Improving the product quality**: The process of the project management helps team members understand the needs of customers. Once customer needs are recognized, team members can implement quality control and assurance techniques to fulfil customer demands.

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1.2.5 Requirement for Project Management

Modern project management ideas originated in the construction and aerospace industries in the USA and Western countries. This was because the environment and activities in those industries demanded flexible and imaginative forms of management. The spread of project management ideas has come about due to necessity rather than desire. The major reason for its slow growth can be attributed to the reluctance in accepting new approaches and techniques. The major problems identified by the managers, who attempted the new system, revolve around conflicts in authority and resources. The three major problems identified are as follows:

- Project priorities and competition for talent would interrupt the stability of the organization and interfere with its long-range interests by upsetting the normal business of the functional organizations.
- Long-range planning would suffer if the company gets more involved in meeting the schedules and fulfilling the requirements of temporary projects.
- Shifting people from project to project would disrupt the training of new employees and specialists.

Let us briefly consider some of the organizational factors influencing the need for project management.

(i) The first is the size of the organization. A small organization such as a consulting firm, an engineering office or a small contractor who has a budget, a schedule and limited requirements to control quality and production could get along without any formal project organizational system. However, the quantitative methods and procedures of the project management approach are still necessary. On the other hand, a large organization executing a prestigious, complex, multi-disciplinary and capital-intensive project would certainly require a formal project management organizational system as well as quantitative techniques.

(ii) The second factor is the style of management needed to meet the complexities of a rapidly changing business environment. Most industrial, public service and government organizations have solved the problem of complexity due to a hierarchical management structure inherited from the military. The top management has been very comfortable with the hierarchy because of its simple 'one boss' reporting system. The hierarchy also lends itself to convenient subdivision of the organization into groups or departments, each of which represents a speciality, a discipline or a function.

While these so-called line, functional or disciplinary divisions often enhance efficiency and maximize productivity, they suffer from the following flaws:

- o The ability of a specialized organization to work together and coordinate effectively with external agencies such as the clients, vendors and regulatory agencies is critical to the success of the project. Line managers often suffer from 'tunnel vision' or lack of knowledge of the overall organizational goals. In addition, competition between line divisions may result in inefficiency or failure to communicate vital information.
- o The responsibility for important external coordination may become mixed-up because of overlapping or inadequately defined roles. The allocation of responsibility for a job that overlaps several functional divisions in a project complicates the process of decision-making affecting the entire project. This may increase the possibility of inadequate or tardy responses to changing

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conditions which could make all the differences between the success or failure of a project.

- o As an organization grows in size and complexity, it becomes increasingly difficult for the top management to connect itself with the day-to-day problems of each project.

A chief executive may face a project failure for any of these reasons, and in an attempt to determine the cause for the failure, the executive may find the divisional managers blaming each other. It can be a very disturbing experience for the top management to realize their inattentiveness over the official issues. A chief executive needs a single point of information and control if complex projects are to be successfully completed.

In determining the need for project management, one should examine the project and organization carefully and ask the following questions:

- Is the job very large?
- Is the job technically very complex?
- Is the job a true system in which it has many separate parts or sub-systems that must be integrated to complete the whole operation?
- Is the job a part of a larger system and must be closely integrated, especially if the larger system has a project-oriented organization?
- Does the top management really feel the need for a single point of information and responsibility for the total job?
- Are strong budgetary and fiscal controls required?
- Are tight schedules and budgetary constraints foreseen?
- Are quick responses to changing conditions necessary?
- Does the job cross many disciplinary and organizational boundaries?
- Will the proposed job drastically disrupt the present organizational structure?
- Are more than two divisions involved? Is more than one division going to deal directly with the client or customer?
- Are there other complex projects being conducted concurrently with this one?
- Is there scope for a conflict between the line managers concerning this project?
- Is the organization committed to a firm completion date?
- Is it likely that changing conditions may seriously affect the project before its completion?
- Are there major items to be procured from outside the company?
- Are there major portions of the system which must be sub-contracted outside the organization?
- Is it necessary to have the project reviewed or approved by government regulatory agencies? Will these review processes and approvals generate problems and controversy?

The answers to the above questions help in the various project management considerations for an organization. From the above discussions, it can be concluded that project management can be applied to any ad hoc undertaking. This includes a broad range of activities such as writing a research paper, remodelling a house or constructing a children's park. There are two situations in which project management should be used:

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- The more unfamiliar or unique the undertaking, the greater the need for project management to ensure that nothing gets overlooked.
- The more numerous, interdisciplinary and interdependent activities in the undertaking, the greater the need for a project manager to ensure that everything is coordinated, integrated and completed.

Cleland and King have suggested five general criteria to decide when to use project management techniques and the corresponding organizational structures. These criteria are briefly described below:

- **Effort**: The magnitude of the effort should be more when the job requires more resources in an organization and for this purpose the project management techniques are necessary. For example, the Atlas missile programme requires major undertakings in the defence, aerospace, space, energy and transportation sectors. However, micro-level industrial activities may also need formal project management, e.g., in the case of relocation of facilities, merger of two companies, placing of a new product on the market etc.
- **Coordination**: Even when a job lies primarily in one functional area, the task of coordinating its work with the other functional area is necessary. For example, the task of computer installation in a company may seem to be the sole concern of the Electronic Data Processing (EDP) department, as many corporate executives thought during the last two decades in India. Only a few smart executives and organizations realized early on in the game that during the process of computerization, there will be a continuous meshing of policies, procedures and resources of all the departments affected by computer installation. Often hundreds of people may be involved and the required coordination and integration might be more than what a single department such as EDP can tackle efficiently and effectively.
- **Modification**: A project always requires modifications from time to time. Minor changes in products such as annual automobile design changes can usually be accomplished without setting up a project team. On the other hand, undertaking the modernization of an automobile plant calls for non-routine efforts such as revising the facilities layout, modifying the assembly line, replacing equipment, retraining employees and altering policies and work procedures. For this, project management requires to bring all the functional areas together. In a changing environment with rapid changes taking place in the economic, social and technological environment, more and more industrial organizations are seeking creative, innovative and flexible forms of management. Companies that operate in the computers, communications, electronics and pharmaceutical sectors are exposed to high innovations, rapid product changes, shifting markets and consumer behaviour. Other industries, such as those in biotechnology, petrochemicals and ceramics, though less volatile, also have highly competitive and dynamic environments.
- **Changing environment**: Another aspect of the changing environment that is particularly relevant for the Indian economy is the government's policy of liberalization and transition to the free market mode. Changing environments present opportunities that organizations must capture swiftly. Project management provides flexibility and diversity needed to deal with changing goals and new opportunities. When a joint effort is required, project management attempts to build lateral relationships between functional areas in order to accelerate work and reconcile

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the conflicts inherent in multi-functional and multi-disciplinary organizations. The project manager links and coordinates the efforts of the divisions within the parent organization as well as those of the outside — sub-contractors, suppliers and customers.

- **Reputation**: The reputation of the undertaking and what is at stake may determine the need for project management. An unsuccessful project will result in either a loss of future contracts, damaged reputation, loss of market share or, in the worst case, financial ruin; therefore, there is a strong case for utilizing formal project management techniques and organizational form. For example, in the launching of American multinational Pepsi soft drinks and snack food operations in India or introduction of its new 1000 c.c. car by Maruti Udyog Ltd or setting up of its joint venture in the form of Tata-IBM by IBM Corporation formally, each of the undertakings warranted the adoption of a formal project management approach. The obvious reason, in each of the above cases, is that the likelihood of successfully completing the undertaking is increased when a single competent individual is assigned responsibility for overseeing it. The project manager, with the assistance of technical support groups, can do much to reduce the problems inherent in large, complex undertakings.

1.2.6 Need of Project Management

Most enterprises require project management, at some point of time in order to convert strategical decisions into operations and set goals. A large number of organizations are project-intensive, such as construction, aerospace, engineering design and software development. In the public domain too, project management has a defining role in translating ideas into reality.

Identification of goals requires an organized system and application of methodical processes particularly in light of contemporary times marked with intense competition, rapid technological developments, socio-cultural milieu, government regulations and economic issues. A number of researches have concluded that substantial entrepreneurial development as well as further organizational efforts often lead to the following risks in deployment of strategies to administer the endeavours:

- Deferment because of ineffectual planning, monitoring, coordination, risk-management and follow-through of the project
- Economic inconsistency because of ineffectual management and staff utilization/ accountability
- Consumer discontent because of lack of responsiveness and communication barriers

Therefore, the fundamental idea for a large number of organizations is to strive for excellence in a growing market facilitated by the best delivery capacity and driven by consistent and effectual procedures, structures, planning and monitoring.

A proficient system of project management aids in the management of various complications with favourable outcomes, and lowers doubts and expenses. The following are certain examples of organizational weaknesses that can be risky but can be controlled through proper managerial techniques:

- Lack of integration concerning schedules managed in silos and dependencies
- Delays attributed to inefficient allocation of resources due to lack of communication between departments

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- Lack of long-term forecasts in scheduling
- Failure in identification of critical areas like non-working time and estimation of defects
- Improper documentation of information due to informal mode of communication
- Lack of accountability in issues concerning decision-making
- Failure of proactive risk classification and administration
- Inadequate reporting - lack of visibility / insight into the true status of the projects
- Frequently forgotten or delayed activities and decisions

The skill of handling projects constitutes uniformity in reaching set goals in time, with no extra expenses simultaneously maintaining good client relationships. This is acquired by the successful management and coordination of human and material resources. The domain of project management propels towards improved cooperation, control, implementation, receptiveness, and positioning of entrepreneurial aspects as well as processes with the characteristics of the product and operation. Project management techniques vary in technical aspects; engineering or construction skills generally aligned with a number of projects and include elements not included in the range of the technical aspects, which are required to be properly controlled in order to meet the goals of the project. Further, project management varies from conventional management as it introduces cross-functional cooperation, management, implementation, receptiveness, and placement of entrepreneurial aspects and processes with characteristics of the result of the projects. Project management aids in bringing novelty and progress based on the alterations in the external conditions.

Proper application of project management for positioning of strategical processes and objectives can offer the following benefits:

- Profits due to consistent meeting of organizational objectives, excellent use of resources and knowledge based decision-making.
- Competitive edge attributed to the human resource based on a background of cooperation, goal achievement and customer satisfaction.

Project management also presents substantial advantages to people at different organizational layers. Project management aids:

- Executives in obtaining precise and correct knowledge in order to reach correct entrepreneurial conclusions in order to remain ahead in the market
- The management in drawing attention towards the ultimate objective of the entrepreneurial efforts. With marked decrease in conflicts and confusions and effectual communication processes, the organization is bound to witness an increase in productivity.

Thus, we can conclude that project management as a managerial subject, structures a larger percentage of financial aspects and entails numerous benefits. The special function of project management in introducing expertise in organizational processes by incorporating innovation can in no way be overlooked.

Check Your Progress

1. Define project management.
2. State the main purpose behind project management.

1.3 LIFE CYCLE OF A PROJECT: CONCEPTION AND SELECTION

Each product passes through four phases during its life cycle, which is called a product life cycle (PLC). The four stages include introduction, growth, maturity and decline.

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When a product is newly introduced in the market, the initial sales and sales growth will be low. It will be followed by a natural growth in demand of the product before it reaches the plateau for stabilized sales and then, starts declining.

What should be the firm's growth direction and associated strategy, therefore, depend on the stage at which the current products are at a given point in time. A firm would like to remain with the current product and current market for those products which are either in the introduction stage or the growth stage. Several of these strategies are operational strategies while some are long-term ones. Promotional efforts at the introduction stage must be followed by either market skimming or penetration strategy depending on the situation. During the growth stage, investment is required for improvement in product quality, product development, expansion of distribution channels (market), shift in advertisement theme and so on. All these strategies involve investment and growth while remaining steadfast to the present product and the present market. However, when a product reaches the maturity stage the firm would face the dilemma whether to stagnate or enter into a related market, which is the change in the direction of growth. Decision to let the product stagnate will follow a strategy of introducing a new product (a product-side growth) in a new or related market (a market-side growth). Figure 1.1 gives the PLC and corresponding profitability and cash flow generation capacity of the product.

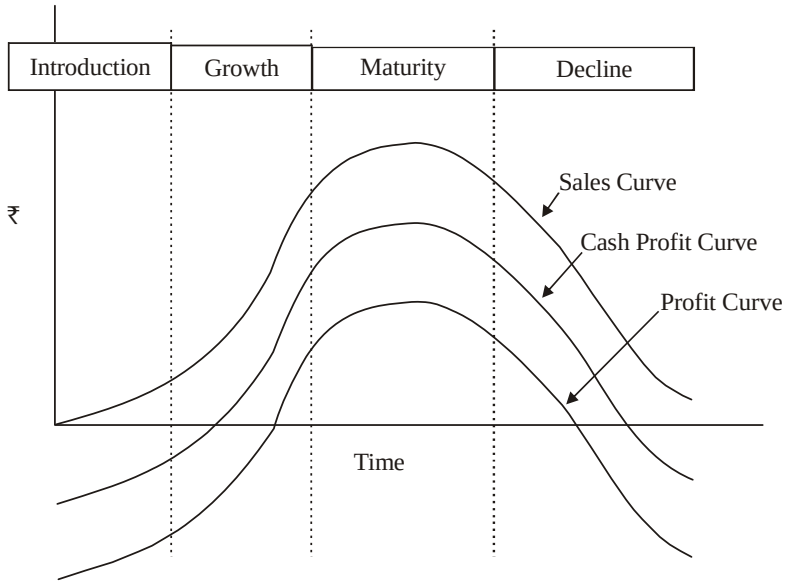

***Fig. 1.1** Product Life Cycle*

These are just examples. They may give the idea that a firm continues to be in the present-product present-market if that satisfies firm's appetite for growth. However, before the product reaches the maturity level, the firm must create alternatives by changing the direction either on the market side or on the product side or even by changing on both the sides at a time.

An important aspect of the system's approach to management is the concept of 'life cycle'. It is the basic pattern of the change that occurs throughout the life of a system. A system changes and fluctuates frequently. It follows a distinct pattern that repeats recurringly. The natural life cycle that occurs in all the living organisms consists of birth, life and death. Similarly, systems in general, and projects in particular, have their own life cycles.

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The life cycle of a system consists of the following phases:

- Conception
- Definition
- Acquisition/Production
- Operation
- Divestment/Termination

Figure 1.2 shows the general life cycle of a system.

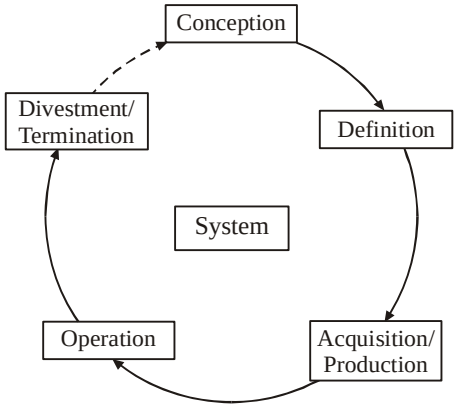

Fig. 1.2 *General Life Cycle of a System*

According to the United Nations Guidelines for Rural Centre Planning, there are seven steps in the project life cycle. These are project identification and appraisal, pre-feasibility study, feasibility study, detailed design project implementation, operation maintenance, monitoring and evaluation.

Rondinelli, Dennis and Palia in their book *Project Planning and Implementation in Developing* countries identified the following twelve steps in the project life cycle.

(i) Project identification and definition

(ii) Project formation

(iii) Preparation and feasibility analysis

(iv) Project design

(v) Project analysis

(vi) Project selection

(vii) Project activation and organization

(viii) Project implementation and operation

(ix) Project supervision (monitoring and control)

(x) Project completion or termination

(xi) Output diffusion and transition to normal administration

(xii) Project evaluation follow-up and action

The World Bank guidelines reveal the following six major steps in the project life cycle.

(i) Conception (identification)

(ii) Formation (preparation)

(iii) Analysis (appraisal)

(iv) Implementation (supervision)

(v) Operation

(vi) Evaluation

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1. Conception/Formation Phase

The conceptual phase involves the preliminary evaluation of an idea. This includes recognition and acceptance of a problem or a need, analysing the requirements and finding out the ways to fulfil the need or to solve the problem. Some of the important actions are: preliminary analysis of risk and their impact on time, cost, and performance requirements.

The conception phase of a system focuses on the analysis of the needs (of an organization) that the system is designed to fulfil these needs. This phase corresponds to the 'birth' of a system. Similarly, in terms of the life cycle of a project and technology/ product, the conception phase is equivalent to the project formation phase and basic research phase, respectively. Some of the specific steps involved in this phase are outlined below:

- Determining the existing need or problem, or potential deficiencies of the existing system
- Examining alternative ways of meeting the need for solving the problem
- Estimating the approximate resources, human and others, required for the system
- Explaining the basic concept of the system
- Preparing the initial estimates of the time, cost and performances of the conceived system
- Determining the initial feasibility and practicability—technical, financial and environmental.

2. Definition/Build-Up Phase

The system conceived in the preceding phase is now investigated in greater detail. The definition phase of a system is mainly a refinement of the ideas described in the conception phase. The sub-systems of the main system are defined and examined. This requires a confident identification of the resources required and the establishment of time, cost and performance parameters. It also includes the initial preparation of all the documents necessary to support the system such as policies, procedures, bid documents, job descriptions, budgets and funding papers. The system definition phase is equivalent to a project build-up phase. The project team is expanded to enable it to identify resource and system performance requirements, major sub-systems, elements, etc. Project management plans to create the activities, schedules, costs and resources are needed to design, build and implement the system. The specific activities and steps in the definition phase of a system can be summarized as:

- Determination of time, cost and performance requirements of the system
- Identification of estimates of human and non-human resources required
- Determination of necessary sub-systems including detailed plans required to support the main system
- Defining the inter-system and intra-system interfaces

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- Identification and preparation of the documents required to support the system, such as policies, procedures, bid documents, job descriptions, budgets and funding papers

This phase of system definition corresponds to the stages of growth of a living organism and applied research for a product, technology, etc. At this stage, the system expert or project manager will decide in terms of men, money and other resources whether to continue with the system of a project or to cancel it. If the decision is one to continue, then the next phase to move on is the acquisition/production phase.

3. Acquisition/Production Phase

The acquisition phase is named such because, at the end of it, the user acquires the system. This phase is also referred to as the production phase as the system is now produced. The efforts are now focused on the standardization, testing and evaluation of the alternative detailed designs and production based on the acceptable detailed design. In case of a living organism, this phase is the maturity phase; in case of the technology/ product life cycle, this phase corresponds to the design development and manufacturing phase of the technology/product. The production phase of a system and a project are similar to each other. Production involves either production of a single item or mass production. Project management oversees and controls resources, motivates the workers and reports the progress to the users of the system. All the documentations must be completed in this phase. At the end of this phase, the system moves out from the control of the project. The specific tasks and activities in the acquisition/ production phase should be to:

- Update the detailed plans and specifications of the definition phase
- Identify detailed resource requirements and managerial procedures, e.g., inventory, scheduling, accounting, bookkeeping, etc.
- Begin the production, construction and installation of the actual system
- Verify system specifications with performance
- Prepare policy and procedural documents
- Develop plans to hand over the system to the user and to provide supporting services such as training during the operational phase

The system that was conceived and defined earlier is now ready for delivery to the user for its deployment and operation.

4. Operation Phase

The system has come a long way from the conception phase and is now deployed by the user who integrates its products/services into the existing organizational system. The user takes over, operates the system and evaluates its performance in terms of its ability to meet the need or to solve the problem for which it was designed. The system manager/ contractor may still be involved in providing services such as commissioning, trial evaluations, operational assistance, maintenance, training, etc. The operation phase also includes the provision of feedback to the system planner/designer so that system improvements can be achieved. The operation phase of a project is identical to that of a system except that in many projects 'one-shot' systems are used which either succeed or fail. The specific activities and steps in the operation phase of a system are as follows:

- Using the system (by the client or the customer)
- Integrating the products/services into the existing organizational system

- Evaluating the system performance vis-à-vis the specifications made in the definition phase with respect to technical, economic, social and environmental parameters
- Providing feedback to the system designer/planner about the efficiency and effectiveness of the system
- Providing training support and maintenance services

5. Divestment/Termination Phase

This is the last phase of the system and in many cases overlaps with the preceding operation phase. The senior management of the organization will now be looking at the means of divestment and reallocation of resources. This can also be understood with the help of a figure. Figure 1.3 shows the life cycle of a project.

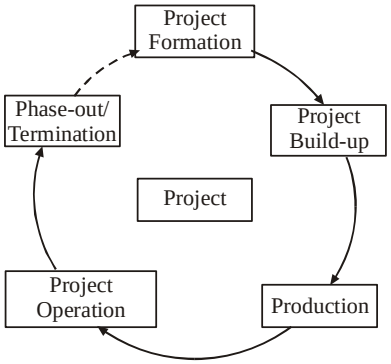

Fig. 1.3 *Life Cycle of a Project*

This figure corresponds to the phase-out and termination of a project. Similarly, compared to the technology/product life cycle, divestment corresponds to the deterioration and death phases of the technology or the product. Figure 1.4 shows the life cycle of a technology product.

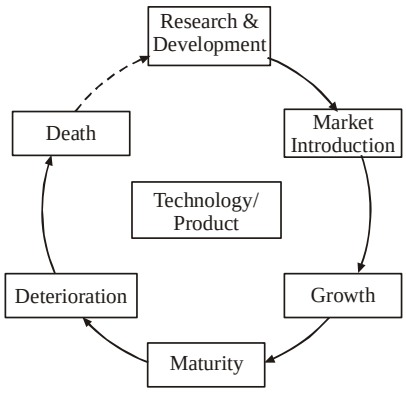

Fig. 1.4 *Life Cycle of a Technology Product*

As one product out of several in an organization enters the deterioration and death phases of its life cycle, other new products or projects must be conceived and developed. Most of the organizations require more than one product or project for survival. In addition to it, new products or projects should be undertaken in such a rate that the total revenue will increase and the organization will acquire the desired growth profile. Prior to the phase-out and termination of a project, senior management makes a comprehensive

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evaluation of the project so that the lessons learned can be used as inputs for new projects. The divestment phase also affects other ongoing projects in a multi-project organization in terms of availability and release of additional common resources. If a priority project is being phased out and terminated, other projects will now creep up in the priority list. The divestment/termination phase of a system/project involves the following final steps and activities:

- Phasing out the system or project
- Transferring responsibility to supporting organizations
- Transferring resources to other systems
- Re-configuring the project group to work on new projects
- Developing the lessons learnt from the system or project for further utility

There is a technological innovation chain that helps in understanding the project life cycle. It follows a particular sequence that can be understood with the help of a figure. Figure 1.5 shows a technological innovation chain.

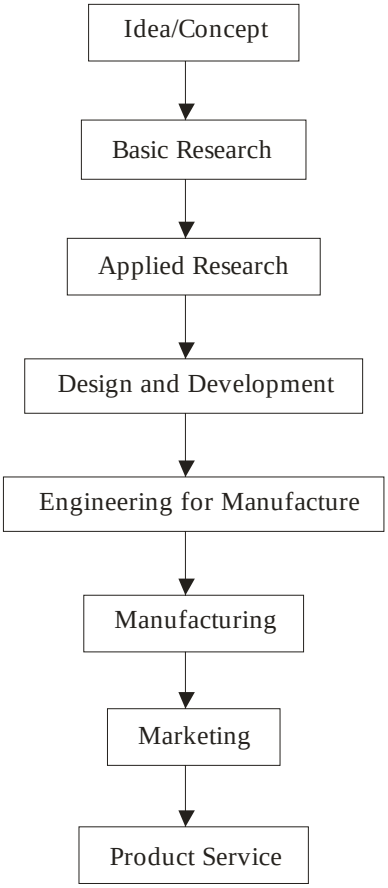

Fig. 1.5 *Technological Innovation Chain*

By comparing the life cycle of a product and its technological innovation chain, it is seen that the technological innovation chain comprises the first two phases of the overall technology life cycle or product life cycle, namely—research and development, and market introduction.

The advantage of using the life cycle concept in the development of a system, project, product or technology is that it enables decisions and actions to be taken in steps. This systematic approach is sometimes called the 'phased planning' approach.

Decisions can be taken at various stages and the system objectives and results are re-evaluated at progressively intensive levels while moving towards the final solution. This reduces the risk of committing resources without a proper assessment of all the relevant factors.

1.3.1 Stages of the Life Cycle Concept

The various stages of the life cycle concept are:

1. Theoretical Framework

During the planning stage, sub-contracts are given, teams and sub-teams are formed, team leaders are appointed, coordination is established, documentations are designed and a reporting system is developed. Now is the time to execute the projects. Project execution is a very active stage in project management. It involves activities like actual construction of work packages, action and coordination and monitoring and control.

2. Constructing Work Packages

A project team will start constructing different work packages (activities) as per the network plan prepared in the detailed project report. The sub-teams in the project, each with their own expertise, are engaged in the construction of work packages. These activities are visible, and create enthusiasm and excitement, which may sometimes take the eyes off the scope of the project.

3. Action and Coordination

There are several sub-teams on the job at any given point in time. Progress on their work together with resources consumed and required have a bearing on what other sub-teams are doing and would do in the future. Someone has to provide strong leadership for the effective coordination among all sub-teams and subcontractors, and also coordination for resource allocation on various sub-teams.

4. Monitoring and Control

Troubleshooting becomes a daily event, review of several configurations and activities takes place and the need for design change is felt. During implementation, there is always a very high chance that the project may go in the wrong trajectory due to the involvement of several people, difficulty in coordination or loss of focus and the project may become unviable or may get delayed. Therefore, a project control mechanism is extremely important. A good project control mechanism would efficiently balance the cost, time and performance aspects, where performance aspects cover quantitative as well as qualitative targets.

Risk Analysis and Utility Theory

Once the design of the project is ready, statistical risk analysis for the project begins. This stage involves the following activities:

- Identifying the main sources of risk
- Measuring the risk
- Incorporating the risk in the decision-making process

Sensitivity analysis is the prescribed tool for identifying the important sources of risk. Various statistical techniques, which measure dispersion value are employed for

quantifying the risk and then some statistically convincing rules, are applied for decision making. The risk can be incorporated in either the cash flow or in the discount rate so that the right choice of project is made.

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1. Identifying Critical Sources of Risk (Sensitivity Analysis)

Management by exception is the rule. Many variables may be uncertain but only a few may matter. The endeavour of the management should be to first identify the sources of risk that matter. This task is performed at various stages. However, if critical sources of risk are identified at the project feasibility stage, the project planning team would derive valuable guidance for the management of risk, in deciding which part of the risk to transfer or leverage out. This may also help in deciding whether market survey is needed or not and if needed, then what should be surveyed.

Sensitivity analysis: Initially, only one value is estimated for each variable and the profit (or NPV-Net Present Value or IRR-Internal Rate of Return) of the project is determined. What if any one variable may actually turn out to be different? What will be the effect of it on profit? The sensitivity analysis technique asks this question for each variable and calculates the project profit each time. It may be noticed at the end of the process that many variables are trivial and have a very negligible impact on the project's viability and only few variables are vital from the project viability angle. Thus, sensitivity analysis identifies a 'vital few' variables that need management' attention for risk mitigation.

This 'what if' analysis can be done using several methods, some of which are listed as follows:

- Percentage change approach
- Accounting break-even point approach
- NPV break-even point approach
- Pay-off matrix

The first three approaches do not require prior knowledge of the key factors for a project. Rather, in those approaches, first important factors are identified based on the sensitivity of NPV to them and then, the question is asked 'to what extent any of those factors are likely to change?' In the following section, we will describe the first three methods in brief but the pay-off matrix in a reasonable detail.

(i) Percentage change approach: In this method, a fixed percentage change is predetermined and one by one, each variable is changed by the same percentage from the initial (point) forecast to calculate the profit. The results are tabulated for easy reading and interpretation. The table containing the result calculated in the NPV of the project may look like the one given in Table 1.1.

Table 1.1 *NPV Tabulation: Result at Per cent Change Approach in Sensitivity Analysis*

	Net Present Value			
Change (%)	**Demand**	**Materials**	**Labour**	**Overheads**
–10	–200	–50	500	625
–5	300	450	625	660
0	700	700	700	700
5	950	800	825	780
10	1250	1,000	900	850

***Note*:** Negative change indicates adverse effect and positive change indicates favourable effect.

It appears clearly that labour and overheads do not pose much risk because NPVs do not vary much and even at 10 per cent adverse change, the NPV is positive in both variables. Between demand and material cost, clearly demand is an important variable that the management would like to watch because variation in demand has a greater variation on the NPV of the project.

(ii) Accounting break-even approach in sensitivity analysis: Accounting break-even point is the point (level) of a particular variable at which the accounting profit (ARR) from the project will be zero. The result could be like the one given below:

Per cent change required for accounting break-even

- Demand reduced by 30 per cent
- Material cost increased by 50 per cent
- Labour cost increased by 120 per cent
- Overheads increased by 250 per cent

One can observe here that the viability of a project, measured in accounting rate of return terms, is more sensitive to demand and least sensitive to overheads.

(iii) NPV break-even approach in sensitivity analysis: Those who use NPV or IRR as the method of evaluation of a project may calculate the breakeven (zero) NPV or breakeven IRR for each variable. The results of a hypothetical problem may be as follows:

Per cent change required for zero (break-even) net present value or IRR

- Demand reduced by 33 per cent
- Material cost increased by 62 per cent
- Labour cost increased by 110 per cent
- Overheads increased by 200 per cent
- Project cost increased by 40 per cent

We can read here that the project is more sensitive to demand and project cost and least sensitive to overheads.

In these three approaches of sensitivity analysis, after the calculation is done, managers have to ask a question: to what extent is it possible that demand will drop by a percentage that would result in either negative NPV or operating below the breakeven point (either accounting or NPV-IRR)? If there is any such chance, then one may like to study that variable more in detail.

(iv) Pay-off matrix and sensitivity analysis: The previous three methods are useful for carrying out sensitivity analysis at the stage of preparing the project feasibility report. Variables are not studied in-depth at that stage. Those methods serve the primary purpose of forming a first opinion about the importance of variables. The realistic range in which those important factors may vary is a matter of further study. Collection of reliable secondary data, cross verification and if need be, market survey for studying the selected variables could be the logical steps to follow the application of any of the first three methods described earlier.

A study of those variables would give enough data on the basis of which managers may form a judgement regarding the most favourable and the most unfavourable outcome of important variables. Now, the pay-off matrix approach of sensitivity analysis becomes relevant. The pay-off result of an imaginary example is given in Table 1.2.

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Table 1.2 *NPV Pay-off for Various Outcomes of Variables*

	Net Present Value		
	Most Unfavourable	**Most Likely**	**Most Favourable**
Demand	340	500	720
Materials	430	500	580
Labour	445	500	545
Overheads	485	500	510

The NPV matrix in Table 1.2 indicates that the NPV may be anywhere between ₹ 340 and ₹ 720 (a range of ₹ 380 or –32 per cent to +44 per cent from point forecast), if demand alone may turnout to be different from the point forecast. The NPV may vary from ₹ 580 to ₹ 430 (a range of ₹ 150 or –14 per cent to +16 per cent from point forecast) due to the risk related to material cost. The NPV might vary from –11 per cent to +9 per cent, a range of 20 per cent or ₹ 100 NPV. The risk related to overheads could result in a 5 per cent range or ₹ 25 range of deviation in NPV.

The net present value is more sensitive to demand than material. Interpretation of data is the same as the previously described method. Pay-off matrix is constructed for the upper and lower side changes that may possibly occur in each factor. Some variables are steady by nature. All the committed fixed costs such as depreciation tax shield, lease rent and, insurance premium, are not subject to change. Also, some variables which may be otherwise subject to change may become fixed (at least partially) if appropriate actions are taken, for example, an agreement with another firm for a fixed quantity processing contract would narrow down the fluctuations in demand, or if plant and machinery can be used for manufacturing an alternate product, the variability of sales revenue may be reduced.

The result of pay-off matrix is used for taking a series of decisions. If coal supply and its price are uncertain but the cost of coal is an important variable, the project study team may consider options of (a) including coal mining and coal washing in the project or (b) signing up a contract or memorandum of understanding with a coal mining company for a fixed quantity supply at a fixed price. The risk involved in coal supply and price will reduce in either case, though (a) will increase the degree of operating leverage.

The project planning team has to apply sensitivity analysis in the appropriate form and at the right stages so that the need for collecting more information is identified at the minimum cost and necessary action is initiated for project risk management. Sensitivity analysis, thus is not only a tool for identifying the sources of risk, but also a guide for appropriately designing the project for better risk management.

Sensitivity analysis suffers some limitations:

- Interrelationship of factors is ignored and it assumes that only one variable may change
- Probabilities are not assigned to the possible outcomes

These two most important weaknesses of sensitivity analysis are often criticized. However, it does not fail in serving the basic purpose of it. Judicious application of sensitivity analysis surely benefits the process of project planning and designing. It is actually not meant for directly using in either measuring the risk or in selecting or rejecting a project.

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2. Measuring the Risk

Dispersion in net profit or NPV or IRR is the risk. Therefore, risk measures are the statistical methods that measure dispersion value. We will discuss the risk measurement methods in three parts: techniques of measuring risk, decision rules and finally some more tools of measure along with decisions on them.

Techniques of measuring risk: Measures of dispersion are the measures of project risk. Some of them use probabilities, others do not. Some consider default probability equal, if probabilities are not assigned. The following statistical techniques are useful in measuring risk.

- Range
- Mean absolute deviation
- Variance
- Semi-variance
- Standard deviation
- Coefficient of variation

In the following pages, we will introduce these techniques and introduce some decision rules. The decision rules are useful for mutually exclusive projects only because they ignore the important step of incorporating risk in the project data analysis. Introduction of decision rules here is just meant for explanation. The final step of incorporating risk in the project analysis will be discussed subsequently.

(i) Range: It is the difference between the highest and the lowest value of an outcome.

$$R_g = R_h - R_i \qquad \ldots(1.1)$$

Here, R_g = Range of distribution

R_h = Highest value

R_i = Lowest value

Range does not consider probabilities, nor does it consider other possible outcomes between the highest and the lowest values. Sensitivity analysers use range values in their application.

(ii) Mean absolute deviation (MAD): The terms 'mean absolute deviation' are quite self-explanatory. The sum of the differences between the mean and observations is taken at absolute value (sign is ignored) and it is divided by the number of observations to get the mean absolute deviation. Equation 1.2 gives the MAD formula.

$$MAD = \frac{1}{n} \times \sum_{i=1}^{n} P_i \left| R_i - ER \right| \qquad \ldots(1.2)$$

Here, P_i = Probability of ith possible value.

R_i = ith possible value of variable.

ER = Mean (expected value) of the distribution.

R_i – ER = Only absolute value is considered; negative is ignored.

n = Number of observations.

Expected return (ER) is calculated using the following equation,

$$ER = \sum_{i=1}^{n} R_i \times P_i \qquad \ldots(1.3)$$

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(iii) Variance: This measures the dispersion of data using the following equation:

$$Variance = \sum_{i=1}^{n} P_i \left(R_i - ER\right)^2 \quad \ldots(1.4)$$

The difference of value from the mean of distribution is squared to avoid a negative value. By squaring the difference, the values which are far away from the mean are attached more weight but it loses the comparability with the expected (mean) return.

(iv) Semi-variance: It is the same as variance but it considers R values only if $R_i < ER$ (i.e., only if there is a chance of getting less than the expected result). If $R_i > ER$, then zero value is taken for $(R_i - ER)$.

$$SV = \sum_{i=1}^{n} P_i \left(R_i - ER\right)^2 \quad \ldots(1.5)$$

Here, SV = Semi-variance

$(R_i - ER)$ is considered only if it is positive and negative $(R_i - ER)$ is taken as zero.

(v) Standard deviation (SD or σ): Variance cannot be compared with the expected (mean) return. Therefore, its root is taken in standard deviation so that it can be compared with the return.

$$SD = \sigma = \sqrt{Variance} = \sqrt{\sum_{i=1}^{n} P_i \left(R_i - ER\right)^2} \quad \ldots(1.6)$$

Standard deviation ignores the size of the project, therefore, comparison of two projects becomes difficult.

(vi) Coefficient of variation (CV): The size of a project is considered in coefficient of variation

$$CV = \frac{\sigma}{ER} \quad \ldots(1.7)$$

CV is the measure of risk (standard deviation) per unit of expected return. It is, therefore, useful in comparing risks of two projects with different sizes. A project with a lower coefficient of variation is accepted.

Example 1.1: *Risk Measurement*

Compute the six measures of risk for the outcome of an investment given in Table 1.3.

Table 1.3 *Risk Measurement*

Outcome (₹)	Probability
1100	0.2
700	0.5
600	0.3

Solution:

$$\text{Range} = 1100 - 600 = 500$$

MAD: First we need to calculate the expected return (ER)

$$ER = \{(1100 \times 0.2) + (700 \times 0.5) + (600 \times 0.3)\} = 750$$

$$\text{MAD} = \frac{0.2 \times |1{,}100 - 750| + 0.5 \times |1{,}100 - 750| + 0.3 \times |1{,}100 - 750|}{3}$$

$$= \frac{0.2 \times 350 + 0.5 \times 350 + 0.3 \times 350}{3} = \frac{70 + 175 + 105}{3} = \frac{350}{3} = 116.67$$

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For the rest of the calculations, the work as per Table 1.4 will be useful.

Table 1.4 *Standard Deviation*

P_i	R_i	$P_i \times R_i$	$(R_i - ER)$	$(R_i - ER)^2$	$P_i(R_i - ER)^2$
0.2	1100	220	350	1,22,500	24,500
0.5	700	350	–50	2,500	1250
0.3	600	180	–150	22,500	6750
	ER	750		Variance	$\sigma^2 = 32{,}500$
				Standard deviation	$\sigma = 180$

$$\text{Variance} = \sum_{i=1}^{n} P_i \left(R_i - ER\right)^2$$

$$= 0.2 \times (1100 - 750)^2 + 0.5 \times (700 - 750)^2 + 0.3 \times (600 - 750)^2$$

$$= 32{,}500$$

$$\text{Semi-variance} = 0.2 \times (1100 - 750)^2 = 24{,}500$$

This is upside risk because we took an observation higher than ER. We can calculate semi-variance and determine the downside risk by taking values less than ER. Note that the sum of both the semi-variances is equal to the variance.

$$\text{Semi-variance} = 0.5 \times (700 - 750)^2 + 0.3 \times (600 - 750)^2 = 1250 + 6750 = 8000$$

$$SD = \sqrt{Variance} = \sqrt{\sum_{i=1}^{n} P_i \left(R_i - ER\right)^2}$$

$$= \sqrt{32{,}500} = 180 \quad \text{(using variance) OR}$$

$$CV = \frac{\sigma}{ER} = \frac{180}{750} = 0.24 \quad \text{(using variance) OR}$$

Some Issues

The real-life issue of cash flow risk is more complicated. The complications creep in because of:

- Cash flows of the same period may be interrelated, for example, advertisement expense has an effect on sales revenue.
- Cash flows of different periods in the life of the project may also be interrelated, for example, if sales revenue of the first year is different, then the second year's sales revenue will be affected.

Statistical formulas are available to handle such correlated (interrelated) cash flow issues. However, it is true that the degree of correlation among different cash flow streams and over the two different time periods are just raw estimates. It is also true that in real life, one does not need a high degree of accuracy in project risk management. The risk assessment methods that we discuss here are adequate for its underlying purpose

of deriving managerial guidance for appropriate action, needed for mitigating risk at the project planning stage.

Decision Rules

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Two different decision rules are discussed in this section. They include: (a) EV rule and (b) coefficient of variation. A decision tree approach uses these two rules. These rules have their own limitations justifying the application of simulation method, which is also discussed later.

EV rule or mean variance rule

The expected return and variance (or standard deviation) are compared for taking the decision. It is also called 'mean-variance' rule. As per the mean-variance rule, the decision is taken by evaluating the investment on the basis of their expected return and variance. Standard deviation is also used in place of variance.

Let us refer to Figure 1.6. As per the rule, Project-A will be selected over Project-B, if one of the following two conditions holds true:

- Select a project that offers higher (or equal) expected return but has equal or less risk
- Select a project with lesser (or equal) risk but higher expected return

Applying these conditions to the risk-return profiles of four different projects depicted in Figure 1.6, any one will select Project A over Project B and Project C over Project D. But, between A and C, C is preferred and between B and D, D is preferred.

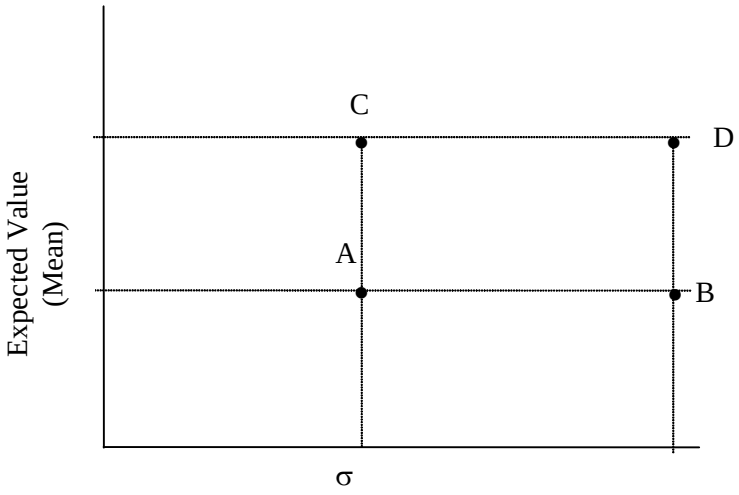

Fig. 1.6 *EV Rule and its Fallacy*

Limitations

There are two obvious limitations of the EV rule. One, it does not help when one project has higher risk but also offers higher returns; and two, it ignores the size of the project. Between Project A and Project C, which one would you prefer? EV rule cannot answer this question.

Least coefficient of variation rule

The coefficient of variation (CV) supposedly removes the limitation of EV rule. CV is the measure of risk per unit of return. The CV rule recommends selection of a project whose risk per unit of return is the least. In other words, the CV rule says 'accept the project with the least *coefficient of variation'*. It takes into account the size of projects.

Limitations

The CV rule has two limitations. One, it assumes that one expects the same premium per unit of risk; implying an assumption that the decision-maker is risk-neutral with equal marginal utility at all levels of risk. This is not true. Another limitation of the CV rule is clearly observed in the data of two alternative projects as per Table 1.5.

Table 1.5 *Limitation of the CV Rule*

Project A		Project B	
Return	**Probability**	**Return**	**Probability**
5	1	8	0.5
		18	0.5
ER = 5		ER = 13	
$\sigma = 0$		$\sigma = 5$	
CV = 0		CV =0.385	

Project B is riskier than Project A as per standard deviation and coefficient of variance. The CV rule will favour the selection of Project A. However, common sense would say that Project B and not A is preferable. The minimum return offered by Project B is higher than the risk-free return offered by project A. Project B does not appear to be risky by any means, though statistically it is risky.

Readers must have noticed that both the decision rules we discussed can be applied only if alternative projects are under comparison. In that situation too, the decision rules are not foolproof.

Decision Tree Approach

Some investment options involve a set of decisions from alternatives in the future point of time. Future decision would be dependent on today's decision. Many decision nodes in future make a tree of decisions, where the future options depend on the current choice. The decision tree approach comes handy in deciding about projects with such features. Usually, after the tree is prepared it is rolled back to determine branches that are obviously eliminated because of negative NPV. Then from the remaining options of branches alternative sets of projects are identified and EV rule is applied for the elimination of some more alternatives. If at the end of the process, there are more than one alternative, none of which can be eliminated on the basis of EV rule, then either CV rule is applied or a decision-maker will use judgement in making the decision.

Simulation

Sensitivity analysis suffers from two basic limitations; it ignores probabilities and it considers change in only one variable at a time. In real life, all critical variables are likely to vary from its forecast. A decision-maker may not feel confident if all critical factors are not included in a single analysis and that too without probabilities assigned to them. Sensitivity analysis, therefore, cannot be applied if the decision-maker wants to get a full picture of risk before making a decision. The simulation method is prescribed as a solution.

Monte Carlo simulation in particular is very useful in project risk analysis. It is a complex method and hence, use of computers and special purpose software becomes a necessity. How is the Monte Carlo Simulation carried out? The procedure is as follows:

- Establish a relation between the net present value and the project parameters and exogenous variables affecting NPV. This is basically the calculation of NPV or IRR using all variables, which is done in any project analysis whether risk is studied or not.

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- Forecast various outcomes for each variable and assign probabilities to them.
- Ideally, take all possible permutations-combinations of all possible outcomes of all variables and calculate the NPV or IRR for each one of them. Taking all permutations-combinations may be extremely difficult and for real life application, it may not be needed either. Therefore, take a few but significant numbers of randomly selected permutations-combinations (iterations).
- For each of the iterations, select a value for each forecast parameter.
- Calculate the NPV for the values of parameters selected in each iteration.
- Repeat steps 4 and 5 for the number of iterations selected.
- Now, one NPV is available for each run or iteration. Plot the frequency distribution of the net present values obtained for all iterations.

The occurrence (outcome) will be random and not predetermined. Therefore, the concept of random number has come. Two features are combined in the Monte Carlo simulation:

(a) It has a realistic assumption that some or all variables may change but randomly. It considers values for several possibilities of outcomes; any one of them may become a reality. However, a large number of parameters and associated parameters would mean almost infinite numbers of permutation combinations.

(b) Random number selection pays due attention to probabilities. Thereby, even if the number of runs (iterations) is less than the total permutations-combinations, the resultant frequency distribution is fairly representative. A large number of runs is, therefore, advisable.

Let us look at the frequency distributions of the net present values of three imaginary projects. Three simulations, one each for projects A, B and C are carried out and the resultant three simulation graphs are superimposed on each other as shown in Figure 1.7.

