PROJECT MANAGEMENT

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978-93-5119-496-5
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PROJECT MANAGEMENT

CURRICULUM

Introduction to Project Management: Defining Project; Examples of Projects; Meaning of Project Management; Project Management Framework; Generic Project Life Cycle Model; Project Management Body of Knowledge (PMBOK); Project Integration Management; Role of Project Manager, Steering Team, Sponsor, Functional Managers, Facilitator, Consultants etc. in Projects; Industry Specific Project Life Cycle Models (Construction, R&D, IT, Agile methods).

Project Organisation: Concept of Project Organisation; Project Organisation Structures; Project Management Offices (PMOs); Project as a Part of Functional Organisations.

Project Selection: Feasibility Analysis- Operating Feasibility, Market Feasibility, Technical Feasibility, Economic & Financial Feasibility, Legal and Regulatory Feasibility, Environmental Feasibility, Social Feasibility, etc.; Approaches to Project Screening and Selection; Financial Models, Risks Involved in Project Selection.

Cost Estimation and Budgeting: Types of Costs; Cost Estimations; Methods for Cost Estimation; Cash Flows; Learning Curves in Cost Estimation; Problems with Cost Estimation; Creating a Project Budget: Top-down Budgeting, Bottom-Up Budgeting, and Activity Based Costing; Developing Budget Contingencies.

Project Decisions and Project Planning: Project Decisions; Project Charter, The Scope Statement; Concept of Project Planning, Work Breakdown Structure (WBS), RACI/ RAM model; Project Planning Estimation, The-Business Cases, Milestones Schedule with Acceptance Criteria.

Project Scheduling and Resource Allocation: Concept of Project Scheduling; Estimating Time; Concept of Resource Scheduling; Project Network Analysis; Gantt Chart, CPM, PERT, GERT; Resource Loading, Resource Levelling and Resource Allocation.

Monitoring and Controlling a Project: Planning-Monitoring-Controlling Cycle; Project Monitoring; Project Controlling; Earned Value Analysis (EVA)

Project Commissioning & Project Closure: Types of Project Termination, Natural Termination or Early Termination of Projects; Write Transition Plan; Create the Close-off report; Post Project Activities; Realisation of Project Benefits.

Computer Applications in Project Management: Management Information System for Projects; Project Management Information Systems (PMIS); Introduction to Project Management Software; Introduction to Microsoft Project and its Applications.

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CHAPTER

INTRODUCTION TO PROJECT MANAGEMENT

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INTRODUCTORY CASELET

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HONG KONG NATURAL GAS PIPELINE PROJECT MANAGEMENT

Hong Kong is an Asian country that lies to the South-East of China. It is a highly populous country with a population of approximately 7.3 million people. It is a daunting task to provide electricity or power to such a vast population. For this purpose, the Hong Kong government provided power using a mix of various types of resources such as natural gas, nuclear power and coal.

CLP Power is the major organisation in the business of power generation, transmission and distribution and electricity and gas retail activities. It provides electricity to 80% population of Hong Kong. From 1996 till the early 2000s, the CLP Power was using natural resources from the reserves of the Yacheng 13-1 gas field in Hainan, a Chinese province. Therefore, the CLP/CAPCO (Joint venture between ExxonMobil Energy and CLP Power Hong Kong) decided that they need to plan for acquiring new sources of natural gas for maintaining a consistent supply of natural gas.

In the late 2000's, the China and the Hong King Governments signed a MoU in order to supply natural gas to Hong Kong from one of the three newly identified gas sources. One of the identified sources of natural gas was Second West-East Gas Pipeline (WEPII). It is one of the longest natural gas pipelines of the world which runs from Xinjiang, joins the Central Asia-China Gas pipeline and connects 15 Chinese provinces. It was decided that a gas pipeline will be connected from WEPII to bring natural gas to Hong Kong by the end of 2012.

Laying down pipelines that run through two or more countries and cross one or more continents is not a small task and requires a lot of effort and most of all extensive project management.

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INTRODUCTORY CASELET

Various challenges involved in this project were:

- **Regulations:** Since the project had to lay down the pipeline extending from China into Hong Kong, the project management team needed to acquire permits from appropriate authorities in both of these countries. Statutory compliance norms of both these countries also had to be looked after.
- **Communication:** Since there were various stakeholders belonging to different geographical regions that used different language for communication and documentation, it was considered as a major roadblock.
- **Environmental requirements:** The project had to acquire environmental clearances from various authorities to ensure that the oceans and the aquatic life of the ocean does not get affected.
- **Groundwork:** There were a lot of physical constraints in the laying down of the gas pipeline. The project demanded that about 20km of the gas pipeline passed under the sea through three shipping channels one of which was amongst world's busiest channels. There were other issues also such as shallow waters, dredged shipping channel, anchorage areas and presence of another subsea pipeline.