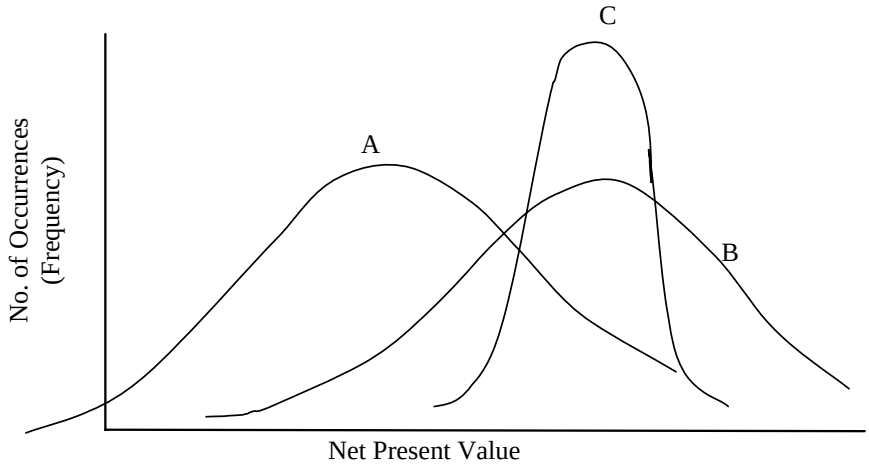

Fig. 1.7 *Simulation Result of Three Projects*

Decision rules: The Monte Carlo simulation method gives the profile of outcome with due recognition of probabilities. However, the decision rules are not given, nor can they be prescribed. However, if the expected return and standard deviation are calculated, then the same decision guideline can be drawn. The basic rules and approaches still remain the same as in the EV and CV rules. In the cases charted in Figure 1.7, the following observations and decisions may be considered:

(i) Project B seems to have a clear edge over Project A. Project B has higher expected value (B is on the right of A) and at almost equal dispersion (or standard deviation) compared to A.

(ii) Between Project B and Project C, the risk perception of the decision-maker will have a greater effect on the choice. Project C is less risky though it seems to be giving the expected net present value almost equal to B. The chance of earning that expected NPV is higher (see the height of the peak) in case of Project C. However, some decision-makers who have the confidence of 'making things happen' would definitely like to pay attention to the chance of earning a higher NPV (they look at the right of the graph). One may look at the left, at the right, at the height and also at the dispersion. The final decision will depend upon what alerts them and what lures them. The decision-maker may seek support to graphic visual and obtain some or all of the following statistical data related to all the projects for taking a decision.

- Maximum NPV (right of graph)
- Minimum NPV (left of graph)
- Standard deviation of NPV (spread of NPV curve)
- Expected NPV
- Z-value

The value of simulation lies in its comprehensiveness. It may be difficult to use it but with easy availability of computer programs and computer skills, the simulation models have started finding users in the industry. Especially, the problems where probabilities can be assigned, like product development in the consumer non-durable segment, the simulation model is applied. Simulation is quite successful in giving a comprehensive picture of the project risk.

3. Incorporating the Impact of Risk Factors on Decision Making

The various techniques of risk analysis studied so far can help in determining which project has a better risk-return balance. However, these techniques do not suggest how to incorporate risk analysis in either project design or in decision-making.

Pay-off and regret models are useful in providing a systematic approach and selection of a project design that can be justified on the basis of the risk profile of the project. And either cash flow or cut-off rate must be adjusted with the risk profile of the project so that projects with different risks can become comparable. Thus, in this section, we will discuss the following three distinct methods for incorporating risk in the investment analysis:

- Pay-off and regret models
- Cash flow adjustment or certainty equivalent method
- Adjustment in discount rate or risk-adjusted discount rate

(i) Pay-off and regret models

Sensitivity analysis can be extended into the decision models for taking a risk-based project decision. In the sensitivity analysis, (a) the most important factor is identified and (b) the most favourable and the most unfavourable scenarios of that factor are forecast. With the extension of sensitivity analysis into the pay-off matrix and the regret matrix, these scenarios of significant variable are further leveraged. The outcome (risk) cannot be altered but the project design can be. If demand was the significant variable having

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vital relevance to project viability, then the project capacity may remain idle if the most unfavourable levels of demand transpire in the future. Similarly, the capacity may be found inadequate if demand turns out to be most favourable. Therefore, a question is asked — Can we have a new project strategy (in terms of capacity, product quality, technology, etc.) which may possibly best suit the lowest estimated demand? Similarly, can we redesign a project to suit the most favourable outcome of demand? Now, the project planning team has got three mutually exclusive projects:

- A *low investment strategy* that best fits the lowest demand
- A *medium investment strategy* which suits the most likely scenario
- A *high investment strategy* matching the most favourable outcome

Net present values are calculated for all the three investment strategies for each possible outcome of a most important variable. The resultant NPVs for an imaginary case is given in Table 1.6.

Table 1.6 *Pay-off Matrix for Alternative Investment Strategy*

Investment Strategy	NPV at Demand		
	Most Unfavourable	**Most Likely**	**Most Favourable**
Low	455	485	560
Medium	400	500	650
High	350	450	720

Low strategy is ideal for the most unfavourable outcome but if the outcome is better than that, the incremental NPV may be less because of either lost demand or subcontracting. Medium investment strategy is suitable for the most likely scenario of demand; if the actual demand turns out to be low, the fixed cost burden will reduce its NPV; if the actual demand turns out to be high, then it will earn a higher NPV but it may be less than the one offered by a high investment strategy.

Maximin decision rule (pay-off model)

Pay-off model is also called 'maximin model' because that is the decision rule applied here. This rule is applied in two stages:

(a) Take the minimum NPV offered by each investment strategy (horizontal reading)

(b) Select that strategy of investment whose minimum NPV is the highest among the minimum NPVs of all strategies

NPVs in bold in Table 1.6 are the minimum NPVs offered by the respective strategies. The maximin criterion would favour investment in low strategy as its minimum NPV is ₹ 455 which is higher than minimum NPVs of medium (₹ 400) and high (₹ 350) strategies. The maximin decision rule offers a conservative choice of project, as it considers only the downside risk.

Minimax decision rule (regret model)

Maximin approach is conservative; it helps those who are worried about downside risk. Another approach looks at the 'regrets' and attempts to minimize the maximum regret. It is called 'minimax' decision rule based on the regret model.

Table 1.7 is a regret table prepared from the pay-off matrix given in Table 1.6. The values in Table 1.7 are found this way — if we selected the low strategy and actual demand turns out to be most unfavourable, then we will get an NPV of 455 (Table 1.6), which is the highest that any strategy would have offered in the most unfavourable outcome. Therefore, Low Strategy has no regret if the most unfavourable

outcome happens. But, the Low Strategy's NPV will be less by ₹ 15 NPV than the best NPV earned by medium strategy if the most likely outcome occurs, that is the regret of the low strategy for the most likely outcome. Low strategy and most favourable outcome would offer ₹ 160 less NPV, which is a regret as compared to the high strategy best for this situation. Thus, medium strategy and most unfavourable outcome have ₹ 55 regret (455 – 400), and so on. Read all regret values in Table 1.7:

Table 1.7 *Regrets of Different Strategies for Different Outcome*

		NPV at Demand		
		Most Unfavourable	**Most Likely**	**Most Favourable**
Investment Strategy	Low	0	15	**160**
	Medium	55	0	**70**
	High	**105**	50	0

The minimax decision rule recommends the decision in the following steps:

(i) Take the value of maximum regret that may be possible in every investment strategy (horizontal reading)

(ii) Select the investment strategy whose maximum regret is the least among all

In Table 1.7, the medium strategy's maximum regret is ₹ 70, which is the lowest as compared to maximum regrets of ₹160 offered by the low strategy and ₹105 by the high strategy. Therefore, a decision-maker who looks at the risk in a reasonable way would select medium investment strategy.

Pay-off and regret models do not fully integrate risk in the analysis. They only consider the range as the measure of risk. They ignore probabilities. This works with only one sensitive variable. However, this is only the model that lays emphasis on redesigning the investment strategies to suit the outcome. The managers may not have control over the outcome but can definitely adjust their plans to make it suitable in various scenarios. These models, therefore, have their own place in the field of total risk management in capital budgeting.

Pay-off and regret models recognize risk better but they do not numerically incorporate risk in the evaluation nor consider probabilities. Risk can be mathematically incorporated in the analysis in two different ways, namely (a) adjusting cash flow and (b) adjusting discount factor. The former one lowers down the figure in the numerator of the NPV formula using the 'certainty equivalent'; whereas the latter inflates the denominator, using risk-adjusted discount rate. These two methods are discussed hereafter.

Certainty equivalent approach

The net present value formula uses cash flow in the numerator and discount rate in the denominator. Cash flow is a risky one. The certainty equivalent approach multiplies the risky cash flow with the certainty equivalent factor and converts it into the equivalent risk-free cash flow. The formula for 'certainty equivalent factor' is given in Equation 1.8.

$$CEF = \frac{Certainty\ Equivalent\ Value}{Expected\ Value} \qquad \ldots(1.8)$$

Here, CEF = certainty equivalent factor, which is always less than 1.

Certainty equivalent cash flow = Expected value × Certainty equivalent factor

The higher the risk, the lower will be the certainty equivalent factor and lower will be the risk-adjusted net present value. Certainty equivalent value can be determined in theory

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by looking at the slope of the utility curve. However, the utility curve is more of an imagination and therefore, the certainty equivalent value will at most be judgemental and cannot be accurate.

Risk-adjusted discount rate

It is practically easy to adjust risk in the discount rate; rather than in the cash flow. This means that, the cash flow of the project should be discounted at the rate that incorporates risk in it, rather than at the risk-free rate.

$$RADR = R_f + R_p \quad \ldots(1.9)$$

Here, R_f = Risk-free rate

R_p = Risk premium

The 'adjusted weighted average cost of capital' method is used for determining the risk-adjusted discount rate. If we use risk-adjusted discount rate, then cash flow should not be adjusted.

Thus, use of pay-off matrix or regret matrix for redesigning of projects and then selecting the one among them is one step that must be followed by risk adjustment in NPV calculation.

1.3.2 Project Selection and Formulation

Earlier, firms considered projects as a part of their strategy and functions; but now-a-days firms are getting specialized in executing projects. Each and every project is important for the firm and requires proper development and implementation strategies.

Project manager should select only those projects that ensure returns in the near future. This is because it helps in allocating the resources that aim at ensuring better returns. Therefore, proper decision-making process is essential for the selection of the project. While selecting a project, the following considerations should be kept in mind:

- **Realism:** The project selection model should consider all the risk factors such as the cost and time that influence the decisions of a project manager. The model should also explain the objectives of the project manager and the firm.
- **Capability:** The selection model should help the project manager take appropriate decisions by considering the risk and constraints involved in the project. The selection model should be capable of evaluating the future project proposals on the basis of the expected returns of the project.
- **Cost:** The various costs associated with the right project selection model should be kept at the minimum level. The costs incurred in designing a project selection model consists of data generation, processing and storage expenses. The objective here is to identify the best project selection model.
- **Flexibility**: The project selection model provides the desired results within the stated conditions of the firm. The model should be flexible enough to adjust with the environmental changes of the firm.
- **Easy usage**: The project selection model is convenient enough to implement inside the firm.

Project Selection Models

Project selection models help the project manager in selecting a project. There are two types of project selection models-numeric and non-numeric.

1. Numeric Models

These models use numbers as input for selecting a project. Numeric models are of two types:

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- **Profit or profitability**: These models consider monetary and non-monetary factors. The biggest advantage of the profitability model is that it is easy to understand and use. Following are the types of profitability models:
  - *Payback period:* This is the easiest way of analyzing project ideas. Payback period represents the time the project takes to return the money spent on the project. The payback period is calculated from the following formula:

$$\frac{\text{Cost of the project}}{\text{Annual cash inflow from the project}}$$

  - *Average Rate of Return (ARR):* The project manager selects the project that provides reasonable return against the investment made. ARR is the simplest way of calculating the return on investment. Following is the formula of ARR:

$$\frac{\text{Annual cash Inflows} - \text{Depreciation}}{\text{Initial Investment}}$$

In the above formula, depreciation is calculated by using the straight-line method,

$$\frac{\text{Cost} - \text{SalvageValue}}{\text{Useful Life}}$$

- **Scoring**: These models involve multiple decision criteria for selecting a project. In scoring models, the decisions are taken after discussions between the project team and the top-level management. Following are the types of scoring models:
  - *Unweighted 0-1 factor:* The management lists the factors that are considered in rating a project. Management consists of a team of raters who help selection of the project. The people involved in the team must be familiar with the organizational goals. In this model, the list of factors is provided to the team of raters and the project is selected on the basis of the score given to it. The benefit of using this model is that it gives equal importance to the opinions of all raters on the basis of which the final result is obtained. Table 1.8 shows the rate sheet for a project.

Table 1.8 *Rate Sheet for a Project*

Project: Rate: Date: Mark () in the appropriate place for each factor		
Particular	Qualified	Not qualified
1. Potential market size		
2. Research break-even with 4 years		
3. Requirement of new facilities		
4. Manageable with current employees		
5. Requirement of extra consultants		
6. Need for external consultants		
7. Requirement of redesigning organization structure		
8. Innovativeness of the project		
Total Score		

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- *Unweighted factor scoring:* In this model, the raters can select any of the values on the scale of 1 to 5 in which 5 is very good, 4 is good, 3 is fair, 2 is poor and 1 is very poor. Table 1.9 shows the profit rating of a project.

Table 1.9 *Profit Rating of a Project*

Rates	Profit for next 2 years (in ₹)
1	Below 1 lakh
2	1-20 lakh
3	20-50 lakh
4	50 lakh to 1 crore
5	Above 1 crore

2. Non-numeric Models

These models use discussions and suggestions as input for selecting a project. These models are constructed on the basis of subjective evaluation of the ideas and opinions of the project manager and the project team. Following are the types of non-numeric models:

- **Sacred Cow**: These are models in which higher officials such as the CEO of a company supports the project.
- **Q-Sort**: This helps in preparing a list of projects that are on priority. In this technique, the project manager gathers the ideas of the project and then classifies them as good, fair or bad. The classification of the project is done on the basis of the market potential, economic and technical feasibility, risks involved and the level of competition.

1.3.3 Greenfield's Project

A Greenfield project is one which is not constrained by prior work. It is constructing on unused land where there is no need to remodel or demolish an existing structure. Such projects are often coveted by engineers.

Some examples of Greenfield projects are new factories, power plants or airports which are built from scratch. Those facilities which are modified/ upgraded are called Brownfield projects.

1.3.4 Special Economic Zone Projects

Special Economic Zone (SEZ) is a specifically delineated duty free enclave considered to be a deemed foreign territory [within India] for the purposes of trade operations, duties and tariffs. SEZ, thus, is a geographical region where the fiscal and economic laws are more liberal as compared to the business undertakings in the Domestic Tariff Area (DTA).

The entire SEZ area is divided into Processing and Non-processing area.

- **Processing Area:** This is in which the core business activities of the SEZ is undertaken by the approved units. At least 50 per cent of the SEZ area has to be processing area.
- **Non-processing Area:** This is in which the support infrastructure is created, primarily to cater to the needs of the employees working in the SEZ.

- SEZ scheme has following two important constituents:
  - o **Developer/ Co-developer:** Who establishes the entire SEZ. There can be more than one Co-developer(s). Usually, the infrastructure in the non-processing area is developed by the Co-developer(s).
  - o **Entrepreneur:** Who sets-up unit in the SEZ.

The State Government shall forward proposals received, along with its comments on the following to the BoA to the effect that –

- The area incorporated in the proposed SEZ is free from environmental restrictions;
- Water, electricity and other services would be provided as required;
- The units would be given exemption from electricity duty or tax on sale of electricity for self generated and purchased power;
- The generation, transmission and distribution of power within SEZ will be allowed;
- The State Government shall endeavour to provide exemption from State sales tax/ Value Added Tax (VAT), octroi, mandi tax, turnover tax and any other duty/ cess or levies on the supply of goods from DTA to SEZ Units;
- For units inside the SEZ, the powers under the Industrial Disputes Act and other related labour Acts would be delegated to the Development Commissioner and that the Units will be declared as A Public Utility Service under Industrial Disputes Act;
- The State Government shall announce its Policy on SEZ supported by requisite notifications before recommending any proposal for setting up SEZ in the State
- Single point clearance system and minimum inspections requirement under State Laws/ Rules would be provided.
- The SEZ scheme has generated tremendous response from the investors, both in India and abroad. The SEZ scheme generated domestic and foreign investment to the tune of INR 2,36,716 Crore (as of 31 March 2013):
- Further, the exports from SEZs have also shown robust growth year after year. The value of physical exports during last three years is as under:

Table 1.10 *Export from Special Economic Zones*

Export from Special Economic Zones			
Year	**Physical Exports from SEZs (in INR – Crores)**	**Physical Exports from SEZs (in USD – Million)***	**Growth rate (over the previous year)**
2012-13	4,76,159	87,546	31%
2011-02	3,64,478	68,769	15%
2010-11	3,15,868	65,806	43%
2009-10	2,20,711	46,521	121%
2008-09	99,689	21,675	50%
2007-08	66,638	16,560	93%
2006-07	34,787	7,629	51%

**Source: EPCES Annual Report*

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Adoption of Technology

If there is an ample market demand without enough supply, the focus should shift over to technology. The following inquiries must be made with respect to technology analysis:

(a) Availability of commercially exploitable technology and its alternatives.

(b) Transferability of those technologies

(c) Other inquiries about the technologies
- Normal capacity utilization
- Requirement of plant and equipment and fabrication facility
- Production process needed
- Possible product mix
- Possible alternate usage
- Flexibility
- Rate of change
- Waste disposal

(d) Risk implications

(e) Resource availability

Investment Planning

Over the past few decades project management has been introduced into knowledge workplaces to enable increased discipline to the way investments are shaped and managed. Project management methodologies were originally developed to increase the certainty that a defined solution would be implemented as planned. In doing this, project management enables the following questions to be answered:

- Will the project complete within budget?
- Will it deliver to its planned schedule?
- Were the expected products delivered?

From the perspective of the investor, what is missing are answers to the following:

Before an investment decision is made

- Is the logic for the planned investment clear?
- Is there a sound case to invest?

After the project is delivered

- Were the expected benefits delivered?

Investment management and project management are complementary disciplines that, together, enable an investor to shape and implement good investments.

Check Your Progress

3. What is conception/ formation phase?
4. Which is the last phase of the project life cycle?
5. Mention the advantage of using life cycle concept in the development of a system.

1.4 PROJECT PLANNING

Project planning refers to a procedural step in project management. During project planning, required documentation is created to ensure successful project completion. All actions required to define, prepare, integrate and coordinate additional plans are included in documentation. The project plan clearly defines how the project is executed, monitored, controlled and closed. Project planning requires an in-depth analysis and structuring of the following activities:

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- Formulation of project goals
- Identification of project deliverables
- Creation of project schedules
- Creation of supporting plans

These activities are discussed ahead under the project planning process.

At the end of the project planning stage, the following are identified:

- Obstacles in the project
- Minimum time required for the completion of the project
- Major deliverables of the project
- Work required for the completion of the project
- People involved in the project and their key responsibilities
- Required milestones of the project

Project planning is never really complete until a project is done. The project plan may return to the planning stage many times before it is accomplished. Usually, the length of the project planning stage is determined by project complexity.

1.4.1 Objectives of Project Planning

It is essential to clearly set the objectives of project planning. Clear objectives result in a higher rate of project success. Once you have defined the objectives of your project, the tasks leading towards these objectives can easily be identified. If a sailor, for example, knows where the fish are, he can direct his boat to the proper spot. So is the case with project planning.

Setting Good Objectives

Since good project plans require good objectives, it is imperative to know how to write good objectives. Good objectives are finite in scope and duration. They can be measured. They are realistic. They are clear and they require actions to complete. They have every element of being achievable if the project plan is followed. Thus, good objectives are specific, measurable, action-driven, realistic and time-bound (SMART).

Examples of Bad Objectives

Below is a list of some poorly written objectives:

- To increase the number of clients
- To make customers happy
- To create some sort of new product
- To find funding
- To eliminate quality problems
- To make more money
- To achieve success
- To share knowledge

These objectives are bad because they lack specifics, they do not rely upon actions, or they focus upon a means to an end rather than an end.

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1.4.2 Process of Project Planning

As mentioned in the definition of project planning, project planning is a four-step process.

Step 1: Setting project goals

A project is said to be successful only when the requirements of the stakeholders have been met. A stakeholder refers to anybody directly or indirectly affected by the project. As a first step, it is vital to recognize the stakeholders in your project. The examples of stakeholders include the project sponsor, the users of the project outputs, the customer who receives the deliverables and the project manager and project team. After you have identified the stakeholders, the next step is to find out their needs. The next step is to prioritize the needs of the stakeholders of the project. From the prioritized list, you need to create a set of goals that can be easily measured. A technique for doing this is to review them against the SMART principle. Once you have determined your goals, you need to record them in the project plan.

Step 2: Project deliverables

On the basis of the goals set in step 1, you need to create a list of things the project needs to deliver to meet those goals. At this step, it is specified when and how each item must be delivered. The deliverables are added to the project plan with an estimated delivery date. More accurate delivery dates are established during the scheduling phase.

Step 3: Project schedule

Now a list of tasks that need to be executed for each deliverable identified in step 2 is created. For each task, identify the amount of effort (hours or days) and resources required to complete the task. After establishing the amount of effort for each task, it becomes easy to workout the effort required for each deliverable as well as an accurate delivery date. Update your deliverables section with the more accurate delivery dates.

Step 4: Supporting plans

This section deals with plans you should create as part of the planning process. These can be included directly in the plan.

Effectiveness of a project is a function of a better understanding of activities and critical success factors at various stages of the project. Any project will typically pass through four stages. The first stage is the conceptualization stage, followed by the planning, execution and termination or clean-up stages. Table 1.11 summarises the stage-wise project activities and critical success factors of a project.

Table 1.11 *Activities and Critical Success Factors at Different Phases of a Project Life Cycle*

Concepualization	Planning	Execution	Termination
Identify need Establish feasibility: • Programme Process Schematics	Develop: • Plan • Block diagrams • Sketches • Standards Conduct studies	Set up organization Working drawings and specifications Design review Procure equipment Procure construction services	Train operators Transfer materials Document results Transfer Responsibility Release resources Reassign project

• Sketches and outline • Basic budget and schedule • Project team • Financing Identify alternatives Present proposal Obtain approval to proceed	Select equipment Reconfirm Economics Develop: • Budget • Schedule • Cash flow Prepare and submit project brief Obtain approval to implement	Produce physical entity Quality assurance Modify as required	team
Hypothesized Dominant Critical Success Factors **Phase 1** Conceptualization Project mission Client Consultation	**Phase 2** Planning Project mission Top management support Client consultation Client acceptance	**Phase 3** Execution Project mission Schedules and plans Trouble shooting Client consultation Tech. task personnel Communication Monitoring and feedback	**Phase 4** Termination Project missing Technical task Client consultation Client acceptance

1.4.3 Project Construction Alternatives

Three distinct alternatives for project construction are as follows:

1. Turnkey Project Construction

In a turnkey project construction, the firm will assign a single contractor, a contract to construct the entire project as per specifications. The project contractor, in turn will have to line up all resources, assign sub-contracts, erect the project and hand over the key, which the firm has simply to turn on and start the commissioning of the project. A firm's manpower continues to remain focussed on its current business activities. This kind of arrangement is costly but convenient. Small businesses, whose resources are scanty, under stress and lacking expertise for project construction, may find this alternative very convenient. Even a large firm may see advantage in this alternative in some situation, for example, a large firm that has no experience of constructing a project in a foreign country may like to opt this alternative.

A turnkey contractor brings expertise, experience and resources for project construction. But, at the same time, turnkey construction alternative has its own challenges. The challenges are in terms of contracting and contract management. Contracting involves writing a legally tenable contract, which also facilitates a clear understanding on the parts of both sides and leaves room for flexibility much needed in project design. Contract management involves quality and time supervision at the contractor's and their sub-contractors' sites, design change management together with their implications on cost and time. If these aspects are left unattended, a turnkey project is most likely to become expensive and finally unviable.

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2. Completely Self-executed Project

In a completely self-executed project, a firm will deploy its own internal manpower or hire experts to construct every work structure of the project. Resources are bought and plant is erected without the help of any external expert. It only involves supply contracts, and therefore, contract and contract management are of less significance in this alternative. However, it puts a tremendous amount of stress on the current manpower of the firm. People's energy will be split between routine operations of current business activities and non-routine project construction activities with multiple reporting in the hierarchy of the organization. Conflict in priorities and absence of necessary skills may cause more harmful effects on project efficiency. However, small projects can best be constructed like this as it offers the best possible control over all the resources and activities.

3. Self-executed Project with Several Contracts for Sub-activities

Most projects, in normal circumstances, are self-executed projects with several sub-activities contracted out to expert agencies. The balance between hiring expert construction agent and use of own manpower depends on the availability of internal manpower, their skill set and the ability to manage several external contractors. Contracting and contract management is surely an issue here, but additionally the issue is of coordination among all contractors and self-executed activities. This alternative offers an opportunity for efficient construction if coordination is achieved.

Planning, monitoring and coordination tasks significantly vary depending upon the project construction alternative selected by the company.

Factors in the Choice of Project Construction Alternatives

There are advantages and disadvantages of each project construction alternative. The choice should be made after weighing several factors, some of which are listed as follows:

- Type of project
- Cost of alternative
- Internal availability of resources and expertise
- Existing management information system
- Organization structure of the company
- Company's strategic route and growth rate requirement

Turnkey contracts may be little costly, as the turnkey construction. Contracting smaller work packages may be less expensive but coordination among contractors would require solid legal and management skills. A self-constructed project could be cost effective but demands special skills and expertise in project management. If the firm does not possess them, then venturing into construction of a project on its own may turnout to be catastrophic. Self-construction may not be favoured even if resources are internally available, if the company's management information system (data capturing, processing and reporting) is not geared up to meet the needs of project construction. A weak MIS may be prove to be expensive. The most important factor is a company's organization structure. Strong functional structure with hierarchical awareness and a strong line of

command leave no scope for self-execution of a project. Inflexible, rule-oriented and demotivated workforce implies that the firm is not capable to handle the project on self-construction basis.

In case of external growth strategy, where the growth of the firm is sought via mergers and takeover, the firm's options are limited. Merchant bankers may be hired for arranging merger and takeover, but post-merger activities have to be managed on ones' own, no agency support is available. A fast growth company is less likely to go for self-execution of projects, though we have seen Reliance Industries growing leaps and bound with internal growth options.

A firm must weigh each of factors before selecting the most suitable alternative for the construction of the project.

Whatever be the project construction alternative selected, a project manager has to rely largely on one or more contractors, many of whom would be project management professional companies. In case of a turnkey project construction option, one has to select a professional company that specializes in the construction of type of projects on hand. In other cases, one may have to select several professional companies expert in various fields such as engineering design, engineering services, engineering erections, fabrication and transportation, civil construction, interior design, project coordination services and others.

1.4.4 Project Scheduling

Project scheduling enables a project team in assessing the time available to complete a project. It facilitates the project manager in assigning responsibilities and getting tasks accomplished. Hence, a large number of project managers depend upon project schedules to set deadline limitations for projects.

Project scheduling takes into consideration the tasks need to be carried out for a project and allocates time limit for their completion. The project scheduler fixes these deadlines by estimating the time given to each task. Scheduling requires an elaborate insight of which action needs to get taken and when. This is discussed in detail in Unit 3.

1.5 PROJECT IMPLEMENTATION AND CONTROL

Project implementation is the most difficult and challenging task in project management. Project execution or implementation it involves several people and teams with different skills, abilities and priorities, constant coordination and adjustment in planned activities, conflict with routine operations of business because of overlapping project organization structure and several such issues. In the following section, we will discuss the topics very essential for care and caution during project execution.

1.5.1 Goals of Project Implementation

The implementation of a project must aim at the following:

- Efficient coordination among all sub-units of project teams and their activities
- Enabling changes in project design appropriate for the final outcome of the projects
- Discouraging those changes in a project design that may not be essential for the final outcome of the project

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Check Your Progress

6. Define project planning.
7. When is a project considered to be successful?
8. Mention the four stages that any project passes through.

- Completing the project within the targeted cost and time
- Minimizing variations in the standards of performance

Action

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Each project sub-team is on action at this stage. Resources are acquired and collected at the site on time; the project sub-teams follow the technical volume of the DPR, build the work package assigned to them and keep records as expected from them. More of technical tasks and resource acquisition tasks are done at this stage.

Possible Mistakes During Execution

The complexities of activities, their interdependence for time, cost and performance and empowered sub-units of project teams often create situations where some unintended mistakes may be made during the execution stage. Many of these mistakes may not be noticed until it is too late. The following is the list of potential mistakes often made during the execution of projects:

- Design change of non-essential nature which may cause delay and extra costs.
- Adding new features and provisions, though they may not have much added value. This occurs more often in support and peripheral assets of the project and not so much in the core assets of the project
- Slow response to unfolding unexpected event, which may delay the project and add to the cost
- Very fast responses to unfolding events, even if the activity is not on the critical path and there is enough slack time
- Excessive cost consciousness that may cause adverse impact on completion time and project performance

These common mistakes can be minimized through better project organization and through a proper system for execution and control of projects.

1.5.2 Monitoring and Control

A detailed project report (DPR) gives a full description of work packages, time schedule and cost budget. In the control process, information on actual cost, time and performance is compared with these estimates. The comparison may be made either on reaching every designated milestone in the project or at specified time intervals. In the former case, there is the problem of matching time and in the latter case, there is the problem of matching work packages to the work actually done. It is likely that some work packages will be partially complete on the reporting date and this makes it necessary to estimate their percentage of completion as a basis for comparing the actual time with the scheduled time. A similar procedure must be used for cost comparisons.

Management is concerned with the following three basic questions during the execution stage:

(a) Is the project likely to be finished by the scheduled completion date?

(b) Is the completed work likely to meet the specifications prescribed at the time of approval of the project?

(c) Is the work likely to be done within the estimated cost?

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If at any time during the course of project execution, the answer to any of these questions is negative, the management would like to know the reasons and alternative corrective actions, if any. These three questions cannot be considered separately from one another, for it is sometimes desirable to make trade-off among time, quality and cost, for example, overtime might be authorized in order to achieve timely completion of work but this would add to the costs; or some of the specifications might be relaxed in order to reduce costs. In any case, a project control system must be structured for effective handling of these three dimensions.

It is desirable to identify the relative importance of quality, time and cost for each work package at the planning stage, so that the project team members can use their judgement regarding what can be compromised and what cannot be.

In addition to the key areas, there has to be provisions for reports and review meetings in the project control exercise.

The Monitoring System

A monitoring system must be objective-oriented. The objectivity can be embedded by initially identifying the key factors to be monitored at various stages of project construction. It helps in defining exactly activities, specifications and costs that needs to be controlled. For example,

- Activities on a critical path are essential for monitoring time.
- Technical specifications of critical work packages are important to monitor the project to avoid failure. Usually, some core assets are important in their specifications, and there may be very little tolerance in constructing these work packages. Some support assets are also critical for the success of projects. For example, the design and specifications of a factory building is more critical than that of an office building.
- Some work packages are more sensitive to price. They must be monitored for costs even if they are not on the critical path.

It would help to define the tolerance limit (acceptable variances) in terms of specifications, schedule (time) and costs for various important work packages to make it easier for adding objectivity in information system; it would also help in the review of progress. Later, in the MIS reports the activities whose variances are beyond the tolerance limit must be flagged to draw the attention of the user.

Some important issues must be addressed in advance of undertaking a project. For example,

(a) When the data must be collected and communicated to the data processing centre for generating reports. Some data is easily available and some need special efforts in documenting them, whereas, some data is not available at the time they have to be communicated. How are such non-availability situations handled?

(b) Several types of data must be collected for measuring the progress of a project. In addition to the financial data (rupee value information), one would need data on percentage work done, inspection results to report technical performance data, information about changes in specifications if any, with supportive evidences and observance of procedures and implications of change on the subsequent project activities, if any, and so on. The list may be endless.

(c) Some data is just narrative information but need documentation and communication.

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(d) Some subjective information has to be reported a standardized numeral rating format. What are they, how should the management information assign numeric rating and report them?

(e) One of the most important issue is designing the data collection system, including format design and procedure.

Thus, a well-focussed project information management system will have a clearly defined focus, a well-designed approach for data collection and data reporting. These issues are further explained in the subsequent sections.

Key Areas of Monitoring

Key areas of monitoring are the same as the key elements of projects. They are (i) time, (ii) cost and (iii) performance. Performance has two dimensions; namely work quantity and work quality. There should be constant monitoring of these elements during the project execution phase. These three are interrelated, still it is difficult to put all these three together and develop a single parameter for their monitoring. Earned value (EV) project management is useful here.

Management Information System (MIS) for Project Control

Goals of project review are achieved through the measurement of actual progress of project construction and comparison with the original plan. A well-designed management information system is needed for doing this job. Every firm is likely to have some formal and informal management information systems for its business operations. The same management information system cannot be relied upon for the project management, because the information system issues in project management are completely different. Project activities are different from the routine operating activities, procedures are different, locations of activities are different, priorities are different, stakes are high, need for quick corrective steps is strong; these and many other factors make essential to have a specially designed management information system for project management.

The management information system for a project would initially serve the purpose of project monitoring and control and also the purpose of project reviews.

1.5.3 Review Meetings and Reports

Reports are studied and interpreted to find out the need for taking corrective actions. Review meetings are essential for brainstorming on the highlights of reports. The objectives of review meeting are listed as follows:

Objectives of Review Meetings

- Controlling multidisciplinary activities at the higher level
- Involvement of all key personnel
- Comprehensive understanding of project situation and potential problem
- Cross-validation of current data for true picture of project status
- Interactive mode, therefore early identification of potential problem
- Action oriented; corrective action can be defined and assigned
- Synergism, unifying force

There are three types of reviews needed:

(i) **Technical review:** This review is carried out at the task level. The task leader calls a technical review meeting and it is attended by all task force members. It is held regularly and frequently. Task status review is the main purpose of technical review. It checks the appropriateness of technology, equipment, etc., so that if need be, some specifications can be changed with a view to make the project viable.

(ii) **Design review:** This review meeting is held at the sub-system level and system level. The design of the project often undergoes change during execution. The reasons are plenty. The existing constraints of land, building, local environment, non-availability of equipment, change in raw material specifications, local weather conditions, energy supply condition, quality of water available, change in government regulations, etc., may require the project team to consider the changes in design in the midway course.

(iii) **Programme review:** This review is a high-level review which involves key personnel from all functional areas. The firm that is proactive may like to review the suitability of the project in the total scheme of the firm in terms of capacity and need. A project may be dropped or modified in the light of new situation.

Results of Review Meetings

A review meeting would obviously make policy decisions about changes, if required. Changes in design, scale, schedule, staffing, and delegation of power, and so on could be the outcome of review meeting. A review meeting must review the viability of a project in the light of experiences in project execution and changes that might have occurred in the environmental factors during the period. Such a review would essentially involve re-calculation of financial parameters. If the project is found to be unviable, then it must be thoroughly reviewed and even the option of abandonment must be considered.

Government projects often become victims of time and cost overruns. Still they go on and continue eating up valuable resources of the nation. The Central Government has for the first time in April 1999 taken a decision to abandon 48 core sector projects costing over ₹ 4500 crore, after the zero-based review of 471 Central projects. That would save about ₹ 100 crore every year on token provision in the budget. It appears that the Finance Ministry has taken a policy decision that a project with 60 per cent time overrun and 20 per cent cost overrun be axed.

Earned Value Management

This is one of the reporting tools but looking into its significance in monitoring all the three dimensions (time, cost and quality) of the project, it has been discussed as a separate topic in this section. The significance of the earned value concept lies in its several important features. The concept of 'earned value' is widely in practice today. Earned value can provide any project manager with an early warning tool that sends out a signal from as early as the 15 per cent completion of a project. This signal allows project managers to forecast the final required funds needed to finish the project within a narrow range of values. The forecast results enable the project manager to judge whether they

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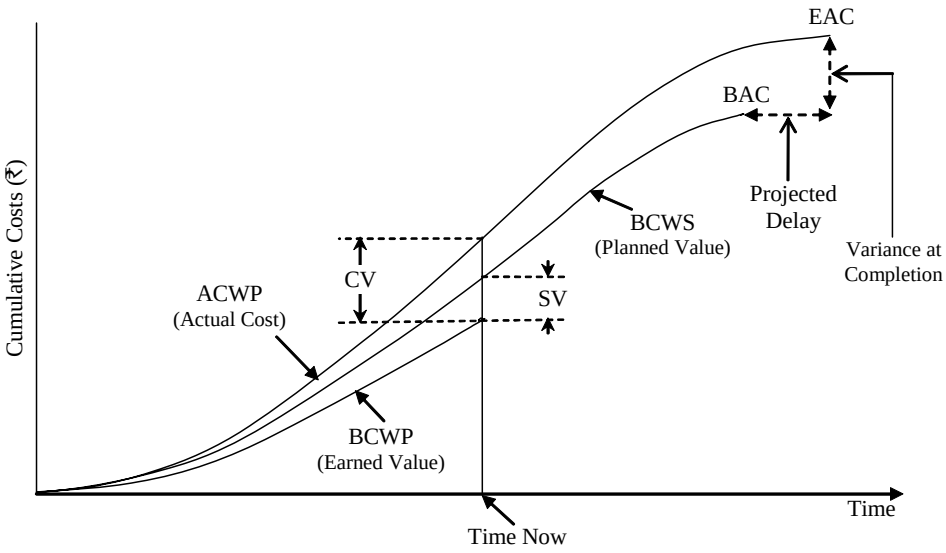
are acceptable or not, so that if the forecast results are unacceptable, immediate actions can be initiated.

The perusal of Figure 1.8 would aptly explain the significance of the earned value management system. It is a graphic presentation for conceptual understanding of the earned value reporting. ACWP comes from the project information system, BCWS, BCWP and BAC are obtained from the initial plans (detailed project report), EAC is estimated based on the current data and SV and CV are calculated from these information.



Legends:
BCWS = Budgeted cost of work scheduled (planned value)
BCWP = Budgeted cost of work performed (earned value)
ACWP = Actual cost of work performed (actual)
BAC = Budget at completion
EAC = Estimate at completion
SV = Schedule variance (BCWP – BCWS)
CV = Cost variance (BCWP – ACWP) positive is favourable

Fig. 1.8 *Project Status Chart using Earned Value*

The earned value chart gives a snapshot of the projected delay, schedule variance, cost variance and estimated variance on completion. If an estimate at completion is acceptable in terms of project viability, the project manager would do nothing and let the project unfold with the variances. However, if the variance at completion is alarming for the viability of the project, then the project manager needs to initiate actions for control of time and cost overruns, depending upon what seems to be a more significant contributor in rendering the project unviable and what is controllable at that point of time.

Like any other system, earned value reporting will work only if some prerequisites are observed. Fleming and Koppelman gave 'ten musts' to implement earned value on all projects. These 'ten musts' are as follows:

1. **Define work scope:** Using the works breakdown structure, all the works of a project must be defined. This is not an easy task, especially defining performance targets. Without defining performance targets, one cannot ascertain the amount of work completed.
2. **Create an integrated bottom-up plan:** An integrated bottom-up plan of detailed measurement cells is called Control Account Plans (CAPs), which combines critical processes including defined work scope, schedule of activities and resource

plans. The performance measure takes place within the detailed CAPs which are then added to get the total project's performance.

3. **Formally schedule CAPs:** Each defined CAP must be planned and scheduled with a formal scheduling system with a specific time frame. As performance takes place on the project, the portion of the planned value actually accomplished becomes the earned value. Both the planned value and earned value use the same matrix to measure their performance.
4. **Assign each CAP to an Executive for Performance:** Each CAP must be assigned to a project sub-team with a leader, who should also be empowered according to the criticality of the CAP.
5. **Establish a baseline that summarizes CAPs:** A total baseline against which a project performance may be measured is formed at this stage. This may be simply a sum of all CAP performance goals, if management reserve is held by a senior manager committee and not assigned to CAP executives or the project manager.
6. **Measure performance against schedule:** The value of the work scheduled and the value of the work accomplished in a given time frame are collected for performance measurement. Each behind-schedule task must be evaluated in terms of criticality to the project. If the late task is on the critical path or if the task carries a high risk, efforts must be made to put the task back on schedule even if more costs have to be incurred.
7. **Measure cost efficiency against costs incurred:** Here, cost efficiency is measured. The difference between value of work performed and the costs incurred to accomplish the work is the measure of cost efficiency.
8. **Forecast final costs based on performance:** Periodically, during project execution, using the zero base approach, one must forecast the total estimated cost at completion. As time passes and activities performed are more accurate, forecasting becomes possible, indicating the viability of the project.
9. **Manage remaining work:** The expenses incurred on the project up to the point of a review time are sunk cost but future activities must be reviewed for improvement, if any.
10. **Manage baseline changes:** The baseline must be adjusted for any changes made in the remaining work.

This earned value management concept has its roots in industrial engineering, where factory managers were concerned about the three dimensions of performance, time, cost and quality. A method of status index number was developed to encompass all the three dimensions in one single index. The development of PERT/Cost in the 1960s later got combined to develop the earned value management system. It began with the US Department of Defence mandating in 1967, the use of cost/schedule control systems criteria on all private industrial firms participating in major government systems. Now, this is practised by most firms for monitoring their projects, including software projects. The benefits are tremendous as an eye on ultimate viability of the project brings objectivity in the project execution tasks.

Corrective Actions

Control reports must be read and interpreted for corrective actions, if needed. The timeliness of an action is extremely important in project management because the decision-maker has to balance among time, cost and quality for ensuring viability of projects. In

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addition, there may be some additional information outside the project reports, which may lead to change in specifications or design of the sub-projects. Some changes may be desirable for project efficiency and some other changes may look good at the face of it, but may cause unjustifiable cost and time overrun without adding any efficiency value to the project. Review meetings on reports and other information pertaining to a project are significant.

Control reports and review meetings bring to the notice of the decision-makers impending problems, if any. The necessary actions must be initiated without loss of time; otherwise, it may prove to be costly. The level at which the required decision is taken will depend upon the type of organization and delegation of power in the project team. Irrespective of the type of project organization and other procedures, the most important is the speed and quality of corrective actions. The following are the prerequisites for achieving effectiveness in decision-making in this matter:

- Knowledge of critical aspects of the project
- Dynamic response cycle

These two points are now explained in brief.

Critical aspects of a project: The firm identifies the critical aspects of a project at the planning stage. For each work package and its component, the firm must identify what is most crucial, i.e., how much slack time is available, what are the cost implications of delay vs the cost of alternate course of action for timely completion of a work package and what will be the cost implications of changed quality of work. The person in charge must be aware of these so that she can respond to the situation and take a right decision whenever a deviation is found or a problem is noticed. The knowledge of critical path and activities on it, the idea about the total cost implication together with the right degree of delegation of power can facilitate better management of overruns. This facilitates dynamic response expected from the project team to the externality.

Dynamic response cycle: Control encompasses all phases of the project from conception to completion. It is a cycle which begins with setting objectives and ends only when the last activity has been completed. Throughout each phase of the operation, the system must provide the management with the capacity to respond to any situation which arises.

The first element in the cycle is preparation of the PERT chart and identification of critical paths. At this stage, various options of priorities and restraints are identified and divided. These are then combined to produce a range of plans reflecting various expenditures of time and money. These plans are summarized on the total project cost curves, showing direct and indirect, and combined time and costs. When the management has selected one of these, the resource needs and the order of commitment will be known. At this point, resources are allocated to project activities in order to produce a schedule.

Once the management has approved a schedule, a time scale diagram is produced which provides immediate visual assimilation of the project at all levels of management. Progress reports can be superimposed on the diagram at regular intervals. The actual results are compared with the estimates. The management is, thus, equipped with specific knowledge of the situation and is in a position to act. The project team is also equipped with sufficient powers for handling the crisis situation.

The company management should also develop some decision norms regarding design change. The proposals for changes come from all levels and in all types of assets.

The policy of review of change in design or change in core assets (plants and equipment) can be developed with its strong linkage with the objective parameters. Review and decision are found to be weak with regard to the proposed changes in non-core assets. They cannot be evaluated on an objective basis. Such types of changes should be discouraged in general. Some companies make the mistake of delegating decision powers regarding changes in non-core assets. The purpose behind it is to ensure that the senior management can focus on the crucial aspects of the project. But, unwanted changes in non-core assets can cause a lot of worries later.

Systems of planning, scheduling and dynamic control are the tools. Much depends on the managers who use them. They help in providing information on which to base decisions. The concerned team will quickly take an alternative course of action, even at extra cost, keeping in mind the criticality of the matters, for example, in one case, a sub-team was in charge of getting machines fabricated and installed at the site of the project. This activity was on the critical path. Soon after the machine fabrication started, the workers at the fabricator's factory went on strike. The team was watching the fabricator and drew conclusion that the strike may last longer, jeopardizing the delivery schedule. They used the contract term and shifted the semi-fabricated work to other fabricators and completed it within time. In yet another case, some machinery was to be transported from a US port in California. Around the time of shipment, the port was closed down due to glitch in the union negotiation. The strike was expected to take long, followed by dock congestion problem, which could delay the shipment of machinery and the whole project. The project team swung into action and diverted the machinery to another port, negotiated with another ship-liner for immediate pick-up and transportation of the machinery and avoided time delay though they spent some more cost. The contract terms in both the cases were clearly defined to handle such eventualities, which made the job easier. Thus, two issues are important — (i) contact terms to deal with unexpected events and (ii) creative alternate solutions as the dynamic response cycle, if the activity does not have enough cushion time.

1.5.4 Project Evaluation and Termination

Project evaluation is defined as the methodical examination of a project's worth or value. The technique is used in projects and programs as well as policies. At the project level, assessment involves practices like discussing a practicable evaluation plan with stakeholders; designing and planning the evaluation; gathering, classifying and scrutinizing information and data; probing the details and dispensing the findings to determine or comprehend the project and/or to make project-associated decisions.

Termination of a project takes place when work on the processes of the project has come to a halt or decelerated to such an extent that there is no probability for further advancement. Project evaluation and termination are discussed in detail in Unit 5.

1.6 SUMMING UP

- Project management is the art of directing and coordinating the human and material resources throughout the project by using modern management techniques. The main purpose of project management is to achieve the predetermined objectives of scope, cost, time, quality and the satisfaction of the participant.
- An important aspect of the systems approach to management is the concept of 'life cycle'. It is the basic pattern of the change that occurs throughout the life of a system.

Check Your Progress

9. What is project implementation?
10. What are the key areas of monitoring?
11. Why is timeliness of an action considered to be extremely important in project management?

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- The life cycle of a system consists of the following phases — Conception, definition, acquisition/production, operation, divestment/termination.
- The advantage of using the life cycle concept in the development of a system, project, product or technology is that it enables decisions and actions to be taken in steps.
- Sensitivity analysis is the prescribed tool for identifying the important sources of risk. Various statistical techniques, which measure dispersion value are employed for quantifying the risk and then some statistically convincing rules, are applied for decision making.
- Project selection models help the project manager in selecting a project. There are two types of project selection models-numeric and non-numeric.
- Project planning refers to a procedural step in project management. During project planning, required documentation is created to ensure successful project completion. All actions required to define, prepare, integrate and coordinate additional plans are included in documentation.
- Any project will typically pass through four stages. The first stage is the conceptualization stage, followed by the planning, execution and termination or clean-up stages.
- Project execution is the most difficult and challenging task in project management. t involves several people and teams with different skills, abilities and priorities, constant coordination and adjustment in planned activities, conflict with routine operations of business because of overlapping project organization structure and several such issues.
- A monitoring system must be objective-oriented. The objectivity can be embedded by initially identifying the key factors to be monitored at various stages of project construction. It helps in defining exactly activities, specifications and costs that needs to be controlled.
- Key areas of monitoring are the same as the key elements of projects. They are (i) time, (ii) cost and (iii) performance.
- Reports are studied and interpreted to find out the need for taking corrective actions. Review meetings are essential for brainstorming on the highlights of reports.
- Control reports must be read and interpreted for corrective actions, if needed. The timeliness of an action is extremely important in project management because the decision-maker has to balance among time, cost and quality for ensuring viability of projects.

1.7 KEY TERMS

- **Project Management:** Project management is the art of directing and coordinating the human and material resources throughout the project by using modern management techniques.
- **Project planning:** Project planning refers to a procedural step in project management.

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1.8 ANSWERS TO 'CHECK YOUR PROGRESS'

1. Project management is the art of directing and coordinating the human and material resources throughout the project by using modern management techniques.
2. The main purpose of project management is to achieve the predetermined objectives of scope, cost, time, quality and the satisfaction of the participant.
3. The conceptual phase involves the preliminary evaluation of an idea. This includes recognition and acceptance of a problem or a need, analysing the requirements and finding out the ways to fulfil the need or to solve the problem.
4. The Divestment/Termination phase is the last phase of the system.
5. The advantage of using the life cycle concept in the development of a system, project, product or technology is that it enables decisions and actions to be taken in steps.
6. Project planning refers to a procedural step in project management. During project planning, required documentation is created to ensure successful project completion.
7. A project is said to be successful only when the requirements of the stakeholders have been met.
8. Any project will typically pass through four stages. The first stage is the conceptualization stage, followed by the planning, execution and termination or clean-up stages.
9. Project execution or implementation involves several people and teams with different skills, abilities and priorities, constant coordination and adjustment in planned activities, conflict with routine operations of business because of overlapping project organization structure and several such issues.
10. The key areas of monitoring are— (i) Time (ii) Cost, and (iii) Performance.
11. The timeliness of an action is extremely important in project management because the decision-maker has to balance among time, cost and quality for ensuring viability of projects.

1.9 QUESTIONS AND EXERCISES

Short-Answer Questions

1. Discuss the short comings of a project formulation.
2. What are the limitations of sensitivity analysis?
3. Write a short note on turnkey project construction.
4. What are the goals of project implementation?

Long-Answer Questions

1. Discuss the characteristics of project management.
2. Describe the reasons behind the need of project management by most enterprises.
3. Discuss the five phases in the life cycle of a system.
4. Explain the four-step process of project planning.
5. Discuss in detail the monitoring system.

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1.10 REFERENCES AND SUGGESTED READINGS

Chandra, Prasanna. 1995. *Projects: Planning, Analysis, Selection, Implementation, and Review.* Delhi: Tata McGraw-Hill.

Kerzner, Harold, R. 2013. *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*. New Jersey: John Wiley and Sons.

Singh, Narendra. 2000. *Project Management and Control*. Delhi: Himalaya Publishing House.

UNIT 2 PROJECT ANALYSIS AND SELECTION

Structure

2.0 INTRODUCTION

Project analysis is the assessment of every expense or problem related to a project, prior to the commencement of work on it. After evaluating the profitability of a project, the selection process is undertaken.

The decisions made during selection of a project directly affect and frame a project's requirements analysis. It is a trend that requirements analysis begins once a project has been selected. Mere existence of a market is not enough for a company or a project to succeed. The company should also be able to sell the product. In this unit, different analytical methods used to evaluate a project— market and demand analysis, technical analysis, economic and financial analysis and social cost and benefit analysis— have been discussed.

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2.1 OBJECTIVES

After going through this unit, you will be able to:

- Identify investment opportunities
- Explain project initiation
- Discuss the enquiries that are made with respect to technical analysis
- Discuss economic and financial analysis
- Explain social cost and benefit analysis
- Assess how project reports are formulated

2.2 IDENTIFICATION OF INVESTMENT OPPORTUNITIES

The investment proposal, which originates from various departments, is the *opportunity*. Those who conceive the idea or sense the opportunity are likely to see only a part of the whole investment requirement. There may be some technically or economically dependent investment requirements (opportunities) that the proposers may not visualize. For example, technological upgradation may require expensive retraining of employees, or may require a sequential change in upstream or downstream activities.

Opportunity is usually incomplete due to the economic dependence of one opportunity on the other. In addition, an alternative opportunity may serve an equal or better purpose. A firm should have a mechanism where (a) opportunities are received, (b) alternatives are searched, (c) economic dependence is studied and then (d) projects are formed before detailed cash flows are estimated. These four actions are the essential ingredients of efficient investment analysis.

Two opportunities are (said to be) economically dependent, if the adoption of one of the opportunities affects the profitability or the ability to adopt the other opportunity.

Economic dependence can be in four forms:

1. Positive synergy emanating from the acceptance of two or more opportunities.
2. Negative synergy, when more than one opportunity is simultaneously accepted.
3. Acceptance of one automatically results in rejection of the other, even if the other is profitable.
4. Stochastic dependence, where uncertainty is considered.

Only positive and negative synergy and mutually exclusive characteristics are considered for the efficient investment analysis at the initial stage.

2.2.1 Projects and Alternative Projects

The process of grouping opportunities is called formation of projects. A project is a set of one or more investment opportunities with the following characteristics:

- Each opportunity included in a project is independent of all other opportunities not included in that project
- Acceptance of any opportunity included in a project (an alternative) is conditional on the acceptance of the (alternative) project itself
- Every opportunity is included in some project

Economic dependence may be of two types in the context of time — (a) two or more opportunities are present at the same point of time and they are economically dependent on each other and (b) some future opportunity may be dependent on the present opportunity. A captive power plant and a steel plant fall in the first type of economic dependence; whereas in case of two alternative machines, one with a lifespan of five years and another of ten years, the first machine has future opportunity dependent on it. If the machine with a five-year lifespan is purchased over the one with a ten-year lifespan, at the end of five years, one more machine will be required. Future investment at the end of the fifth year is dependent on the option of machine selected at present. All opportunities that are dependent either immediately or in the future should be included in a single project. Without that, economic analysis will be less than efficient.

Let us take an example. Ten investment opportunities are received and developed by a capital expenditure committee (CEC) of XYZ Company Limited. The CEC has studied the dependence factor and concluded that:

- O_1, O_2, O_3 and O_4 are economically dependent on each other, but independent of all other opportunities
- O_5, O_6 and O_7 are economically dependent on each other, but independent of the rest
- O_8 is independent of all other projects
- O_9 and O_{10} are mutually exclusive opportunities, but independent of all others

In this case, the number of projects and project alternatives are as follows:

Project No.	Opportunities Included in the Project	Project Alternatives	No. of Alternatives in the Project
A	O_1, O_2 and O_3	O_1, O_2, O_3, O_4, O_1O_2, O_1O_3, O_1O_4, O_2O_3, O_2O_4, O_3O_4, $O_1O_2O_3$, $O_1O_2O_4$, $O_1O_3O_4$, $O_2O_3O_4$, $O_1O_2O_3O_4$, None	16
B	O_5, O_6, O_7	O_5, O_6, O_7, O_5O_6, O_5O_7, O_6O_7, $O_5O_6O_7$, None	8
C	O_8	O_8 or None	2
D	O_9, O_{10}	O_9, O_{10}, None	3
Total number of alternatives			29

In an efficient investment analysis, after formation of projects and identification of alternative projects, the best alternative which offers the highest profit is selected. Here, the second condition is applied. If the $O_1O_2O_3$ alternative is found attractive, then O_1, O_2 and O_3 are all selected.

2.2.2 Sources of Project Ideas

Project ideas could originate from the various sources, such as:

- Success story of a friend/relative
- Experience of others in manufacture/sale of product or rendering service
- Examination of the inputs, processes and outputs of industries and search for improved process, substitute input, and so on
- Government plan outlays, schemes and guidelines
- Development programmes of financial institutions and developmental agencies
- Investigation of local resources, material and human and the ways of tapping them

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- Economic and social changes of the economy
- B2B advertisements, C2B communications, and so on
- Project profiles and industrial potential surveys
- Visits to trade fairs, industrial exhibitions
- Unfulfilled human needs
- Possibility of reviving and rehabilitating sick units
- New inventions and patents, and new technological developments and business opportunities around them
- Tender notifications of businesses, government departments, universities, etc.
- Liberalization, privatization and globalization policy drives by governments, as this means new business opportunities for private sector, MNCs, etc.

Let us briefly discuss these sources of project ideas.

- **Analysis of the performance of existing industries:** A study of existing industries in terms of their profitability and capacity utilization is helpful. The analysis of profitability and break-even level of various industries could indicate promising investment opportunities. An examination of capacity utilization of various industries provides information about the potential for further investment. Such a study becomes more useful if it is done region-wise, particularly for products which have high transportation costs.
- **Examination of the inputs, process and outputs of industries:** An analysis of the inputs required for various industries may throw up project ideas. Opportunities exist when (i) materials and supplies are presently being procured from different sources with attendant time lag and transportation costs and (ii) several firms produce internally some components/parts which can be supplied at a lower cost by a single manufacturer who can enjoy economies of scale. A study of the output structure of existing industries may reveal opportunities for further processing of output or even processing of waste. A study of the processes followed may reveal opportunities for improving the process, with time and cost advantages.
- **Examination of volume, value and direction of imports and exports:** An analysis of import statistics for a period of five to seven years is helpful in understanding the trend of imports of various goods and the potential for import substitution. Indigenous manufacturing of goods currently imported is advantageous for several reasons:
  - o It improves the balance of payments situation.
  - o It provides market for supporting industries and services.
  - o It generates employment.

  Likewise, an examination of export statistics is useful in learning about the export possibilities of various products in various countries.
- **Plan outlays and government guidelines:** The government plays a very important role in many economies. Government's proposed outlays in different sectors provide useful pointers toward investment opportunities. For instance, the schemes of distribution of free colour TVs, gas stoves, dhoties and sarees, bicycles, books, etc. are providing new opportunities for businesses. They indicate the potential demand for goods and service required by different sectors.
- **Developmental schemes of financial institutions and developmental agencies:** In a bid to promote development of industries in their respective states, state financial corporations, state industrial development corporations and other

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developmental bodies conduct studies, prepare feasibility reports and offer suggestions to potential entrepreneurs. The developmental schemes suggested by them lead to new project ideas.

- **Investigation of local resources (material and human):** A search for project ideas may begin with an investigation into local resources and skills, various ways of adding value to the locally available materials. Similarly, the skills of local artisans may suggest products that may be profitably produced and marketed.
- **Analysis of economic and social changes:** A study of economic and social changes is helpful in projecting demand for various goods and services, identifying shifts in demand for goods and services, and so on. Changing economic conditions provide new business opportunities. A great awareness of the value of time is dawning on the public. Hence, the demand for time saving products like packaged food items, ovens and powered vehicles has been increasing. Another change that we are witnessing is that the desire for leisure and recreational activities has been increasing. This has caused a growth in the market for recreational products, fitness products and services.
- **Exploration of the possibility of reviving and rehabilitating sick units:** Industrial sickness does happen in developed and developing countries. Sick units are either closed or face the prospect of closure. A significant proportion of sick units, however, can be nursed back to health by sound management, infusion of further capital and provision of complementary inputs. Hence, there is a fairly good scope for investment in this area. Such investments typically have a shorter gestation period because one does not have to begin from scratch. Indeed, in many cases, marginal efforts would suffice to revive such units.
- **Identification of unfulfilled human needs:** For well established, multi-brand product groups like bathing soaps, detergents, cosmetics and tooth pastes, the question to be asked is not whether there is an opportunity to manufacture something to satisfy an actual physical need but whether there are certain psychological needs of consumers which are presently unfulfilled. To find whether such an opportunity exists, the technique of spectrum analysis may be followed. This analysis is done somewhat as follows.
  - o Important factors influencing brand choice are identified
  - o Gaps which exist in relation to consumer psychological needs are identified
- **Visit to trade fairs:** Attending the national and international trade fairs/exhibitions/ conventions/conferences provides an excellent opportunity to know about new products/services and their development.
- **B2B advertisements, C2B communications, Yellow page ads, and so on:** B2B advertisements, C2B communications, and so on give out business solicitations, joint venture opportunities and the like. Trade journals and business dailies also provide business solicitations.
- **Government agencies, credit institutions, non-governmental organizations, village panchayats and public:** Project ideas may be generated by the government agencies, credit institutions, non-governmental organizations and also by public. The government has the largest resources and has the necessary information to generate project ideas and it plays a predominant role in this sphere. The government has the required facilities and manpower to conduct detailed

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studies which may lead to making investment decisions. Banks and other financial institutions are actively involved in sharing the social responsibility of achieving the national objectives of economic development. The cooperatives and non-governmental organizations as well as individual entrepreneurs now actively participate in identification of projects. The awareness of involving the people or the beneficiaries in project identification is now increasing fast. Since the local people have the first hand knowledge of the potentials and problems of the area to which they belong, more realistic project identification has become possible with their involvement. It needs no emphasis that the project ideas would be generated in better manner both in the qualitative as well as quantitative terms when the knowledge and ideas of the government functionaries, people, financial institutions and other experts are pooled together.

2.3 PROJECT INITIATION

The purpose of project initiation is to evaluate proposed projects and to reach a consensus on the projects that are to be selected. During project initiation, the project charter is presented, the strength of a project's business case and the viability of the proposed solution are evaluated. A determination is made as to whether the project is consistent with the institution's business and/or strategic plan, and if the budget of the project planning (high level) is affordable.

In project initiation, all the necessary analysis is undertaken to allow the project to be planned. It usually involves a considerable amount of work, and expenditure. Project initiation is considered to be a stage in its own right i.e., it should be formally given approval to go ahead and should be planned and budgeted for as a phase of the project.

Project Initiation Document (PID) is the single most important piece of documentation that is produced at this stage, and probably during the course of the entire project. The Project Initiation Document starts with the business Case, if it exists, and capitalizes on it using the information and analysis data produced during the initiation activities.

A Project Initiation Document (PID) should include:

- Detailed project goals and objectives and the critical success factors on the basis of which the achievement of the objectives will be judged.
- Details of the scope of the project in relation to the organization, functional areas and time as well as a statement about any related areas that are considered to be out of scope.
- Details of identified risks and any constraints affecting the project.
- Details of any kind of assumptions made about the project. These assumptions might be based on the support you will receive from other parts of the institution or, if you are working with a third party supplier, assumptions about what the supplier will deliver.

The project initiation document is the 'contract' for the project (between the project manager and the project board.) It sets out:

- What does the project aim to achieve?
- Why it is important to achieve it?

Check Your Progress

1. List the different forms of economic dependence.
2. Why is indigenous manufacturing of goods advantageous?

- Who will be involved in managing the process and what are their responsibilities?
- How and when will the project be undertaken?

The PID has to answer the above questions to a sufficient level of detail to help maintain control of the project.

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2.4 MARKET AND DEMAND ANALYSIS

Market analysis aims at assessing the potential sales revenue from a proposed project. It is also known as market-feasibility study.

Approach for conducting a market-feasibility study would vary depending on the type of proposed product. For instance:

- In case of a novel product idea, a market-feasibility check has to be based on indicators of buyer behaviour (in terms of their response to 'new' or 'dream' products) for estimating potential demand.
- If a proposed product is new in an economy, but is successfully marketed in some other economy, its market feasibility is assessed through a meaningful comparison of some broad economic and cultural indicators in the two economies.
- Per-capita income, income disparity level, pattern-indicating shift in choice for consumption, literacy level and such other economic factors can indicate the potential of demand for a particular proposed product.
- If the proposed project is for addition in the capacity existing in the economy, the task of market-feasibility study will be historical data analysis and study of factors, which influence consumption trends. The following discussion is centred around a market-feasibility study for that product which is already selling in the market.

2.4.1 General Economic Indicators

The demand potential of any product is likely to have some kind of association with some economic indicators. Changes in demand and changes in a particular or some economic indicators may take place simultaneously or with lead or lag. Some of the important economic indicators include gross domestic product, per capita income, income disparity, rate of urbanization, population growth rate, literacy rate, government spending, money supply and others.

Situational Analysis

Situational analysis is, especially, important if the project proposal is for enhancing the capacity. It is important where the project proposal involves production and sale of new products and services—new for the company but not new in the market.

The situational analysis framework is primarily designed for preparing marketing plan. It can also be used as a part of market analysis in project planning. Mere existence of a market is not enough for a company or a project to succeed. The company should also be able to sell the product. Situational analysis studies some internal factors in the light of some external factors with a view to judge whether the company can sell the product in the market. The factors studied in situational analysis are called five Cs. These factors and a sample of items studied in each of them are as follows:

Check Your Progress

3. What is the purpose of project initiation?
4. Which questions does the project initiation document answer?

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1. **Company:** The assessment of a company can be done with an opinion-based evaluation of the following factors:
   - Number of products
   - Market perception of the company
   - Company's strategic plans and goals
   - Company's culture and values
   - Company's current technology and technology gap, if any
   - Overall financial position

   No one else would know the company better than the internal management. However, a frank review is required. If one is in a mode of denial and attempts to justify everything, he is more likely to ignore the mistakes.
2. **Collaborators (or partners):** A company's collaborators include:
   - Major customers
   - Distributors
   - Major suppliers
   - Joint ventures, management agreements and other alliances, if any

   A lot of this information can be obtained without much difficulty from published or paid sources.
3. **Customers:** This is about the potential markets for the product that will be produced as a part of the project.
   - Size of the market along with segments
   - Expected rate of growth of the market
   - Current demand–supply gap
   - Potential customers' expected behaviour and factors affecting their choice of product
   - The decision-maker and the decision unit
   - The current market of the product
   - Method of product purchase (impulse buys, the Internet, etc.)
   - Trends in consumer tastes
   - Company's distributors

   Industry data is available for existing products. For new products, one may need to conduct a survey and sometimes, test marketing. A lot depends on judgement too. For a foreign market, a country report can be used.
4. **Competitors:** Know your rivals:
   - Who are your actual and potential competitors?
   - What are their products, positioning, market shares, strengths, weaknesses and marketing strategies?
   - Who competes indirectly with you, because they produce competing products?
   - Is the quality of competition, healthy or unhealthy?

   Those who keep their eyes open know their competitors well. One can hire a consulting firm too to get a balanced view of the competitive scenario.
5. **Climate (or environment):** Economic environments, political scenario, regulatory system, all have effect on markets:
   - What is the political environment like? Who is in the government? Is the government and its policies stable? How does the bureaucracy work?
   - What are the regulations and their implementations?
   - What are the macroeconomic factors (like business cycle, inflation, interest rate) and which are likely to affect the market?

- What are the social and cultural trends? (This may go with the 'customer' factor also.)
- What is the technological environment?

By combining analyses of customers, competitors and climate with the company's strengths and collaborators, a firm can identify market opportunities and can prepare workable marketing strategies to include them in the marketing plan.

2.4.2 Demand and Supply Estimate

Demand projection is one of the most important steps in a project feasibility study. The following are the important points related to demand estimation:

- A product may have different usages and different end-users. The total demand of a product is constituted by different end-users like government and non-government or urban and rural. For example, demand for cement can be divided into some broad categories, namely housing, business and rehabilitation activities and infrastructure projects. In case of plastic, a whole market of packaging is wide open with newer applications, which may affect and in fact, has affected the tinplate-packaging industry.
- Product demand may have influencing factors as well. The demand of some products may be direct, while for some others it may be derived. For example, demand of tyre depends upon the sale of automobiles, a fertilizer sale is dependent on monsoon and sales of steel and industrial growth have some association.
- The market potential of a product in different segments may be different for several reasons because there may be regional imbalances. For example, India has a large demand for electric power but due to inadequate infrastructure for its distribution, some states are power-surplus, whereas some others have power shortage. International relations, import and export barriers in respective countries and such other factors also affect demand.
- Infrastructure impacts market. For example, Indian cement's exportability is less due to high cost of transportation.
- Growth in demand in the past can be indicative of the future demand.

Supply estimate

The past trend of supply of goods can be studied and further extrapolated. Projections so made need to be adjusted with the help of additional information like new projects planned by businesses in the economy, import possibility as governed by import policy, import tariff and international prices. Information regarding entry barrier is also useful. Long gestation period and high capital to labour ratio in an industry may create natural entry barriers. Government licensing policy, non-availability of the required input like material and skilled labour also create entry barriers.

Estimating Demand–Supply Gap

Demand and supply estimates, fine-tuned with the changing factors, are now compared with each other for finding a gap. A demand–supply gap for a relevant geographical territory only is meaningful. Multiple-point forecast for demand–supply gap gives the most adverse, most likely and most favourable forecasts. Table 2.1 shows calculation of demand–supply gap for a particular product in the next five years.

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Table 2.1 *Demand–Supply Gap Calculation for Five Years*

Year	Cement Demand			Cement Supply		Demand Surplus		
	Min.	Likely	Max.	Likely	Max.	Min.	Likely	Max.
1	48.00	48.00	48.00	48.00	48.00	0.00	0.00	0.00
2	49.44	50.40	51.36	50.70	50.70	–1.26	–0.30	0.66
3	51.66	53.93	56.50	53.38	63.24	–11.58	0.55	3.12
4	54.76	58.78	63.84	61.03	65.46	–10.70	–2.25	2.81
5	58.60	65.25	74.69	62.45	53.38	5.22	2.80	12.24

Demand Surplus: Minimum = Min demand – Max supply
Likely = Likely demand – Likely supply
Maximum = Max demand – Likely supply

Note: All the confirmed capacity additions constitute 'likely supply scenario', while 'maximum supply scenario' assumes another capacity addition in the third year to the fifth year. It is assumed that firms will be able to operate at 80 per cent capacity.

In case supply shortage is sufficiently large, the market feasibility of the product is said to be positive.

SWOT Analysis

Strategic plans, budgets and operating plans must be backed up by an analysis of the situation. An element of situational analysis makes plans realistic and achievable. A generic model of situational analysis is popularly known as SWOT analysis, where

S = Strength; W = Weakness; O = Opportunities; T = Threats

Strength and weaknesses pertain to factors internal to the business. The external environment offers opportunities or poses threats. A careful and balanced study of opportunities, threats, strengths and weaknesses help the process of efficient resource allocation.

SWOT is neither a tool nor technique. It is an approach. Therefore, a SWOT analysis could be based on certain perceptions. The following statements will serve to create a better understanding of a SWOT analysis:

- SWOT is a perception.
- An apparent weakness of the firm may actually be a result of some strength. For example, better quality also means higher costs.
- External or internal threats need not endanger chances of survival and growth. Co-survival with threatening factors is possible. It is not always necessary to fight a threat.
- Everyone possesses certain weaknesses. All weaknesses need not be removed. One has to learn to live with many of them.
- Remove selected weaknesses if they are likely to become an obstacle to survival and growth and simultaneously build strengths.
- Oppose and vanquish threatening factors if they are likely to obstruct growth.
- Identify those opportunities which can be tapped with the firm's strengths, and channelise the strengths in that direction.

A good understanding of the situation would be helpful in planning a viable fit between the firm's resources and changing opportunities. These firms stand a better chance of forming the winning habit.

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2.4.3 Demand Forecasting Techniques

A key aspect of any decision-making situation lies in being able to predict the circumstances that surround the decision and that situation. Business managers are expected to know and apply forecasting techniques in their decision-making process.

Two classes of demand forecasting techniques are:

- Quantitative techniques find solution directly based on historical data and assume that the past trend and relationship will continue in the future.
- Qualitative techniques aim at forecasting changes in a basic pattern such as forecasting an expected decline in the demand of a product that has touched maturity point.

1. Pattern-based Forecast

Where one or few independent factors may not have explanatory power for demand, just the pattern of demand over time can be studied for forecasting purposes. Therefore, patterns are observed over a timeline. For that, let us first see various patterns of historical data.

Types of pattern

Patterns can be divided into four groups:

- A seasonal pattern is observed due to the seasons of a year.
- A horizontal pattern indicates product maturity.
- There are four stages in a cyclical pattern — recession, recovery, growth and decline.
- A growth pattern means a cyclical pattern with a long-term increasing trend.

Figures 2.1(a) to 2.1(d) give a pictorial presentation of these patterns. For a project's market analysis purpose, one should look at the annual demand data pertaining to at least the last two or three business cycles, and then study the pattern. The pattern is then extrapolated to make projections of demand for the future. The extrapolated data must be then adjusted with the phase of the next business cycle and changes in factors (like income, saving rate and, changing taste) affecting the demand. Seasonal adjustment is required for periodic budgets and not for the project's market analysis.

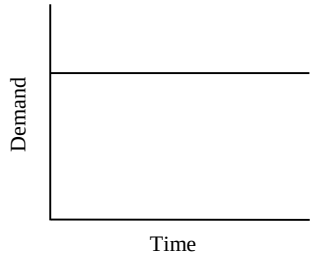

Fig. 2.1(a) *Horizontal Pattern*

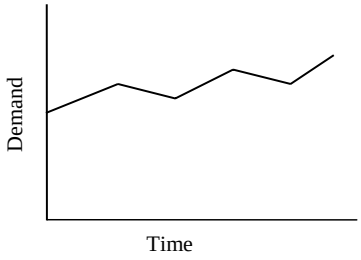

Fig. 2.1(b) *Seasonal Pattern*

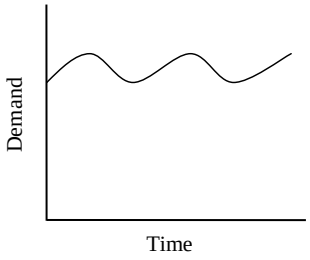

Fig. 2.1(c) *Cyclical Pattern*

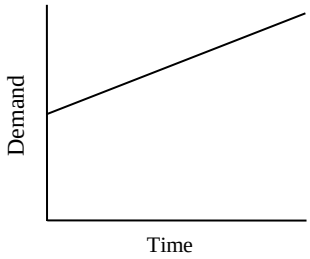

Fig. 2.1(d) *Growth Pattern*

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Methods of pattern-based forecasting

- A simple arithmetic *mean* of the historical data can be taken as forecast for the next period, if a horizontal data pattern is observed. However, it has to be ensured that the relevant data period does not represent the end of product maturity.
- The *naïve* method of forecasting uses the most recently observed value as a forecast. This method can be used for forecasting the sales in the next one week.
- The *moving average* method reduces the randomness in variables because the average of the last few observations is considered the forecast value.
- In the *exponential smoothing* method, exponentially decreasing weights are assigned to various observations so that the most recent values receive more weight than older values. (Moving average method assumes equal weights for each value).
- In the a*uto-regressive moving average* (ARMA) method along with past values and their weights, the past error in forecast (deviation of actual from forecast) is also weighed. The procedure developed by Box and Jenkins is most commonly used in this class of methods. Filtering method also falls in the same class.
- *Regression* is also useful in time series analysis. For the time series analysis, a simple regression is normally used, either linear or non-linear. For studying the pattern underlying the observations (past demand), a regression chart is prepared to plot observations on Y-axis against the timeline (years) on the X-axis. Then, a best-fit line (known as regression line or slope) is drawn in such a way that the distances of data points on both sides of the best-fit line are approximately equal. The regression equation that one would obtain would be as follows:

$$Y = a + bx \quad \text{... (2.1)}$$

Where, Y = What we need to forecast

a = Regression coefficient or a constant value

b = Slope of the best-fit (regression) line or regression coefficient of x

x = Value of independent variable, which is time (year) in this case

Then, the *Y*-value is predicted on the best-fit line for a given *X*-value (year). The distance of actual data points from best-fit line indicates error.

2. Causal Model–based Forecast

Forecasting methods can be aptly applied if all factors influencing the demand remain constant during the forecast period. Some of these methods are as follows:

Regression

Regression techniques are more useful when one studies a dependant variable (demand) in association with its causal (independent) variable. If we take one *x*-variable and run a linear regression, the regression function will look like the one given in Equation 2.1. The only difference will be that the *x*-variable will not be time (year) but any other variable. For example, one can take per capita income as *x*-variable if it is thought to be determining the demand for cars.

Non-linear regression analysis can be done if it is observed that the association between *x* and *y* variables is not linear. The purpose is to draw a best-fit line that really

fits best, whether that line is linear or not. In non-linear regression, we would get different types of regression equations, depending upon what type of non-linear lines are drawn: for example, a second-order polynomial regression would give the following equation:

$$y = b_1 x^2 + b_2 x + a \quad \text{... (2.2)}$$

Where, y = What we need to forecast (demand)

a = Regression coefficient or a constant value

b_1 = Regression coefficient of x^2

b_2 = Regression coefficient of x

x = Value of independent variable, which is a causal variable

Multiple Regression is used when there is more than one causal variable that determines the value of y. The results of multiple regression would be in the form of the following equation:

$$y = b + b_1 x_1 + b_2 x_2 + b_3 x_3 + ... + b_n x_n \quad \text{... (2.3)}$$

Here, b is a constant and $b_1, b_2, b_3 \ldots b_n$ are the regression coefficients of independent variables $x_1, x_2, x_3 \ldots x_n$ respectively.

Sometimes, it may not be possible to pinpoint that one is a dependent variable and the other independent, though they may have some observable relations. In such cases, it is said that the two variables are correlated.

Coefficient of correlation

The correlation coefficient (or coefficient of correlation or just correlation) is a calculated number, which indicates the degree to which two sets of numbers are statistically related.

Coefficient of correlation is the square root of the explained variation from *Y* over the total variation. This can be mathematically written as follows:

$$\rho_{xy} = \frac{Cov(r_x, r_y)}{\sigma_x \sigma_y} \quad \text{... (2.4)}$$

Here,

$$Cov(r_x, r_y) = \sum_{i=1}^{n} \frac{(x_i - \mu)(y_i - v)}{n} \quad \text{... (2.5)}$$

Here, μ = Expected value of x

v = Expected value of y

σ_x = Standard deviation of x

σ_y = Standard deviation of y

The range of values it takes is between –1 and +1. A negative value of ρ_{xy} indicates an inverse relationship; a positive value of ρ_{xy} indicates a direct relationship; a zero value of ρ_{xy} indicates that the two variables are independent of each other. The ρ_{xy} closer to +1 and –1 indicates a stronger relationship between the two variables, for example, we may expect a negative relationship between the demand for a product and its selling price because the higher the selling prices, the lower the demand.

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Decomposition method

The decomposition method attempts to explain the pattern or the change in it with some factors responsible for the change. Decomposition is mathematically represented as,

$$S = T \times C \times I \times R \quad \text{... (2.6)}$$

Here, S = Forecast value

T = Trend factor

C = Cyclical factor

I = Seasonal factor

R = Randomness

Input-output tables

Input-output tables have their own places in forecasting. These tables use coefficients that are assumed to remain constant, for example, savings rate and GNP growth relations are used in planned economies for preparing their annual plans. Such tables can be used for projections of demand of certain products.

2.5 TECHNICAL ANALYSIS

If there is ample market demand and not enough supply, the focus should shift to technology. The following inquiries must be made with respect to technical analysis.

- **Availability of Technology**

A task force will search for a commercially exploitable technology for the operations required for running the project. One must also look at of the technologies currently being used by businesses and study their experiences.

Usually, in a cheap labour economy, less than the latest technology works fine from the labour-to-capital ratio angle. However, the choice has to depend on the effects of technology on the desired quality of product and cost of product, versus investment needed in a given technology.

- **Transferability**

The technology transfer issue has to be addressed in a dual fashion—(a) Whether the transfer of technology is possible from the political angle and (b) whether transfer of technology is possible from the operations (environment) angle.

In today's World Trade Organization's regime, normally one cannot expect import restrictions (unless there is no political relationship between the two countries), but economic sanctions from the exporting nations are quite possible, making it impossible to transfer technology from one country to another. Sometimes, the technology owners may not be willing to transfer the technology.

Technology is usually very sensitive to the environment or climate in which it is used. The success of technology transfer depends on the temperature level, moisture level, quality of atmosphere, quality of material, method of work and skill of labour, power supply quality and a host of other variables, which may be unique for each user. Thus, adjustments and modifications in a technology may be warranted. Those

Check Your Progress

5. What is the aim of market analysis?
6. When is situational analysis important?

modifications add to the project cost and sometimes, a few of the modifications may not be feasible at all.

- **Normal Capacity Utilization**

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Every technology has its own capacity and rate of normal utilization. In addition, a rated capacity is usually not available fully, depending upon the environment in which it is used. Capacity utilization has a direct impact on available production and cost of production. Therefore, an inquiry about a potential 'normal' capacity utilization of a given capacity assumes great importance.

- **Requirement of Plant and Equipment and Fabrication Facilities**

Technology comes with knowledge. However, machines for operations have to be fabricated separately. The following questions are essential:

- What type of plant, machines and equipment would be required for the operations?
- Are there machine fabricators who can make the required machines as per specifications?
- Can the fabricated machines be transported easily from the fabrication site to the project site?
- Can the required sequencing of processes, synchronization of machines and balancing of machines be attained?

- **Production Process Needed**

Efficiency of technology depends on process design. The following questions would be appropriate:

- What type of process design will be required?
- Can we build those processes in a desired sequence?
- Are there any site limitations (in terms of size and existing design of building, etc.) and can the required processes be arranged with or without modifications?
- Whether the company currently has one or more of the processes required in the new technology and if yes, can we use the same with expanded capacity?

- **Possible Product Mix**

A project may involve production of goods and services in a particular range and therefore, the technology and processes should be able to produce them in an appropriate mix.

- **Possible Alternate Usage**

A technology that has an alternate use is better because if the company is not able to achieve its sales target, it can always change the product and establish in a different market. For example, a company engaged in the business of manufacturing glass-lining equipment for chemical industry can use several of its processes to manufacture concrete-mixing machines.

- **Flexibility**

The tastes of the customers change fast and the rate of change is becoming faster every day. If the product from the new project is closer to the consumer and has very little room for alternative use, then the processes must be flexible, so that the firm can adapt to changes quickly. Thus, if the market analysis indicates shorter lifespan of demand of

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the current product and a potential change is envisaged, then one has to look for the technology, processes and machines that can easily adapt to the changes, for example, in the world-recessionary situation of the year 2008, Nissan Motors shifted its sizeable operations to Japan, because their plant in Japan is capable of producing sixty different models of passenger cars.

- **Rate of Change**

It is important to know and estimate the rate of change in technology. For example, information technology changes fast, requiring firms to buy latest technologies as far as possible.

- **Waste Disposal Problems**

Waste disposal is a legal as well as a moral issue. Some technologies have the problem of waste disposal and may prove costly, for example, nuclear power plants.

- **Resource Availability**

Can we have access to the required quality of resources needed by the selected technology? For example, a cold-roll mill (CRM) technology in the steel industry requires high-quality coal with low moisture content and high carbon content. Long-term access to coal mines that have large reserves of coal at different levels of depth is essential. A task force may even consider visiting shortlisted coal mines, take samples from different depths and conduct lab tests to determine suitability of the coal for the technology being considered.

- **Risk Implications**

Every technology has its own consequential fixed and variable costs during operations. A technology that ensues in high fixed cost but low variable cost creates a higher degree of operating leverage. A higher degree of operating leverage would enlarge the effect of change in sales revenue on operating profits. High degree of operating leverage is still good if demand is increasing because increase in sales revenue will increase operating profit faster but if sales revenue declines, then operating profit will decline faster. Therefore, if there is any uncertainty about the sales revenue trend, then one must select a technology that has a low fixed cost even if its variable cost may be high.

One must study the technology in such a way that simultaneous commercial exploitability of a technology, in the environment that can be created in the company, can be evaluated.

- **Identifying Critical Success Factors**

Success of a project depends on the actual outcome of some key variables called critical success factors. Inaccuracy and uncertainty surrounding these factors may render the project unattractive. Each industry has its own critical success factors identified from the experience of businesses. For example, in case of a cement project, availability of limestone, availability of wagons, freight charges, supply of power and supply of coal are the key success factors, as they generally constitute 65 per cent of the variable cost and 40 per cent of realization. Critical success factors are product and region specific. Risk is studied in the light of possible variations in the critical success factors.

2.5.1 Selection of Site of a Project

Site selection involves measuring the needs of a new project against the merits of potential locations. The site selection process includes a detailed evaluation of project needs

which are then measured against the merits of potential locations. The process typically includes selecting and evaluating communities, real estate site analysis and acquisition, and may include negotiating tax incentives.

According to the U.S. General Services Administration, site selection considerations should begin early in the capital development process and play a significant role in pre-planning discussions. The process includes the following steps:

- Define project criteria
- Evaluate communities
- Create short list of communities based upon project criteria
- Identify real estate sites within each finalist community
- Real estate analysis
- Negotiate tax incentives
- Site acquisition

Detailed site selection typically requires nine months for federal projects and four to six months for private sector projects. The National Environmental Protection Act may extend the site selection timeline for federal agencies, depending on the level of environmental analysis required.

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2.6 ECONOMIC AND FINANCIAL ANALYSIS

Before any financial analysis is carried out, four basic decisions must be in place. These basic decisions are briefly explained as follows:

1. Period of analysis
    - Usually, the period of forecast is a matter of the company's policy based on the considerations of factors like product life cycle, business cycle, rate of change in technology, and taste, managerial ability to foresee in the future and database available to support the forecast.
    - Information technology projects typically can be planned for about three years due to the technological development rate, short product life cycle and uncertainty caused by low entry barrier.
    - Project report for the purpose of loans will be prepared for the period of the loan. This limits the life of a forecast.
    - Time-value based evaluation techniques are sensitive to the cut-off rate and length of time and their results become less relevant for decision-making with the increasing span of time in analysis, especially when the cut-off rate is high. One can give a thumb rule that for a cut-off rate of around 15 per cent, about a 10-year analysis will be fine if time-value-based techniques are used.
    - If the length of analysis is less than the approximate project life, then it is appropriate to forecast the resale value of all assets at the end of the terminal period and incorporate the terminal value in the last year's cash flow for the project.
2. At the stage of financing mix and cost, the firm might not have raised capital for financing the project. The financing mix decision has three purposes:

Check Your Progress

7. The success of technology transfer depends on certain factors. Which are these factors?
8. Why is it better to opt for a technology that has an alternative use?

NOTES

(i) Investigating the effect of new project financing on the company's capital structure. Sometimes, a capital-intensive project may not be feasible if it may result into a very high debt as the only possible way of financing the project.

(ii) Approximating the cost of each type of new funds that will be raised for financing the new project.

(iii) Approximating the weighted average cost of capital, which can be used in deriving the cut-off rate required for accepting the new project.

3. Cut-off criterion
   - The cut-off decision is a benchmark against which the project cash flow stream is compared to determine whether the project would attain its financial goal.
   - A cut-off rate is sometimes called a go-no-go criterion, hurdle rate or required rate of return.
   - If time-value-based evaluation techniques are used, the cut-off rate will be determined on the basis of cost of capital.
   - For other techniques where time value concept is not used, the appropriate cut-off must be decided.
   - There is a general belief that one has to use the cost of capital as the cut-off point when time-value-based techniques are used. However in the following situations, a cut-off rate must be determined separately:
     - o If the new project is likely to change the risk profile of the company, the cut-off rate will be different from the cost of capital.
     - o In most cases, a firm undertakes more than one project and makes a financial plan for a group of projects. The risk associated with each project in the group will be different, warranting different cut-off rates for different types of projects.
   - An ideal cut-off rate can be calculated in many alternative ways such as
     - o Adding risk premium in the risk-free rate of return. The risk-free rate is usually drawn from treasury bonds. The amount of risk premium is decided on the basis of change in the risk profile of the business as a result of accepting the new project.
     - o Using the capital asset pricing model (CAPM). The CAPM is only rhetorically appropriate in determining the rate of expected returns from a project.
     - o Calculating a risk-adjusted rate of return. By adding/subtracting the differential risk from the weighted average cost of capital.
4. There are many techniques for the evaluation of investment proposals. Some focus on capital recovery, some measure profitability and some take into account the time value of money. For instance:
   - A project for establishing a new market territory may be evaluated on the basis of accounting rate of return but replacement of machines on the basis of net present value.
   - An appropriate evaluation technique is one that may be justifiably applied to a given investment proposal for the attainment of financial and non-financial goals within the constraints in which the firm operates.

NOTES

2.6.1 Cost of Capital and Cut-off Decision

We need to determine cut-off rate for the financial evaluation of a project. One important method of determining the cut-off rate is based on the weighted average cost of capital, which in turn needs cost of debt and cost of equity. In this section, we will get some familiarity with calculating the cost of debt, cost of equity and weighted average cost of capital before we proceed to have a look at the methods for determining the cut-off rate.

Cost of Debt

Debt already obtained by a firm has a defined and contracted cash flow commitment against the exact amount that the firm received. Therefore, the cost of debt can be easily calculated following the steps given hereafter:

Step A: Know the policies related to the treatment of upfront costs

Raising funds costs money in the beginning. This is called floatation or up front cost. Depending on the size of the issue and issuer's market image, the issue of bonds may cost seven to eight per cent. Bank loan also has some upfront costs. Firms adopt one of the following two alternative policies:

- Include the upfront cost as the cash outflow in the project cash flow, or
- Include the upfront cost as the cash outflow in the calculation of the cash flow associated with the debt.

Conceptually, upfront cost is the financing cost and therefore, must not be included in the project cash flow but must be treated as the debt cash flow.

Step B: Know the marginal tax rate

There may be situations where the income tax rate may be progressive. A progressive rate means a lower rate for lower income and higher rate for additional income. In India, personal income tax rate follows the progressive rate concept but corporate tax rate is flat.

If progressive rate is followed, then one has to estimate taxable income in different years and the marginal income tax rate applicable for that marginal income in the respective year must be selected for tax adjustment in the calculation of cost of debt.

Step C: Prepare the debt cash flow stream

Using the terms and conditions of debt (issue price, coupon rate, frequency of payment of interest, maturity period and maturity amount) we can prepare the cash flow stream during the life of the debt. Do not forget to factor the tax at this stage and obtain the debt cash flow after tax.

Step D: Find the rate

This is just a mathematical process to find the rate at which the present value (discounted value) of the cash outflow stream is equal to the initial cash inflow. This rate is the cost of debt. The equation can be written as follows:

$$CF_0 = \frac{CF_1}{(1+R)^1} + \frac{CF_2}{(1+R)^2} + \frac{CF_3}{(1+R)^3} + ... + \frac{CF_n}{(1+R)^n} \qquad ... (2.7)$$

Where, CF_o = Initial cash inflow

CF_1 through CF_n = Cash outflow on debt servicing from year 1 to year n, n being the last year.

NOTES

R = Rate at which the present value of all cash outflows is equal to the initial cash inflow received at the time of raising the debt

Or,

$$CF_0 = PV_{R,t} = \sum_{t=1}^{n} \frac{CF_t}{(1+R)^t} \quad \text{... (2.8)}$$

where, $PV_{R,t}$ = present value at the rate R for the cash flow of period t

CF_t = cash flow in year t

Solve for R to get the cost of debt. Solving for R means finding the internal rate of return (IRR) for a given cash flow stream.

If tax is not factored at the time of preparing the debt cash flow stream, you get K_d which is in pre-tax terms. One needs to adjust it with tax to get post-tax K_d. The formula for such adjustment is:

$$K_d = R \times (1-t) \quad \text{... (2.9)}$$

where, t = tax rate

Let us repeat; it is appropriate to take after-tax debt cash flow in step C; rather than adjusting tax-using equation 2.7.

Step E: Find annual rate if interest is paid more than once a year

It is a common practice to pay interest (coupon) rate on bonds and other debt instruments more frequently than once a year. In that case, debt cash flow in step C will be the periodic cash flow (if coupon is paid semi-annually, cash flow will be semi-annual and if coupon is paid quarterly, then cash flow will be quarterly). Therefore, the rate we get in step D will be the periodic rate (semi-annual or quarterly or monthly). In this case, periodic rate in converted into the annual rate (called annual percentage yield or APY). APY is calculated from the periodic rate using the following formula:

$$APY = K_d = (1+R)^i - 1 \quad \text{... (2.10)}$$

Where, APY = Annual percentage yield, which is K_d here

R = Rate found in step c, which is a periodic rate for interest payment more than once a year

i = Number of times interest is paid in a year

Cost of equity (K_c)

It is most difficult to calculate the cost of equity because the cash flow obligation associated with the equity is unknown as servicing of equity is not a contractual liability. Payment of dividends to equity shareholders is determined by the distributable profit earned by the firms as well as the amount retained for financing the growth requirement. Still, we need to estimate equity shares-related cash flow or its surrogates for the claculation of the cost of equity.

2.6.2 Cut-off Rate (Required Rate of Return) Decision

The different methods prescribed for the determination of the cut-off rate are described as follows:

1. Opportunity cost

The required rate of return should be at least equal to the returns from the foregone opportunity (opportunity cost). This is theoretically the best cut-off rate. It is theoretical because in most situations, the opportunity is foregone and its returns are not ascertainable. In addition, the opportunity cost approach does not consider the presence of risk premium in the discount rate of the opportunities.

2. Cut-off rate or required rate of return (RRR) or risk-adjusted discount rate (RADR)

Risk adjustment is the real issue in determination of cut-off rate for projects. When the discount rate is calculated after the adjustment for risk, it is called risk-adjusted discount rate, popularly known as RADR. A simplistic formula for RADR will be:

$$RRR = RADR = R_f + R_p \quad \text{... (2.11)}$$

Where, R_f = risk-free rate

R_p = risk premium

Four different methods described for the RADR calculation are as follows:

(i) Intuitive approach

In this approach, first the risk-free rate (R_f) is estimated using the prevailing yield on treasury securities and then, the intuitively decided risk premium (R_p) is added it to get the required rate of return. The intuitive judgement for deciding the risk premium needs the following information:

- **Type of project**: For example, a 3 per cent premium for replacement of machinery, a 5 per cent for expansion, 8 per cent for new product development and 12 per cent for research projects. This method does not consider the effect of new project on the risk profile of business.
- **Other factors**: Other factors may include industry characteristics, debt-equity ratio, degree of total leverage, etc.

(ii) CAPM approach

Earlier, we mentioned the capital asset pricing model (CAPM) with reference to cost of equity. The CAPM was developed for estimating the investors' required rate of returns from an investment in equity share in the security market. Companies invest in projects and therefore, theoretically, can use the CAPM in the *project market* situation to find the required rate of returns from the project. If risk-free projects (like risk-free securities) exist and their returns are known and if similar projects are available in plenty and if projects have a ready market for trading (like stock and bonds markets), then companies can find the required rate of return using CAPM formula given in equation 2.12.

$$K_e = R_f + (R_m - R_f)\beta_i \quad \text{... (2.12)}$$

Where, R_f = risk-free rate on risk-free projects

R_m = return on market portfolio of projects

β = systematic risk of projects (covariance of return on surrogate firm's project and project-market return)

The CAPM is just hypothetical and not practical.