The project was taken up and implemented after carefully planning the minutest details. The plans, schedules and the engineering plans were all developed during the planning phase. The project was primarily based on a waterfall methodology wherein certain activities had to be completed before any other activities can be taken up. The project was scheduled to tight deadlines. The channel dredging had to be completed before the pipeline could be laid. To avoid any unwarranted environmental consequences, the project team ensured that they did extensive Marine Traffic Impact Assessment (MTIA). They were able to lay down the 20 km pipeline within seven months with the support of marine and port authorities.

The project management team knew that any changes in the scope can significantly affect the project; therefore, they ensured that all scope changes had to undergo through a change management process. Effective communication between the teams was encouraged. Teams were encouraged to carry out teamwork in a collaborative manner. To avoid any confusion as a result of difference in the language; project management decided to conduct all discussions and the documentation in multiple languages. Project managers focussed on ensuring safety and quality by ensuring timely and proper control and monitoring of project activities.

INTRODUCTORY CASELET

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Project managers performed daily site visits along with scheduled and non-scheduled walkthroughs. In addition, third-party inspections were also conducted for critical project activities such as welding of pipes.

Project managers used all good practices and methodologies of project management specifically focussing on the ones mentioned in the PMBOK Guide published by the PMI.

As a result of careful project planning, the CLP/CAPCO's project team was able to finish the project on time. The first gas arrived in Hong Kong on 19 December 2012. However, the natural gas supply for producing the electricity was supplied to Hong Kong's power plants only in 2013.

The project was declared as highly successful because it was completed on time without any schedule and cost overruns. In addition, there was no impact on marine traffic and aquatic life. The entire project was completed without even one negative incident.

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LEARNING OBJECTIVES

After studying the chapter, you will be able to:
- Define the term project
- Discuss the meaning of project management
- Describe the project management framework
- Explain the project management body of knowledge (PM-BOK)
- Describe the process of project integration management
- Explain the different roles in a project

1.1 INTRODUCTION

Project is a term that is widely used in the business world, such as power projects, software projects, railway projects, etc. An organisation may work on various projects at a given time. Performance standards of the organisation are measured on the basis whether the the projects have been executed successfully on time or not. Therefore, projects are integral to the survival of an organisation. Let's understand what exactly the term project means.

A project is a set of pre-defined activities having a defined beginning and end, which are undertaken to achieve a specific goal. Let's understand this better with an example. Suppose a real estate company undertakes a new housing development project. The project would involve several activities, such as creating a plan, preparing land, and constructing buildings. It would have a definite beginning, which would include planning for the land and designing the buildings, and a definite end, which would be the completion of the project.

Different activities undertaken by an organisation, such as setting up plants, launching products, and constructing buildings are examples of projects. Different types of organisations undertake different types of projects. For example, construction companies take up construction projects, software companies take up software development projects, and consumer goods companies, such as HUL, take up product development projects.

Unless an organisation has requisite knowledge of project management, it cannot manage a project successfully. As a discipline, project management entails various skills pertaining to budgeting, planning and resource management.

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These skills are essential to ensure that a required end deliverable is completed within the timeframe allocated for it. Let's take an example to understand this better. Suppose an organisation undertakes a road construction project. Before starting the project, the organisation needs to prepare a proper project plan. To ensure that the project runs smoothly, the organisation also needs to set targets and milestones, procure the resources, recruit the workforce, implement the plan, monitor the project's progress, and finally ensure its successful completion. Each of these activities of the project involves a standard set of practices and procedures that make up the discipline of project management.

This chapter deals with different aspects of project management in detail. It begins by defining the term and then goes on to discuss the objectives and advantages of project management. Apart from this, the chapter describes the project management framework. Next, the chapter discusses the concept of Project Management Body of Knowledge (PMBOK). Moreover, you learn about project integration management and various roles needed in a project which includes project manager and consultants.

1.2 DEFINING PROJECT

A project is a pre-determined set of activities with a definite beginning and a definite end. This means that it is a temporary undertaking the purpose of which is to create a unique product, service, or result. Each project is unique because the product, service, or result it hopes to produce is different from all other similar products or services.

Each project also has a unique objective that it seeks to attain. It is very important for the organisation to attain that objective. However, the budget to attain it is limited. Examples of projects are the various activities that organisations undertake, such as setting up plants, launching products, constructing buildings, putting a new business process or procedure in place, etc.

Project as a term can be defined in a number of ways. The Project Management Institute (PMI) defines a project as *A project is a temporary endeavor undertaken to create a unique product, service, or result. The temporary nature of projects indicates that a project has a definite beginning and end. The end is reached when the project's objectives have been achieved or when the project is terminated because its objectives will not or cannot be met, or when the need for the project no longer exists. A project may also be terminated if the client (customer, sponsor, or champion) wishes to terminate the project.*

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PMI is one of the world's largest non-profit membership associations for project management professionals. The institute plays an important role in in the field of project management and is responsible for developing standards, conducting research, providing education and training and networking opportunities.

A project is an activity that is non-routine and conducted by organisations and individuals to achieve definite goals. For example, if an organisation wants to know why its sales are falling, it may decide to do a survey and collect customer feedback. This survey, which is a non-routine activity, is an example of a project. Such a project has a specific goal, that is, to determine the reasons for the decline in sales.