NOTES

(iii) Adjusted WACC approach

We can use the weighted average cost of capital (WACC) as a required rate of return from a new project, if and only if the WACC remains unchanged after the new project is undertaken. If the WACC changes with the new project, then we cannot take either pre-project WACC or post-project WACC as a cut-off rate. Follow the steps given here to find the cut-off rate using the adjusted WACC approach:

Step 1: Calculate the WACC before the new project and its financing plan is announced to the market.

Step 2: Announce the new project and its financing plan to the market and allow the market to reprice the share and bond.

Step 3: Now calculate (a) cost of the new bonds that will be issued, using new market price of outstanding bonds (b) cost of equity using the new price of equity shares and finally (c) weighted average cost of capital in the post-project announcement situation. In WACC calculation, include outstanding bonds and debt, proposed new bonds and equity increased with the additional equity funds (irrespective of whether raised through new issue of equity or funded with retained earnings) for financing the project.

Step 4: Now calculate the required rate of return using adjusted WACC approach explained in the following example:

Example 2.1: XY Ltd: Calculating RRR using adjusted WACC approach

XY Ltd has got the gross market capitalization of ₹ 1 crore. Its present weighted average cost of capital (WACC) is 18 per cent. After the company announced new investment plans of ₹ 50 lakh for the next plan period, its WACC went up to 18.5 per cent. Calculate the required rate of return (also known as RADR) for XY Ltd's new projects. What would be the RADR, if WACC had reduced to 17.75 per cent?

Solution*:* XY Ltd*:* Calculating RRR using adjusted WACC approach

The required rate of return from the new project of XY Ltd will be as shown in Table 2.2.

Table 2.2 *Required Rate of Return*

Scenario	Size in ₹	Cost of Capital	Earnings Required = Size × Cost of capital
Business-as-is	1,00,00,000	18.00%	18,00,000
Business with new project	1,50,00,000	18.50%	27,75,000
New project	50,00,000	19.50%	9,75,000

The answer is RRR = RADR = Cut-off Rate = $\frac{9,75,000}{50,00,000}$ = 19.50 per cent

If business continues as is, it would require to earn ₹ 18 lakh (18 per cent of ₹ 1 crore) to meet the expectations of fund suppliers but if the new project is accepted, the firm will have to earn ₹ 27.75 lakh (18.5 per cent of ₹ 1.5 crore). Thus, the business with a new project will have to earn an additional ₹ 9,75,000 (₹ 27,75,000 – ₹ 18,00,000) in return. These additional returns must come from the additional investment in the new project. Thus, the new project must earn at least 19.50 per cent (₹ 9,75,000 ÷ ₹ 50 lakh).

If the WACC (K_o) falls from 18 per cent to 17.75 per cent, the RRR from the new project will be as shown in Table 2.3.

Table 2.3 *RRR from the New Project*

Scenario	Size in ₹	Cost of Capital	Earnings Required
Business-as-is	1,00,00,000	18.00%	18,00,000
Business with new project	1,50,00,000	17.75%	26,62,500
New project	50,00,000	17.25%	8,62,500

XY Ltd should use the 17.25 per cent discount rate (cut-off rate) for the evaluation of the new project when K_o has reduced from 18 per cent to 17.75 per cent due to the announcement of investment plan.

In a way, the cut-off rate (required rate of return) based on adjusted weighted average cost of capital uses the following equation:

$$RADR = WACC \pm \Delta R_p \quad \text{... (2.13)}$$

Where, ΔR_p indicates differential (change in) risk premium.

2.6.3 Project Cash Flow Estimate

The process of estimating project cash flow can start after the detailed assumptions are drawn from market analysis, technical analysis and chosen financing options. We will discuss this topic in three parts — (a) types of cash flow, (b) principles of cash flow estimates and (c) workings for preparing cash flow.

Types of Cash Flow

The project cash flow can be classified on the basis of pattern, interdependence, etc. We will now look at the types of project cash flow on the basis of the timing of occurrence.

- The cash outflow incurred during the construction of the project is considered initial cash flow.
- The cash flow that occurs after a project is commissioned is called operating cash flow.
- The cash flow that occurs at the end of the project life (or to be more precise, at the time when the period of analysis is completed) is called 'terminal cash flow'.

Principles of Cash Flow Estimates

The basic principle for estimating project cash flow is 'only the cash flows relevant to the project should be included in the project cash flow.' It is also true to say that 'all future cash flows are relevant' or 'all opportunity cash flows are relevant'. However, the terms 'relevant', 'future' and 'opportunity' cash flows are not very self-explanatory. They are explained as follows through four principles.

1. Incremental cash flow: This is the basic principle; only incremental cash flow is relevant to a project. Some important points to be remembered are:

- Sunk costs are not relevant
- Overheads may not be relevant
- Any cost can be relevant or irrelevant
- Project cash flow may occur anywhere in the firm

NOTES

2. Salvage value: The salvage value of assets, along with any tax implications, on the date of project termination must be included as cash inflow.

3. Working capital: Working capital is the net investment in circulating assets (like cash, raw material, semi-finished goods, finished goods and receivables) *minus* current liabilities (like creditors and other payables). In most cases, capital investment proposals require additional (incremental) working capital, without which the wheels of fixed assets cannot operate.

Any increase (decrease) in core or permanent working capital is an initial cash outflow (inflow) and is held through the project life (no effect on operating cash flow). Upon the termination of the project, the working capital changes back to the original level and therefore, results in the decrease (increase) of the working capital, incurring cash inflow (outflow) as the terminal cash flow. That means, the change in working capital affects the initial cash flow as well as the terminal cash flow but with opposite signs (inflow vs outflow).

However, note that as per the 'long-term funds principle', fluctuating working capital requirement, together with the source funds and cost of funds, is considered a part of the operating cash flow of the project.

4. Tax implications: Incremental tax is usually the largest single component in the project cash flow. The government provides incentives and disincentives for investment in selected areas of business and location. Central and state tax structures (direct and indirect) must be appropriately considered at realistic level, that is, the extent to which it is applicable to the firm.

Working for Preparing the Project Cash Flow

The following statements are prepared for every year in the life of the project:

- Projected cash flow statement
- Projected income statements
- Projected balance sheets

For preparing the above statements, one needs to prepare several schedules. Some of the important schedules for preparing a project cash flow include:

- Debt servicing schedule (interest payment and principal repayment schedule for loans)
- Working capital schedule
- Working capital loan, interest and repayment schedule
- Depreciation schedule for income tax purpose
- Depreciation schedule for the purpose of reporting under the Companies Act, 1956 (if depreciation policy is different from the income tax rules)

All these statements and schedules are prepared in two sets: (i) assuming business as it is and (ii) business with the new project. The difference between the two projected cash flow statements is the project cash flow used for the financial evaluation.

2.6.4 Financial Evaluation

Financial evaluation approaches may be classified into selected accounting ratios and capital budgeting evaluation techniques.

Useful ratios: Based on the projected income statements and projected balance sheets, some important financial indicators are calculated for a quick viability check. For this purpose, all the data are taken on an annual average basis to reflect more than one year's life of the project. Important financial indicators are discussed hereafter.

1. Interest Cover Ratio

Interest cover ratio, also known as times interest earned (TIE), indicates the potential safety and timely payment of interest to the lenders of money. The following formula is used:

$$Interest\ Cover\ Ratio = \frac{PAT + Depreciation + Interest\ Expense}{Interest\ Expense} \quad \ldots (2.14)$$

Where, PAT = profit after tax

Lease rental, if any, is also added in the numerator as well as the denominator.

The interest cover ratio shows how many times the operating cash flow is earned against the interest expense. Usually, the interest cover ratio of three and more is considered desirable. Though this ratio is useful in determining the health of the earning power of the project, it is not a very important measure of overall project viability. This ratio is useful to lenders in evaluating the default risk, if any.

2. Debt Service Coverage Ratio (DSCR)

Debt service coverage ratio (DSCR) uses the same numerator as interest cover ratio but in the denominator, the principal sum repayment is added to the interest expense. The formula for DSCR calculation is:

$$DSCR = \frac{PAT + Depreciation + Interest\ Expense}{Interest\ Expense + Principal\ Sum\ Payment} \quad \ldots (2.15)$$

Academically and as per several financial institutions, an average DSCR of 1.5 or higher is considered good. A firm that attains 1.5 or greater DSCR is considered to have preserved credit worthiness. Even a minimum DSCR of 1.33 is accepted, especially in financing a sick business in its effort of turning around. The DSCR is a safety indicator; safety of not only the interest but also of the principal sum. DSCR also indicates whether the project is self-sustainable. A project that generates enough funds to repay all loans along with interest during the period of loan taken for the project is considered good from the business prudence perspective.

2.6.5 Capital Budgeting Evaluation Techniques

There are several capital budgeting evaluation techniques, some of which use accounting information and others use cash flow information. Some cash-flow-based techniques use time value concepts as well. We shall discuss important techniques in this section through example 2.2.

Example 2.2: HVBB Ltd is considering an option of buying a new machine with an investment of ₹ 1,00,000. The investment will last for six years, after which it can be salvaged at ₹ 3,000. It would also require an additional investment of ₹ 15,000 in working capital items like spares. The firm's cost accountant estimated the incremental operating cash inflow after tax for the life of the machine as shown in Table 2.4.

NOTES

Table 2.4 *Incremental Operating Cash Inflow*

Year	Operating Cash Flow (₹)
1	50,000
2	60,000
3	30,000
4	20,000
5	20,000
6	12,000

Evaluate the proposal of buying the machine using various methods of evaluation. Consider 20 per cent cost of capital where required.

1. Accounting or Average Rate of Return (ARR)

This method uses the average accounting profit on incremental basis and divides it by the annual average investment in the project during the life. The formula is:

$$ARR = \frac{Average\ Incremental\ Profit}{Average\ Incremental\ Investment} \quad \text{... (2.16)}$$

Solution 2.2(a): Accounting (average) rate of return

We need to calculate the year-wise accounting profit from the given cash flow and the year-wise annual investment for the calculation of the accounting rate of return for HVBB's project. For the calculation of the year-wise net profit, we must deduct depreciation from the operating cash flow. We will take 33 per cent depreciation on declining balance.

Table 2.5 *Calculation of Year-wise Profit and Average Investment: Depreciation Rate: 33 per cent WDV*

	Depreciation rate based on written down value (WDV) method: 33%						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Cash Flow	50,000	60,000	30,000	20,000	20,000	12,000	1,92,000
Depreciation	33,000	22,110	14,814	9,925	6,650	10,501	97,000
Net Profit	17,000	37,890	15,186	10,075	13,350	1,499	95,000
Investment (M/c)							
Beginning value	100,000	67,000	44,890	30,076	20,151	13,501	Six year
Ending value	67,000	44,890	30,076	20,151	13,501	3,000	average
Average	83,500	55,945	37,483	25,114	16,826	8,251	37,853

Ending value of investment in machines = Beginning value – depreciation

Annual average investment = (83,500 + 55,945 + 37,483 + 25,114 + 16,826 + 8,251) ÷ 6 years = 37,853

Average annual profit = Total net profit ÷ number of years = ₹ 95,000 ÷ 6 years = ₹ 15,833

Average annual investment: ₹ 37,853 + ₹ 15,000 = ₹ 52,853 (where ₹ 15,000 is the investment in working capital)

Accounting rate of return (WDV depreciation): (₹ 15,833 ÷ ₹ 52,853) × 100 = 29.96 per cent.

Discussion and cut-off rate

- The accounting rate of return method is theoretically an unacceptable method because (a) it does not take into account cash flows and time value of money and (b) the ARR figure is sensitive to the accounting policy regarding the method of depreciation. But managers seem to understand the results of this method better.
- Still, ARR has remained a popular method because even now, shareholders get accounting information and therefore, the market is always looking for profitability from the project.
- Other evaluation techniques fail if the project life is too long (like that in setting up of a foreign subsidiary) because of discounting process. ARR is the preferred and recommended technique for very long life or perpetual life projects.
- Determining cut-off ARR is not easy. It will be mostly judgemental or intuitive; rather than objective. However, a project that generates ARR higher than the projected ARR of the business without the new project will help in reporting higher ARR in future.

2. Payback Period

Payback period (PBP) is defined as the number of years required for recovering the original cash outlay invested in a project. If the project cash inflow is in the uniform series, the PBP can be computed by dividing the initial cash outlay by the annual cash inflow. That is,

$$PBP = \frac{Cash\ outlay\ (= investment)}{Annual\ cash\ inflow} \quad \ldots (2.17)$$

If the cash inflow is not in the uniform series, the PBP is calculated by accumulating the cash flows starting from the beginning. When the cumulative cash flow becomes zero, the initial investment, is fully recovered and PBP is reached. Let us calculate the PBP for HVBB example.

Solution 2.2(b): PBP

Initial outlay: ₹ 1,15,000 (i.e., ₹ 1,00,000 in fixed assets and ₹ 15,000 in working capital) as per Table 2.6.

Table 2.6 *Payback Period of HVBB Ltd*

Year	Cash Inflow	Cumulative Amount	Remark
0	₹ 1,15,000	₹ 1,15,000	
1	50,000	–65,000	
2	60,000	–5,000	← PBP
3	30,000	25,000	

Note that in year 1, cash inflow of ₹ 50,000 reduced the balance of initial investment of ₹ 1,15,000 to ₹ 65,000; and in year 2, cash inflow of ₹ 60,000 further reduces the balance of investment from ₹ 65,000 to just ₹ 5000. This balance will be fully recovered in the initial few months of the third year. Thus, the payback period is in the third year. We can calculate the PBP as follows:

$$PBP = 2\ \text{years} + \frac{5{,}000}{30{,}000} = 2 + \frac{1}{6}\ \text{years} = 2.1625\ \text{years} = 2\ \text{years}\ 2\ \text{months}$$

NOTES

Discussion and cut-off rate

- This is a simple method but (a) it ignores the total life of the project (b) it neither measures the value creation nor the profitability. It just measures the time taken to recover the initial investment.
- The firm has to predetermine the acceptable payback period. If project PBP is shorter than the acceptable one, the project is accepted; otherwise, it is rejected. But, a cut-off PBT could be at the most, a raw judgement.
- Despite all obvious limitations of the PBP method, it has remained very popular.
- PBP is useful where, (a) the firm is anticipating liquidity crisis in the time to come and (b) the proposed project is considered risky. Low PBP indicates fast cash flow coming in, easing the liquidity problem and mitigating the risky.

3. Net Present Value (NPV)

This is a discounted-cash-flow-based method of project evaluation. NPV is the excess of the present value of cash inflow over the present value of cash outflow of the project. The present value is calculated by applying the cut-off rate as the discount rate. We can calculate the present value of each single cash flow using equation 2.18a and then, add up all the present values to get the NPV.

$$PV = \frac{CF_t}{(1 + RRR)^t} \quad \text{... (2.18a)}$$

Alternatively, we can express Equation 2.18a for a multi-period cash flow and call it as NPV, as shown in equation 2.18b:

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1 + K)^t} - C \quad \text{... (2.18b)}$$

Where, PV = present value
NPV = net present value
CF_t = cash flow in period t
RRR = required rate of return or discount rate
C = initial outlay

Discussion and cut-off rate

- The NPV method of project evaluation is consistent with the corporate financial objective of value creation. The net present value is the value that the project is creating for the shareholders.
- Accept the project if the NPV is positive. Reject it if the NPV is negative. A decision-maker will be indifferent to a project that offers zero NPV.
- Some managers are uncomfortable with the NPV method because the NPV is an absolute amount of value and they are more comfortable with per cent figures.
- Some believe that since the NPV is in absolute amount, two mutually exclusive projects of different sizes cannot be compared based on NPV. This is not true. It can be proved that NPV remains a better measure even in the evaluation of mutually exclusive projects.

Solution 2.2(c): NPV

The investment proposal of HVBB Ltd is evaluated on NPV basis in the calculation shown in Table 2.7.

NOTES

Table 2.7 *Calculation of NPV of HVBB Ltd*

NPV Calculation		Rate	20%
		PV Calculation	
Year	Cash Flow	PVIF (Equations 3.32(a, b))	PV (CF × PVIF)
0	(115,000)	$1\div(1+0.2)^0 = 1.0000$	(115,000)
1	50,000	$1\div(1+0.2)^1 = 0.8333$	41,665
2	60,000	$1\div(1+0.2)^2 = 0.6944$	41,664
3	30,000	$1\div(1+0.2)^3 = 0.5787$	17,361
4	20,000	$1\div(1+0.2)^4 = 0.4823$	9,646
5	20,000	$1\div(1+0.2)^5 = 0.4019$	8,038
6	30,000	$1\div(1+0.2)^6 = 0.3349$	10,047
		Net Present Value	13,421
PVIF, the 'present value interest factor', is calculated using equation 3.32a for CF = Re 1 and RRR of 20 per cent in this case.			

The net present value is positive; the company can accept this project. This project will create a value of ₹ 13,421.

4. Profitability Index (PI) or Benefit-cost (B/C) Ratio

This is one variant of the net present value method. Profitability index (PI) is sometimes called as benefit cost ratio (B/C ratio). PI is calculated in two ways (equations 2.19a and 2.19b), both giving the same results if interpreted appropriately.

$$PI = \frac{PV\ of\ Cash\ Inflow}{PV\ of\ Cash\ Outflow} \quad \text{... (2.19a)}$$

Alternatively,

$$PI = \frac{NPV}{PV\ of\ Cash\ Outflow} \quad \text{... (2.19b)}$$

Discussion and cut-off rate

- The PI is the rate at which value is created. Therefore, some managers may feel comfortable with it and may feel that it can help in comparing two projects with different sizes. This is not true, though.
- If the PI is greater than one (in equation 2.19a), the project is acceptable. If we use equation 2.19b, then we look for a PI greater than zero.

Solution 2.2(d): PI

Profitability index of the proposed investment in new machine is,

$128{,}421 \div 115{,}000 = 1.12$ (using equation 2.19a)

or $13{,}421 \div 115{,}000 = 0.12$ (using equation 2.19b)

The PI of 1.12 implies that an investment of ₹ 1 will become ₹ 1.12 or will appreciate by 12 per cent, in the present value terms. This project is acceptable on PI basis.

5. Internal Rate of Return (IRR)

The IRR is a rate at which a project NPV is zero. We use equations 2.19(a, b) that we used for the calculation of NPV but the difference is that instead of finding the net present value, we find the rate (*K*) at which the net present value is zero.

IRR, therefore, is calculated with trial and error. Start with any discount rate and calculate the NPV. If the NPV is positive, try another higher discount rate and go on

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trying out different rates till a rate is found at which the NPV is exactly zero. We see this process of calculation in the example of HVBB Ltd.

Solution 2.2(e): IRR

Internal rate of return (IRR) shown in Table 2.8.

Table 2.8 *IRR*

	Rate	25%		26%	
Year	Cash Flow	PV Calculation		PV Calculation	
		PVIF	PV	PVIF	PV
0	1,15,000	1.0000	1,15,000	1.0000	1,15,000
1	50,000	0.8000	40,000	0.7937	39,685
2	60,000	0.6400	38,400	0.6299	37,794
3	30,000	0.5120	15,360	0.4999	14,997
4	20,000	0.4096	8,192	0.3968	7,936
5	20,000	0.3277	6,554	0.3149	6,298
6	30,000	0.2621	7,863	0.2499	7,497
		NPV	1,369		793

In fact, we should try a rate, say 25.5 per cent, and if the NPV is still positive, try say, 25.6 per cent and if it is still positive, try say 25.61 per cent and so on until we get exactly a zero net present value. But, many a times, we may not need such a precision; an approximate value of IRR may be just fine. For approximating IRR, when we find two successive rates, where at a lower rate, NPV is positive and at a higher rate, it is negative, we interpolate the value of IRR. The interpolation formula is given in equation 2.20.

$$IRR\ (Approximately) \approx IRR\ at\ Lower\ Rate + \frac{NPV\ at\ Lower\ Rate}{NPV\ at\ Lower\ Rate - NPV\ at\ Higher\ Rate} \quad \ldots (2.20)$$

By interpolation process, we assume that the NPV will change between the two successive rates in a linear fashion.

Plugging the values in equation 2.20 for the HVBB Ltd example, we get

$$IRR\ (Approximately) \approx 25\% + \frac{1{,}369}{1{,}369 + 793} \approx 25.63\%$$

Discussion and cut-off rate

- The IRR is a rate at which the initial investment is returned in the present value terms.
- A many managers like this method because it gives a rate; rather than just an absolute value.
- A project is accepted if the IRR is greater than the cut-off rate; otherwise it is rejected.
- The IRR-based decision will be the same as the NPV-based decision in case of accept-reject situation but in case of mutually exclusive projects, NPV gives the correct choice.
- The limitation of IRR arises from the fact that in IRR calculation, there is an inherent assumption that intermittent cash flow is reinvested at the rate equal to

the IRR rate; whereas, a firm may be willing to invest future cash flows at the rate equal to the weighted average cost of capital or at the risk-adjusted discount rate.

6. Modified Internal Rate of Return

Modified internal rate of return (MIRR) removes the unrealistic assumption of the IRR. In the MIRR calculation, the intermittent cash flows are reinvested at the rate equal to the cut-off rate or any other rate appropriate for the future investment, up the terminal period. In the process of reinvestment, we calculate the future value, which uses the following formula:

$$\textit{Future Value } (FV) \textit{ or Terminal Value} = CFt \times (1 + K)^t \quad \ldots (2.21)$$

Using equation 2.21, all intermittent cash flows are reinvested to mature at the terminal point of the project. As a result, there will be only two cash flow points in the project cash flow. One, initial period cash flow and two, terminal period cash flow. Then, an IRR is calculated for this cash flow series, which may equate the terminal value with the initial outflow in the present value terms. It is called MIRR. Let us take the example of HVBB Ltd. and calculate MIRR.

Solution 2.2(f): MIRR

Let us take 20 per cent discount rate given in the example as the reinvestment rate for MIRR purpose as per Table 2.9.

Table 2.9 *MIRR Calculation*

			Reinvestment Rate 20%	
Year	**Cash Flow**	**TV Calculation**		**MIRR Cash Flow**
		FVIF	**FV**	
0	(1,15,000)			(1,15,000)
1	50,000	$1 \times (1+0.2)^5 = 2.488$	1,24,400	0
2	60,000	$1 \times (1+0.2)^4 = 2.074$	1,24,440	0
3	30,000	$1 \times (1+0.2)^3 = 1.728$	51,840	0
4	20,000	$1 \times (1+0.2)^2 = 1.440$	28,800	0
5	20,000	$1 \times (1+0.2)^1 = 1.200$	24,000	0
6	30,000	$1 \times (1+0.2)^0 = 1.000$	30,000	3,83,480

Note that year 1 cash flow of ₹ 50,000 is reinvested for the remaining *five* years; the maturity (future) value is ₹ 1,24,400. Year 2 cash flow of ₹ 60,000 will be reinvested for the remaining *four* years; year 3 cash flow of ₹ 30,000 will be reinvested for the remaining *three* years and so on. Last year's cash flow is not reinvested at all. The result is that the firm will now receive all reinvested cash flows at the end of the year 6. All maturity amounts add up to ₹ 3,83,480. That means, the rate at which the present value of ₹ 3,83,480 is equal to the initial investment of ₹ 1,15,000 is the *modified* internal rate of return (MIRR). Using equation 2.21, we get the following MIRR:

$$115{,}000 = \frac{383{,}480}{(1+K)^6} \text{ Solving for K (using method of calculating IRR)}$$

$\therefore$ MIRR = 22.23 per cent

The management of HVBB should accept this project because it generates an MIRR greater than the required rate of 20 per cent.

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Discussion and cut-off rate

- MIRR is surely a better method than IRR because it gives a per cent without limitation of inappropriate assumption of reinvestment rate.
- Accept the project if the MIRR is greater than the cut-off rate.
- We can prove that when it comes to mutually exclusive projects, MIRR may fail and the NPV method will be proved reliable.

At the cost of repetition, note that in case of accept-reject situation, NPV, PI, IRR and MIRR will all give the same decision but in case of mutually exclusive projects with size disparity, pattern disparity or life disparities, one should use NPV.

Real Life Application

What is the most pragmatic approach for the application of financial evaluation methods in real life? The answer is:

- Firms have conflicting goals like, liquidity needs, the need to report year-to-year profitability and to create value. Therefore, it is advisable to use a two-layered approach for the financial evaluation of projects, for example, at the first stage, use either ARR or PBP as a first screening method and further apply NPV or MIRR only if a project is cleared in the first screening.
- In case of acute liquidity situation or very high uncertainty situation, use PBP method.
- If the project life is too long, either rely on ARR or just look at the potential market size and do not bother about financial evaluations. Many multinational firms have set up successful foreign subsidiaries with calculated negative NPV; they simply relied on potential market size.
- Remember, there could have been several costs and benefits that were not translated into financial numbers. To that extent, financial analysis is incomplete and therefore, before any project is either accepted or rejected on financial grounds, we have to consider the strategic and other aspects of the project.

Risk Assessment

The process of building logic (also known as information or knowledge through market research, test marketing, etc.) is also the process of reducing risk. Thus, some risk can be mitigated at the stage of the designing of the project. After an initial design is ready, one does a financial analysis. However, financial analysis uses single point forecast values, which may be subject to risk or uncertainty. Therefore, an analysis is not complete without the systematic study of risk. A project risk is studied initially with sensitivity analysis to identify the critical success factors, so that those selected few factors can be studied further to identify probabilities and various outcomes. Then, the project design is reviewed to develop alternative designs to match each possible outcome. This process helps in selecting the right project alternative from the risk-return perspective.

In addition to the project risk, one must study the project portfolio risk. A project that is independently risky may be desired if its cash flow is negatively associated with the cash flow of the rest of the business. In that case the new project offers diversification advantages and therefore may be preferable from the overall risk-return angle.

Check Your Progress

9. What is cut-off decision in financial analysis of a project?
10. Define yield to maturity (YTM).

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2.7 SOCIAL COST AND BENEFIT ANALYSIS

The concept of economic rate of return can be expanded to encompass the social cost and benefits, thereby, calculate the social rate of return. This method of project evaluation is also popularly known as Social Cost-Benefit Analysis (SCBA). Government and social projects are evaluated on the line of social cost-benefit analysis. Many international funding agencies would finance a social project based on its social rate of return.

SCBA is a very subjective method but conceptually sound. The following brief text gives a conceptual explanation. The details are kept out of the domain of this book. The readers who are interested in reading authentic material on SCBA should read *Manual for the Evaluation of Industrial Projects*, UNIDO publication, 1980. *A Guide to the Economic Appraisal of Projects in Developing Countries*, by the Ministry of Overseas Development is also useful.

2.7.1 Non-Quantifiable Cost-Benefits in Projects

Financial cost-benefit is from the angle of a firm; economic cost-benefit is from the angle of a nation's economy. Both involve assessment of identifiable rupee value of costs and benefits for either the firm or for the nation. Economic cost-benefit analysis will be done by government and government agencies in determining incentives and disincentives to businesses either in terms of concessional rate of power supply or supply of cheap paper or guaranteed supply of scarce resources or offering guarantees such as rate-guarantee, and so on.

Some projects, private or government, generate non-quantifiable cost-benefits. Many such projects are initiated to provide economic impetus and not for tapping the currently available opportunities, for example, construction of a dam has several social costs like displacement of habitants, loss of agricultural land, potential effect on ecology, and so on, against many social benefits such as irrigation, flood control, beautification and tourism potential. In economically backward areas, social infrastructure projects like literacy programmes, education initiatives and family planning programmes create conditions for economic growth. The non-quantifiable costs and benefits in such projects are plenty.

In private projects, a type of social cost-benefit analysis would help in shaping government policies and policies of foundations who work for the community. For example, the impact of global warming may not be felt in the foreseeable future, but at least all (beyond scientific community) have started agreeing now that global warming is a serious issue. Therefore, any project that affects the ozone layer is less desirable and deserves disincentives and other projects like research for alternate energy or projects using alternative energy deserve incentives. Thus, today, the environment effect must be built into the social cost-benefits.

Therefore, all agencies that aim at social welfare, such as government and international institutions like the World Bank, International Monetary Fund and UNIDO use social cost-benefit analysis for the evaluation of projects.

Social projects of the government and those financed by the government will be appraised on SCBA lines. The following factors warrant social cost-benefit analysis:

- Market imperfection
- Taxes and subsidies
- Concern for savings
- Concern for redistribution

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Most of the markets are imperfect. The degree of market imperfection is high in underdeveloped and developing nations. Market imperfection is manifested in immobility of resources or in mobility-shy resources. Land is not mobile; lack of infrastructure keeps away the business from faraway places where land may be very cheap. Labour is mobility shy due to family and social reasons, coupled with inadequate communication facilities and immigration laws. For such reasons, market prices do not reflect true economic prices, requiring the use of shadow price for the valuation of costs and benefits.

Typical low savings investment rates and unequal distribution of income and income-generating opportunities are the matters of concern for such nations. A project, which results in effective redistribution of income, is more valuable than those projects where income is concentrated in a few hands. These factors must be assigned a higher value as they are the immediate concerns of developing nations.

2.7.2 United Nations International Development Organization (UNIDO) Approach to SCBA

As in any project evaluation, SCBA also involves (a) estimating costs and benefits in terms of cash flow and (b) determining discount rate for calculation of the project's net present value.

Estimating Social Cash Flow

United Nations International Development Organization (UNIDO) follows three steps in estimating cash flow in the SCBA approach.

Step 1: Calculate financial cost-benefits

The first step of measuring the financial profitability of a project at market price, involves evaluation of the project from the company's angle only. When it is translated into the economic cost-benefits, (a) some costs and benefits are excluded because they only amount to change of hand in the economy as stated in the discussion on ERR and (b) the economic cost and benefits are priced at economic rates, rather than markets rates.

Step 2: Calculate economic cost benefits

Goods produced and consumed by the project must be handled in three sub-steps, namely

- Separate non-economic cost benefits from economic benefits
- Identify tradable goods and price them
- Identify non-tradable goods and price them

Some flow of money in financial cost-benefits may not involve any economic costs or benefits. These cash flows must be excluded from the social cost benefit analysis. UNIDO has developed application models for different economies.

There are three alternative prices possible for goods and services, namely:

- Market (producer's) price
- Free-trade price (world price)
- Shadow and second best shadow price

For determining prices, goods and services are grouped into two categories:

- Goods that are imported or exported or close to being imported or exported are tradable goods. Because of market distortions one cannot take market price for tradable goods. Therefore, tradable goods are priced at the

international price of goods. Resources consumed are priced at and resources produced.

- There are also some non-tradable goods; for example, value of lives saved, value of time saved, cost of pollution, etc. Also included in non-traded goods are land, buildings, electricity, transportation and others, which are not traded internationally. As a result, international prices are not available as economic prices. These non-tradable goods are valued at shadow prices. Some bases for shadow prices are suggested as follows:

Step 3: Adjustment for social concerns: Developing nations have three major social concerns:

1. Impact on savings
2. Impact on income distribution
3. Goods that may be merit or demerit ones

The economic values derived at the end of the second step explained earlier must be adjusted for these three concerns. The adjustment is based on the extent the project contributes in achieving the goals of social concerns.

Incorporating impact on savings

The impact on savings is measured as per equation 2.22.

$$Impact\ on\ Savings = \Sigma \Delta y_i \times MPS_t \quad \text{... (2.22)}$$

Where, Δy_i = Change in savings in year i

MPS = Marginal propensity of savings in year i

The value of rupee of savings is the present value of additional consumption stream produced when that rupee of saving is invested at the margin. As a thumb rule, it is believed that one rupee invested in agriculture generates, say ₹ 7, industry ₹ 10, infrastructure projects, ₹ 30, and social infrastructure generates a net value of ₹ 70.

Incorporating impact on income redistribution

The impact on income redistribution is measured in terms of willingness to pay. Various sectors or parties, such as other businesses, government, workers, consumers and others, may gain or lose due to the project. Their willingness to pay (or charge) for goods they receive (or lose) is estimated. However, the methods of estimation may be much less objective. For example, a survey method, which involves administration of questionnaire may not offer reliable shadow price because of lack of experience of goods and also because of psychological issues if they are the loser of goods. One can determine weight (price) by using elasticity of marginal utility of income based on equation 2.23.

$$W_i = \left(\frac{B}{C_i} \right)^n \quad \text{... (2.23)}$$

Where W_i = Weight assigned to income at the level of C_i

B = Base-level income, with weight of 1

n = Elasticity of marginal utility of income

Incorporating importance of goods

Merit goods are ones whose social value is greater than economic value, for example, conservation of oil and generation of employment are more valued items. Energy is

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merit goods. Some others are demerit goods, where social value is less than economic value. Cosmetics are demerit goods. The list of merit and demerit goods and their importance may vary from nation to nation.

Economic prices of resources are adjusted upward or downward, as the case may be, on the consideration of savings, income distribution and merit or demerit goods. The adjustment factors for various resources are generally pre-decided by the agency, like UNIDO for each country. These factors are periodically reviewed in the light of changed conditions.

The stream of social costs and benefits is obtained after the three steps described above.

Little–Mirrlees Approach to SCBA

In the field of social cost-benefit analysis, the other approach that is more discussed is the Little–Mirrlees (LM) approach or manual. Little–Mirrlees wrote this approach and subsequently redefined it. This approach created several controversies, which resulted in many authors attempting an explanation.

The basic concepts of SCBA in both UNIDO approach and LM approach are the same. Most approaches are also the same, but some countries and the World Bank use the LM approach because it gives a ready-to-use detailed procedure for computation of difficult shadow prices. The main contribution of LM is in bringing simplicity by the way of using 'world prices' or 'real foreign exchange prices' as shadow prices for all goods, whether tradable or non-tradable. It is based on the assumption that international market is perfect or efficient. LM approach suggests:

1. Use CIF (Cost-Insurance-and-Freight or Import) price if the goods produced in the economy reduces import, or
2. Use FOB (Free-on-Board or Export) price if the goods produced in the economy are available for export.

One can see a similarity with the UNIDO approach in these suggestions, but the difference is that these suggestions are even applicable to the pricing of non-tradable goods. However, the Little–Mirrlees approach is less widely used than was initially expected.

Comparison between UNIDO and LM Approaches

The following similarities can be cited:

- Both approaches use shadow (accounting) prices especially for foreign exchange savings and unskilled labour
- Both consider factor of equity
- Both use the discounted cash flow (DCF) method

UNIDO	LM
Uses domestic currency basis	Uses 'world price' for cost-benefits
Is based on the consumption value of costs and benefit	Is based on 'uncommitted social income'
Is a stage-by-stage analysis	Is an integrated analysis

Let us look at the differences in details of approach through a hypothetical example. For example, a project consumes electricity. How should we determine the social cost of the consumption of electricity? As per the UNIDO approach, the marginal social cost is calculated by taking the material costs involved in generation of electricity and each

material cost is priced at international price; and the wages component is taken at social wage rates. Wages may be categorised and an appropriate rate may be applied for each category. In the LM approach, the cost will be divided into three categories—tradable goods, labour and other expenses consumed in the generation of electricity. These components are converted into the social cost by applying social conversion factors, which are based on international prices.

Estimating Social Discount Rate

One needs to determine the rate at which cash flow must be discounted for calculating the net present value. Alternatively, one can calculate the internal rate of returns for a given cash flow. The internal rate of return in the SCBA is known as social rate of return (SRR). At SRR, the present value of cash inflow outflow becomes equal. However, SRR has to be compared with a benchmark, which is social discount rate (or social required rate of return). Thus, whether it is NPV that is calculated or SRR, one needs to know the social discount rate.

Applying the opportunity cost rule, the SRR from the project foregone in favour of this project should be taken as a social required rate of return or social discount rate. Some alternatives are:

- After-tax interest rate
- Consumption rate of interest
- Foreign exchange in the hands of government

After-tax interest rate is more appropriate from the firm's point of view in calculating financial rate of return. In absence of the opportunity return, the consumption rate of interest can be taken as cut-off rate, as done in the UNIDO approach. The LM approach is in favour of using 'investment discount rate'. The discount rate would be the comparative value of future and present foreign exchange held by the government.

It is said that marginal foreign exchange held by the government in a developing economy would be utilized for investment. That is why discount rate in such an economy would be called investment discount rate instead of consumption discount rate. Some others argue and recommend integrating equity concerns because the funds used by the governments, especially have intergenerational equity effect. Intergenerational equity occurs in deficit financing activity, because the burden of deficit financing is on the future generation, implying that the cost of equity in the future is relevant as a discount rate. Thus, intergenerational equity cost should be considered as the social required rate of return.

Difficulties in SCBA

- Elements of subjectivity may creep in while determining economic prices.
- Shadow prices are always subject to criticism as are 'world prices'.
- The theoretical solution for shadow price that uses the consumers' willingness to pay as a shadow price causes more difficulties in practical life.
- A survey method and its results for determining the 'willingness to pay' can be extremely subjective largely because intangibles are being evaluated here.
- Determining weights assigned to savings, redistribution of income and merit goods can only be judgemental.
- The cut-off rate or the social required rate of return also becomes a matter of debate.

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2.7.3 SCBA in India

SCBA is carried out in detail in India. All developmental agencies do SCBA while funding major private projects. State governments also carry out SCBA when luring and approving new mega projects for the state. For example, development banks like ICICI, IDBII and IFCI used a modified LM approach for appraising projects costing more than five crore rupees.

SCBA is available for several projects in India, including the Delhi Metro Project and the Watershed Development Project in Karnataka.

The following example is the NCAER study of a POSCO project in Orissa.

An example of SCBA

The NCAER study broadly used the ADB/World Bank methodology on the social cost-benefit with minor adjustments for the local parameters. Econometric models were used to project border prices for useful life of the project. The project's impact from the state economy perspective—in terms of the impact on state GDP (output multiplier effects) and employment opportunities created within the state (employment multiplier effects) was also assessed.

The output multiplier for iron ore was found to be 1.4 compared to 2.36 for steel. In other words, every ₹ 1 lakh worth of output in the iron ore sector would result in ₹ 1.4 lakh of output (including the ₹ 1 lakh output of iron ore) compared to ₹ 2.36 lakh for every ₹ 1 lakh output of steel. The employment multipliers for iron ore and steel work out to 0.35 and 0.69 man-years respectively. Therefore, in terms of both output and employment, steel has a larger impact.

These multipliers imply that the Posco project would create an additional employment of 50,000 person years annually for the next thirty years vis-à-vis 870,000 person years in the steel project alternative. In terms of value addition, the iron ore and steel project alternatives would contribute 1.3 per cent and 11.5 per cent to Orissa's State Gross Domestic Product (or SGDP) by 2016-17 respectively.

An important part of the study was the Least Cost Analysis of technology options in the steel-making, the Finex process that Posco purports to bring and the traditional blast-furnace technology. The Average Incremental Economic Cost was used as the yardstick; this was followed by computing the economic IRR (internal rate of return) to examine whether the project was economically worthwhile from the national economy point of view.

The EIRR for the Orissa project works out to 16.6 per cent for base case and even in the worst case scenario, the EIRR at 13.9 per cent would remain above the hurdle rate of 12 per cent. The economic impact of the project was estimated at $2.5 billion at the test discount rate of 12 per cent.

The significant feature of the study was the estimation of depletion premium or the opportunity cost for depletable and non-renewable resource iron ore for the following reasons:

India's high-grade ore (+ 65 per cent Fe content — Haematite) reserves, proven and probable, amount to only 0.58 billion tonnes. And even if we were to factor in indicative and inferred reserves (probable/feasible), the total reserves (proven and possibly future potential) would be only 0.92 billion tonnes.

India's medium-grade ore (+62 per cent Fe to 65 per cent Fe — Haematite) reserves, proven and probable, is only 1.3 billion tonnes. Here too, if we factor in indicative and inferred (probable/feasible and pre-feasibility estimated) reserves, the total reserves (proven and possibly future potential) will be only 2.8 billion tonnes.

Policy Implications

Orissa stands to gain significantly if instead of exporting iron ore it processes it to steel within the state, in terms of both employment generation (17 times), and GDP impact (9 times).

India's high and medium grade iron ore reserves may not last more than 19 years even if exports of these grades are frozen at the current level or if the targets set out in the draft steel policy are to be met. The economic analysis considered the depletion premium for high and medium grade iron ore. This is the opportunity cost to the national economy of using the depletable resource, which is the average incremental cost of depletion premiums computed year-wise.

'Any exporter of iron ore of medium and high grades from the state needs to pay a depletion premium of $27 per tonne. Even this would be a sub-optimal policy from the State's viewpoint if it can process the medium and high grade ore to steel. No such depletion premium has been applied for coking coal as its price did not exhibit any trend before the recent steep price hike.'

'For the eastern states seeking to raise the mineral sector's share in their GDP, it may be a good idea to set up processing facilities. It would not be advisable to allocate iron ore mines through open bids or accept increased royalty payments, even accounting for the depletion premium, compared to the option of processing iron ore to steel. Future cost-competitiveness and logistical advantage imply that iron ore-rich states can compete with existing overcapacities in the US, Europe and Japan even after factoring in the capital charges for new investments.'

'Export of iron ore needs to be restricted to grades other than medium and high-grade ore categories; for instance, export of beneficiated ore from Goa using inland waterways logistics advantages could be encouraged. Allowing exports of high grade ore would facilitate export of steel from existing overcapacities in the US, Europe and Japan to East Asia at the expense of future steel exports from new Indian steel capacities which are likely to enjoy cost-competitiveness over existing overcapacities elsewhere.'

2.8 PROJECT REPORT AND AUDIT

The management information system must evolve to generate the required reports so that cost, time and work can be monitored. Different levels of the management require different reports at varying frequencies. Figure 2.2 gives the pictorial idea about the report requirement at various levels.

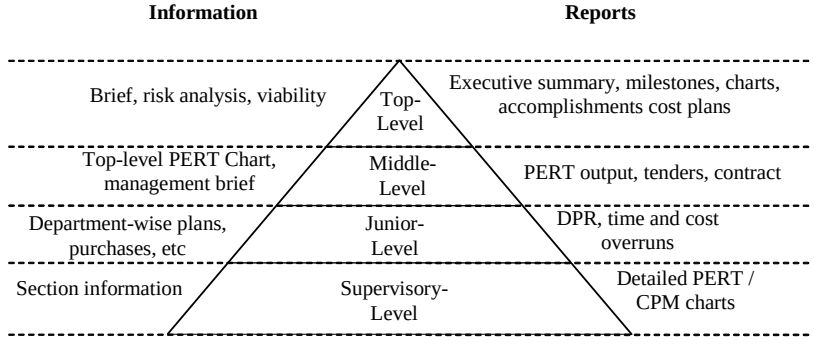

Fig. 2.2 *Management Levels and Required Information/Reports*

2.8.1 Types of Project Reports

There are many reports and information sought on a regular basis as well as on need basis. A small list of the three types of reports is given as follows:

Check Your Progress

11. What are the factors that warrant social cost-benefit analysis?
12. State the three alternative prices possible for goods and services.

1. Cost reports

(a) Activity cost report

(b) Cost flow report

(c) Variance report

2. Time and efforts reports

(a) Time activity report

(b) Time analysis report

- Programme schedule and work efforts are highly interrelated
- These reports provide PERT/CPM-type information

3. Work status report

- Status index report (this report attempts to combine all the three—cost, time and work—into a single index)
- Earned value project management report

Alternatively, the types of reports can be listed in five parts as follows:

1. Financial reports
   (a) Monthly commitment and expenditure
   (b) Monthly cash flow forecast
   (c) Monthly bank guarantee position
   (d) Monthly outstanding payments to consultants, suppliers and contractors
   (e) Weekly documents retired through bank
2. Procurement monthly reports
   (a) Order placement details
   (b) Pending ordering schedule
   (c) Bids processing status
   (d) Delivery forecast
3. Inspection expediting reports
   (a) Weekly vendor-wise details status report
   (b) Constraints report technical and commercial
   (c) Exception report
   (d) Sub-ordering report
4. Engineering reports
   (a) Documents release and balance status report (monthly)
   (b) Bid's technical scrutiny and recommendation report
   (c) Construction drawings release and status report
   (d) Operation manual
   (e) Model
5. Construction and erection reports
   (a) Weekly job-wise, contractor-wise report
   (b) Monthly detailed progress review
   (c) Exception report
6. Project management reports
   (a) Monthly overall review covering the above aspects
   (b) Exceptions and recommendations

The frequency and the details of project control reports are very need specific and therefore, will vary from firm to firm and from project to project. Some general points regarding the reports are outlined as follows.

Reports on Cost and Time

Reports on actual cost comparison with the budgeted cost and actual time comparison with the budgeted time are relatively straightforward. The interpretation of time reports is relatively easy. The interpretation of the cost report is somewhat different, for the possibility that if actual costs are less than the budget, quality may have suffered. For this reason, mere comparison of actual cost with the budgeted cost would be often misleading, unless we find a unique method of estimating the costs requirements, in the context of both time and quality.

In most cases, the cost reports compare 'actual costs to-date' with the 'budgeted costs for the work accomplished to-date'. The reports may also show the current estimate of costs for the entire project compared to the budgeted cost for the entire project. The current estimate is obtained by taking the 'actual costs-to-date' and adding in it an estimate of the costs required to complete the project. The latter type of report is called review report. It is a useful way of showing how the project is expected to come out.

It is important that actual costs is compared with the budgeted costs of the work done, which is not necessarily the same as the budgeted costs for the time period. The danger of misinterpretation is illustrated in Table 2.10 which shows the actual and the budgeted costs for a project. As of end September, the actual costs were ₹ 3,45,000 compared to the budgeted cost of ₹ 3,00,000 which indicates a cost overrun of ₹ 45,000. However, the budgeted cost of the work actually completed through September was only ₹ 2,60,000, so the true overrun was ₹ 85,000.

Table 2.10 *Cost Variances*

Month	Budgeted cost	Actual cost	Budgeted cost for work done	Spending variance	Schedule variance	Total variance
August	2,25,000	2,75,000	2,00,000	–50,000	–25,000	–75,000
September	3,00,000	3,45,000	2,60,000	–45,000	–40,000	–85,000
October	3,65,000	4,15,000	3,10,000	–50,000	–55,000	–105,000

***Note*:** Negative variance means adverse variance.

Spending variance = Budgeted Costs – Actual Costs

Scheduled Variance = Budgeted Costs for Work Done – Budgeted Costs

Total Variance = Budgeted Cost for Work Done – Actual Costs (or Spending Variance + Schedule Variance)

2.8.2 Feasibility and Detailed Project Report

Feasibility study report

Feasibility study report is prepared to support the investment proposal. Feasibilities related to technical, commercial and financial aspects are examined in detail by the experts. Feasibility study report is termed as a techno-economic feasibility study.

It is the primary report for the formulation of the investment proposal. Investment decisions are taken based on the details incorporated in the study. Thus feasibility is prepared only for the formulation and investment decision-making. The first step in feasibility study is the needs analysis. The purpose is to define overall objectives of the system proposed to be designed. The second and perhaps the most important thing is system identification. This is referred to as activity analysis.

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Feasibility study report contains:

- Knowledge of demand and availability of the product
- Required sources for the development of the project
- Selection of suitable process and technology
- Fixation of capacity on the basis of the project
- Process description and layout plans for the project
- Available facilities and their evaluation
- Capital cost
- Profitability analysis
- Project schedule and schedule control
- Design and flow diagrams

This report should be submitted to the experts of the concerned departments of operation such as finance, commercial, project etc once it has been made. In case of any differences, the feasibility study report is discussed with the experts, consultants and is modified according to it.

A detailed project report is a complete blueprint for the execution of the project. It is the project implementation guide for the project team. It describes functions, authority and activities along the line of time, cost and technical parameters. This report sets the standards for time, cost and work with which results can be later compared as and when the work progresses.

2.8.3 Project Completion Report

Once the project is terminated and handed over to the operations team, project review is undertaken. The end result of project review is the preparation of the project completion report (PCR). Project completion report is a document which would give a comparison of the actual costs and the time with the originally budgeted ones. The reasons for deviations are recorded. The initial scope and the level of its attainment are also documented with observations upon them. The degree of attainment of goal is also recorded in the project completion report. It is usually quite detailed and informative.

The contents of a project-completion report may vary depending upon the type of project and the perceived benefits from project review activity. The European Commission uses 'Seven-Framework-Programme' for technical review of a project.

Post-Completion Audit (PCA)

We can always learn from our past experiences so that we can do better in the future. Though, project planning is done with due care and diligence, not all things would go as planned. For being competitive in today's fast changing world, companies need to analyse the results of their capital projects after these projects have been implemented, though bygones are bygones. Post-completion audit may serve as a major vehicle for project analysis and also to help reinforce the learning curve for the organization, at least for some types of projects.

Meaning and definition of PCA

'Audit' is generally defined as 'an examination of documents and results to find out whether they are in the desired order'. Thus, PCA is an attempt at assessing the actual profile of the given project in terms of results, vis-à-vis the intended profile of it besides focussing on whatever matters the senior management desires.

Many authors have defined post-completion audit in different ways. Some such definitions lay emphasis on 'check … after the project has been operating for some period of time', or 'an audit at some point after the occurrence of transaction'.

Objectives of PCA

Post-completion audit of capital projects is supposed to accomplish at least four primary objectives.

First, post-completion audit should be an important financial control mechanism. It helps provide the means of evaluating — (1) financial and non-financial impact of the project on the company, whether positive or negative; (2) how the actual results of the project compare to data and assumptions included in the program; (3) future actions that are necessary or expected regarding the project.

Second, post-completion audit should provide information for future capital expenditure decisions. Through post-completion audits, managers can detect weaknesses in their estimating and forecasting techniques as well as their information systems, essentially for future use.

Third, post-completion audit aims at removing certain psychological and/or political impediments usually associated with asset control and abandonment. Recognition of post-completion audit as a formal part of capital budgeting process adds legitimacy to it. Legitimacy to PCA may eliminate some of the possible barriers to the learning process usually experienced in a corporate life. A learning organization will have fewer political processes in it. Objectivity and transparency brought by legitimate PCA would impair political processes and make them ineffective.

The fourth objective of post-completion audits is to have a psychological impact on the individuals proposing capital investments. In other words, merely knowing that a formal review of a project might occur afterwards should encourage many managerial actions beforehand.

These objectives, thus, render the following benefits to the organization:

- Provides a check on personal biases
- Improves the quality of estimates
- Improves productivity, as estimates become goals
- Identifies factors responsible for non-fulfillment of the project's promises
- Gives a sense of recognition to those involved in capital expenditure planning and control as it shows that the management recognizes the importance of investment decisions
- Improves the originator's estimating proficiency
- Provides information for subsequent decision-making and can be used for corrective action if estimates were poor
- Holds estimators responsible and become more careful in forecasting

It is needless to say that the most important objective of post-completion audit is learning lessons for the future; rather than simply faultfinding or fixing blames. Precautionary care should be taken to avoid misplaced perceptions about PCA. It should be ensured that people do not consider PCA as the process for initiating punitive actions. Otherwise, that will discourage initiative and lead to excessive conservatism and may cause managers to suppress risky projects. PCA should remain educational in nature and purpose.

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Design of a PCA system

All the projects need not be audited in the same detail and PCA is always project specific. So, a few managerial decisions, related to PCA have to be taken. These decisions are based on the following questions:

- When to design PCA?
- Should PCA be conducted?
- Who should audit?
- When should the audit take place?
- What should be audited to audit?
- Should the findings of the PCA be shared?

The following factors, common to all these questions, would affect their answers:

- Whether a similar project is likely to be undertaken in a short period
- Size of the project as compared to the present size of the firm
- Stakes involved in the project
- Scope of learning from the PCA
- Strategic importance of the project to the company
- Portfolio effect of the project under consideration for PCA

When to design PCA

Theoretically, the post-completion audit programme should be incorporated in the plan itself. PCA should be designed at the time of preparing the final plan of capital investment. To fulfill the objective of improving the quality of future investment decisions, the original investment proposal should include a post-audit programme that identifies those variables which could be critical to the estimated NPV of the project. It may not be cost effective to track all subsequent cash flows associated with the project. Consequently, it should be the responsibility of the planners to single out those elements that have a significant effect on the estimate of NPV and have a significant potential for variation from the mean estimates employed for the analysis.

The team entrusted with the task of making a detailed project report (DPR) should be responsible for pointing to those events that might cause results to differ substantially from forecasts. Are competitors likely to come to the market with major capital innovations? What could be the likely impact of changing environmental protection rules or changing energy supplies? What could happen that might result in subsequent abandonment of the project? While this information may help the management in appraising the risks of the proposed project, it will also provide the auditor with clues as to the causes of variances experienced. Moreover, it permits the auditor to assess whether variances have resulted from controllable factors or non-controllable ones, whether due to predictable events or non-predictable events.

Conducting PCA

Should PCA be conducted or not? From a cost benefit perspective, it is impractical to think that all capital expenditures must be audited. Hence, companies must be careful when they pick and choose. One generic approach is to classify assets (projects) into operating, administrative and strategic categories and to have different decision rules for post-auditing assets within each class.

- *Operating assets* usually are the responsibility of lower-level managers, are short-run and routine in nature, involve minor resource commitments and are often repetitive. An example might be operating minor office equipment.
- *Administrative assets* usually are the responsibility of middle mangers, have a medium duration and require moderate resource commitments. An example would include replacements for manufacturing equipment.
- *Strategic assets* usually are the responsibility of senior managers, are long-run and non-routine in nature and require major organizational resource commitments. Example includes major plant and equipment, acquisition of an entire business, new R&D undertakings and major advertising campaigns.

These criteria appear to acknowledge that the benefits from post-auditing certain types of assets should surpass the costs in terms of money, time and effort. Also, a firm may not conduct PCA in case of a particular project if there is no scope for learning, or if similar project is unlikely to be taken up again, or if project is too small, or for some other reasons specific to the project.

Who should audit

A person or a team who would conduct PCA need not be identified at the planning stage, but certain policy decisions must be taken beforehand. The alternative policy decisions in this regard could be:

- The group that evaluates the project may conduct the PCA.
- The project team may conduct the PCA.
- Some other internal groups not associated with project planning and implementation can conduct PCA.
- A team representing the planning group, the execution group and the neutral members can be assigned the task.
- An external agency can be entrusted with the task.

In certain cases, a firm may decide to assign the task of performing PCA to a single person or to a team of persons. Each of these alternative policies regarding who should conduct PCA has its own merits and demerits. We often hear the argument that individual(s) conducting a post-completion audit should not have been involved in the process leading to selection of the capital asset under review. That way, according to this line of reasoning, the project can be assessed in an unbiased manner. In contrast, others would argue that managers who are associated with investment decisions are in a better position to interpret data for audit purpose than independent reviewers. Either way, if managers have to use the post-completion audit process as a learning tool for future investments and as a control device for the existing projects (including the possibility of abandoning some projects), then those individuals who are responsible for selecting projects need to be informed about the post-completion audit process. In fact, the choice should depend on the need and the situation of the firm.

When to audit

How often should capital projects be post-audited and at what point in its life the post-audit should be conducted? Deciding how often to post-audit capital projects is in large part determined by the type of project under consideration: for example, because of their impact on a company, strategic projects should be post-audited over shorter intervals than either administrative or operating capital projects. The risk of an asset also should

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partly determine post-audit frequency. Generally speaking, however, the overall emphasis of a post-audit programme should be on regular and periodic reviews as opposed to one-time, post-completion reviews.

The timing of post-audit partly depends upon the purpose of the audit. If the primary purpose is to improve the quality of future investment decisions, then the trade-off between the cost of conducting the audit and the value of the lessons to be learned would suggest that the audit be delayed until an informative track record has been established. The more the information available, the less costly should be the audit process and the higher the chance that the results of the audit may contribute to the improvement of future investment decisions.

However, if it is anticipated that the audit may set in motion corrective steps to change the scope or the scale of the project, the audit should probably be moved forward in time. The costs and the errors of estimate of the audit probably decline over time. Hence, the greater the cost of audit and the greater the increase over time in the expected value of the information gained, the longer the audit should be delayed. However, the cost of corrective steps rises over time. Thus, greater the probability that a corrective step will be taken and greater the expected impact of that corrective step on the present value of the firm, the sooner the audit should be undertaken.

Moreover, multiple post-audits of investment project are justified primarily if there is a potential corrective action to be undertaken. Given the information developed in the first audit, the desirability of further audits can be envisaged based on the fact that the information gained will generate a corrective step or would provide learning value for the organization. Indian Railways follow the policy of triple post-audit programme and conduct post-completion audits in the sixth, eleventh and sixteenth years of the completion of major projects. The trend of projections coming true is the factor, which determines the next phase of the project. At the same time, as a result of the PCA, new projects of similar type also gain in terms of quality of estimates.

What to audit

As cited earlier, factors such as size of the project, stake involved, scope of learning and strategic importance of the project for the organization, should be taken into account while deciding the details of the PCA. A full PCA will conduct inquiry about the strategic and policy decision along with questioning assumptions and MIS, so that the true reasons for the gap between the actual and the plan can be identified.

Sharing the findings of the PCA

Whether to share the findings of the PCA is one of the very sensitive decisions to be taken by the higher management to whom PCA report is submitted. It is not necessary that the findings of the PCA be shared with all the concerned parties. The need and sensitivity of the matter must be taken into account while deciding on this issue. There may exist a chance that the morale of the project team is badly affected if the PCA findings are revealed. Such possibilities may be avoided by maintaining secrecy, but the required action still has to be initiated by the top authority so that future plans become more realistic. But, under such circumstances, the firm should get the post-auditing done by one senior single officer who was not associated with the project work. It may not be desirable to announce the outcome of the PCA of the first modernization phase, especially if its finding is not encouraging, if the project has a strategic importance; rather than financial, and if the firm

has already planned a few more phases of modernization which are in the pipeline. Strategic projects are such that financial estimates may not be reliable but still they are desirable.

PCA Procedure

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The auditor of the completed project has to be very careful in carrying out the audit. He/she must ensure that all procedures are followed and that full justice is done to the work. Some points related to the PCA procedure are described as follows:

• Collection of appropriate information

The starting point for collecting post-audit information is the project completion report. Post-completion audits generally compare the projected data with the accounting data collected through regular MIS. The MIS needs to be geared up so that projected cash flows from the original capital budget can be compared with the actual cash flows realized during the period elapsed before the PCA of the project has started. Another point that needs to be kept in mind is that the auditor needs to collect information about the incremental cash flows or the cost, rather than the total cost figures. Incremental cash flow figures are readily available for green-field projects but it is not so easy for the projects in an existing plant. The data in the latter case needs to be appropriately dealt with to arrive at the incremental cost figures.

• Recasting data

Either collected data or budgeted data should be recast before it is compared. The significant time gap and a host of factors which were not considered at the budgeting stage would warrant the recasting of data, for example, inflation should be adjusted before variances are calculated. Sales mix difference due to external factors also should be taken into account. In the absence of adjustment for those 'external' factors, the quality of audit would suffer. Inflation adjustment is explained subsequently in this section.

• Comparison of projected financial parameters with actuals

This is the next important step in the post-completion audit procedure. There are four techniques available for the comparison of the actual with the projected financial parameters. They are explained subsequently in this unit. Comparison is the starting point from which the real audit begins. Only comparable data is compared. Adjustments are first done for inflation and external factors before comparison is carried out under any method. Methods described later are not mutually exclusive. More than one method may be applied for the comparison if there are such requirements. A broad level ROI or NPV comparison can be done initially followed by a detailed cost variance or cash flow variance analysis. Comparison is a step-by-step approach so that causes are identified systematically with minimum cost, time and energy.

• Establish the possible causes of variance

Once the variance figures are calculated, if they are significant, the possible causes for the same are searched. An auditor goes by exceptions and from there he tries to reach the root causes of deviations. This process of investigation can be effective only if the auditor possesses skills of inquisitiveness and skills of persuasion and negotiation. A summary report of the PCA findings should also be prepared.

• Final recommendations

Once the causes are ascertained, the post-completion auditor can give his recommendations based on which the manager may take decisions for cash flow

forecasting to reinvest or abandon the ongoing project. Hopefully, after post-completion audit, cash flow prediction and project evaluation become more accurate.

• Inflation adjustment

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Bare actual data cannot be easily compared with the original plan data because more often the planned data is at current price and do not factor the inflation in it. The difference between the two can be partly attributed to inflation. Inflation effect must be removed from the actual before the data analysis is further carried out. How is inflation effect removed? A foolproof methodology for the adjustment of inflation is not available but the following suggestions can be considered.

1. For a broad level analysis, inflation can be adjusted by calculating profits for actual period at base level margin. Alternatively, base level profit can be calculated at actual period margin. One Indian company conducted a post-completion audit in 1986–87 for a project which was planned in 1980–81. As per common practice, inflation was ignored completely at the planning stage and all budget data was based on current price. Data collected for the PCA purpose was:

Gross margin of 1986–87	₹ 21,135 lakh
Gross margin of 1980–81	₹ 5,122 lakh
Capital expenditure	₹ 36,849 lakh
ROI without inflation adjustment	43.46 per cent (21,135 – 5122) ÷ 36,849

Inflation can be adjusted in either the base value or in the current value to bring both the values at the same time. If we adjust inflation in the base value to bring it to the current value, then we need to compound the base value at the rate of inflation for the number of years. In this example, if we assume an inflation of 10 per cent, the number of years is six (1986–87 *less* 1980–81).

ROI with inflation adjustment:

Gross margin of 1986–87 profit at 1980–81 profitability, using equation 2.24 (present value equation):

$$PV = \frac{FV}{(1+i)^n} \quad \text{... (2.24)}$$

$$PV = \frac{21{,}135}{(1+0.1)^6} = 11{,}930$$

ROI = (11,930 – 5,122) ÷ 36,849 = 18.48%

Gross margin of 1980–81 profit at 1986–87 profitability using the future value equation:

$$FV = PV \times (1+i)^n \quad \text{... (2.25)}$$

$$= 5{,}122 \times (1+0.10)^6 = 9{,}074$$

ROI = (21,135 – 9,074) ÷ 36,849 = 32.73%

It is the choice of the auditor whether to adjust inflation in base year values or in values of the year when the PCA was conducted. The choice has influence on the calculation of return on investment. It is implicitly assumed in this method of inflation adjustment that, (a) the margin difference is only due to inflationary effect on income and expenses and (b) there was no change in the sales-mix during the period.

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2. In-depth inflation adjustment would expect the MIS to collect item-wise prices in the plan year and in the year of the PCA, and to completely recalculate the cost of products at the prices in any one of the years. Most MISs are not geared up to provide such service. The cost incurred in making inflation adjustment may also be very prohibitive.

The problem of inflation adjustment is more difficult in the projects such as modernization, rather than expansion or green field projects. Still, the auditor cannot neglect the inflationary effect, if he wants to really find out the learning opportunity from his exercise.

PCA Techniques

There are four techniques of post-completion audit, namely — (i) cost variance analysis, (ii) profit variance analysis, (iii) cash flow and financial criteria variance analysis, and (iv) present value depreciation technique. These are described as follows:

(i) Cost variance analysis

In this method, only project cost (actual and estimated) is studied, revenue aspect is not included in the audit. This approach is adopted when the PCA is conducted during execution or just after completion of the project.

(ii) Profit variance analysis

In this method, plant-wise profit analysis is carried out by the auditor; the estimated gain adjusted with inflationary effect is compared with the actual. An important point to note here is that even if the aggregate of gains (realized and estimated) is the same, there can be wide variations for individual projects indicating the need for further investigation.

(iii) Cash flow and financial criteria variance analysis

This method is developed around four schedules. These schedules can provide the management with the information it needs to find engineering, operational and administrative costing faults of past projects.

- **Profit variance analysis schedule**

This schedule is prepared for the calculation of profit variance between projected and actual project results. The information for the 'projected' column is obtained from the approved capital expenditure request. The information for the 'actual' column is obtained from regular accounting sources. Supplementary schedules require itemizing and explaining the basis of calculation for revenues, costs and expenses need to be given.

- **Cash flow and financial criteria variance analysis schedule**

This is used for illustrating project cash flow and return variances between the projected and the actual results. The approved capital expenditure request is again used for providing information for the 'projected' column and regular accounting sources for the 'actual' column.

- **Project cash flow schedule (projected and actual)**

This is used for showing the projected and actual cash flows of the project. They illustrate the timing of cash flows to compute payback and to provide net cash flow information required for the IRR calculation. Each cash flow entry is made according to the time it was projected to be incurred or was actually incurred. The period cash flows are for

individual quarters, whereas, the cumulative cash flows represent all cash flows for the project. The payback point is reached when the cumulative net cash flow equals zero.

- **Supplementary schedules**

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As mentioned earlier, supplementary schedules provide an explanation to significant variances. The detailed or supplementary schedule to it explains item-wise variances. These schedules would look just like variances of regular operating results as one finds in management accounting.

(iv) Present value depreciation (PVD) technique

DCF techniques give only a single value of NPV which is for the whole life of the project. IRR is the average return during the life of the project. But, at the time of conducting the PCA, the major part of the project life is not completed. Then, how can we compare the actual with the total net present value or the average internal rate of return? The concept of the present value of depreciation is used in some techniques for the calculation of year-wise NPV and IRR. 'Present value depreciation' is defined as the decline in the present value of the expected future cash flow during the year using IRR as the discount rate. Two models, namely the IRR model and the NPV model, are suggested under the technique of present value depreciation. Let us apply this concept and calculate the year-wise NPV and year-wise IRR in one example.

Example 2.3 Dravid Associates

Dravid Associates deals in sports items. Recently, they have set up a manufacturing facility. The abstract of capital budget and the actual cash flow in the first two years is given in Table 2.11. The post-completion auditor has estimated the subsequent two years' cash flow. Estimated life of the project is four years. Initial cash outlay is ₹ 1,34,000.

Table 2.11 *Abstract of Capital Budget and Cash Flow of Dravid Associates*

Year	*Cash Flow*		
	Budgeted	*Actual*	*Projected*
1	30,000	25,000	
2	50,000	40,000	
3	70,000		50,000
4	70,000		50,000

The company's cost of capital is 15 per cent. Calculate the following:

1. The net present value (NPV) and the internal rate of return (IRR) of the project
2. The present value of depreciation
3. The year-wise net present value and the year-wise internal rate of return for the planned figures
4. The year-wise net present value and the year-wise internal rate of return for the first two years' actual and the next two years' projected cash flows
5. The net present value and the internal rate of return variances over the period

Solution:

$$\text{(1 a) Net present value} = \frac{30,000}{1.15^1} + \frac{50,000}{1.15^2} + \frac{70,000}{1.15^3} + \frac{70,000}{1.15^4} - 134,000 = 15,943$$

(1 b) Internal rate of return = 20% per cent (rate at which NPV is zero)

Before we go into the second step, we need to calculate the uniform annual series (UAS) for the present value of the cash inflows. The function of the uniform annual series is to convert a non-annuity cash flow into an equivalent annuity cash flow, so that both the present value of original cash flow stream as well as of the UAS will be equal when discounted at the discount rate. This follows the concept of straight-line depreciation. Capital recovery, thus, is constant. The formula for uniform annual series is:

$$UAS = \frac{PV\ of\ Cash\ Inflow}{PVIAF_{i,t}} \quad \ldots (2.26)$$

Here, $PVIAF_{i,t}$ = Annuity factor for period t at the rate equal to I, which is IRR in this case.

Applying equation 2.26, (a) PV of cash inflow at the IRR rate is equal to the initial cash outflow ₹ 1,34,000 and (b) $PVIF_{0.15, 4}$ is 2.5887. Therefore,

UAS of PV of Cash inflow at IRR rate = 1,34,000 ÷ 2.5887 = 51,763

(2) Calculation of present value of depreciation

Table 2.12 *Calculation of Present Value of Depreciation*

UAS	$PVIF_{0.15, t}$	*Year 1*	$PVIF_{0.15, t}$	*Year 2*	$PVIF_{0.15, t}$	*Year 3*	$PVIF_{0.15, t}$	*Year 4*
51,763	0.8333	43,136						
51,763	0.6944	35,947	0.8333	43,135				
51,763	0.5787	29,955	0.6944	35,946	0.8333	43,136		
51,763	0.4823	24,963	0.5787	29,955	0.6944	35,947	0.8333	43,136
Total	2.5887	1,34,001		1,09,038		79,082		43,136
PV of Depreciation		24,963		29,955		35,947		43,136

***Notes*:**

1. The PV of depreciation in year-1 is the difference of the total in year-1 and year-2. Similar calculations are used for the rest of the years' PV of depreciation. In the last year, the total value of that year's PV is the PV of depreciation because the subsequent year's PV is zero.
2. Average IRR and year-wise IRR will be equal if there is a constant (annuity) cash flow.

(3 a) Year-wise NPV for Planned Data

Table 2.13 *Year-wise NPV for Planned Data*

Beginning of the (1)	*Cash Flow*	*PV@15% (2)*	*PV@ IRR 20% (3)*	*Difference in PV (4 = (2) – (3))*	*Year-wise NPV (5)*
Year 1	30,000	149,943	134,000	15,943	4296
2	50,000	142,434	130,787	11,647	4791
3	70,000	1,13,800	1,06,944	6856	4319
4	70,000	60,870	58,333	2537	2537

Notes:

1. Column 2 shows the present value at the cost of capital that will come in the beginning of the respective year from the cash flow expected during the subsequent period. Column-3 calculates the present values in the beginning of the different years at the internal rate of return.
2. The difference between the present value at IRR and the present value at the cost of capital (column 4) indicates the present value expected to come at that point of time from the future cash flow beyond that time.
3. The successive change in the net present value in column-4 indicates how much net present value is earned in each year, as shown in column-5.

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(3 b) Year-wise IRR for planned data

Table 2.14 *Year-wise IRR for Planned Data*

	Year 1	*Year 2*	*Year 3*	*Year 4*
a. Cash flow	30,000	50,000	70,000	70,000
b. *less:* PV of Depreciation	24,963	29,955	35,947	43,136
c. Net income for PCA (a - b)	5037	20,045	34,053	26,864
d. Beginning investment	1,34,000	1,34,000	1,34,000	1,34,000
e. Accumulated PV of Depreciation	0	24,963	54,918	90,865
f. Net investment (d-e)	1,34,000	1,09,037	79,082	43,135
IRR (year-wise) (c ÷ f) %	3.76	18.38	43.06	62.28

***Note*:**

1. Since all cash flows occur at the end of the year as per common assumption, the depreciation expense also occurs at the end of the year. Hence, the accumulated depreciation in year-1 is zero. During the year-1, there is no depreciation. The figures of the PV of depreciation come from part 2 of the solution.

(4 a) Year-wise IRR for the actual at PCA Time

Table 2.15 *Year-wise IRR for Actual at PCA Time*

	Actual		*Projected at PCA Time*	
	Year 1	*Year 2*	*Year 3*	*Year 4*
a. Cash flow	25,000	40,000	50,000	50,000
b. *less:* PV of Depreciation	24,963	29,955	35,947	43,136
c. Net income for PCA	37	10,045	14,053	6864
d. Beginning investment	1,34,000	1,34,000	1,34,000	1,34,000
e. Accumulated PV of Depreciation	0	24,963	54,918	90,865
f. Net investment (d–e)	1,34,000	1,09,037	79,082	43,135
IRR (year-wise) (c ÷ f) %	0.03	9.21	17.77	15.91

(4 b) Year-wise NPV for Actual and Projected at PCA Time

Table 2.16 *Year-wise NPV for Actual and Projected at PCA Time*

Beginning of the year	*Cash Flow*	*PV@15%*	*PV@ IRR 20%*	*Difference in PV*	*Year-wise NPV*
1	25,000	1,13,448	1,34,000	-20,552	-6345
2	40,000	1,05,466	1,19,673	-14,207	-6286
3	50,000	81,285	89,206	-7921	-5088
4	50,000	43,478	46,311	-2833	-2833

(5) Variances in NPV and IRR

Table 2.17 *Variances in NPV and IRR*

Year	*NPV*			*IRR (%)*		
	Budgeted	*Actual*	*Variance*	*Budgeted*	*Actual*	*Variance*
1	4296	-6345	-10,641	3.76	0.03	-3.73
2	4791	-6286	-11,077	18.38	9.21	-9.17
3	4319	-5088	-9407	43.06	17.77	-25.29
4	2537	-2833	-5370	62.28	15.91	-46.37
Total	15,943	-20,552	-36,495	20.00	7.97	-12.03

One may feel that the purpose of the PCA can be served by the comparison of the cash flow and an auditor need not carry out the cumbersome exercise of calculating the year-wise net present value or year-wise internal rate of return. But, how much shareholder value is lost or gained every year till the date of conducting post-completion audit, as compared to what was expected, can only be known if the year-wise NPVs or IRRs are compared. The difference in time value will also get reflected if discounted cash flow methods are used for the purpose of audit.

PCA Investigation

The project completion report will provide information on the deviations in the project cost, time and performance parameters. The variance analysis report will provide information on the deviations in operating income and cash flows from the project. These reports provide pointers to the PCA auditor. The exception items draw her attention. The PCA auditor assumes the inquisitive posture for those exceptions and from there, she tries to get to the root of variances. For example:

(i) A low production volume and a low capacity utilization could be attributed to many factors; some of these would include low demand, inadequate supply of power, inconsistent supply of raw materials, unavailability of trained workers, low morale of workers, unsuitable quality of resources, lack of maintenance facility, unavailability of spares, wrong assessment of technology, poor working conditions, and so on. The list can be long. If wrong assessment of technology is found to be one of the responsible factors, then the auditor will further investigate in that line. He/she may find that the assessment of technology went wrong because of many factors such as lack of expertise of the study group members, negligence of the study group, the study group studied the technology but the study sample was of much less capacity than planned for the company, the study sample worked in a different environment but that aspect was not considered, the study group was more eager and biased for the proposal either because some members had vested interest in it or because the CEO had shown keen interest in the project.

(ii) The low order booking may have been the factor responsible for the low production. Further inquiry in this direction may reveal that one or some of the factors were primarily responsible for it, for example, low demand could be due to reasons such as wrong assessment of market and competition, unsuitability of quality, segmentation problem, weakness in deciding the marketing policies, non-recognition of business politics, failure in estimating demand-sensitive factors, lack of effort on the part of marketing staff, lack of coordination between the advertising, other sales promotion efforts, sales promotion material, channel of distribution, training of sales staff and others. The auditor has to carefully isolate the factors primarily responsible for the lack of order booking.

The auditor might as well have to question even the choice of project vis-à-vis its alternatives. The auditor has to be careful at this stage. Though a broad-based opinion about the appropriateness of the current choice over its alternatives can be possible if the project similar to the one not accepted by the firm is experimented by another firm and its data is available. Still it may be advisable to desist from such comparison. Any amount of such comparison would be futile and inappropriate because the actual data of the foregone projects is just not available for comparison. Therefore, the auditor should

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restrict his investigation to the project that is selected, implemented and commissioned and should not go into comparing the accepted project with the foregone projects.

The investigative skills of the PCA auditor may take her from the apparent causes revealed in the post-completion report and the variance analysis report to the root of causes. The investigative skill of the auditor is of vital importance in carrying out this immensely important step of the audit. In the process of investigation, the auditor would question policies, factors considered in designing the policies, role of people and their equations with other people, organizational system and culture, procedures, assumptions and their basis, forecast and calculations. Everything and every one come under scrutiny.

Some Issues in PCA

The following issues are also important, though some of them are repeated:

1. Cost of PCA

- A PCA team will include some professional and supporting clerical staff. Salary paid and other expenses borne on them would form a part of the PCA cost.
- Another cost element is associated with accumulation, storage and maintenance of volumes of auditable data.
- As long as the post-completion audit is on, the project team is worried and anxious psychologically. It also leads to distraction from their project work.
- Another cost of PCA would be the dip in the morale of the project team if the audit report were not written in a constructive tone. A vindictive approach would be counterproductive.

2. Human issues

Most of the issues related to the human aspects of post-completion audit are raised earlier while discussing the policy aspects of the post-completion audit. They are briefly mentioned here for laying emphasis.

- **Faultfinding approach vs constructive approach:** The post-completion auditor has to ensure that people do not perceive his/her function as the faultfinding mission. A constructive approach is necessary for deriving the best out of the PCA activity.
- **Whether the auditor should be independent of the project team or part of it:** Each has its own advantages and disadvantages. An external auditor is likely to be objective and impartial. But, if the project is designed in phases, while auditing the first phase, an auditor who is part of the project team can gain valuable insights which will be beneficial in the succeeding phases.
- **Whether to share audit findings:** If the findings are adverse, care should be taken while sharing the audit findings so that it does not affect the project team morale (who might be working on some other project). Further, the audit findings of the projects of a strategic nature which are crucial to the future of a company need to be shared selectively.
- **Whether one-member or multi-member audit team:** This decision is often made on the basis of whether the audit findings need to be shared with a few or many.

- **Fears of the project team members:** As regards the external auditor, they may fear that the auditor would not understand several intricate issues of practical significance. For internal auditors, they may feel that the auditor has some personal motive or an axe to grind.
- Sometimes, project team members may pursue their own individual motives that may be in conflict with the company goals.
- Auditors should avoid being embroiled in conflicts and rivalries among project team members.

3. Limitations of PCA

- Lack of incremental costing information, especially for projects in existing plants, is common. The regular MIS is geared to obtaining full costing information.
- For mutually exclusive projects, the actual data for the foregone alternative is not available. This makes comparison almost impossible. The auditor cannot really verify whether the chosen alternative was right as compared to the previous one.
- While comparing the realized data with the predicted performance of the project, ordinarily the performance realizable in the absence of the project is ignored. This leads to only one-sided operational comparisons.
- In many companies, discounted cash flow techniques are used during cash flow estimation, but the same is not used during the PCA. This discrepancy leads to inaccurate audit findings.
- If the intentions of the management while having the audit conducted is not bona fide or if they were defensive about the audit results, the audit would not serve its purpose.
- Another obvious limitation of PCA is the credibility of the project team in the eyes of the management.

PCR and PCA Format

Comprehensiveness and readability of final report is important. The details in report will depend on who gets the report.

Project Report for Obtaining Finance

A firm needs to prepare a business plan or a project report or a prospectus for obtaining funds for financing a project. Lending institutions require submission of a detailed set of documents for their evaluation so that they can take a decision whether to finance the project or not. If public issue of security is planned, then one must prepare the 'offer document' or the 'prospectus' as per the guidelines issued by SEBI. Contents of reports submitted along with loan application to lending institutions and contents of prospectus are quite similar because both documents attempt to convince the potential supplier of funds about the worth of the project. Application for funds must provide the following information:

1. About the promoters
2. About the management and management structure
3. Company background
4. Activities and past performance of the company

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5. Details of projects currently under implementation along with their financing
6. About the project
   - Type of project and project capacity
   - Technical arrangements
   - Location and site
   - Resource planning (material, labour, power)
   - Implementation schedule
7. Marketing plan
   - Demand analysis, domestic and export
   - Supply analysis
   - Market potential
   - Selling arrangement, if any
8. Production cost estimates and sales estimates, along with detailed assumptions
9. Financial information
   - Breakdown of project cost
   - Means of financing
   - Details on the proposal for raising share capital, loans and debentures (including arrangements made so far)
   - Promoters' contribution and list of people who will provide promoters' share
   - Details of securities proposed
   - If internal funds are planned, give estimates and the basis for estimates
10. Project cash flow projection on timeline (at least for the period of loan)
    - Depreciation schedule as per Companies Act and as per Income Tax Act
    - Amortization schedules, if any
    - Working capital schedule
    - Projected income statements for business without new project and with new project
    - Projected balance sheets for business without new project and with new project
    - Cash flow estimate
11. Financial evaluation
    - Break-even calculation
    - Interest cover ratio (times-interest-earned)
    - Debt-service cover ratio (DSCR)
    - Return on investment (ROI) calculation
    - Internal rate of return (IRR) calculation
12. Risk assessment
    - Sensitivity analysis
13. Socio-economic impact of the project with all details
14. Environmental impact of the project
15. Status of government consents

Please note that internal project evaluation and financial plan presented to the funding agency need not be the same, for example, internal project evaluation is done for the life of the project, whereas, loan agencies want financial projections for the period

Check Your Progress

13. What are the components of a financial report?
14. What is a detailed project report?

equal to the loan period; for internal purposes one may use evaluation techniques like payback period and net present value, whereas, funding agencies may want calculation of internal rate of return. There are several reasons why financial plan for internal purpose and for funding purpose has to be different.

2.9 SUMMING UP

- Each opportunity of investment is considered 'capital expenditure' but not a project. In an efficient investment analysis, one should identify all opportunities, group them on the basis of their dependence on each other and then develop alternative sets of projects before taking a project decision.
- The investment proposal, which originates from various departments, is the opportunity.
- The process of grouping opportunities is called formation of projects.
- Economic dependence may be of two types in the context of time: (a) two or more opportunities are present at the same point of time and they are economically dependent on each other and (b) some future opportunity may be dependent on the present opportunity.
- The purpose of Project Initiation is to evaluate proposed projects and to reach a consensus on the projects that are to be selected.
- Market analysis aims at assessing the potential sales revenue from a proposed project. It is also known as market-feasibility study.
- Situational analysis is especially important if the project proposal is for enhancing the capacity. It is important where the project proposal involves production and sale of new products and services—new for the company but not new in the market.
- Demand projection is one of the most important steps in a project feasibility study.
- The past trend of supply of goods can be studied and further extrapolated. Projections so made need to be adjusted with the help of additional information like new projects planned by businesses in the economy, import possibility as governed by import policy, import tariff and international prices.
- A generic model of situational analysis is popularly known as SWOT analysis, where

  S = Strength; W = Weakness; O = Opportunities; T = Threats
- A key aspect of any decision-making situation lies in being able to predict the circumstances that surround the decision and that situation.
- Where one or few independent factors may not have explanatory power for demand, just the pattern of demand over time can be studied for forecasting purposes.
- If there is an ample market demand and not enough supply, the focus should shift to technology.
- The technology transfer issue has to be addressed in a dual fashion—(a) Whether the transfer of technology is possible from the political angle and (b) whether transfer of technology is possible from the operations (environment) angle.

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- The required rate of return should be at least equal to the returns from the foregone opportunity (opportunity cost). This is theoretically the best cut-off rate. It is theoretical because in most situations, the opportunity is foregone and its returns are not ascertainable. In addition, the opportunity cost approach does not consider the presence of risk premium in the discount rate of the opportunities.
- The process of building logic (also known as information or knowledge through market research, test marketing, etc.) is also the process of reducing risk. Thus, some risk can be mitigated at the stage of the designing of the project.
- The concept of economic rate of return can be expanded to encompass the social cost and benefits, thereby calculate the social rate of return. This method of project evaluation is also popularly known as social cost-benefit analysis (SCBA).
- All agencies that aim at social welfare, such as government and international institutions like the World Bank, International Monetary Fund and UNIDO use social cost-benefit analysis for the evaluation of projects.
- A project, which results in effective redistribution of income, is more valuable than those projects where income is concentrated in a few hands.
- SCBA is carried out in detail in India. All developmental agencies do SCBA while funding major private projects. State governments also carry out SCBA when luring and approving new mega projects for the state.
- Once the project is terminated and handed over to the operations team, project review is undertaken. The end result of project review is the preparation of the project completion report (PCR). Project completion report is a document which would give a comparison of the actual costs and the time with the originally budgeted ones.
- 'Audit' is generally defined as 'an examination of documents and results to find out whether they are in the desired order'. Thus, PCA is an attempt at assessing the actual profile of the given project in terms of results, vis-à-vis the intended profile of it besides focussing on whatever matters the senior management desires.
- There are four techniques of post-completion audit, namely: (i) cost variance analysis, (ii) profit variance analysis, (iii) cash flow and financial criteria analysis, and (iv) present value depreciation technique.

2.10 KEY TERMS

- **Operating cash flow:** The cash flow that occurs after a project is commissioned is called operating cash flow.
- **Payback period (PBP):** Payback period is defined as the number of years required for recovering the original cash outlay invested in a project.
- **PCR:** Project completion report is a document that gives a comparison of the actual costs and the time with the originally budgeted ones

2.11 ANSWERS TO 'CHECK YOUR PROGRESS'

1. Economic dependence can be in four forms:
   (i) Positive synergy emanating from the acceptance of two or more opportunities.
   (ii) Negative synergy, when more than one opportunity is simultaneously accepted.

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(iii) Acceptance of one automatically results in rejection of the other, even if the other is profitable.

(iv) Stochastic dependence, where uncertainty is considered.

2. Indigenous manufacturing of goods currently imported is advantageous for several reasons:
   (i) It improves the balance of payments situation.
   (ii) It provides market for supporting industries and services.
   (iii) It generates employment.
3. The purpose of project initiation is to evaluate proposed projects and to reach a consensus on the projects that are to be selected.
4. The project initiation document answers the following questions:
   (i) What does the project aim to achieve?
   (ii) Why it is important to achieve it?
   (iii) Who will be involved in managing the process and what are their responsibilities?
   (iv) How and when will the project be undertaken?
5. Market analysis aims at assessing the potential sales revenue from a proposed project.
6. Situational analysis is especially important if the project proposal is for enhancing the capacity. It is important where the project proposal involves production and sale of new products and services—new for the company but not new in the market.
7. The success of technology transfer depends on the temperature level, moisture level, quality of atmosphere, quality of material, method of work and skill of labour, power supply quality and a host of other variables, which may be unique for each user.
8. A technology that has an alternate use is better because if the company is not able to achieve its sales target, it can always change the product and establish it in a different market. For example, a company engaged in the business of manufacturing glass-lining equipment for chemical industry can use several of its processes to manufacture concrete-mixing machines.
9. The cut-off decision is a benchmark against which the project cash flow stream is compared to determine whether the project would attain its financial goal.
10. The yield to maturity (YTM) is the yield (return) of an investor who buys the outstanding bonds at the current price and holds them up to maturity.
11. The following factors warrant social cost-benefit analysis:
   (i) Market imperfection
   (ii) Taxes and subsidies
   (iii) Concern for savings
   (iv) Concern for redistribution
12. There are three alternative prices possible for goods and services, namely:
   (i) Market (producer's) price
   (ii) Free-trade price (world price)
   (iii) Shadow and second best shadow price

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13. The components of a financial report are the following:
    (i) Monthly commitment and expenditure
    (ii) Monthly cash flow forecast
    (iii) Monthly bank guarantee position
    (iv) Monthly outstanding payments to consultants, suppliers and contractors
    (v) Weekly documents retired through bank
14. A detailed project report is a complete blueprint for the execution of the project. It is the project implementation guide for the project team. It describes functions, authority and activities along the line of time, cost and technical parameters. This report sets the standards for time, cost and work with which results can be later compared as and when the work progresses.

2.12 QUESTIONS AND EXERCISES

Short-Answer Questions

1. What is leading indicator method?
2. What are the three purposes of financing mix decision?
3. Distinguish between operating cash flow and terminal cash flow.
4. Write a short note on risk assessment.

Long-Answer Questions

1. Discuss some of the methods used in 'Causal model-based forecast'.
2. Explain the four basic decisions that should take place before any financial analysis is carried out.
3. Describe the UNIDO and LM approaches to SCBA.
4. Explain the concept of Post-Completion Audit.

2.13 REFERENCES AND SUGGESTED READINGS

Chandra, Prasanna. 1995. *Projects: Planning, Analysis, Selection, Implementation, and Review.* Delhi: Tata McGraw-Hill.

Kerzner, Harold, R. 2013. *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*. New Jersey: John Wiley and Sons.

Singh, Narendra. 2000. *Project Management and Control*. Delhi: Himalaya Publishing House.

UNIT 3 PROJECT PLANNING AND SCHEDULING

Structure

3.0 INTRODUCTION

Project planning is that component of project management, which is linked to the use of schedules like Gantt charts and PERT (project evaluation and review technique) charts to plan and consequently convey the progress within the project setting. To begin with, the project span is outlined and the appropriate methods for completing the project are determined. Next, the timeslots for a variety of tasks essential to complete the work are scheduled and clustered into a work division configuration.

Project planning is usually used to systematize numerous zones of a project, inclusive of project plans, work-loads and the administration of teams and personnel. The logical interdependence between tasks is specified with the help of an activity network diagram that facilitates identification of the crucial path. Project planning is intrinsically tentative as it has to be carried out prior to the actual start of the project. Hence, the length of the tasks is generally anticipated using a weighted average of positive, standard and negative cases.

Project scheduling is the tool concerned with the techniques that can be employed to manage the activities that need to be undertaken during the development of a project

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in order to get it ready on time. Float or slack time in project scheduling can be gauged with the help of project management software. Following this, the required resources can be estimated and expense for every activity can be distributed to every resource, thereby reaching upon the total project cost. This is when the project scheduling may be revamped to get the optimum equilibrium between utilization of the resource and duration of the project to conform to the project goals.

After being confirmed and approved, the project schedule gets transformed to the baseline schedule. Developments will be measured against the baseline schedule all through the life of the project. Evaluate progress corresponding to the baseline schedule is called earned value management. The contributions of the project planning phase comprise the project charter and the concept proposal. The outputs of the project planning phase consist of project requirements, project schedule and the project management plan.

3.1 OBJECTIVES

After going through this unit, you will be able to:

- Explain the various methods used for planning resources
- Discuss project organizing
- Describe the various techniques involved in project scheduling
- Explain the concept of Network/PERT analysis

3.2 PLANNING RESOURCES

Work structure planning and arrangement of work packages in network to identify slacks and early and late start of activities are meant for resource planning and levelling. Here, we will briefly outline three major resources, namely machine and equipment supply, material procurement and manpower planning.

Engineering Design and Erection Plan

Presumably, the plan for the project specifies the end product that is desired and in some cases it may contain considerable details about the components that make the end product. Such information provides the basis for constructing work packages and specifying their contents. In many cases, however, the nature of the work packages cannot be determined simply from the specifications for the end product and engineers must develop a concrete plan, perhaps working backward from the end product first to its components and then to the activities that are required in order to obtain such a component. This process finally culminates in a detailed engineering design and erection plan.

The engineering design would detail all specifications like size, shape, thickness, alloy characteristics and properties and functionalities of every piece included in a machine or equipment and their sub-parts. Erection plan is a step-by-step process of putting all pieces together with the stages of testing and experimentations. The actual idea of time needed for completing an activity and interdependence of a given activity with other activities and cost of activities becomes clear only after the engineering design and the erection plan is prepared. We can call this aspect as the quality and technical performance aspect of the project.

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3.2.1 Planning of Physical Resources Equipment Supply

Projects involve significant investments in machines and equipment, which may be either the core assets for the project or the support assets. The capacity of each machine, the balancing of equipment and the technical specifications are very important in the purchase of machines and equipment. More often than not, machines and equipment have to be fabricated as per specifications. Specialist fabricators with excellent track record and transportation of fabricated machines either in full or in knock-down condition, together with cost are the issues of greater concerns in the planning of equipment supply. Equipment needed for activities on critical path has to get better attention and close follow-up from the procurement team. Contracts with fabricators are the main driving factors in the successful acquisition of machines and equipment.

Material Procurement

Project construction involves procurement of thousands of special material that the business would not keep for its routine activities. Vendors may be unknown and their reliability uncertain. A procurement team has to develop vendors for various material items and buy the resources as and when needed.

3.2.2 Planning of Human Resources Manpower Planning

Manpower with different skills and experience would be in demand at different times of project construction. Some scarce manpower would raise the issue of its allocation, which would have a bearing on the project activities' start and end dates. If the firm is drawing some or all manpower resources for routine business operations, then coordination with operations would be an added challenge.

3.2.3 Planning of Financial Resources Budgeting

Project budget has two components in it, cost and cash flow. Cash flow budget is required for liquidity planning and for obtaining funds in time. A budget offer has to work in close coordination with the technical staff who prepare project network and with the procurement officers.

PERT-cost

Project budgeting can improve with PERT-cost. This helps in developing a critical path that is optimum considering both the time and the cost aspects jointly for planning purposes, as it is supposed to provide cost-time trade-off. For control purposes, it is supposed to provide a basis for analysing actual time and actual costs jointly. It also helps in determining the cash flow requirement during the course of the project.

PERT-cost is so complicated that it often loses practical application. In order to control time, the work packages must be quite small but difficulty is experienced in estimating the cost of each small work package.

Bell Curve

If the budgeted cost and the cash flow, prepared in conjunction with the network and the resource plans, are depicted on a chart over the timeline (or activities on critical path), one of the two common patterns is likely to appear. It would be either a bell curve or an S-curve. The costs (or cash flow) depicted over the timeline is likely to be a bell curve as shown in Figure 3.1.

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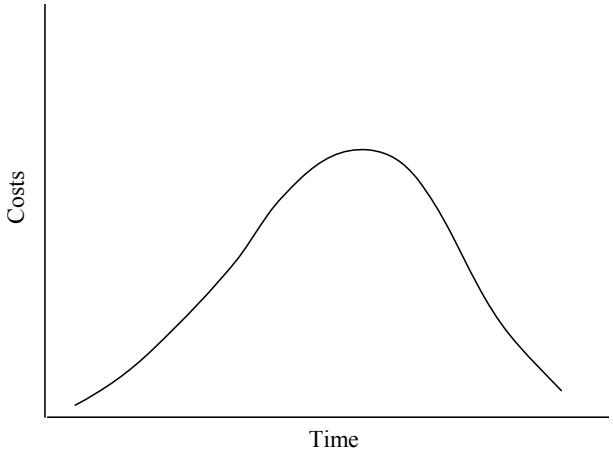

Fig. 3.1 *Bell Curve of Costs over Time*

The goal of the procurement officer should be to either flatten the bell curve or to make it slowly rising towards the end, like a hockey stick. That will save costs in terms of time value of money. The bell curve can be adjusted by reviewing slacks and determining late start and late finish of activity together with crashing of activities.

S-Curve

The project costs accumulated over time would show S-curve shape as depicted in Figure 3.2. S-curve initially rises slowly, followed by a steep rise and then tapers down. This is a result of bell shaped periodic expenses on project construction.

The goal should be to achieve the rising part of the S-curve as late in the project construction as possible to help minimize the opportunity costs. This again emphasizes on the network design and the coordination among technical staff and procurement staff.

Before producing a resource allocation plan, we should list the resources that will be required along with the expected level of demand. The resource requirement list should be as comprehensive as possible.

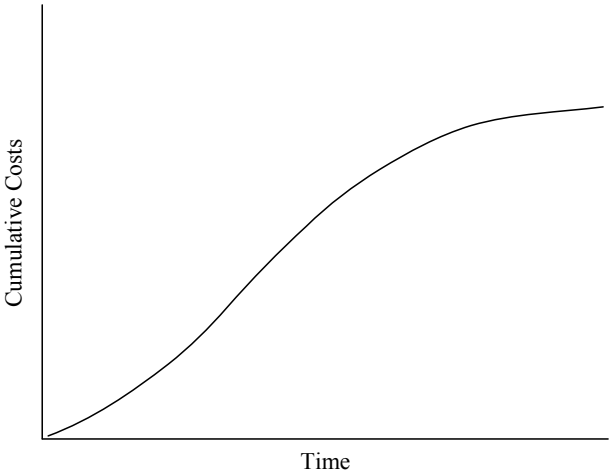

Fig. 3.2 *S-Curve of Cumulative Costs over Time*

After a resource requirement list has been prepared, the next stage is to map this to the activity plan to access the distribution of resources required over the duration of

the project. It is better to represent the activity plan as a *bar chart* and use this to produce *resource histogram* for each resource.

In practice, resources have to be allocated to a project on an activity-by-activity basis and finding the best allocation is time-consuming and difficult. As soon as a member of the project team is allocated an activity, that activity acquires a start and finish dates on the schedule. Thus, allocating a resource to one activity limits the flexibility for resource allocation and scheduling for other activities.

Resource Levelling

The network diagram drawn based on the work breakdown structure and the critical path identified on it, both are based on ideal condition of abundance of resources. The network plan is a time schedule and not the resource utilization plan. The resources requirement determined by the ideal network plan is called **resource loading** with reference to time. The resource loading may face two situations:

- The need for a particular resource may vary over time. Often, the need for a resource may vary between 70 per cent and 120 per cent. This means that resource may remain idle sometime, whereas, some other time the same resource may be simply non-available for some task because it is more in demand. By adjusting the project schedule (network plan) through the use of slack (early start and late start of non-critical activities) it may be possible to make efficient use of the resource. This is called **resource smoothing**. Resource smoothing does not delay the project completion time, but it reallocates the resources as a result of which schedule of activities change within the available slack time.
- Resource loading does not consider the cost implications. It is possible that the resources are available as per the loading needs, but the cost of resources may not be at the minimum level. The resource levelling aims at reallocation of resources, and as a result the rescheduling of activities also, to minimize the cost of project. As a general rule, an early consumption of resources costs more than the late consumption. Even the cost-implications of delayed completion is considered and if late completion is found cost-effective, the network plan and critical path may be changed.

Resource smoothing and levelling can be done using either the heuristic methods or optimization models. Heuristic methods are judgmental and intuitive. They use thumb rules but are often effective in complex situation. Some examples of heuristic approach for resource smoothing and levelling are the late or an early start of some activities, taking up short and simple activities first, completing those activities early which consume less resource, assigning different resources, changing task dependency, removing or adding tasks, etc. Optimization models include mathematical models like linear programming, but it is very difficult to apply them in a complex activity structure. Most project planning software offer resource smoothing and resource levelling features.

3.3 PROJECT ORGANIZING

A firm, especially a large one, has to set up a system to facilitate the process of idea generation, for testing ideas, evaluating them and subsequently executing them for better effectiveness.

Check Your Progress

1. What is erection plan?
2. What are the two components of project budget?
3. Define resource loading.

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System for Idea Generation

A proactive organization builds a strong system for idea generation. An example is given in Table 3.1.

Table 3.1 *Systems for Idea Generation*

Formal system →	A management committee Planning department or group Strategy group Periodic strategic planning exercise Management audit (also cost audit and functional audit) Periodic consulting by external expert Target costing mechanism Slack management system
Semi-formal system →	Suggestion box system and committees Innovation committees Joint departmental committees Quality circles Dialogue session and open house Value engineering groups Task forces and individual reports/proposals
Informal system →	Individual experiments Individuals encouraged to work as task force

Formal and semi-formal systems would work better if a very clearly shared vision is evolved and if a strategic planning process is in place to provide a trickledown effect of strategic plans in the entire organization. In an informal system, individuals are empowered to think and act creatively. A large fertilizer firm in Gujarat created managerial slack and built a system for slack management, in which even individuals are encouraged to envision and work on their own ideas that can help the company.

Objectives of an Organizational System

Clarity of goals and objectives are prerequisites for organizational effectiveness. A large organization aims at the following objectives while designing the capital budgeting system:

- Delegating authority for timely decision without creating lack of harmony
- Conducting efficient investment analysis by generating alternatives and making proposed opportunities holistic
- Studying the risk involved in the proposed project and deciding on the suitable decision criteria
- Removing bias in estimates, as those who propose projects are more likely to show upward bias on benefits and downward bias on costs of the project
- Bringing transparency in action

Process and Authorities Involved

Consider the example of company which has classified investment schemes as ‘major schemes’ and ‘minor schemes’. The other two classifications, namely ‘equipment and furniture scheme’ and ‘repair and maintenance scheme’ are delegated to the discretion of the concerned department. Figures 3.3(a) and 3.3(b) show the process and authorities involved in a major scheme and a minor scheme respectively.

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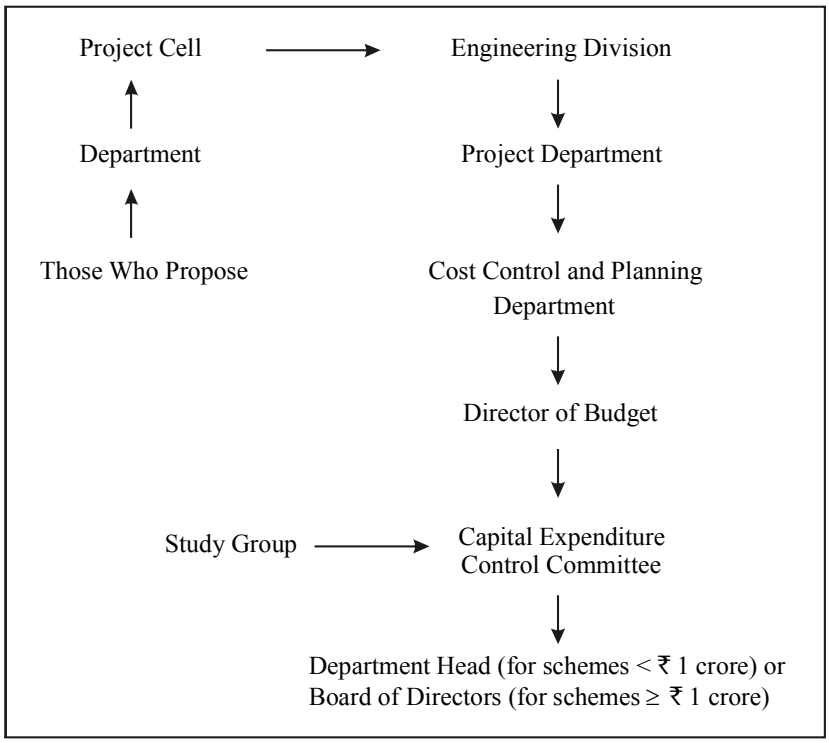

Fig. 3.3(a) *Process and Authorities: Major Schemes*

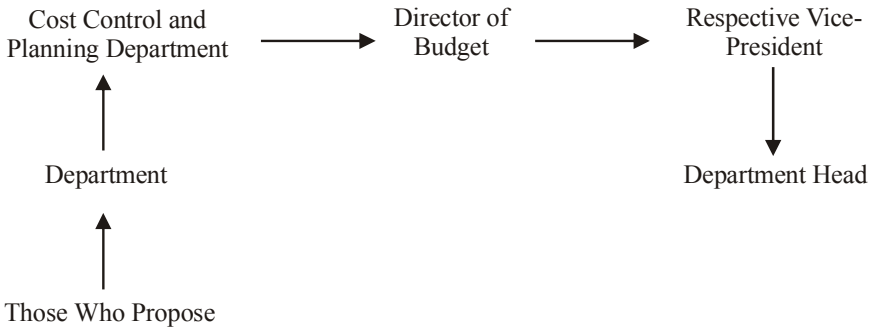

Fig. 3.3(b) *Process and Authorities: Minor Schemes*

This structure takes the entire process up to the allocation of funds over the competing projects. The process begins with the department level review (brainstorming). The project cell, the engineering department and the project department are involved in the major schemes, but not in the minor schemes. The project cell receives several proposals from the different departments and is better positioned to determine suitability of the proposals if there are mutually exclusive ones. The engineering department may verify the proposal from the technical standpoint before the proposal goes to the cost control and planning department for estimating the financial implications. The director of budget allocates limited funds over the competing projects and the proposals that get budgetary allocation go to the capital expenditure control committee, who appoint one or more study groups depending upon the position of the proposal on the decision-grid. The study groups collect data that is more precise, conduct risk analysis and come up with a design of the project. After the study group has designed the project, it is assigned to the

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respective department if the investment is less than the prescribed amount. Otherwise, it is referred to the board of directors for formal approval. Now, a detailed project report is prepared and a project team is formed for the implementation of the project often approved by the board of directors.

Project Management Organizations

A firm would require a right type of organization structure for the construction of a project. The firm would have one organization structure, which would suit the needs of routine operations. Project structure is superimposed on the existing organization structure. The overlapping of the two structures does create problems.

Issues in Project Organization

The firm has to answer the following questions while making the choice of project organization:

- How much independence should be given to the project team?
- Where should a project organization fit in the total organization?
- How should people be assigned to the project?
- What directive/authority should managers have (i.e., degree of empowerment)?

Answers to these questions will be somewhat different in different forms of organizations. A survey of the Fortune 500 companies in 1982 revealed the following regarding project organization and powers for project team:

- A majority of companies must obtain authorization for capital projects above certain limits (limit averaged $136,000).
- In most others, all capital expenditures must have received corporate approval or have been previously authorized in the budget.
- Only in a few cases, divisions were allowed to raise finances externally and that too only from short-term sources.
- The main reason given was that capital investment decisions were of such importance for the whole organization that they required central control.
- Divisional managers, however, do have substantial influence over projects submitted for authorization and thus, formal authorization was seen as corporate monitoring of decisions that are essentially the responsibility of divisional managers (on account of the concept of 'investment centres' being followed).
- Informal concepts with central management assured great significance for the entrepreneurial spirit of divisional managers as it helped them know which proposals would be accepted.
- The principle of 'delegation within guidelines' helped to maintain the balance mentioned earlier.

3.3.1 Types of Organization Structure

Project organization can be set up in different forms. Various types of organization are:

- Functional organization
- Divisionalized organization
- Projectized organization

- Matrix organization
- Task force organization

The issues in some of these types of organizations are discussed hereafter.

1. Functional Organization

When activities are divided on the basis of functions of the organization, it is called 'functional organization'. This may allow recruitment of subject expertise but at the same time it may result in a greater coordination problem causing lesser control. This type of organization is desirable where repetitive work has to be handled. Project activities are not repetitive and hence, functional type of organization is hardly suitable for project construction. A simplified functional organization chart will look like the one given in Figure 3.4.

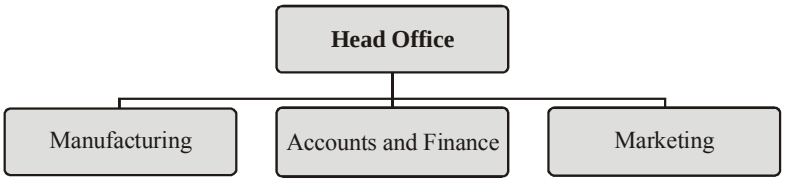

Fig. 3.4 *A Simple Functional Organizational Chart*

2. Divisional Organization

Some firms are either too large or too dispersed in terms of geographical area and product or market that may not be convenient for a complete functional organization. These firms create subunits or divisions. Each division works as almost a separate firm, though a high degree of coordination with head office is maintained. Divisional activities are classified on functional basis. This type of organization is also suitable for routine work, rather than project work.

Initially, divisions are created as profit-centres with powers to determine the price of their goods and services and powers to decide on expenses and with responsibilities of earning profits. The divisions do not enjoy powers to decide their own capital budget, except minor capital expenditures. Profit-centre divisions are usually subject to the following capital expenditure controls:

- Broad guidelines are issued to divisions, which are then expected to produce long-term projects in consonance with the established corporate objectives.
- Once the budgets are presented to the corporate management, financial analysis like discounted cash flows and accounting rate of return (ARR) are calculated for the evaluation of the division's proposals. The second level of control, therefore, envisages the formal authorization and since divisional managers know the required rates, they would present for consideration only such proposals, which meet the criteria. In addition, while authorizing, not merely financial details are considered but non-financial aspects are also considered.
- The third level of control involves post completion audit. This ensures that the estimates are not overstated, as they will be subject to an unbiased audit. Post completion audit reinforces corporate guidelines.

Over a time, divisions become investment-centres and enjoy capital expenditure powers. Most firms do not fully practice the investment centre concept. However, where the investment centre concept is truly followed, the head office will issue only broad guidelines

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and provide funds for the projects. The divisions decide their investment at their full discretion and will be held responsible for the earnings of return on investment or for creation of shareholder value. A simple divisional organizational chart is given in Figure 3.5. As you notice, the divisions are organized similar to a functional organization.

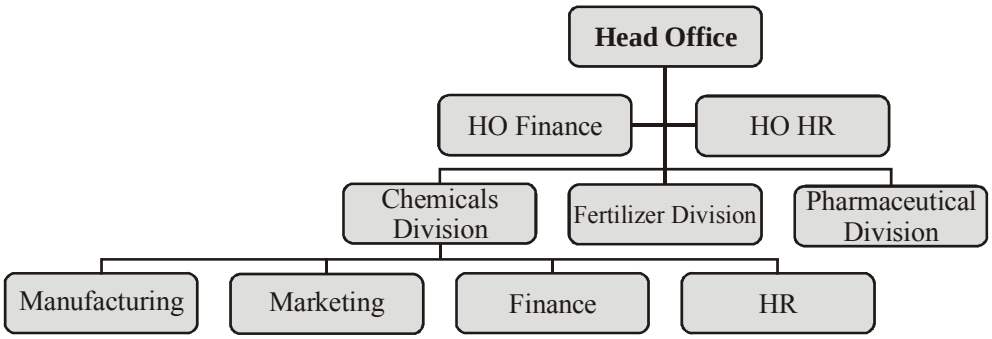

Fig. 3.5 *A Simple Divisional Organizational Chart*

3. Projectized Organization

A projectized organization is a completely autonomous structure. In this structure, a project manager takes the full responsibility for the construction of a project. He has under him, a complete team of people who are capable of carrying out various expert jobs required as a part of the project. The project team works independently. This type of structure is advisable where, (a) the project has to be completed at a different location than the existing operations of the firm, (b) maximum control and flexibility is required and (c) the project requires different accounting policies and procedures. The projectized structure will look like the one depicted in Figure 3.6.

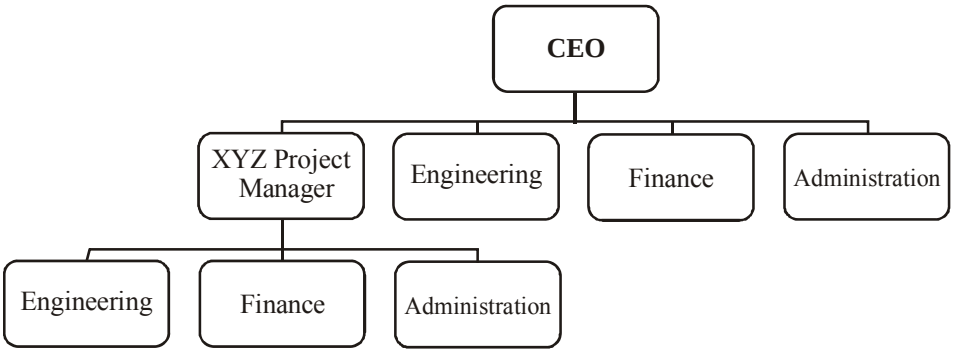

Fig. 3.6 *Projectized Structure of Organization*

4. Matrix Organization

In a matrix organization, the project team and the different functional departments enjoy the authority to work together on the project. There are two types of matrix organizations:

- **Matrix project organization with strong project functional management:** The project manager includes functional heads in his team who liaison between him and the respective functional departments to expedite the work. This type may be most suitable in a mature firm, which is accustomed to project management and where good understanding of the total requirement is prevails.

- **Matrix project organization with normal functional management:** Coordination is normal in this type of organization. The requirements of a project are taken care of along with routine demands in the functional departments. This type is suitable where complicated planning and decision-making is required and where a project plan can be broken into relatively unrelated tasks for the functional departments.

The dual responsibilities in this type of organization would appear as depicted in Figure 3.7.

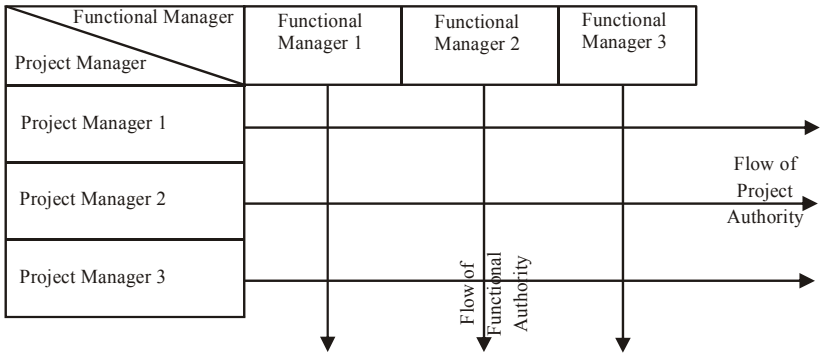

Fig. 3.7 *Responsibility Matrix in Matrix Organization*

Management control problems are the most severe in the matrix organization. The project manager has the responsibility for the project but does not have the corresponding authority over the resources used in the project. The interests of project managers often do not coincide with those of functional managers. Project managers want full attention given to their projects, while functional managers must take into account all the projects in which their departments are involved. Planning is complicated in the matrix organization for the interrelationship between the project and the functional responsibility centres that provide resources of complications.

5. Task Force Organization

In this type of organization, a special task force is formed with the responsibility to see that the project is successfully completed. The task force is not subject to internal rules and procedures. Its main goal is to perform the task assigned to it. The project manager is delegated with all authority and he fully shares the responsibilities related to project execution within the broad guidelines. A group of personnel is assigned to the project manager or he can hire the services. This type of organization is suitable where the present organization is set in a stereotype, where the firm has decided to carry out the project construction by itself and the size of the project is relatively small.

3.4 PROJECT SCHEDULING

Project scheduling is concerned with the techniques that can be employed to manage the activities that need to be undertaken during the development of a project.

Scheduling is carried out in advance of the project commencing and involves:

- Identifying the tasks that need to be carried out
- Estimating how long they will take
- Allocating resources (mainly personnel)
- Scheduling when the tasks will occur.

Check Your Progress

4. State the classification of investment schemes.
5. What are the various types of organization?

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Two basic decisions are important before the network techniques for project scheduling are deployed — one, whether to have multi-level scheduling and two, whether to have multi-project scheduling.

1. Multi-level Scheduling

Different levels of management need different degrees of details in the schedule plan and network diagram. This is more desired in project planning, especially if the project work is an amalgamation of numerous tiny activities. Each minute activity cannot be incorporated in a single work plan, unless the project itself is small and simple (like replacement of machine). So, multi-level scheduling is more common and desirable.

When schedules are prepared at multiple levels, it is called multi-level scheduling. Three to four level schedules can be prepared depending upon the requirements, for example:

- **Master project schedule** is prepared for the top management. This is essentially the milestone chart which gives a one-glance picture of the total activities. Only major groups of activities are recognized as discrete activities and sub-activities are ignored, for example, activity groups can be land development, civil work, electric work, plumbing, mechanical work, etc. The details in each of these work packages are excluded from the master project schedule for convenience.
- **Functional area schedules** are prepared for the project related activities of each functional department. Usually, the functional heads would need this level of scheduling. The functional area schedule is essentially the sub-group of corporate level master schedule.
- **Schedules of work packages** are the detailed schedules for all work packages that form the part of either the master project schedule or the functional area schedule. This essentially serves the purpose for project sub-teams or subcontractors who execute the activities.

2. Multi-project Scheduling

A firm, handling more than one project simultaneously, may require multi-project planning and resource allocation. Several resources, including manpower and money, are in common demand from all projects under construction. In that case, if separate project teams are allowed to operate independently, there could be conflicts and sub-optimal utilization of resources leaving unutilized resources some times and scarcity of resources some other times. The task of planning and control, therefore, is more difficult in multi-project activities.

In multi-project scheduling, all projects are collectively treated as a single project for the breakdown of work packages, their sequencing and resource allocation. Activities of one project may have a predecessor activities and/or successor activities in other projects. It becomes imperative for multi-project scheduling to follow multi-level scheduling also and plan for a greater degree of communication, reporting and coordination.

A firm may avoid difficulties of multi-project scheduling by scheduling each project independently but the costs and other potential conflicts in this approach may not be worth taking the risk.

3.4.1 CATS and RATS

One more decision is whether to have CATS only, RATS only or both. The term CATS stands for Critical Activity Time Schedule and the term RATS for Realistic Activity

Time Schedule. CATS provides more stringent time standards for project execution, whereas RATS is based on achievable time schedule. Figure 3.8 gives an idea of how CATS and RATS compare.

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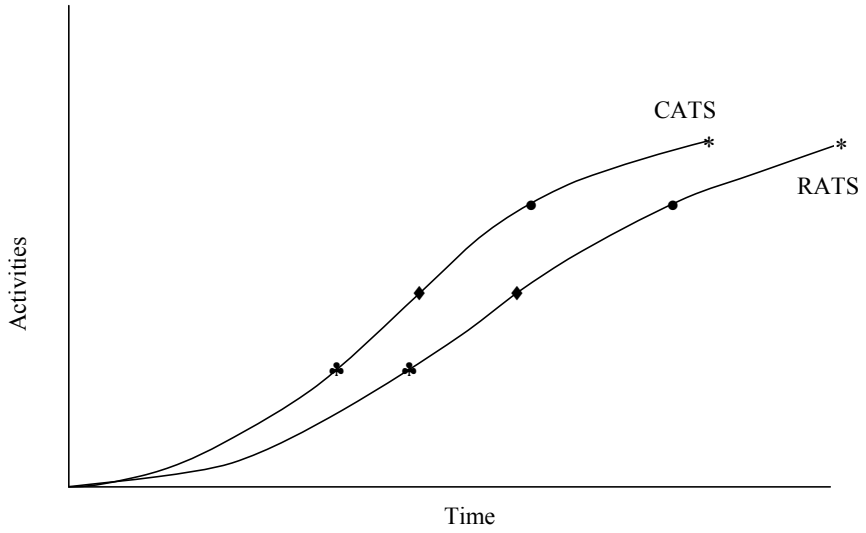

Fig. 3.8 *Critical Activity Time Schedule (CATS) and Realistic Activity Time Schedule (RATS)*

Both CATS and RATS are time schedules. CATS can be used to provide stringent time standards for project execution and can be useful for setting targets for project teams, machine fabricators and other project contractors for the completion time. Stricter standards may result in an effective execution of a project. RATS provide a more realistic time planning; therefore, it can be used for negotiations with funding agencies, who would expect timely attainment of major milestones in the project construction before they would release additional instalment of loan.

CATS and RATS have another purpose too. The difference between them could (a) reflect the risk associated with the time of completion and (b) cushion for contingency. Thus, evaluation of actual performance in the light of both CATS and RATS both would indicate whether the project is remaining within the boundary of acceptable level of risk associated with time.

3.4.2 Scheduling Techniques

A good schedule helps project managers establish achievable and realistic goals in order to fulfil project objectives, improve credibility, and manage the expectations of clients better. Project managers should deliver results, fulfil requirements, and adhere to time and cost constraints agreed upon so that their projects are successful. Project estimation and project scheduling should be given a lot of importance and attention. Combined with appropriate negotiation and prioritization, the competitive demands of the business can be successfully met.

When goals are set for projects, the SMART policy should be followed. The goals should not only be Specific and Measurable but also Achievable, Realistic and Timed. Wherever the time factor comes in, the significance of scheduling is highlighted.

In most scheduling software, the format being used will have certain standard terms used for time analysis- related calculations. Let us look at these first:

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- **Activity Identifier (ID):** This is a unique alphanumeric identifier allotted to each scheduled activity.
- **Duration (Dur):** This is the total time period (hours, days, weeks, etc.) required to accomplish the work of the activity.
- **Early Start Time (EST):** This is the earliest point in time when a scheduled activity can begin. It could also be referred to as ESD (early start date) or ES (early start)
- **Early Finish Time (EFT):** This is the earliest point in time when the scheduled activity can be accomplished or completed.
- **Late Start Time (LST):** Keeping in mind the deadline for completion of project, this is the latest point in time when the schedule activity can begin without delaying the project.
- **Late Finish Time (LFT):** This is the latest point in time when the schedule activity can finish that the project completion date is not defaulted. This is often referred to as Late Finish Date (LFD) or Late Finish (LF)
- **Free Float (FF):** This is the time period by which an activity can be shifted without affecting the Early Start of any other succeeding activity or event.
- **Total Float (TF):** This is the time period by which an activity can be shifted or rescheduled without affecting the date of completing the work.
- **Critical Path:** This is the longest sequence of activities from start to finish. It comprises the sequence of activities that will take the longest to complete or, the sequence of activities that will determine the earliest possible finish date.

In order to be able to schedule the project properly, the project manager usually keeps track of all the bullet points mentioned and performs the following:

- Sits with the team and narrows down the objectives to something specific, concrete, measurable and achievable within a specific time.
- Enters each specific point on the project into the software being used or a general calendar software. Activates reminder systems to keep track of the progress of the project.
- Allows all members access to the schedule and the progress so that everyone is aware of the effort required to achieve the goal/deadline.

In the sections that follow, you will learn about the various methods or techniques adopted by organizations to ensure that their projects are on track.

3.4.3 Gantt Chart

Gantt chart is a type of bar chart that illustrates a project schedule. Gantt charts illustrate the start and finish dates of terminal elements and summary elements of a project. These elements comprise the work breakdown structure of the project. Some Gantt charts also show the dependency (i.e., precedence network) relationships between activities. Gantt charts can be used to show the current schedule status using per cent-complete shadings and a vertical Today line as shown here.

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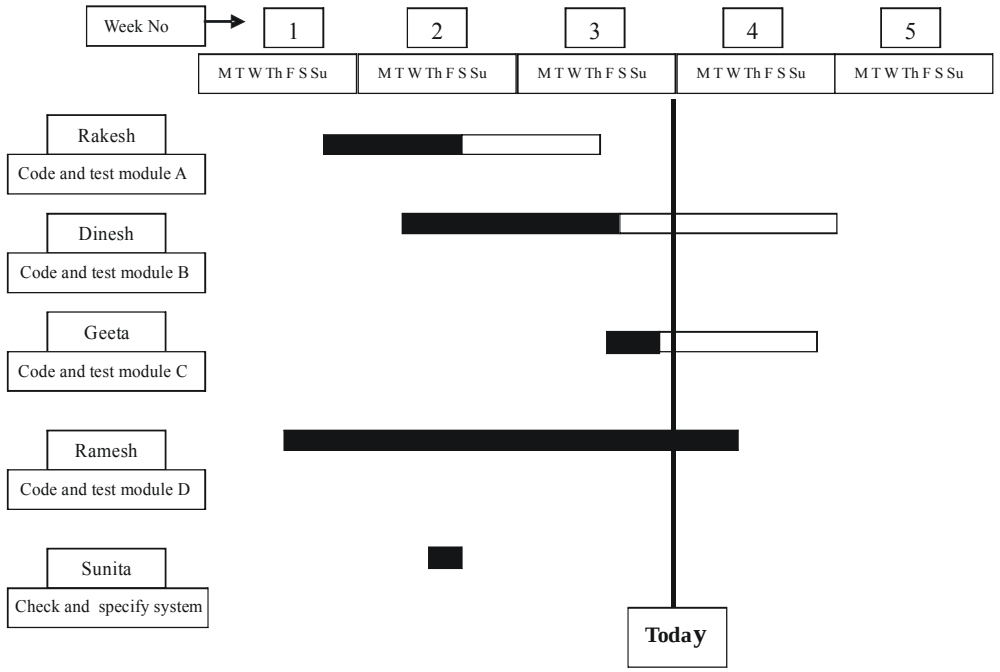

Fig. 3.9 *A Gantt Chart*

A Gantt chart is one of the simplest and oldest techniques to track project progress. This is an activity bar chart indicating scheduled activity dates and durations frequently augmented with activity floats. Although now regarded as a common charting technique, Gantt charts were considered revolutionary when these were introduced. In recognition of Henry Gantt's contributions, the Henry Laurence Gantt Medal is awarded for distinguished achievement in management and community service. This chart is used also in information technology to represent data that has been collected.

Gantt charts have become a common technique for representing the phases and activities of a project WBS, so that they can be understood by a wide audience.

A common error made by those who equate Gantt chart design with project design is that they attempt to define the project WBS at the same time that they define scheduled activities. This practice makes it very difficult to follow the 100 per cent rule. Instead, the WBS should be fully defined to follow the 100 per cent rule, then the project schedule can be designed.

Although a Gantt chart is useful and valuable for small projects that fit on a single sheet or screen, they can become quite unwieldy for projects with more than thirty activities. Larger Gantt charts may not be suitable for most computer displays. A related criticism is that Gantt charts communicate relatively little information per unit area of display. That is, projects are often considerably more complex than can be communicated effectively with a Gantt chart.

Gantt charts only represent part of the triple constraints of projects, because they focus primarily on schedule management. Moreover, Gantt charts do not represent the size of a project or the relative size of work elements. Therefore the magnitude of a behind-schedule condition is easily miscommunicated. If two projects are the same number of days behind schedule, the larger project has a larger impact on resource utilization, yet the Gantt chart does not represent this difference.

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Work Breakdown Structure (WBS)

A work breakdown structure (WBS), in project management and systems engineering, is a deliverable oriented decomposition of a project into smaller components. It defines and groups a project's discrete work elements in a way that helps organize and define the total work scope of the project.

A work breakdown structure element may be a product, data, a service, or any combination. A WBS also provides the necessary framework for detailed cost estimating and control along with providing guidance for schedule development and control.

The work breakdown structure is a tree structure, which shows a sub-division of effort required to achieve an objective; for example a programme, project, and contract. In a project or contract, the WBS is developed by starting with the end objective and successively sub-dividing it into manageable components in terms of size, duration and responsibility (e.g., systems, subsystems, components, tasks, subtasks, and work packages), which include all steps necessary to achieve the objective.

The work breakdown structure provides a common framework for the natural development of the overall planning and control of a contract and is the basis for dividing work into definable increments from which the statement of work can be developed and technical, schedule, cost, and labour hour reporting can be established.

The concept of work breakdown structure developed with the Programme Evaluation and Review Technique (PERT) in the United States Department of Defense (DoD).

A work breakdown structure permits summing of subordinate costs for tasks, materials, etc., into their successively higher level 'parent' tasks, materials, etc. For each element of the work breakdown structure, a description of the task to be performed is generated. This technique (sometimes called a *system breakdown structure*) is used to define and organize the total scope of a project.

The WBS is organized around the primary products of the project (or planned outcomes) instead of the work needed to produce the products (planned actions). Since the planned outcomes are the desired ends of the project, they form a relatively stable set of categories in which the costs of the planned actions needed to achieve them can be collected. A well-designed WBS makes it easy to assign each project activity to one and only one terminal element of the WBS. In addition to its function in cost accounting, the WBS also helps map requirements from one level of system specification to another, for example, a requirements cross reference matrix mapping functional requirements to high level or low level design documents.

3.5 CRITICAL PATH METHOD (CPM)

In 1950, a joint venture between the Dupont Corporation and the Remington Rand Corporation for managing plant maintenance projects led to the (CPM). Today, it is commonly used with all forms of projects such as construction, software development, research projects, product development, engineering, plant maintenance and so on. Any project with interdependent activities can apply this method of scheduling. Whenever an activity is scheduled by various planning techniques, the necessary resources such as capital, equipment, labour or other inputs are needed for executing the work package or an activity. The fact is that necessary resources are not always available when desired;

so, activities must be scheduled at time when resources are available. It is also important to note that the cost and duration of the project are interdependent variables. Altering project schedules influences costs and it should be possible to alter the activity schedules so as to achieve optimum trade-offs between the project cost and the scheduled completion date.

The CPM is the graphical representation of the interrelationships between the tasks in a project to be performed in a well-defined sequence. It lays stress on the following two aspects of a project:

- The effect of applying more men or other resources to shorten the duration of given jobs
- The increased cost of these additional resources

The procedure of deciding the critical path is executed through the following steps:

- Firstly, the project is categorized into a series of labelled activities. These activities are then arranged in a logical sequence and represented graphically with an arrow diagram.
- All the nodes and activities are then numbered. The time required for each activity is calculated and indicated in the arrow diagram.
- The earliest start and ending time along with the latest start and finish time are then calculated and jotted down.
- The total float for each activity is then determined by taking the difference between the earliest and the latest time for each node.
- The critical activities (zero float activities) are then identified and connected with the beginning and the ending node in the network diagram by double line arrow. This gives the critical path.
- The total project duration is then calculated.
- In case the total project duration needs to be reduced, the critical activities of the network are crashed.
- The cost is optimized and the network is then updated accordingly.

Since project schedules change on a regular basis, CPM allows continuous monitoring of the schedule. It enables the project manager to track the critical activities and ensures that the non-critical activities do not interfere along with the critical ones. The following example illustrates CPM in detail.

A small maintenance project consists of the following jobs whose precedence relationships are given in Table 3.2.

Table 3.2 *Precedence Relationships*

Job	***1–2***	***1–3***	***2–3***	***2–5***	***3–4***	***3–6***	***4–5***	***4–6***	***5–6***	***6–7***
Duration (days)	15	15	3	5	8	12	1	14	3	14

1. Draw an arrow diagram representing the project
2. Find the total float for each activity
3. Find the critical path and the total project duration

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Figure 3.10 shows the arrow diagram representing the project.

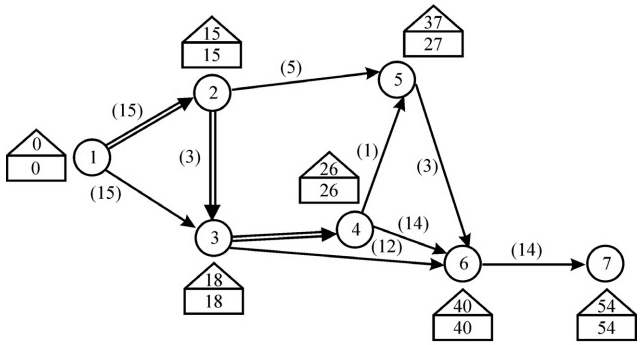

Fig. 3.10 *Arrow Diagram*

To calculate the critical path and total project duration we first need to find the forward and backward pass calculations.

- **Forward Pass Calculation**: In this calculation, it is estimated that the earliest start and the earliest finish time ES_j is given by

$ES_1 = 0$

$ES_2 = ES_1 + t_{15} = 0 + 15 = 15$

$ES_3 = \text{Max}(ES_2 + t_{23}, ES_1 + t_{13})$

$= \text{Max}(15 + 3, 0 + 15) = 18$

$ES_4 = ES_3 + t_{34} = 18 + 8 = 26$

$ES_5 = \text{Max}(ES_2 + t_{25}, ES_4 + t_{46}, ES_5 + t_{56})$

$= \text{Max}(15 + 3, 0 + 15) = 18$

$ES_4 = ES_3 + t_{34} = 18 + 8 = 26$

$ES_5 = \text{Max}(ES_2 + t_{25}, ES_4 + t_{46}, ES_5 + t_{56})$

$= \text{Max}(15 + 5, 26 + 1) = 27$

$ES_6 = \text{Max}(ES_3 + t_{36}, ES_4 + t_{46}, ES_5 + t_{56})$

$= \text{Max}(18 + 12, 26 + 14, 27 + 3)$

$= 40$

$ES_1 = ES_6 + t_{67} = 40 + 14 = 54.$

- **Backward Pass Calculation**: In this calculation, we calculate the latest start and latest finish time LF_i, given by $LF_i = \text{Min}_i (LF_j \text{ ‘}t_{ij})$ where LF_j is the latest finish time for the event j.

$LF_1 = 54$

$LF_6 = LF_1 - t_{67} = 54 - 14 = 40$

$LF_5 = LS_6 - t_{56} = 40 - 3 = 37$

$LF_4 = \text{Min}(LS_5 - t_{45}, LS_6 - t_{46})$

$= \text{Min}(37 - 1, 40 - 14) = 26$

$LF_3 = \text{Min}(LF_4 - t_{34}, LF_6 - t_{36})$

$= \text{Min}(26 - 8, 40 - 12) = 18$

$LF_2 = \text{Min}(LF_5 - t_{25}, LF_3 - t_{23})$

$= \text{Min}(37 - 5, 18 - 3) = 15$

$LF_1 = \text{Min}(LF_3 - t_{13}, LF_2 - t_{12})$

$= \text{Min}(18 - 15, 15 - 15) = 0$

Table 3.3 gives the calculation for critical path and total float.

Table 3.3 *Critical Path and Total Float*

Activity	*Normal time*	*Earliest*		*Latest*		*Total Float*
		Start	*Finish*	*Start*	*Finish*	$LF_j - ES_j$ or $LF_i - Es_i$
1–2	15	0	15	0	15	0
1–3	15	0	15	3	18	3
2–3	3	15	18	15	18	0
2–5	5	15	20	32	37	17
3–4	8	18	26	18	26	0
3–6	12	18	30	28	40	10
4–5	1	26	27	36	37	10
4–6	14	26	40	26	40	0
5–6	3	27	30	37	40	10
6–7	14	40	54	40	54	0

From the above table, we observe that the activities 1–2, 2–3, 3–4, 4–6, 6–7 are the critical activities and the critical path is given by 1–2–3–4–6–7. The total project completion time is 14 days.

Advantages of CPM

A CPM schedule simplifies the planning of work assignments in advance and helps improve communication among those who are responsible for project performance. The CPM also helps in better project planning by providing evaluations and forecasts the success of alternative plans of action. Following are the advantages of the CPM:

- It helps the top management to focus on the critical activities and their timely accomplishment.
- It provides the knowledge of critical and non-critical activities and their completion in time. This helps the management to divert the resources from non-critical to critical activities. The performance of an activity on the critical path is essential otherwise it may postpone the project completion time.
- It creates the best way of planning and scheduling a construction project by showing the critical path.
- It provides the complete information about the importance, duration, size and performance of an activity.

Disadvantages of CPM

The CPM also suffers from certain drawbacks such as high cost, time consumption, poor time estimate provision and resource allocation.

Some other disadvantages of the CPM are as follows:

- The CPM is based on the estimation of duration of activities which is impractical in real life.

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- In case there are changes in the predetermined network, the entire evaluation of the project has to be repeated and a new critical path is required to be created all over again.
- It does not include statistical analysis in determining the time estimates.
- The CPM can become complicated when it involves larger projects.

3.5.1 An Example of CPM Project Analysis

Consider a simple project having six events and seven activities for the CPM example illustration. Table 3.4 gives the normal durations, T, and direct costs, *C*, as well as the crash durations, T_c, and direct costs, C_c, for the project activities.

Table 3.4 *Normal and Crash Durations and Costs for CPM Example Project*

Activity code	***Normal***		***Cash***	
	Duration T_n, weeks	***Direct cost C_c, ₹***	***Duration T_n, weeks***	***Direct cost C_c, ₹***
A	9	20, 000	6	26, 000
B	8	15, 000	5	24, 000
C	5	12, 000	4	13, 000
D	8	18, 000	6	28, 000
E	7	14, 000	3	22, 000
F	5	13, 000	4	16, 000
G	5	17, 000	2	32, 000

The first step in the CPM analysis is to assume normal durations for all the project activities and to perform PERT analysis. The results of this analysis are shown in Figure 3.11 where the earliest expected and latest allowable times for all events as well as the critical path of the project are illustrated.

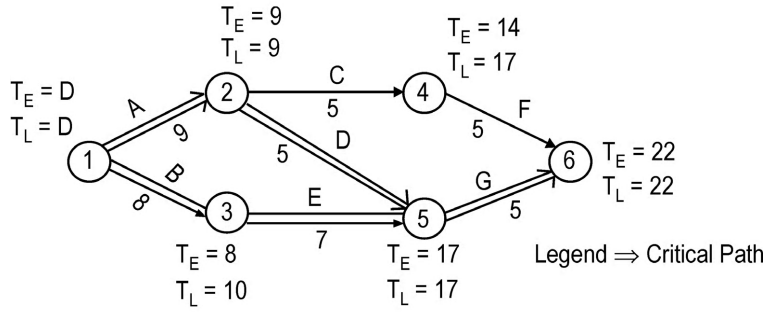

Fig. 3.11 *'Normal' Duration PERT Analysis for CPM Example Project*

Suppose you are interested in the answers to the following questions vis-à-vis this example project:

- What is the least costly way to decrease the scheduled project duration to 19 weeks?
- What is the minimum total project direct cost to quicken the project to its shortest duration?

From Figure 3.11, the expected project duration under normal conditions is 22 weeks and the corresponding normal direct cost is ₹ 1,09,000. Follow step 3 of the above algorithm to selectively crash project activities. In order to do this, compute the cost-time (negative) slopes of all the activities. These values are shown in Table 3.5 and the calculations have been made using equation and Table.

Table 3.5 *Cost-Time Slopes of Activities for CPM Example Project*

Activity code	*Cost-time (negative) slope, ₹/ week*
A	2, 000
B	3, 000
C	1, 000
D	5, 000
E	2, 000
F	3, 000
G	5, 000

In the first step, the duration of activity A is shortened from nine to seven weeks that resulted in critical path 1–3–5–6 in comparison to the earlier critical path 1–2–5–6. At the end of the first step of the iteration, the expected duration of the project is 20 weeks and the direct cost is ₹ 1,13,000.

In the second step of the iteration, there are two critical paths, namely, 1–2–5–6 (A–D–G) and 1–3–5–6 (B–E–G). To reduce the project duration, you must shorten both the paths. Along the first path, activity A is least costly to expedite and it can be shortened by one week, from seven to six weeks. In Table 3.6, the crash duration of activity A is 6 weeks; hence, it cannot be crashed any further. Denote this by an asterisk (*) after A at the end of the second iteration. Along the second path (B–E–G), E is the activity with the lowest cost time slope; hence, this is shortened by one week. The resulting project duration is 19 weeks; the total direct cost has increased to ₹ 1,17,000.

During the third iteration, the critical paths remain as A–B–G and B–E–G; however, A cannot be crashed anywhere. You could either crash activities D and E at an incremental cost of ₹ 7,000 per week, or crash only activity G (which is common to both critical paths) at a cost of ₹ 5,000 per week. Since the latter option is less costly, you should choose to crash activity G by three weeks. Now, the project duration has reduced to 16 weeks while the direct cost has increased to ₹ 1,32,000. Table 3.6 shows the iterative steps for selective crashing of activities in the CPM Example Project.

The above table denotes that the activity has been crashed. Since A, C, and F, all on one critical path, has been crashed; this is the 'optimal' solution. Having reduced the duration of activity G to six weeks, all the three paths in the project network, namely, A–C–F, A–D–G and B–E–G have become critical. Hence, to reduce the project duration, you need to shorten at least one activity along each of the critical paths. Durations of activities C, D and E have been reduced by one week each. This results in the project duration being reduced to 15 weeks and the project direct cost going up to ₹ 1,40,000. Please note that at this stage of the iteration process, activities A, C and G have been crashed to their minimum durations.

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Table 3.6 *Iterative Steps for Selective Crashing*

Iteration No.	***Activities along critical path (s)***	***Eligible activity having least cost-time***	***Minimum of slack / crashable duration, weeks***	***Reduce Duration***		***Revised Project Status***	
				Activity	***By weeks***	***Duration, weeks***	***Cost, Rupees***
1.	A, D, G	A	2	A	2	20	1,13,000
2.	A, D, G	A	1	A*	1	19	1,17,000
	B, E. G	E	3	E	1		
3.	A, D, G	D, G	3	G*	3	16	1,32,000
	B, E, G	E	3				
4.	A, C, F	C	1	C*	1		
	A, D, G	D	2	D	1	15	1,40,000
	B, E, G	E	3	E	1		
5.	A, C, G	F	1	F*	1		
	A, D, G	D	1	D*	1	14	1,50,000
B, E, G	E	2	E	1			

In the fifth iteration step, the three paths A–C–F, A–D–G and B–E–G are all critical. Shorten activities D, E and F each by one week. The resultant project duration is 14 weeks; the total direct cost of the project is ₹ 1,50,000. At this stage, activity D has been crashed to six weeks and activity F has been crashed to its minimum duration of four weeks. It is important to realize that activities A, C and F which constitute all the activities on the critical path A–C–F have now been crashed (to their minimum durations). This condition implies that the project duration cannot be reduced further since shortening any activity on the two other paths, A–D–G and B–E–G, will not help in speeding up the project. When there are multiple critical paths, at least one activity on each critical path needs to be shortened to effectively reduce the project duration.

Now, give the answers to the two questions that have been raised at the beginning of this example project analysis.

- The first question was to find out the least costly way to decrease the project duration to 19 weeks. The answer to this is obtained at the end of the second step of the iteration that has just carried. The least costly way to decrease the project duration from the normal duration of 22 weeks to the scheduled duration of 19 weeks is to crash activity A by 3 weeks and activity E by 1 week. The incremental direct cost is ₹ 8,000; the total project direct cost for duration of 19 weeks is ₹ 1,17,000.
- The second query was regarding the total project direct cost to quicken the project to its shortest duration. This is answered by the last and fifth iteration shown in Table 3.4 and described earlier. The minimum total project direct cost to achieve the shortest project duration of 14 weeks is ₹ 1,50,000.

You are advised to verify that any means of achieving project duration of 14 weeks, other than by the way shown in the iterations of Table 3.4, will result in a higher

total direct cost of the project. For example, one obvious (and trivial) solution to the problem of crashing the project duration would be to crash all the project activities to their minimum (crash) durations. This would certainly result in the project being completed in 14 weeks but at an enhanced direct cost of ₹ 1,61,000. The reason for this additional direct cost of ₹ 11,000 over the optimal direct cost of ₹ 1,50,000 arrived at in the fifth iteration in Table 3.4 is that you will unnecessarily be crashing activities B and E by an additional 3 weeks and 1 week, respectively. The 'optimal' solution of the selective crashing process indicates that activity B can be scheduled for 8 weeks and E for 4 weeks. Rescheduling B to its crash duration of 5 weeks and E to 3 weeks does not result in any gain in the project duration but only causes an additional direct cost of ₹ 11,000. This is the reason why you do a selective crashing of project activities rather than resort to an 'indiscriminate' crashing of all the activities in the project.

3.5.2 Total Cost-Time Trade-Off

The CPM analysis, so far, has only dealt with direct costs which are costs directly associated with individual project activities. The direct cost for an activity increases linearly as the project activity is expedited. You can plot the total project direct cost versus the project duration by taking the values after each iteration step from Table 3.4.

It is obvious that the cost of executing a project is more than just the direct activity costs. The other costs of the project include the indirect costs as well, such as the costs of utilities, facilities, rents, administration, marketing, taxes, etc. As opposed to the direct costs which vary inversely with project duration, indirect costs increase as the project duration increases (because the indirect costs are per day or per week costs which have to be met regardless of the level of the project activity for as long as the project is scheduled). The mathematical function to express the indirect cost, *CI*, in terms of the expected project duration, T_e, can either be derived by estimation of actual (historical) costs or can be approximated by a formula. You can estimate the indirect costs for the CPM example project to be as follows:

Where

$CI = 17{,}000 + 6{,}000\, T_e$

CI = indirect project cost in Rupees

T_e = expected project duration in weeks

The above equation implies that the start-up indirect cost, even for zero project duration, is ₹ 17,000. Thereafter, the indirect cost increases by ₹ 6,000 for every additional week's increase of the expected project duration.

The total project cost can be computed by summing up the direct and indirect costs. The curve, for most projects will be U-shaped with the trough of the curve representing the duration at which the total project cost is the minimum. Thus, if you have a choice in selecting the scheduled completion time, T_s, you should select this optimum duration point.

3.5.3 Planning Time Scales-Network/PERT Analysis

A systematic approach in planning the activities would include several steps and decisions. First, the firm has to decide whether they would want multi-level scheduling and multi-project scheduling or not. Then, the activities must be identified discretely, the time for

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each activity must be estimated, the resource requirement must be planned and the interdependence must be determined. These activities should then be presented in a manner that will help grasp the complexities clearly and also help to determine slack, if any. It will also help in effective resource allocation considering the time period. In this section, we will discuss these issues.

Concept of Network

Conceptually, we can say that a network diagram is a graphical presentation of all the activities of a project, arranged in a proper sequence and with clearly established interdependencies. The network diagram provides a full picture of the project. The diagram can be presented as:

(a) A Gantt chart

(b) A PERT (programme evaluation and review technique) diagram

(c) A CPM (critical path method) diagram

PERT and CPM are quite similar, except in the incorporation of uncertainty of time needed for the completion of each activity.

Purpose of network analysis

The goals and purposes of network analysis can be listed as follows:

1. Identifying discrete activities and sub-activities
2. Identifying events signalling either the beginning or ending of the activities
3. Estimating the time taken for completion of each activity, if possible on crash basis, normal basis, worst-scenario basis
4. Identifying interdependence, if any, of activities
5. Identifying critical path, so that one may know the existence of slack time in any activity
6. Identifying slack for efficient resource allocation
7. Determining economics of crashing of activities

3.6 PROJECT EVALUATION AND REVIEW TECHNIQUE (PERT)

The program (or project) evaluation and review technique, commonly abbreviated PERT, is an analytical means, used in project management, which was developed for the analysis and representation of tasks that were part of implementation a given project. Initially developed by the United States Navy in the 1950s, PERT is widely used together with the critical path method (CPM). In addition to being used as a method to analyze the involved tasks in completing a given project, PERT is also used to calculate the time required for every task independently and to spot the least possible time required for completing the entire project.

The PERT was created to handle such projects where the time estimate of activities is non-deterministic. The PERT is used to organize and coordinate tasks within the project. The objective of the PERT chart is to determine critical path which comprises critical activities that should be completed on schedule. This chart is prepared with the help of

Check Your Progress

6. Define multi-level scheduling.
7. What is Gnatt Chart?
8. Define work breakdown structure.
9. What is the basic objective of CPM?

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information generated in project planning activities such as estimation of effort, selection of suitable process model for software development and decomposition of tasks into subtasks. The advantages of using the PERT are listed below:

- It represents the project in graphical form.
- It provides information about the expected completion time of the project.
- It describes the probability of completion of the project before the specified date.
- It specifies the activities that form the critical path.
- It specifies the starting and ending dates of activities involved in the project.

Figure 3.12 shows an example of the PERT chart. The milestones are numbered as '1', '2', '3', '4' and '5' and represented by either circles or rectangles. When a milestone is completed, it is assigned a greater number than previous milestones. Each milestone is linked with one or more arrows. The activities of the project are represented by 'A,' 'B', 'C', 'D', 'E' and 'F'. The direction of arrows determines the sequence of activities. When the activities are completed in sequence, they are known as serial activities. Here, activities 'A', 'C' and 'F' are performed in sequence. Similarly, activities 'B' and 'E' are serial activities. On the other hand, when two or more activities are being performed simultaneously, they are known as concurrent activities or parallel activities. Here, activities 'A' and 'B' and activities 'C' and 'D' are performed concurrently. Each activity is allocated a specific amount of time, which is depicted by 't'. Here activity 'A' requires 3 weeks to get completed, activity 'B' requires 4 weeks and so on. Figure 3.12 shows the PERT chart.

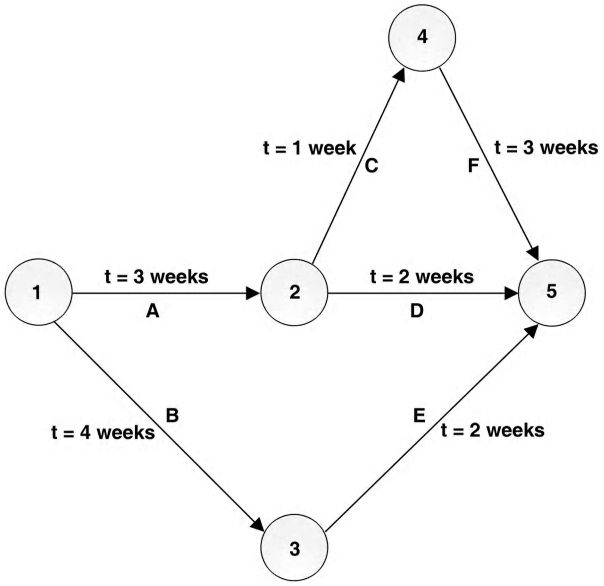

Fig. 3.12 *PERT Chart*

To create the PERT chart, follow the steps listed below:

1. **Identify the activities and milestones**: In this step, the activities and milestones that are required to complete the project are described. Once the tasks and milestones are specified, it is easy to understand the sequence and duration of each activity.
2. **Identify the sequence of activities**: In this step, the sequence of activities is determined. The sequence describes the dependency of one activity on another. These activities can either be serial or concurrent. Based on the sequence and

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dependency of activities, the relationships among activities are depicted. Note that this step is sometimes combined with step 1.

3. **Prepare the PERT chart**: In this step, the PERT chart is prepared.
4. **Estimate the time consumed in activities**: In this step, the amount of time consumed in carrying out each activity is specified. The time can be estimated in months, weeks or days. Generally, the time estimates followed to determine the time consumed in the activities are listed below:
   - o **Optimistic time**: It is the shortest time in which an activity can be completed.
   - o **Most likely time**: It is the completion time having the highest probability.
   - o **Pessimistic time**: It is the longest time that an activity may require for completion.
5. **Determine the critical path**: In this step, the critical path for completion of activities is specified. Critical path determines the calendar time required to complete a series of activities according to the project schedule. Note that the speed-up or delays in activities that are outside the critical path do not affect the total project time.
6. **Update the PERT chart**: In this step, the PERT chart is modified as changes take place in the project on completion of each activity. This chart is also updated when there is a delay in completion of activities or when the additional resources are required to complete the project on time.

The steps involved in executing this method are as follows:

1. **Project planning**: The purpose of project planning is to identify all the important events which are essential for completion as well as making up of the project. The interdependence of these events is shown explicitly in the form of a network.
2. **Time Estimation**: Estimates of the time required to perform each of the network activities are made which are based upon manpower and equipment availability and certain assumptions as a part of the project plan. By incorporating the time required for completing, each of the activities in the network, the project duration as well as the criticality of the activities are calculated.
3. **Scheduling**: The scheduling computations give the earliest and the latest allowable start and finish times for each activity. As a by-product, they identify the critical path through the network and indicate the amount of 'slack' time associated with the non-critical paths.
4. **Time-cost trade-off**: If the scheduled time to complete the project as determined in step 3 is satisfactory, the project planning and scheduling may be complete. However, if one is interested in determining the cost of reducing the project completion time, then time-cost trade-offs of activity performance times must be considered for those activities on the critical and nearly critical paths.
5. **Resource Allocation**: The feasibility of each schedule must be checked with respect to the manpower and equipment requirements. Establishing complete feasibility of a specific schedule may require re-planning and re-scheduling or time-cost trade-offs.
6. **Project Control**: When the network plan and the schedule have been developed to a satisfactory extent, they are prepared to final form for use in the field. The project is controlled by checking the progress against the schedule, assigning and scheduling manpower and equipment and analyzing the effects of delays. Whenever major changes are made in the schedule, the network is revised

accordingly and a new schedule is computed. In short, this stage comprises periodic updating of the network to monitor the progress of the project and making necessary changes in the schedules to ensure completion of the project as close to the target time as possible.

3.6.1 PERT: Single Time Estimate

Perhaps the best amongst the relatively new project management techniques is the PERT. It was developed in the late 1950s by Special Projects Office of the US Navy in collaboration with the consulting firm, Booz, Allen, and Hamilton, and the prime contractor, Lockheed Missile Systems.

The developers were concerned with the performance trends in large military programmes in general and Polaris Missile System in particular. The basic requirements for using the PERT as established by the US Navy are as follows:

- All the tasks that are needed to complete a given project must be visualized in a manner that they can be clearly depicted in a network which comprises events and activities. In other words, the PERT network must follow the WBS.
- Events and activities must be sequenced in a network using a highly logical set of ground rules that help determine important critical and sub-critical paths for a project.
- Critical path and slack times must be computed. Critical path is the sequence of activities and events that require the greatest expected time to accomplish an activity.

In complex Research and Development (R&D) programmes such as the US Navy's Polaris missile development effort, several questions area asked to find the feasibility of the research. Some of these questions are as follows:

- What kind of research needs to be done?
- What stages of development are necessary?
- How fast can R & D be completed?

These questions arise largely because of the uncertainty about the final outcome of the R&D project. Such projects are implemented while new developments are still occurring and previous problems in technology, materials and processes can be resolved. Since the time of its development in the late 1950s, the PERT has spread rapidly amongst all industries and is particularly used in those projects where the major emphasis and concern is on the time element or project duration.

3.6.2 PERT System of Three-Time Estimates

The PERT is a technique where the activity times are represented by a probability distribution. This probability distribution is based upon three different time estimates made for each activity. These estimates are as follows:

- **Optimistic time estimate**: It refers to the time estimate of an activity when everything is assumed to go well as per the plan. It is the estimate of the minimum possible time which an activity takes to complete under ideal conditions and is denoted by t_0 or a.
- **Most Likely time estimate**: It refers to the estimate of the normal time an activity would take to complete. This assumes normal delays and calculates the time which the activity will take most frequently if performed a number of times. It is denoted by t_m or m.

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- **Pessimistic time estimate**: It refers to the longest time that an activity would possibly take if normal conditions do not prevail. However, this does not include major catastrophes such as labour strikes, natural calamities and unrest and is usually denoted by *b* or *t*.

These three-time values *a, m* and *b* are combined statistically to develop the expected time (t_e) for an activity which is given by:

$t_e = \frac{t_0 + 4_{tm} + t_p}{6}$ (β distribution with weights of 1,4,1, for t_0, t_m and t_p estimates, respectively)

Variance of the activity is given by:

$$\sigma^2 = \left[\frac{t_p - t_0}{6}\right]^2$$

The expected length or duration denoted by T_c, of the entire project is the length of the critical path or the sum of the t_c's of all the activities along with the critical path.

The main objective of the analysis performed through the PERT is to find the completion of a particular event within specified date T_S, given by:

$$P(Z \leq D)$$

where *Z* stands for standard normal variable and

$$D = \frac{\text{Due date} - \text{Expected date of completion}}{\sqrt{\text{Project variance}}}$$

3.6.3 PERT Process

The PERT process is performed through the following steps:

1. Draw the project network
2. Compute the expected duration of each activity using the formula,

$$t_e = \frac{t_0 + 4t_m + t_p}{6}$$

3. Calculate the expected variance σ^2 of each activity
4. Compute the earliest start, earliest finish, latest start, latest finish and total float of each activity
5. Find the critical path and identify the critical activities
6. Compute the project length variance σ^2 which is the sum of the variance of all the critical activities and find the standard deviation of the project length σ.
7. Calculate the standard normal variable $Z = \frac{T_s - T_e}{\sigma}$

Where T_s = The scheduled time to complete the project
T_e = Normal expected project length duration
σ = Expected standard deviation of the project length

Using the normal curve, we can estimate the probability of completing the project within a specified time.

The PERT can be illustrated with the help of several examples which are as follows:

Table 3.7 shows the jobs of a network along with their time estimates.

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Table 3.7 *Jobs of a Network*

Job	1–2	1–6	2–3	2–4	3–5	4–5	6–7	5–8	7–8
a (days)	1	2	2	2	7	5	5	3	8
b(days)	7	5	14	5	10	5	8	3	17
c (days)	13	14	26	8	19	17	29	9	32

Draw the project network and find the probability that the project is completed in 40 days.

First, the expected time and standard deviation for each activity should be calculated as shown in Table 3.8.

Table 3.8 *Expected Time and Standard Deviation*

Activity	$t_e = \frac{t_o + 4t_m + t_p}{6}$	$\sigma^2 = \left[\frac{t_p - t_0}{6}\right]^2$
1–2	$\frac{1+4\times7+13}{6} = 7$	$\left(\frac{13-1}{6}\right)^2 = 4$
1-6	$\frac{2+4\times5+14}{6} = 6$	$\left(\frac{14-2}{6}\right)^2 = 4$
2–3	$\frac{2+4\times14+26}{6} = 14$	$\left(\frac{26-2}{6}\right)^2 = 16$
2–4	$\frac{2+5\times4+8}{6} = 5$	$\left(\frac{8-2}{6}\right)^2 = 1$
3–5	$\frac{7+4\times10+19}{6} = 11$	$\left(\frac{19-7}{6}\right)^2 = 4$
4–5	$\frac{5+5\times4+17}{6} = 7$	$\left(\frac{17\ 5}{6}\right)^2 = 4$
6–7	$\frac{5+8\times4+29}{6} = 11$	$\left(\frac{29-1}{6}\right)^2 = 16$
5–8	$\frac{3+3\times4+9}{6} = 4$	$\left(\frac{9-3}{6}\right)^2 = 1$
7-8	$\frac{8+4\times17+32}{6} = 18$	$\left(\frac{32-8}{6}\right)^2 = 16$

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A graphical description of the above Table 3.8 is shown in Figure 3.13.

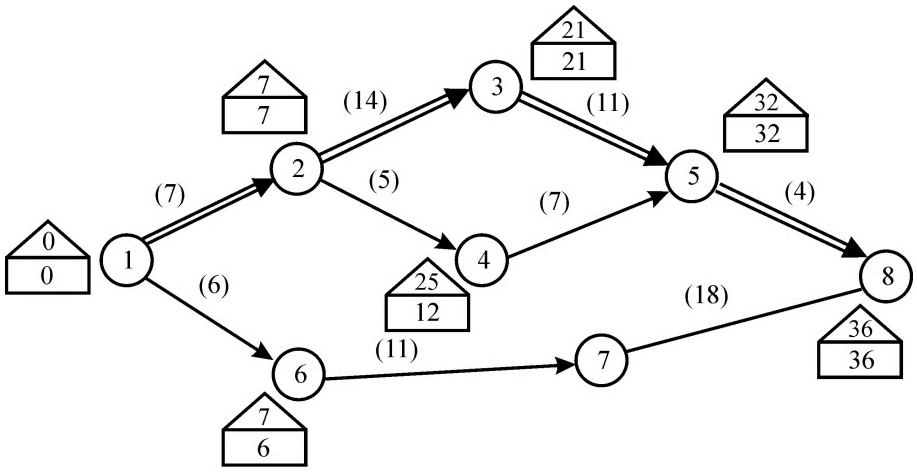

Fig. 3.13 *Expected Time and Standard Deviation*

From the above calculation and Figure, we can conclude the expected project duration as that of 36 days and the critical path can be determined as 1–2–3–5–8.

Project length variance is

$$\sigma = 4 + 16 + 4 + 1$$
$$= 25$$
$$\sigma = 5$$

Probability that the project will be completed within 40 days is given by:

$$P(Z \le D)$$
$$D = \frac{T_s - T_e}{s} = \frac{40 - 36}{5} = \frac{4}{5} = 0.8$$

Area under the normal curve for $\Delta = 0.8$

$$P(Z \le 0.8)$$
$$= 0.5 + \phi(0.8) \left[\phi(8) = 0.2881 \text{ (from table)}\right]$$
$$= 0.5 + 0.2881$$
$$= 0.7881$$
$$= 78.81\%$$

If the project is performed 100 times under the same conditions, there will be 78.81 occasions for this job to be completed in 40 days.

Assuming that the expected times are normally distributed, find the probability of meeting the schedule date as given for the network. Table 3.9 shows the necessary data for calculation.

Table 3.9 *Activity Times*

Activity	***Days***		
(i–j) a	***Optimistic A***	***Most likely M***	***Pessimistic b***
1–2	2	5	14
1–3	9	12	15
2–4	5	14	17
3–4	2	5	12
4–5	6	6	12
3–5	8	17	20

The scheduled project completion date is 30 days. Find the date on which the project manager can complete the project with a probability of 0.90. The expected time t_e and variance for each activity is calculated in the following Table 3.10.

Table 3.10 *Expected Time and Variance*

Activity	$t_e = (a + 4_m + b) / 6$	$\sigma^2 = (b - a / \sigma)^2$
1–2	6	4
1–3	12	1
2–4	13	4
3–4	5	1
3–5	16	4
4–5	7	1

To determine the critical path, the earliest expected time and the latest allowable time, it is required to draw the project network. Figure 3.14 shows the relevant network.

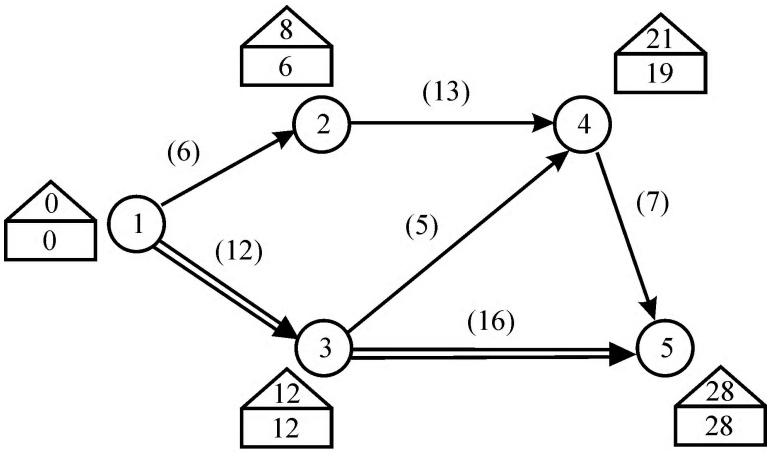

Fig. 3.14 *Project Network*

The critical path is given by 1–3–5 and the project duration is 28 days. Project length variance: $\sigma^2 = 1 + 4 = 5$

Standard deviation: $\sigma^2 = 2.236$.

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The probability of completing the project within 30 days is given by:

$$P\ (Z \le D) \text{ where, } D = \frac{T_s - T_e}{\sigma} = \frac{30 - 28}{2 - 236} = 0.8944$$

$$P\ (Z \le 0.8944) = 0.5 + 08944$$
$$= 0.8133$$
$$= 81.33\%$$

If the project is performed 100 times under the same conditions, then there will be 81.33 occasions for this job to be completed in 30 days.

If the probability for the completion of the project is 0.90, then the corresponding value of $Z = 1.29$.

$$Z = \frac{T_s - T_e}{S.D} = 1.29$$

$$\text{that is, } \frac{T_s - 28}{2\ .236} = 1.29$$

$$\text{Therefore, } T_s = (1.29)\ (2.236) + 28$$

$$T_s = 30.88 \text{ weeks}$$

3.7 INVESTMENT DECISIONS: MANAGEMENT, APPROVAL AND SANCTIONING

The scale and complexity of the project should be reflected in its management structure and information system. Unless it already exists (e.g. for ongoing capital programmes) the management structure should always be identified and established once approval in principle has been obtained. In some cases, it may be possible to outline the proposed structure, filling some of the roles immediately and leaving others to be filled later on, as appropriate. However, the senior decision-makers for the project, and the senior managers should all be identified clearly at the outset, and their involvement and relative role clearly agreed. Three issues should be carefully considered. These are:

- What kind of management structure would be suitable for the project?
- Who is to be accountable for what aspects of the project?
- What kind of reporting systems should be installed?

The management of the project should usually be organized along the following lines:

1. Sanctioning Authority

The Sanctioning Authority (Government, Department, Local Authority, etc.) is responsible for conveying approval to a project, within specified cost, to specified standards and time limits, etc.

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2. Sponsoring Agency

The Sponsoring agency has overall responsibility for the proper management of the project, including its detailed planning; for obtaining necessary approvals from the Sanctioning Authority and for ensuring that the project proceeds along the lines approved by the Sanctioning Authority. Usually, the Sponsoring Agency is the body with whom the contractor(s)/supplier(s) will have a legal commitment.

3. Steering Group

A Steering Group has the responsibility for overseeing the execution of the project. A Steering Group will usually be required on a complex and large scale project and particularly where a number of bodies are interested or involved in the project. It should usually be chaired by a representative of the Sponsoring Agency. The group should include appropriate professional staff e.g. architect/engineer/quantity surveyor. The Group may include a representative from the Sanctioning Authority and/or the Department of Public Expenditure and Reform.

4. Project Coordinator

The Project Coordinator is the person who is responsible for the execution, on time to the requisite quality and within budget, of the decisions taken by the Steering Group, or by the Sponsoring Agency in the absence of a Steering Group (where the project is small). For very large projects it may be necessary to appoint a professional firm to take on the task of actually managing the project. It would report to the Project Coordinator (who in turn would report to the Steering Group, and/or Sponsoring Agency, as appropriate) and it would be responsible for ensuring that the project came in on time and within cost.

5. Design Team Leader

A Design Team Leader should normally be appointed for every project with more than one technical consultant. The Design Team Leader would report to the Project Coordinator or, where a project management firm had been appointed, to that firm.

When plans and designs have been finalised, the project proposal should be reviewed, taking into account any major changes in relevant circumstances and the more precise information generated by the design process. In particular, if the expected total cost of the project has increased, then the project should be re-examined and reductions achieved without lowering the quality standard of the project below acceptable levels, in order to bring the project within the approved limit. Works should not be omitted so as to achieve reductions if they will have to be reintroduced later as being essential for the completion of the project, or for the generation of its full benefits, or if they significantly change the nature of the project. The Sanctioning Authority should be notified of any significant changes.

The pre-tender review is necessary to provide the information required by the Sponsoring Agency and the Sanctioning Authority to decide whether or not to approve the project and to allow it to proceed to Request for Tender.

Check Your Progress

10. State the objective of PERT chart.
11. What is optimistic time estimate?
12. Why is pre-tender review necessary?

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3.8 SUMMING UP

- The actual idea of time needed for completing an activity and interdependence of a given activity with other activities and cost of activities becomes clear only after the engineering design and the erection plan is prepared.
- A budget offer has to work in close coordination with the technical staff who prepare project network and with the procurement officers.
- The network diagram drawn based on the work breakdown structure and the critical path identified on it, both are based on ideal condition of abundance of resources. The network plan is a time schedule and not the resource utilization plan. The resources requirement determined by the ideal network plan is called resource loading with reference to time.
- Clarity of goals and objectives are prerequisites for organizational effectiveness.
- A firm would require a right type of organization structure for the construction of a project.
- The various types of organization are— Functional organization, divisionalized organization, Projectized organization, matrix organization and task force organization.
- Two basic decisions are important before the network techniques are deployed: one, whether to have multi-level scheduling and two, whether to have multi-project scheduling.
- A firm may avoid difficulties of multi-project scheduling by scheduling each project independently but the costs and other potential conflicts in this approach may not be worth taking the risk.
- A good schedule helps project managers establish achievable and realistic goals in order to fulfil project objectives, improve credibility, and manage the expectations of clients better.
- A work breakdown structure (WBS), in project management and systems engineering, is a deliverable oriented decomposition of a project into smaller components. It defines and groups a project's discrete work elements in a way that helps organize and define the total work scope of the project.
- The CPM is the graphical representation of the interrelationships between the tasks in a project to be performed in a well-defined sequence.
- The basic objective of the CPM is to determine which time-cost trade-offs should be used for each activity so as to achieve the maximum or scheduled speed project at the minimum total direct cost.
- The PERT was created to handle such projects where the time estimate of activities is non-deterministic. It was developed by a Navy sponsored research team of Messrs D.G. Malcolm in 1950. The PERT is used to organize and coordinate tasks within the project.
- The objective of the PERT chart is to determine critical path which comprises critical activities that should be completed on schedule. This chart is prepared with the help of information generated in project planning activities such as estimation of effort, selection of suitable process model for software development and decomposition of tasks into subtasks.

- The PERT is a technique where the activity times are represented by a probability distribution. This probability distribution is based upon three different time estimates made for each activity.
- The sanctioning authority is responsible for conveying approval to a project, within specified cost, to specified standards and time limits.

3.9 KEY TERMS

- **Resource loading**: The resources requirement determined by the ideal network plan is called resource loading with reference to time.
- **Resource smoothing**: By adjusting the project schedule (network plan) through the use of slack (early start and late start of non-critical activities) it may be possible to make efficient use of the resource. This is called resource smoothing.
- **Multi-level scheduling**: When schedules are prepared at multiple levels, it is called multi-level scheduling.
- **Multi-project scheduling**: In multi-project scheduling, all projects are collectively treated as a single project for the breakdown of work packages, their sequencing and resource allocation.

3.10 ANSWERS TO 'CHECK YOUR PROGRESS'

1. Erection plan is a step-by-step process of putting all pieces together with the stages of testing and experimentations.
2. Project budget has two components in it, cost and cash flow.
3. The resources requirement determined by the ideal network plan is called resource loading with reference to time.
4. Investment schemes have been classified as 'major schemes' and 'minor schemes'. The other two classifications, namely 'equipment and furniture scheme' and 'repair and maintenance scheme' are delegated to the discretion of the concerned department.
5. The various types of organization are— Functional organization, divisionalized organization, Projectized organization, matrix organization and task force organization.
6. When schedules are prepared at multiple levels, it is called multi-level scheduling.
7. Gantt chart is a type of bar chart that illustrates a project schedule. Gantt charts illustrate the start and finish dates of terminal elements and summary elements of a project.
8. A work breakdown structure (WBS), in project management and systems engineering, is a deliverable oriented decomposition of a project into smaller components. It defines and groups a project's discrete work elements in a way that helps organize and define the total work scope of the project.
9. The basic objective of the CPM is to determine which time-cost trade-offs should be used for each activity so as to achieve the maximum or scheduled speed project at the minimum total direct cost.

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10. The objective of the PERT chart is to determine critical path which comprises critical activities that should be completed on schedule.
11. Optimistic time estimate refers to the time estimate of an activity when everything is assumed to go well as per the plan. It is the estimate of the minimum possible time which an activity takes to complete under ideal conditions and is denoted by t_0 or a.
12. Pre-tender review is necessary to provide the information required by the sponsoring agency and the sanctioning authority to decide whether or not to approve the project.

3.11 QUESTIONS AND EXERCISES

Short-Answer Questions

1. Mention the objectives of an organizational system.
2. Distinguish between projectized and task force organization.
3. Discuss the advantages of CPM.
4. Mention the advantages of using the PERT analysis.
5. What do you mean by 'most likely time estimate'?

Long-Answer Questions

1. Explain Bell curve and S-curve with the help of diagrams.
2. Discuss the various types of organization with the help of diagrams.
3. 'Two basic decisions are important before the network techniques are deployed'. Discuss.
4. Discuss the concept of CPM in detail.
5. Explain the concept of PERT analysis with the help of PERT chart.

3.12 REFERENCES AND SUGGESTED READINGS

Chandra, Prasanna. 1995. *Projects: Planning, Analysis, Selection, Implementation, and Review.* Delhi: Tata McGraw-Hill.

Kerzner, Harold, R. 2013. *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*. New Jersey: John Wiley and Sons.

Singh, Narendra. 2000. *Project Management and Control*. Delhi: Himalaya Publishing House.

UNIT 4 IMPLEMENTATION AND CONTROL

NOTES

Structure

4.0 INTRODUCTION

The purpose of implementation and control is to give a standard strategy to the process of project management and universal measures for preparation, supervision, control and accounting for the advancement of the project. The procedure directs the project throughout the development process to project conclusion and delivery.

The procedure will make certain that the controls listed as follows, are in place:

- Minimum norms for reporting project performance
- Determined and accepted instructions, cost plan and agenda, corresponding to which, change can be assessed
- Tracking of likely transformations and disparities
- Controlling actual variations to ensure least bearing on the project deliverables

This practice should be taken up simultaneously with the following project procedures:

- Planning management
- Project management
- Evaluation and approval

4.1 OBJECTIVES

After going through this unit, you will be able to:

- Explain the salient features of a project management information system
- Describe the monitoring and reporting of physical and human resources

- Discuss the role of financial resources in implementation and control of projects
- List ways of reducing costs pertaining to projects

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4.2 PROJECT MANAGEMENT INFORMATION SYSTEM

Information technology has made project management easy and also challenging. Effective use of information technology in project management can reduce cost, improve communication and coordination, help in timely completion, help in resource planning and allocation, facilitate monitoring and control, and provide opportunity for fast responses to deviations. Information technology is the combination of (a) computer hardware and software, (b) Internet services, (c) other tools such as artificial intelligence and neural network.

Computers and Project Management

The use of information technology was never so important before because today's project management environment is quite complicated with features such as the following:

- A project is carried out at multiple sites.
- The size of project is usually large.
- A firm simultaneously undertakes many projects, which share resources.
- Multiple agencies are involved in project construction.
- Fast pace of activities.
- Intense competition puts pressure on completion in time and budget.

Project Planning Software

With computers becoming smaller in size but bigger in capabilities, an explosive growth was observed in project management software during the 1990s. More than 500 project management software were developed in this period. The different types of project management software are capable of handling multi-project situations with several features for planning, resource levelling, multi-level reporting, cost analysis, integration with word-processor, e-mailing, spreadsheet, database, graphics and even world-wide sharing of project information and multi-party intervention with the project management system.

Popular project management packages are MS Project, Intellisys Project, Open Mind, Project Kick Start, INSTAPLAN, PRISM and many others. The following website reviews project management software and ranks them:

http://project-management-software-review.toptenreviews.com/

Ranking is done based on several features and criteria including collaborations, resource management, project management, remote capability, help/support and system requirements. The project management feature is further divided into several aspects of project management. A print screen view of the comparison of the major project management software is given in Figure 4.1.

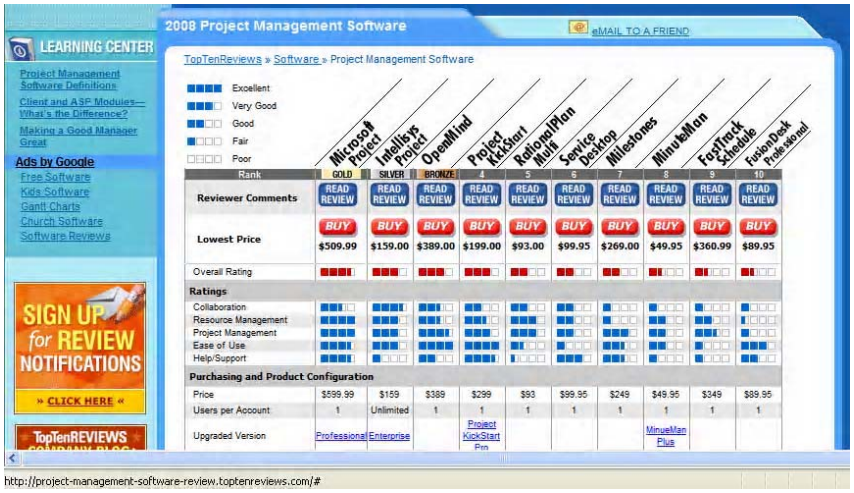

Fig. 4.1 *Ranking of Project Management Software, 2008*

These software programs are capable of handling multiple projects with a great degree of dynamism. However, much depends on the quality of initial data input in it. Software can do difficult math and logic work and prepare network along with resource planning, but its effectiveness is surely dependent on data input and the users of the output.

Management Information System (MIS) for Project Control

Goals of project review are achieved through the measurement of actual progress of project construction and comparison with the original plan. A well-designed management information system is needed for doing this job. Every firm is likely to have some formal and informal management information systems for its business operations. The same management information system cannot be relied upon for the project management, because the information system issues in project management are completely different. Project activities are different from the routine operating activities, procedures are different, locations of activities are different, priorities are different, stakes are high, need for quick corrective steps is strong; these and many other factors make essential to have a specially designed management information system for project management.

The management information system for a project would initially serve the purpose of project monitoring and control and also the purpose of project reviews.

4.3 MONITORING AND REPORTING HUMAN AND PHYSICAL RESOURCES

4.3.1 Human Resources

Human resources are significant for effectual monitoring and assessment, even after acquiring sufficient financial resources. For high-quality monitoring and reporting, there should be:

- **Committed staff time**

For the purpose of efficient monitoring and reporting, staff should be devoted to one function. The practices of employment of staff for monitoring differ among organizations.

Check Your Progress

1. What are the benefits of effective use of information technology in project management?
2. What does information technology combine?

A few of the companies have set up monitoring and reporting divisions with certain terms of references (ToRs), committed and trained staff, work schedules and other resources.

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- **Skilled workforce**

Staff delegated with monitoring should have the required technical skills in the domain. A number of offices have a special monitoring and control specialist. Where required, skill levels should be improved to fulfill requirements with continuing efforts in building such capacity within the office as needed.

Every monitoring and control entity that works at various levels, for instance at the project, programme or output level, should have clarity on the ToR specifying its task and responsibilities. Generally, these tasks should involve:

- Establishing an organized supervisory scaffold and coming up with an evaluation plan
- Having timely meetings with the concerned partners and stakeholders to report the progress in the direction of achieving results
- Carrying out combined field monitoring and assessment assignments to review accomplishments and limitations
- Classify any lessons or good practices
- Identification of further capacity growth needs among stakeholders and associates
- Reporting on a periodic basis to the lead members or groups for the key result areas and exploring opportunities to inspire policy and decision-making processes
- Ensuring the quality of monitoring and reporting work and offering support as required
- Monitoring and reporting the importance of the monitoring structure on a regular basis, according to the rising development precedence and transforming perspective

4.3.2 Physical Resources

Physical resources can be explained as the assets that are made by man by means of his abilities and expertise. Technology and structures in addition to the many products that are made by man are all instances of physical resources.

Physical resources pertaining to a project generally include the following:

- Personnel
- Facilities
- Equipment
- Suppliers
- Contracts
- Travel

Let us discuss a few of these.

- **Personnel**

The most interesting, variable and costly resource a project manager is likely to work with are people. People and their exchanges can significantly impact both, the success and failure of any project. For managing people there has to be a remarkable a human

resource plan for a project in place and it should be decided as to how personnel and interpersonal relationships in an organizational set up can be better comprehended.

Initially, the more direct way is to systematize the people who would be part of the project. This has to be preceded by creating a role and responsibility matrix for the project charter. An *organizational chart* of a *project should* not be very different from a normal organizational chart. This document should clearly specify the reporting hierarchy, on the basis of the role and responsibilities of every individual within the project. The project manager should be at the top of the project organization chart and hold the final accountability and answerability for the success of the project.

- **Equipment**

The equipment that falls within the scope of the management of a project, as a constituent of the project is based on the nature of the project. For instance, a project to build a cold-storage food warehouse would require earth moving equipment, cranes and cement-mixers. In the case of a project to launch a new edition of a computer game, the equipment would comprise computers, test gear and replication and packaging machines. The project management input for equipment is similar to that of human resources. One has to ensure that the right equipment is in the right place, at the right time and that it has the provisions required for proper functioning.

Majority of the projects involve the purchase of material. In the case of a cold-storage food warehouse, this would be deep-freezers, the building HVAC machinery and the material management equipment. If the project is about launching a music DVD by a popular artist, it would involve blank DVDs, graphics designer equipment for the jewel case and press releases to be communicated to deejays. The project management predicament with provisions is to ensure that the right materials are available as and when required.

Every skill that goes in management of resources will be of no use, if the project schedule is not adhered to. Time management is also a crucial factor in successful project management.

- **Suppliers**

Project management also requires the use suppliers to help facilitate the delivery of projects. However, managing supplier performance can be a difficult task at the best of times. A project management function is also to ensure that a supplier delivers the right goods, on time and of the right quality. Three steps to manage suppliers are as follows:

For efficient management of suppliers, one needs to have a procurement management process in place. Procurement management is the practice of managing the supplier's supply of a scope of work within a project. By organizing the scope of work provided by suppliers from the output of the project management templates and project management software, a project manager is able to:

- o Ascertain that the delivery of suppliers is according to the contract
- o Categorize and work out supplier issues rapidly and effortlessly
- o Get the best performance out of supplier associations

- **Contracts**

In general, the type of the contract used for a project differs according to the type of the work and industry. A contract is simply a detailed agreement between two or more parties. One or more parties may supply goods or services in exchange for something supplied by other party/parties.

The type of contract between the parties involved in the project and the contract type defines the risk involved. Let us see the most popularly used contract types.

(i) Fixed price (lump sum)

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This is the most straightforward type among contracts. The terms are quite simple and clear to understand. In other words, the service provider commits the provision of a specified service for a certain time period and the client agrees to pay a definite amount of money for the provided service. This contract type may mark out various landmarks for the release as well as KPIs (Key Performance Indicators). Also, the contractor might have an approval standard defined for the target and the ultimate delivery. The major advantage of this type of contract is that the contractor is aware of the entire project cost prior to commencement of the project.

(ii) Unit price

In this contract, the project is segregated into units and the cost of every unit is done independently. This contract type can be launched as one of the more accommodating methods when compared against fixed price contract. In general, the owner (contractor/ client) of the project has the final say on the estimation. This is a good practice in the case of different project units requiring a variety of skills to complete.

(iii) Cost plus

In this contract model, the service providers are compensated for their equipment, workforce and associated costs, along with the contractor paying a contracted fee to the service provider. In this type of contract, the service provider should offer an elaborate schedule and resource allocation for the project. In addition to this, all costs should be systematically enumerated and reported to the contractor at regular intervals. The contractor may be paid after specific durations (such as monthly, quarterly) or at the end of the delivery of specific modules.

(iv) Incentive

Incentive contracts are typically used when there is a certain level of vagueness in the project cost. Even though there are almost precise assessments, the technological challenges may affect the resources in general in addition to the effort. This category of contract is widespread for the projects consisting of pilot programs or projects that employ new technologies. The core mechanism of incentive contract is to break up any target price overrun between the client and the service provider for the purpose of reducing the business risks for both parties.

(v) Retainer (Time and Material - T&M)

This is one of the most ideal contracts that can bind two or more parties. This contract type bears the least amount of risk, in which the time and material used for the project are priced. The contractor only needs to be aware of the time and material for the project, for the purpose of making payments. This type of contract has brief delivery phases and for every cycle, individual quotes are sent. After the contractor accepts and approves the estimate and Statement of Work (SOW), the service provider can begin the project. Different from majority of the other contract types, retainer contracts are largely employed in long-term business engagements.

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(vi) Percentage of Construction Fee

These types of contracts are used for engineering projects. On the basis of the resources and material needed, the cost for the construction is worked upon. Following this, the client signs an agreement with a service provider and pays a percentage of the cost of the project in the form of the fee for the service provider.

In managing a project team, a project manager needs to possess excellent analytical and organizational skills. A technical proficiency in the specialist area of the project is also a distinct advantage. Remember, though, that projects achieve their outcomes through people—a variety of people working together in a coordinated way to produce the desired results.

Effective teams are so much more productive than groups working on the same task because they are able to leverage off each others' strengths and compensate for each others' weaknesses. Making sure that we have the right mix of team members in our project team is therefore an important consideration. Conducting a team profiling exercise is also an effective method for getting each project team member to appreciate their respective strengths and weaknesses.

4.4 FINANCIAL RESOURCES

Ownership funds and debt funds are the two main classifications of sources of funds. Ownership securities are, as the name suggests to be used for funds by owners of businesses at the time of need. Some securities are of hybrid type with some features of ownership securities and some features of debt securities. An owner of ownership securities enjoys ownership rights; whereas an owner of debt security enjoys the rights as a lender but an owner of a hybrid security enjoys mix of rights depending upon the terms and conditions.

One can include subsidy and tax incentives as sources of funds. These sources are available in a limited way, subject to qualification of projects and businesses. Usually, small entrepreneurs and export oriented units qualify for subsidy on their qualified investments. Tax incentives are also available to desired investments made by any firm.

4.4.1 Types of Ownership Securities

For non-corporate (sole-proprietorship and partnership) businesses there is a single type of ownership security available and that is the owners' capital. Owners (sole-proprietor or partners) bring capital and enjoy the rights to participate in managing business (depending upon agreement) and the right to share profit or loss (usually in the proportion of every partner's share in capital). Therefore, the following material on the types of ownership security is more appropriate for corporate form of business.

1. Common or equity shares

In case of a company, total ownership fund is called a 'stock' and it is divided into smaller units called 'shares' or 'common shares'. This allows a company to obtain funds from several owners, who are called 'shareholders' or 'members'. However, a private company can issue shares only privately through friends and relatives but a public company can issue shares to the public. The salient rights and obligations of equity shareholders are listed as follows:

Check Your Progress

3. Define the term physical resources.
4. What do physical resources pertaining to a project generally include?

- Shareholders have dividend rights but getting it is uncertain depending upon the profits of the company and decision of the company to distribute profits as dividends.
- Shareholders enjoy the right to vote on matters defined by the Companies Act, which includes right to elect their representatives on the board of directors. Right to vote can be exercised in person or via proxy.
- Shareholders have preemptive right which means a right to get allotment of new issue of shares.
- Shareholders have residual right on surplus funds in the event of liquidation of the company.
- Shareholders have the right to transfer shares, albeit with restrictions if the shares are in a private company.
- Shareholders' liability for the debt of the company is limited to the par value of shares held by them.

A firm has to pay tax on its profit and when the profit is distributed as dividends, the firm again pays dividend distribution tax, subject to law and the shareholders also pay personal income tax on dividend income.

Equity shares give permanent funds to the business and put no pressure on the liquidity of the firm because dividends are payable only if profit is earned and capital is never repayable. However, equity shares have other implications too. It is usually more costly than debt funds and after the successful project, if the firm does not grow enough or does not adjust the dividends policy, it can sit on a large cash balance. Demoralized shareholders' action of selling shares can create a situation where someone can takeover the firm.

Retained earnings also are a source of equity capital. Most firms distribute only a part of the profit and retain the rest. This is internal financing of capital. Retained earnings are a part of equity capital, because it belongs to the shareholders.

2. Types of common shares

Firms issue different types of common shares (so, common shares are not common anymore). In India, the first time a different type of common share issue was opened at the end of September 2008 by Tata Motors. Accordingly to Tata Motor's announcement, they will issue two types of shares on preemptive right basis; one at ₹ 340 on one-vote-one-share basis and another at ₹ 305 with lower voting right (one-tenth vote per share) and 5 per cent extra dividends. This creates two categories or types of common shares.

In the West, some types of common shares are entitled to dividends from a particular stream of income stream. Similarly, other varieties or types of common stock are found.

The suppliers of common share capital are promoters, friends and relatives (sometimes termed as 'love money'), general public, venture capitalists, angel capitalists and charitable venture capitalists. Some of the sources are described in the following:

4.4.2 Venture Capitalists

Usually, start-up businesses with new ideas (like information technology businesses and bio-technology businesses are the current examples) are risky and therefore, it is unlikely that regular suppliers of funds will fund such projects. Such ventures may be potentially quite profitable but very risky. Some investors (usually wealthy individuals, investment

banks and other financial institutions) see an opportunity here. They pool their own funds to form a venture capital fund with the purpose of finding and providing equity capital to such high potential growth firms. Venture capitalists also provide technical and managerial expertise and have a say in the firm's decisions. In the initial agreement, venture capitalist inserts an exit clause, which is via taking the firm public or sale of business. As per this clause, after a predetermined number of years, the new venture will 'go public' (means it will become a company and will make initial public offering of shares), or sell the firm and the venture capitalist walks out with his share from the proceeds.

The entrepreneur, while getting the much-needed funds and technical and managerial expertise, faces the risk of interference in the activities of business and more importantly the risk of losing ownership and control of business upon going public.

Angel capitalists

Angel investors are those who 'save struggling firms with both finance and know-how when no one else will' (Van Osnabrugge and Robinson, 2004). Historically, it was appropriate to say that angel investors were willing to accept more risk than venture capitalists. There is hardly any angel investing in India but in the West this is more common. Angel capitalists and venture capitalists are quite similar in nature except for risk taking. Angel funds can be considered for project investment as a part of turning around a sick business, where venture capitalist is not available.

4.4.3 Charitable Venture Capitalists

Charitable venture capitalists are not present in the Indian market, but the West has adopted this mechanism for regional growth. These are venture capitalists with a charitable purpose, which fund the early-stage high potential small businesses. This kind of venture capitalists are established privately as non-profit organizations with the support of operating funds from the government (like state governments and municipal corporations) and funds worth investing are provided by charitable organizations and foundations. Operating funds are used for the operating expenses of the fund and investible funds are used for financing different ventures in the region.

Charitable venture capitalists operate exactly like venture capitalists but have a broader list of businesses that they support (usually ones that are likely to result into a positive regional growth in terms of employment and tax revenue). Charitable venture capitalists do make profit but reinvest the same for further investment purposes. Those who are interested to learn about such funding organizations may have a look at example from the US. There is scope for such organizations in different regions of India also.

4.4.4 Preference Shares

Preference shares are also ownership shares but with a difference. Preference shareholders enjoy preferential rights over the rights of equity shareholders. They have a right to get dividends (subject to an upper limit specified in the issue document) before any dividend is paid to the equity shareholders. They also have a right to get their money back before anything is paid back to the equity shareholders in the event of winding up of the business and if there is a surplus of proceeds after paying all the liabilities of the company. In exchange of these two important rights (which protect their monetary interest to some extent), the preference shareholders forgo their voting rights on issues that are not concerning the preference shares directly. However, continuous non-payment

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of dividends will restore their voting right. Preference shares and their types under the heading 'hybrid securities' have been discussed because preference shares have a mix of characteristics of equity shares and bonds.

Deferred shares

Deferred shares are the type of ownership security that offers a more proportionate right of voting. The owner of one deferred share can have more than one vote, depending upon the terms of issue. In exchange for these extraordinary voting rights, the deferred shareholders' right to get dividend is deferred until a specified amount of dividend is paid to the equity shareholders. As a result of these disproportionate voting rights and deferred dividend rights, the owners of deferred shares can have a control over the management of the company with less investment. Also, they stand a chance of earning windfall dividend income if the company makes extraordinary profits.

Deferred shares were innovated for promoters of businesses. Promoters have ideas and willingness to take risk but may not have enough money to preserve the controlling interest in the company promoted by them. By way of buying deferred shares, promoters can get controlling interest in the company with little investment. However, deferred shares are not allowed anymore.

Implications of deferred share capital on the firm's cost of funds, liquidity and future growth options are the same as that of equity shares.

4.4.5 Subsidy and Tax Incentives

The central government and state governments offer incentives for investment through subsidies, tax incentives and concessions in land and utility prices. Schemes vary from state to state. Usually, subsidy and tax incentives are offered for encouraging small entrepreneurs, women entrepreneurs and for encouraging investment in desired locations and businesses.

For example, the central government developed a scheme for capital investment subsidy in 1997 for units in 'growth centres' for the north eastern region and other areas. The central government announces subsidy plans for different regions from time to time. One needs to read the current industrial policy of the Government of India, with special attention to learning about the applicable subsidy based on the classification of the zone in which business is set up.

Many states, through the state finance corporations or state industrial development corporations provide subsidy to small scale industries (SSIs) for investment in plant and machinery and provide industrial land, sheds, water and electricity at preferential rates.

Subsidy is shown as capital and is tax-free.

The Government had approved a package of fiscal incentives and other concessions for the North East Region namely the '**North East Industrial and Investment Promotion Policy (NEIIPP), 2007'**, which envisaged the following:

(i) Coverage

The North East Industrial Policy (NEIP), 1997 announced on 24.12.1997 covered the States of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. Under NEIIPP, 2007, Sikkim will also be included. Consequently, the 'New Industrial Policy and other concessions for the State of Sikkim' announced vide O.M. No.14(2)/2002-SPS dated 23.12.2002 and the Schemes thereunder i.e. Central Capital

Investment Subsidy Scheme, 2002, Central Interest Subsidy Scheme, 2002 and Central Comprehensive Insurance Scheme, 2002, notified vide Notifications No. F.No.14(2)/ 2002-SPS dated the 24.12.2002 will be discontinued from 1.4.2007.

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(ii) Duration

All new units as well as existing units which go in for substantial expansion, unless otherwise specified and which commence commercial production within the 10 year period from the date of notification of NEIIPP, 2007 will be eligible for incentives for a period of ten years from the date of commencement of commercial production.

(iii) Neutrality of location

Incentives will be available to all industrial units, new as well as existing units on their substantial expansion, located anywhere in the North Eastern Region. Consequently, the distinction between 'thrust' and 'non-thrust' industries made in NEIP, 1997 will be discontinued from 1.4.2007.

(iv) Substantial Expansion

Incentives on substantial expansion will be given to units effecting 'an increase by not less than 25% in the value of fixed capital investment in plant and machinery for the purpose of expansion of capacity/modernization and diversification', as against an increase by 33½ % which was prescribed in NEIP, 1997.

(v) Excise Duty Exemption

100% Excise Duty exemption will be continued, on finished products made in the North Eastern Region, as was available under NEIP, 1997. However, in cases, where the CENVAT paid on the raw materials and intermediate products going into the production of finished products (other than the products which are otherwise exempt or subject to nil rate of duty) is higher than the excise duties payable on the finished products, ways and means to refund such overflow of CENVAT credit will be separately notified by the Ministry of Finance.

(vi) Income Tax Exemption

100% Income Tax exemption will continue under NEIIPP, 2007 as was available under NEIP, 1997.

(vii) Capital Investment Subsidy

Capital Investment Subsidy will be enhanced from 15% of the investment in plant and machinery to 30% and the limit for automatic approval of subsidy at this rate will be ₹1.5 crores per unit, as against ₹30 lakhs as was available under NEIP, 1997. Such subsidy will be applicable to units in the private sector, joint sector, cooperative sector as well as the units set up by the State Governments of the North Eastern Region. For grant of Capital Investment Subsidy higher than ₹1.5 crore but upto a maximum of ₹30 crores, there will be an Empowered Committee Chaired by Secretary, Department of Industrial Policy & Promotion with Secretaries of Department of Development of North Eastern Region (DONER), Expenditure, Representative of Planning Commission and Secretary of the concerned Ministries of the Government of India dealing with the subject matter of that industry as its members as also the concerned Chief Secretary/ Secretary (Industry) of the North Eastern State where the claiming unit is to be located.

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Proposals which are eligible for a subsidy higher than ₹30 crores, will be placed by Department of Industrial Policy and Promotion before the Union Cabinet for its consideration and approval.

(viii) Interest Subsidy

Interest Subsidy will be made available @ 3% on working capital loan under NEIIPP, 2007 as was available under NEIP, 1997.

(ix) Comprehensive Insurance

New industrial units as well as the existing units on their substantial expansion will be eligible for reimbursement of 100% insurance premium.

(x) Negative List

The following industries will not be eligible for benefits under NEIIPP, 2007:-

- All goods falling under Chapter 24 of the First Schedule to the Central Excise Tariff Act, 1985 (5 of 1986) which pertains to tobacco and manufactured tobacco substitutes.
- Pan Masala as covered under Chapter 21 of the First Schedule to the Central Excise Tariff Act, 1985 (5 of 1986).
- Plastic carry bags of less than 20 microns as specified by Ministry of Environment and Forests Notification No.S.O. 705(E) dated 02.09.1999 and S.O.698 (E) dated 17.6.2003.
- Goods falling under Chapter 27 of the First Schedule to the Central Excise tariff Act, 1985 (5 of 1986) produced by petroleum oil or gas refineries.

(xi) Incentives for Service/other Sector Industries Incentives under NEIIPP, 2007 will be applicable to the following service sector activities/industries:

I. Service Sector

- Hotels (not below Two Star category), adventure and leisure sports including ropeways
- Medical and health services in the nature of nursing homes with a minimum capacity of 25 beds and old-age homes
- Vocational training institutes such as institutes for hotel management, catering and food crafts, entrepreneurship development, nursing and para-medical, civil aviation related training, fashion, design and industrial training.

A number of tax concessions under the existing provisions of Section 10A and 10AA of the Income Tax Act are already available to the IT sector. However, one of the important impediments to the development of Software Technology Parks or IT related SEZs in the North Eastern Region is the non-availability of trained human resources in the North Eastern Region. Accordingly, tax benefits as is availed under Section 80 IC of the Income Tax Act would be extended to IT related training centers and IT hardware units.

II. Incentives for Bio-technology industry

The biotechnology industry will be eligible for benefits under NEIIPP, 2007 as applicable to other industries.

III. Incentives for Power Generating Industries

Power Generating plants will continue to get incentives as governed by the provisions of Section 81A of the Income tax Act. In addition, power generating plants upto 10 MW based on both conventional and non-conventional sources will also be eligible for capital investment subsidy, interest subsidy and comprehensive insurance as applicable under NEIIPP, 2007.

(xii) Establishment of a monitoring mechanism for implementation of the NEIIPP, 2007

In order to establish a monitoring mechanism for implementation of NEIIPP, 2007, a 'High Level Committee' / an 'Advisory Committee' under the Chairmanship of Secretary, Department of Industrial Policy and Promotion and comprising Secretaries of the Ministries/Departments of Revenue, Department of Development of North Eastern Region (DONER), Banking and Insurance, Representative of Planning Commission, CMD, NEDFi as well as major stakeholders including the industry associations of the North Eastern region would be constituted. In addition, an 'Oversight Committee' will be constituted under the Chairmanship of the Union Commerce and Industry Minister with Industry Ministers of NE States as its members.

(xiii) Value Addition

In order to ensure genuine industrial activities in the North Eastern Region, benefits under NEIIPP, 2007 will not be admissible to goods in respect of which only peripheral activities like preservation during storage, cleaning operations, packing, re-packing, labelling or re-labelling, sorting, alteration of retail sale price etc. take place.

(xiv) Transport Subsidy Scheme

The Transport Subsidy Scheme would continue beyond 31.3.2007, on the same terms and conditions. However, an early evaluation of the scheme will be carried out with a view to introducing necessary safeguards to prevent possible leakages and misuse.

(xv) Nodal agency

1. The North East Industrial Development Finance Corporation (NEDFi) will continue to act as the nodal agency for disbursal of subsidies under NEIIPP, 2007.
2. The 'New Industrial Policy and other concession in the North Eastern Region' announced vide O.M. No.EA/1/2/96-IPD, dated 24.12.1997 (NEIP, 1997) will cease to operate with effect from 1.4.2007. Industrial Units which have commenced commercial production on or before 31.3.2007 will continue to get benefits/ incentives under NEIP, 1997.
3. Government reserves the right to modify any part of the Policy in public interest.
4. All concerned Ministries/Departments of the Government of India are requested to amend their respective Acts/rules/notifications etc. and issue necessary instructions for giving effect to these decisions.

4.4.6 Cost Control

Nearly every project has to be directed all the way through in order to get the necessary and expected yield at the completion of the project. It is the team that is accountable for the project and most prominently the project manager who is required to have the ability

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to execute effective management of the costs. There are, nevertheless, quite a few methods that can be used for this objective.

Besides the project goals that the project manager has to watch over, the management of a variety of costs is also a very significant task for any project. Project management would not be successful at all if a project manager does not succeed in this direction, as it would fundamentally establish whether or not a company would make a profit or loss.

Cost Control Approaches

A few of the important and indispensable techniques used for effective project cost control are as follows:

1. Planning the project budget

One would need to ideally formulate a budget at the start of the planning session with reference to the project at hand. This is the budget that would be helpful for all meeting all payments and costs that are incurred all through the project life cycle. Hence, the making of this budget involves a great deal of research and decisive judgment.

Similar to any other budget, adjustments would always have to be accounted, for as the costs would keep on undergoing changes all through the period of the project. Adhering to the project budget during all stages of the project can reap in profits from project.

2. Keeping track of costs

Keeping track of all actual expenditure is also as important as any other function. In terms of this, it is ideal to make a budget on the basis of time. This is helpful in keeping track of the budget of a project in every phase. The actual costs will have to be compared with the periodic targets that have been marked out within the budget. These targets could be based on months, or weeks or even years, if the duration of the project is lengthy.

This is much easier to work with instead of having one entire budget for the whole period of the project. In case of any new work to be carried out, it would have to be estimated and adjusted to find out whether it can be accommodated within the costs of the budget. If not, necessary arrangements would have to be made for 'Change Requests', where the client will pay for the additional work or the transformations.

3. Efficient time management

Another good technique would be efficient time management. Even though this technique is not applicable to a variety of management domains, its importance is very high with respect to project cost control. This is due to the cost of project that may increase if the project deadlines are not met; the more time the project takes, the more will be the costs incurred which in effect means that the budget will be exceeded. The project manager would need to continuously remind his/her team of the critical targets of the project for the purpose of ensuring that work is done on time.

4. Project change control

Project change control is also an important technique. Change control systems are necessary for taking into consideration any probable changes that might take place

through the course of the project. This is owing to the actuality that every alteration to the span of the project will have a bearing on the cut-off dates of the deliverables. Therefore the changes may raise project cost by increasing the effort required for the project.

5. Use of Earned Value

To find out the value of the work that has been done at a point of time, it is very helpful to use the accounting method generally referred to as 'Earned Value'. This is specifically helpful in the case of large projects and makes it possible to incorporate any quick changes that are extremely important for the project to be successful.

Additional Steps for Project Cost Control

It is a good practice to regularly evaluate the budget and the development and other financial details. Creating reports on project economics at standard intervals will also help keep up with the progress of the project. This will ascertain that reckless spending does not occur and if it does, it is rectified before time. The quicker the problem is spotted, the easier and faster it can be taken care of. All documentation should also be made available at regular periods of time to auditors, who would be able to point out to you any potential cost risks.

Simply coming up with a project budget is not sufficient during the project planning sessions. The project management team would have to keep a vigil on whether the costs stay closer to the figures in the first budget.

It always needs to be kept in mind that the risks are accompanied with cost increases and the necessity to prevent this in the best possible ways. To accomplish this, use of the discussed techniques should be accompanied with constant monitoring of the project costs.

4.5 SUMMING UP

- Information technology has made project management easy and also challenging.
- Information technology is the combination of
  - o Computer hardware and software
  - o Internet services
  - o Other tools such as artificial intelligence and neural network
- Today's project management environment is quite complicated with features such as the following:
  - o A project is carried out at multiple sites
  - o The size of project is usually large
  - o A firm simultaneously undertakes many projects, which share resources
  - o Multiple agencies are involved in project construction
  - o Fast pace of activities
  - o Intense competition puts pressure on completion in time and budget
- Different types of project management software are capable of handling multi-project situations with several features for planning, resource leveling, multi-level reporting, cost analysis, integration with word-processor, e-mailing, spreadsheet, database, graphics and even world-wide sharing of project information and multi-party intervention with the project management system.

Check Your Progress

5. What are the two main classifications of sources of funds?
6. Who are Angel investors?

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- The management information system for a project would initially serve the purpose of project monitoring and control and also the purpose of project reviews.
- Physical resources can be explained as the assets that are made by man by means of his abilities and expertise.
- Technology and structures in addition to the many products that are made by man are all instances of physical resources.
- Physical resources pertaining to a project generally include the following:
  - o Personnel
  - o Facilities
  - o Equipment
  - o Suppliers
  - o Contracts
  - o Travel
- Effective teams are so much more productive than groups working on the same task because they are able to leverage off each others' strengths and compensate for each others' weaknesses.
- Ownership funds and debt funds are the two main classifications of sources of funds.

4.6 KEY TERMS

- **Metronics:** An organization's attempt to help people in reatring full life.
- **Empowerment:** The process of giving power or authority to a team member, to take decisions.
- **Deferred shares:** The type of ownership security that offers a more proportionate right of voting.

4.7 ANSWERS TO 'CHECK YOUR PROGRESS'

1. Effective use of information technology in project management can reduce cost, improve communication and coordination, help in timely completion, help in resource planning and allocation, facilitate monitoring and control, and provide opportunity for fast responses to deviations.
2. Information technology is a combination of (i) computer hardware and software, (ii) Internet services, (iii) other tools such as artificial intelligence and neural network.
3. Physical resources can be explained as the assets that are made by man by means of his abilities and expertise.
4. Physical resources pertaining to a project generally include the following:
   (i) Personnel
   (ii) Facilities
   (iii) Equipment
   (iv) Suppliers
   (v) Contracts
   (vi) Travel

5. Ownership funds and debt funds are the two main classifications of sources of funds.
6. Angel investors are those who 'save struggling firms with both finance and know-how when no one else will'.

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4.8 QUESTIONS AND EXERCISES

Short-Answer Questions

1. What is the role of computers in project management?
2. What is the importance of a project's vision for the whole team?
3. What are the motivation factors for people in a work environment?

Long-Answer Questions

1. Explain the role of information technology in project management.
2. Discuss the role of financial resources in implementation and control of projects.
3. Describe the various ways of reducing costs pertaining to projects.

4.9 REFERENCES AND SUGGESTED READINGS

Chandra, Prasanna. 1995. *Projects: Planning, Analysis, Selection, Implementation, and Review.* Delhi: Tata McGraw-Hill.

Kerzner, Harold, R. 2013. *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*. New Jersey: John Wiley and Sons.

Singh, Narendra. 2000. *Project Management and Control*. Delhi: Himalaya Publishing House.

UNIT 5 PROJECT COMPLETION AND EVALUATION

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Structure

5.0 INTRODUCTION

This unit takes a look at a few characteristics of bringing an intricate project to completion. There are numerous factors to be taken into account in the closing stages of a project. It is necessary to ascertain that the targets of the project have been accomplished and that all the results and deliverables have been handed over to the client (or that any inconsistencies have been dealt with). Delivery can comprise a variety of presentations for different types of outputs. It is likely that a physical object may be part of the deliverables, but other deliverables may comprise, for instance, training the personnel for enabling use of new technology or processes. The manner in which the output is delivered is different for different projects. Whatever may be the case, there is an agreement to resolve any issues that come up at the time the control and responsibility is passed on to the owners of the project.

Completion of a project is usually followed by an evaluation (even though evaluations occur throughout the life of a project).

Different types of evaluations have roles to play in the management of a project. Evaluations have a cost attached to them. However, there are a variety of ways in which they can be guided and designed to be cost-effective. Evaluation provides us the ability to learn from studying what has happened and we look at topics like; management of transition for project to operation, project completion and termination, review, etc.

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Project evaluation translates as the systematic investigation of an object's importance or value. The technique is applicable to projects, programs and policies. At the project stage, evaluation entails processes like discussing a feasible evaluation plan with stakeholders; devising and setting up the evaluation; putting together, classifying and probing information and facts; validating the information and dispensing the results to explain or provide clarity about the project and/or to make project-affiliated decisions.

Evaluation is necessary to validate the value or merit of a project and to identify areas for improvement. It upholds suitable choices to select from, along with changes to the project's goal and approach. It is important to plan an evaluation with care. There is no single technique or one set of technique that is suitable for every type of project. The evaluation method, design and methodologies should agree with the particular project. The focus and aim of an evaluation varies according to the needs of stakeholders that may involve project developers, financing agencies, local government, cooperation, academic staff and students. Stakeholders must be consulted at the time of selecting the most optimum approach. When the best features and the drawbacks of a project are highlighted, evaluation gives rise to inferences that may impact potential decision-making. The results of evaluation reports, depending on exhaustive analysis, are indispensable contribution to the planning processes. Evaluation aids learning and upgrading through inclusion of suggestions into new projects, programs and plans.

5.1 OBJECTIVES

After going through this unit, you will be able to:

- Explain integrated project management control system
- Define the management of transition for project to operation
- Discuss the concepts of project completion, termination and evaluation
- Assess the importance of project review

5.2 INTEGRATED PROJECT MANAGEMENT CONTROL SYSTEM

An integrated project management control system consists of software tools for building of the project databases as well as the processes and procedures required to systematize and administer the project. The integrated project management control system is designed to assist the management in:

- Knowing the status of the project
- Drawing a comparative study of project status with respect to the threshold plan
- Executing and controlling the change process
- Track the Earned Value (EV) as and when required

The integrated approach to project planning and control is centralized and anticipative. Integrative means that every stage of the project and all the components of information listed above are connected with each other in a logical manner. Predictive implies that the system has the ability to foretell what will happen in the future, on the basis of existent plans and evaluations, with the tangible physical advancement and reported costs, continually updating the to-do list and cost threshold for the potential forecasts.

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Effectual use of the robust computer-aided integrated project planning and control systems that are in the market today calls for the use of a single integrated system (often consisting of project-oriented subsystems that are appropriately coupled collectively) for each and every project running in the organization to:

- Identify and methodically regulate the project's goals and range
- Validate and take initiative in the management of every project risk, simultaneously with the cumulative project portfolio risks
- Characterize and manage the specification, quality, pattern and quantity of transitional and ultimate products (or deliverables) of the project.
- Analytically determine and streamline the work to be executed with the help of the project/assignment itemization configuration (P/WBS) approach.
- Approximate the workforce, material and others costs related to the project's final products and associated work components and every summary element in the P/WBS.
- Plan and control the series and schedule of the project deliverables and interrelated work components with the help of a senior-level project master schedule in addition to a suitable configuration of schedules.
- Approve and take charge of the costs of funds and work hours needed to carry out the project.
- Supply the information pertaining to both;
  - o Actual development and costs and
  - o Futuristic predictions required by project managers, department heads, functional team leaders and work-package leaders on a regular and realistically accurate basis
- Consistently appraise advancement and envisage and alleviate issues with quality, outlay, plan and risk with the help of earned value project management techniques.
- Update the management and clients on the existent status and future stance of the project quality, cost and schedule conclusion, inclusive of post-completion reports.

5.3 MANAGING TRANSITION FOR PROJECT TO OPERATION

There have been instances where project teams have struggled in the process of supporting a newly installed application at the same time as running ensuing releases. There have been projects which have faced problems with project transition to operations. Enterprise projects and programs usually have quite a few releases to different countries and business units. Project teams encounter the threat of getting lost in the transition when the first delivery is not suitably transitioned to a process support model.

In this situation, the project team carries on working on the subsequent delivery while working hard on the production support role. The project team unproductively organizes operational actions with significant project releases. Due to lack of definite operational functions and tasks, project teams imperil future deliveries in addition to putting up with role uncertainty. There are several suggestions to stay away from getting lost in transition.

During a latest project, an IT organization was executing a new financial accounting package since six months with two releases in the pipeline. The initial release was executed in 1/3 of the organization and the next release was scoped for the rest of the

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company. The first delivery was a tough launch because the system encountered production support problems and the business partners were not at ease that the system was sufficiently durable to hold up to the remaining 2/3 of the organization. While the team neared the launch resolve for the second release, the business partners and the project team decided to delay the launch for a month.

The main cause was not the technical potential of the product or unresolved petty production support occurrences. At the time of the launch decision meeting, the business partners elevated apprehensions pertaining to the unsteadiness of the application and the absence of adequate operational aid. Following a deeper study, the instability was realized to be an opinion instead of a reality. The application response time was good enough and the Web server on no account went down. The system performed according to expectations. However, the seeming instability was straightforwardly linked to the absence of response from the support team. The main reason adding to the lack of response was that production support was given by the present project team. There was no transition of operational support from the project team to another team or an individual.

The project team carried on responding to operational issues at the same time as trying to deliver the subsequent release of the software implementation. The project issues log was a collection of operational issues and delivery-specific issues. The project also depended upon several vendors to manage incorporation with the software product. The variety of vendors elevated operations problems to several points of contact. The final outcome was a chaos. After the decision to postpone the launch was confirmed, the project team members turned defensive and a bit discouraged as there was no ownership and appreciation for the long hours that went into delivery of the second phase and production support.

This whole 'lost in transition' phase could have been averted had the project team included operations support planning and transition during the initial phases of the project planning and schedule development. The project team resolved the issue by executing the following six simple steps to improve application governance and operational support.

1. Categorize support resources for the application

Even in companies where there is dearth of resources, there has to be an individual resource or team that is accountable for production support. On the basis of the volume, there may be role-sharing or it may be devoted to production support and application management.

2. Set up an operations standing discussion with business associates and IT stakeholders

An operations status meeting is like a project status meeting barring the fact that the focus is on operations of the IT application and the result being delivered to the business. The operations status meeting comprises business partners and the IT management to collectively evaluate the improvement and working of the application.

3. Schedule a production issues and events meeting with business subject matter specialists and the technical team

By arranging an individual meeting to evaluate production problems and happenings, the project team can concentrate on problems pertaining to the subsequent release while the operations team focuses on the more pressing support concerns. Being unsuccessful in segregating production-related issues from project issues will consume the project team in such a way that they will diverge from their core goals and objectives. This creates

confusion in the end users as they have to exert a lot of effort in classifying a single point of contact for support.

4. Create a change control team to administer constant changes in the operational setting

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Change management is a continuous operational process in addition to a domain of project management. Business requirements will undergo changes and new reports, fields, interfaces and modifications will be required. A few of these developments can be attached to a future software release and others can be rolled on in the form of a cycle as requested by the user. By introducing a change control board, the business customer will have a means to ask for the incorporation of alterations to the application without dissuading the project team from their anticipated target. The alterations introduced to the change control board should also be examined and evaluated with the project team to ascertain there are no crashes or disputes.

5. Convey the control model to project stakeholders

After the members are finalized for every key operational meeting, the operations governance model must be brought to the notice of and reviewed by business and IT stakeholders. When a solution of the manner in which issues, changes and operational status will be reviewed will be presented, the business partners will have increased confidence in the IT manager's role in providing services and supporting the business.

6. Facilitate knowledge transfer between project team and support team

One more key to a thriving operations process is the knowledge transfer facilitated by the project team to the operational support team. In a few of the cases, project team members will become operational support and in others, new operations support teams will be appointed, independent of the project. The project schedule should contain transition documentation, tasks to communicate the course of the project and measures required to support the application. The process documentation can comprise batch schedules, help desk synchronization, escalation contacts, recognized issues and their resolutions and disaster recovery measures.

It may come as astonishment to readers that even an experienced project team may not be able to successfully manage transition. However, this usually happens that when projects encounter a shortage of resources and difficult deadlines. The three-fold restrictions of capacity, time and resources is attuned only after the time factor is fixed. By adhering to and putting into practice, the mentioned six steps, project teams can be certain of a better distribution of tasks between ongoing processes and future release of the application.

Check Your Progress

1. What does an integrated project management control system consist of?
2. In what way is the integrated project management control system designed to assist the management?

5.4 PROJECT COMPLETION AND TERMINATION

A project is said to be complete when all its stages have ended successfully.

5.4.1 Project Completion

The steps comprised in the completion of a project are as follows:

1. Final inspection

When the contractors inform the project manager that work has completed, the project manager carries out a final assessment to find out whether any work remains pending.

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This includes a quick walk through all stages of the project and discussing with the project team members to find out anything that seems to be incomplete or half done. The project manager makes a note of all unfinished or inadequate aspects to be fixed along with an action plan to do the same.

2. Defects liability period

The defects liability period is the time assigned for rectifying faults and resolving problems. These faults and problems are the ones that are identified during the final inspection. No alterations or additions can be made after the defects liability period is over, except of course if they are covered by warranty. The defects liability period may vary for different projects.

3. Maintenance retention sum

Throughout the defects liability period, the maintenance retention sum (as specified within the contract), is kept on hold with respect to the final payment, for ensuring that the faults and problems are resolved and rectified. If the corrective work does not finish in a reasonable time, the project manager should adopt the general dispute resolution processes. This might translate to hiring the services of another contractor to do the work, though this could affect the warranties, if any. The payment of retention is done only after all the work is completed as per the standards.

4. Final documentation

After completion of the project, the client needs all the final paperwork to close the project and pay off the retention amount. Once this is done, the project is completed, signed off and closed.

5. Guarantees, warranties and product information

Guarantees and warranties are not too different. Characteristically, product manufacturers guarantee that their products will perform in a certain way for a specified time. For instance, a roofing manufacturer may guarantee that with proper maintenance, the roof will be leak-proof for a period of 10 years. The majority of guarantees are only applicable if the product is maintained, as specified by the manufacturer. The project manager collates all the guarantee and maintenance care documents from the contractors and hands them over to the client.

6. Closing the project file

One of the final tasks is to close the project file. All the final documentation needs to part of the project file, which is to be stored securely. The file is important since it has contains the relevant guarantees that are needed when the product malfunctions.

7. Discharge the project control group and project manager

The ultimate task is to release the project manager and disengage the project control group. The board appraises the work of the project manager and reviews any non-performance issues. The project manager might be bound to a service contract with the board and it is the discretion of the board, based on his/her performance, whether they would continue or end it.

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5.4.2 Project Closing and Termination

Project closing down phase comprises evaluating and reporting findings and results of the project and the assessment of the project team's performance (Luecke, 2004, pp. 146). In addition to this, it is also the phase in which the managers can express their appreciation towards the individuals involved and acknowledge their participation.

While the project is executed till its intended completion, the settlement of the result of the project corresponding to the specifications statement and project schedule is one of the most significant steps. According to this reconciliation, the project can essentially be closed. This process facilitates the project team to assess whether the project was successful. Usually, the team is aware whether the targets have been achieved in time and within the range of the budget. However, this is a step about documenting the achievement and/or explaining any divergence from the intended goals. On the basis of this methodical report, the patron, the customer and any other stakeholder in charge will sign off the project and hence, the project will officially be closed. The formal project closing is varies from one project to another and the associated documentation. Nevertheless, it nearly always includes preparation of closure reports and acceptance documentation.

The scenario is not the same in the case where a project is terminated before its formal closure date. There will be no settlement of capacity deliverables to be prepared instead of reporting the causes for closure and the state of the project when the decision to terminate it was taken. This needs to be prepared, irrespective of the reason for closure and recorded for future reference. An important aspect of this process is the correct identification of the reason for termination: for instance, if the project is discontinued for shortage of funds, it needs to be determined whether the cause is the financial situation of the patron, or market trends, or faulty project's budget estimates. Determining the actual reason behind terminating a project is vital for preparing a 'lessons learned' report. It needs to be reinstated here that all of it must be systematically documented and signed off by all the concerned individuals and groups.

In case of termination of the project, a procurement closure must also be carried out. However, inevitably, process statement will not be verified, as the project has stopped before the scheduled end date. The process adopted to close contracts in this case, depends on the contractual agreements. For instance, a key point is focusing on the compensation and ways to make sure that the resources receive payment for the work they have completed. In the same way, it is also important to ensure that the resources are not paid for the work that was scheduled to be done, but was suspended.

5.5 PROJECT EVALUATION

Project evaluation is the methodical appraisal of the procedures and/or results of a programme with the objective of promoting its advancement and betterment. By its very nature, it is a combined process in which evaluators put in their collective efforts in synchronization with the project team to design and put into practice an evaluation design that is receptive to the requirements of the project. For instance, throughout the implementation of the project, evaluators can offer decisive evaluation findings to enable the project team to take prompt, data-based decisions pertaining to the implementation of the project and delivery. Also, evaluators can, at the conclusion of a project or on its completion, provide collective and comprehensive evaluation findings, usually required

Check Your Progress

3. What is defects liability period?
4. What does a project closing down phase comprise?

by financing agencies and used to make decisions about continuation or expansion of the project.

5.5.1 Objectives and Essentials of Project Evaluation

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If a project is well formulated and thoroughly appraised, a good follow-through on the subsequent stages of the project cycle will ensure the achievement of its goals. Evaluation involves a cautious examination of the basic data, assumptions and methodology used in project preparation; an assessment of the project's organizational and management aspects; an in-depth review of the work plan, cost estimates and proposed financing; and finally the validity of the financial, economic and social benefits expected from the project.

On the basis of these assessments, it can be ascertained whether the project is financially reasonable, technically sound and viable from the viewpoint of the economy as a whole. The exercise of project evaluation simply means the 'assessment of a project in terms of its economic, commercial, market, social and financial viability in terms of returns and risk'. This exercise basically is aimed at determining the viability of a project and sometimes also in reshaping the project so as to upgrade its viability.

In other words, it aims at sizing up the quality of projects and their long-term profitability. Evaluation of projects by funding institutions is an important exercise for the financial institutions and investing companies in credit decisions. The art of project evaluation puts more emphasis on the economic and technical soundness of the project and its earning potential than on the adequacy and liquidity of the security offered.

Hence, the process of evaluation requires a dynamic approach as it is linked with the present and future. Project evaluation is a scientific tool. It follows specific pattern. Evaluation can be referred to as ex-ante, on-going and ex-post.

The effectiveness of a project may be determined in several ways. It may range from a one-off assessment, through a periodic independent review, to an on-going project management overview. As there exist many possibilities in the testing of the effectiveness of a project, it will be suitable to use the term project evaluation. The particular project circumstances determine the type of evaluation to be chosen.

5.5.2 Need for Project Evaluation

Project evaluation is a practical, constructive and essential diagnostic tool available for enhancing the capability of the sponsoring organization's project management team. It is helpful in providing information ranging from an informal enquiry to an extensive analysis of the effectiveness of every aspect of the project process. In the latter context it can be conducted to ferret out common failings of many project management arrangements.

Thus, project evaluation is helpful in:

- Identification of the strengths of current practices in a project management organization, or on an existing project
- Establishment of various groups' perception of the organization's effectiveness in managing projects
- Examination of the effectiveness of project communication and documentation, and clarification of the relationships between project scope, quality, time and cost
- Identification of barriers to better performance, or critical skills needed by project managers or their supporting teams to increase their effectiveness

- Immediate identification of specific aspects which require improvement and hence speed the achievement of results
- Facilitation of an exchange of ideas, information, problems, solutions and strategies with project team members, which leads to development of a plan of action for carrying out improvements
- Creation of a supportive environment focusing on project success, and the professional growth of project team members

Thus, project evaluation in a timely and favorable manner helps in identifying potential difficulties and bringing them out into the open for appropriate corrective action. Further, it may avoid potential problems altogether, if the concept and timing of project evaluation is built into the project plan from the outset.

Identifying projects whose evaluation should be conducted

Project evaluation is most suitable for the projects involving significant risk of potential difficulties. It assumes that the sponsoring organization has recognized the potential for risk on the project, and has, or will include risk management as a standard functional component of the project management effort. The sponsor involves the project evaluator in the project risk identification stage of the project planning phase.

Intent of project evaluation

The intent of the project evaluation should be to avoid useless and unnecessary costs in the future. Since avoided costs are not reflected in normal accounting procedures, it is often difficult to justify this additional expenditure until management knows that it is already in trouble.

Thus, the actual extent of an evaluation is determined by the following factors:

- The size and complexity of the project
- The extent of the concern that management has with the project
- The duration for which the project has been running and the time it is expected to take to complete
- Whether or not previous enquiries have already been conducted

It is significant to the success of project evaluation that it be structured on the basis of serving to advance the prospect of success of the project. Simply finding fault and pointing the finger at those responsible does not help.

5.5.3 Qualities of a Project Evaluator

Project evaluation should be carried out with a certain degree of independence to protect the credibility and reliability of the resulting findings. In other words, it needs to be carried out by a third party. However, the third party may enjoy varying degrees of independence. For example, the evaluation may be carried out by someone from another department or division of the sponsoring organization. On the other hand, a completely independent party commissioned for the purpose may conduct the evaluation.

Irrespective of the way of conducting the project evaluation, it is important to ensure that the persons undertaking the evaluation have no direct personal, financial or organizational ties with the management of the project. In addition, if the findings are to be convincing, the evaluation must be done by people who are familiar with the technology of the project, and/or who are thoroughly knowledgeable in managing the processes of realizing a capital project.

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The objective of the evaluator is to provide consistent and realistic advice to the owner or sponsor's executive through a professional approach and a degree of independence. The evaluator must be recognized as being competent, fair, objective and thorough.

5.5.4 Approach to Project Evaluation

Project management experts are almost unanimous that the project evaluation should be carried out and the subsequent report written, in a strictly constructive way. If this basic principle is ignored, the morale of the project would be so undermined that it will be hard to obtain the required information for project evaluation purposes, and any potential benefit will be totally negated.

The project evaluation, whether conducted formally or informally, regularly or one-off, is fundamentally the development of a set of questions and answers found through the examination of data or through personal interviews. It provides a current snapshot of the health of the project. In this sense, however, it is just like a company's annual financial statement. It may possess many interesting information, but does not serve its full purpose so long as it is compared either with similar previous reviews or with the governing project management plan.

In developing the set of questions, it needs to be ensured that each question has been cross-referenced to the relevant section of the governing plan or procedure, the potential concerns have been identified, and the persons to whom each question will be addressed have been identified. The questions should also be most conveniently grouped according to the project management function. Essential to the success of the process are three considerations, namely the reporting level, a future orientation (not past) and a perceived net benefit to the members of the project team.

The project evaluator must not be responsible to any of the individuals who may be referenced in the report. It does not mean that the draft findings need not be shared with those involved. They should certainly be. Early acknowledgement of this vital point will be in the interests of accuracy and honesty. This will also facilitate cooperation among the evaluation team members and early implementation of the recommendations. The final project evaluation report must be presented to those who are in a position to act on the advice, or ensure that the recommendations are successfully executed.

5.5.5 Methodology and Timing of Evaluation

Evaluation methodology

Project evaluation process should demonstrate the following:

- Potential problems are being identified earlier than they might otherwise be.
- The presence of the project evaluator is welcomed by the project team.
- Practical and timely recommendations for corrective action are being offered.

The methodology involved in the project evaluation involves the following steps:

Step (i) Establishment of the project evaluation's goal and scope

Step (ii) Acquisition of information

Step (iii) Examination and correlation of the information and, in the light of the reviewer's experience, determination of its relevance, completeness and reliability

Step (iv) Description of conclusions on the current status of the project

Step (v) Development of recommendations affecting the future project status

Step (vi) Discussion on the preliminary draft of the findings and recommendations with those interviewed, and subsequent modification

Step (vii) Presentation of the final results for discussion with those who commissioned the evaluation

Step (viii) Discharge of the evaluation team, until recalled

Timing of project evaluation

There may be both 'planned' and 'spot' evaluation s. However, a planned project evaluation (concerned parties notified in advance) is much less unapproachable and more positive. This helps in extraction or retention of information to serve as a basis for the review, with the least interruption to on-going work.

The other advantage of such evaluation is that management is bound to set standards of conduct and performance, while individuals remain mindful of these standards in the course of their daily activities. In determining the timing for PMA, it is important to relate to the four basic phases in a typical project life cycle.

The first phase of a project involves its conceptualization, including preliminary configuration, technical and economic feasibility, positive and negative social and environmental impacts, and examination of project alternatives. The second phase involves stages in which the technical plans are developed, any required technical feasibility studies are conducted, and the resulting findings provide input to a thorough planning stage.

The third or execution phase of a construction project typically encompasses the stages of detailed design, procurement of construction services, i.e., tendering and award of contract(s), followed by the major part of construction. The final or finishing phase of a construction project not only involves the testing and startup of the facility, but typically includes training of operating personnel, transfer of responsibility for the facility, release of project resources and closing of project documentation.

The project evaluation should be planned into the project early in the second phase. The identification of the project evaluator and the establishment of a suitable mandate should be the first step. The evaluation can be carried out with advantage towards the end of the second phase, which provides an opportunity to verify the various risks involved, and possibly identify additional risks, which can then be provided for in the project brief. The project evaluation activity should usually be stepped up during the several stages of the third phase of the project and, like the various other project activities, trailed off in the final phase.

5.5.6 Scope of Project Evaluation

The scope of project evaluation may be as extensive or limited as circumstances indicate. However, it is important to note that there are at least three separate dimensions which may be covered by any evaluation of the project. Each dimension has equal importance to its final outcome and success. The first consideration is related to the technical objectives of the project as represented by its scope and quality parameters, which need specific attention of the management, both in terms of technological content and managing and controlling the development of the content, consistent with the overall objectives of the project.

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The second dimension of the project is related to the business management objectives as represented by its time and cost parameters. The third dimension is related to stakeholders' satisfaction and their collective perception of the success of the project. Depending on the nature of the project, the stakeholders may be many and various.

Checklist for Determining Criteria for Project Evaluation

The checklist for project evaluation criteria may be prepared under the following heads:

- **Relevance and importance**

How substantially does your project support values, demands, programmes and priorities of the customer (Evaluation of the relevance of project objectives)?

- **Validity of assumptions**

How realistic and accurate are these characteristics? (Assessment of the validity of project assumptions)

- **Methodology acceptability and feasibility**

How well does the methodology support the project? How acceptable will it be to other project stakeholders? How reasonable and adequate will be its inputs and outputs? (Examination and prove/disprove of the logistic, economical acceptability and feasibility of your project methodology)

- **Stakeholder competence and credibility**

How capable is the project team? What financial power can the sponsor provide to your project? How "deeply" can the customer be involved in the project? (Evaluation of competence and credibility of key stakeholders including the owner, team and customer)

- **Failure risk:** How sensitive will the project be to changes occurring in the working environment? How can undesirable factors and outcomes be mitigated? (Assessment of the risk and consequences of unexpected results or failure)

Components of an Evaluation Report

An evaluation report includes the following:

- Executive Summary describing main findings and recommendations on improving the project.
- Subject of your evaluation, including a brief history and description of the project and its cultural, technical, natural, economic, and social environments.
- Description of the background of the evaluation, including purpose, methodology, assumptions, limitations etc.
- Name of the participants of the project and those who own and use the final product.
- Confirmation of your project to prioritized needs and demands of the customer.
- Brief review of benefits of your project and how they correlate with costs (cost-benefit analysis).
- Report on the probability of achieving expected results and effectiveness of your project.

- List of factors that ensure sustainability and compatibility of the project goals.
- List of factors that ensure economic and financial sustainability of the project results.
- Confirmation of appropriateness of technology used within the project.
- Report on environmental impact (if any)

5.6 PROJECT REVIEW

Project review is an assessment of a project or activity with the following intent:

- Re-examining the activities that took place
- Assessment of the reasons for the activities and events that occurred
- Formulating the right procedures to be taken to improve the outcome of the following event or project

There is no fixed time for a project review to take place in the process of a project. They can be used to validate the success of projects. They are learning tools created to develop information and feedback that add to consistent improvement agenda in the planning and release of all projects. While every review is essentially project-specific, it is vital that the results are brought to the notice of others within an organization and those offering services to that organization.

The salient features of a good project review are as follows:

- It categorizes important outcomes (positive as well as negative) to be shared, so that future project delivery teams are able to:
  - Reproduce the exercises that have led to lucrative results
  - Establish practices to avert, or manage in a better way, the issues that have emerged in the past projects
- It facilitates process owners to detect where present policies, practices and benchmarks might be hindering better project performance;
- It recognizes opportunities for additional organization-wide enhancement in design, release and operations and
- It sets up an organized plan of action to put these improvements into practice

Good project reviews provide the following advantages:

- Helps in to the point evaluation of the suitability of the delivery method and results achieved
- Provides a opportunity for clear and straightforward discussions, beneficial feedback and debate of sensitive matters
- Provides end user input to the needs of upcoming projects
- Creates a database of information from the whole stakeholder group;
- Adds innovativeness to the delivery of projects;
- Provides a base for a process of consistent improvement;

Results in numerous lessons learned, directed at ascertaining that faults or substandard features are not repeated in future projects and constructive features are used to their full strength.

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5.6.1 Precautions for Project Review

Project review is likely to be misunderstood, especially because it is done by a team other than a planning team and an execution team. The purpose of project review must be made explicit in the beginning. One must take precautions before the project review is undertaken. Some important precautions are listed below:

- Establish procedures and guidelines for the project review and make sure that all the participants have understood them well and that they are available to all the participants prior to the event.
- Ensure that all the participants are convinced that the process will be positive and blame free.
- Provide an environment that fosters openness and candour.
- Ensure that results are shared with all the concerned parties so that there is a positive effect on the future projects.
- Ensure that project review is conducted economically. It is an act of balancing between the costs of project review and benefits. The depth of the project review has to be decided judiciously as the review processes unfold.
- Provide a flexible set of tools and methods that will allow project teams of all sizes and complexity to analyse significant project events and synthesize the findings into a plan of action for remediation.
- A good project review will provide a feedback loop from the findings to the solutions implemented on future projects.

5.7 SUMMING UP

- An integrated project management control system consists of software tools for building of the project databases as well as the processes and procedures required to systematize and administer the project.
- Transition is the move from project to work, with work being the state of operation.
- Project review is the evaluation or assessment of a project.
- A project is said to be complete when all is stages have ended successfully.
- Project evaluation is the methodical appraisal of the procedures and/or results of a programme with the objective of promoting its advancement and betterment.
- When a project is faced to end, due to one or more factors, before its scheduled end date, it is said to be terminated.

5.8 KEY TERMS

- **Project evaluation:** A systematic investigation of an object's importance or value.
- **Change management:** A continuous operational process in addition to a domain of project management.
- **Defects liability period:** The time assigned for rectifying faults and resolving problems.
- **Termination of project:** Forced end of a project due to certain difficulties, hurdles or other problems.

Check Your Progress

5. What is the purpose of a project review?

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5.9 ANSWERS TO 'CHECK YOUR PROGRESS'

1. An integrated project management control system consists of software tools for building of the project databases as well as the processes and procedures required to systematize and administer the project**.**
2. The integrated project management control system is designed to assist the management in:
   (i) Knowing the status of the project
   (ii) Drawing a comparative study of project status with respect to the threshold plan
   (iii) Executing and controlling the change process
   (iv) Track the Earned Value (EV) as and when required
3. The defects liability period is the time assigned for rectifying faults and resolving problems.
4. Project closing down phase comprises evaluating and reporting findings and results of the project and the assessment of the project team's performance.
5. A project review is carried out with the following purposes:
   - Re-examining the activities that took place
   - Assessment of the reasons for the activities and events that occurred
   - Formulating the right procedures to be taken to improve the outcome of the following event or project

5.10 QUESTIONS AND EXERCISES

Short-Answer Questions

1. How can knowledge transfer be facilitated between the project team and the support team?
2. What are the steps involved in project completion?
3. What are the objectives of project evaluation?
4. What are the salient features of a good project review?

Long-Answer Questions

1. Explain the steps that may be taken to improve application governance and operational support.
2. Differentiate between project closing and project termination.
3. Discuss the scope of project evaluation.
4. Give a detailed account of the precautions to be taken before undertaking a project review.

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5.11 REFERENCES AND SUGGESTED READINGS

Chandra, Prasanna. 1995. *Projects: Planning, Analysis, Selection, Implementation, and Review.* Delhi: Tata McGraw-Hill.

Kerzner, Harold, R. 2013. *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*. New Jersey: John Wiley and Sons.

Singh, Narendra. 2000. *Project Management and Control*. Delhi: Himalaya Publishing House.

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