Projects can be classified on the basis of various parameters. These parameters may be size (small, medium, or large), level of complexity (easy, moderate, or complex) location (national or international), nature (industrial or non-industrial), and deliverables (cement projects, telecommunication projects, refinery projects, steel projects and fertiliser projects).

All projects consist of a number of activities. Let's understand this with the customer survey project mentioned earlier. The activities in this project may include defining the sample group, determining the sample size, designing a questionnaire, getting the questionnaire filled by the target customers, etc. These activities may be divided further into a number of tasks. For example, the designing questionnaire activity may involve tasks such researching on the suitability of various types of questionnaires, finalising the questions, inserting them in the Word processor, printing the questionnaires, etc. Therefore, a project may involve numerous activities and tasks, which need to be successfully executed to achieve the project's objectives. However, the number of activities and tasks involved in a project depends on the nature and the scope of the project and will be discussed later in the chapter. A market survey project, for example, would involve fewer activities than those in a new airport construction project.

1.2.1 CHARACTERISTICS OF A PROJECT

All projects have a unique goal and fulfil some specific objectives of an organisation. For example, highway projects undertaken by construction organisations are different in terms of scope, time involved, and resource requirement than product development projects. However, in spite of these differences, the general characteristics of all projects remain the same. Figure 1.1 lists the common characteristics of a project:

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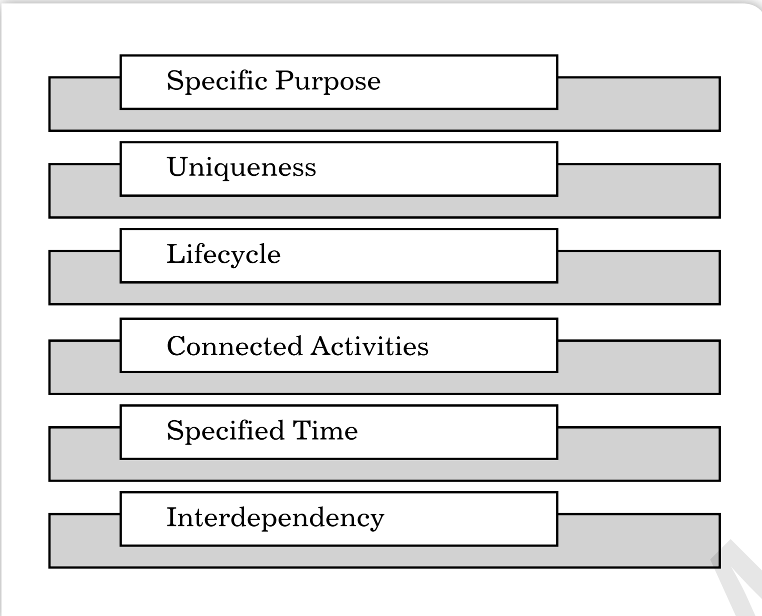

Figure 1.1: Characteristics of a Project

The characteristics shown in Figure 1.1 can be briefly explained as follows:

- **Specific purpose:** Each project has certain specified goals that it has to achieve. These goals differ from project to project. For example, a new terminus may be built to accommodate more traffic in an airport. In this case, capacity expansion is the main objective or purpose for constructing the new terminal. In the same way, projects related to new product development or customer surveys are undertaken for specific purposes, such as increasing sales or studying the tastes and preferences of customers, etc.
- **Uniqueness:** Each project is unique in certain parameters such as scope, objectives, technology used, budget, number of workers employed, etc. For example, there are hundreds of road construction projects undertaken by different construction companies at any given time. However, all these projects will be unique in some respects such as their location, nature of project, and the construction company undertaking the project, etc.
- **Lifecycle:** All projects follow a well-defined life cycle, which begins with the generation of project ideas. In the next stage, the ideas are documented and a project plan is developed. Next, the project plan is executed and the project's progress is monitored. Finally, the project is completed.
- **Connected activities:** A project consists of a number of activities, which are required to be executed in a certain order or sequence. For example, you can build the floor of the bridge only after the

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beams supporting the floor are put in place. A logical flow of activities is at the heart of every project.

- **Specified time:** When an organisation undertakes any project, it must ensure that the goals of the project are achieved within the allotted time. Failure to do so may result in the organisation suffering a financial loss. For example, suppose an organisation decides to launch a new product in the market and has fixed a certain time period for it. However, due to some reason, it fails to launch the product during that period. When the organisation does finally launch the product at a later stage, it may discover that the product is no longer in demand as there are already several other organisations selling the same type of product with better features and at competitive rates. As a result, the organisation will suffer financial loss. However, you should note that the time required to create and launch a project depends on the type and scope of the project.
- **Interdependency:** Generally, organisations undertake several projects simultaneously. For example, construction companies such as DLF or GMR have various national and international projects running at the same time. In such a multi-project environment, there is a degree of dependence among the different projects. For example, allocating funds to one research and development project may lead to a situation where they may not be enough funds for other research and development projects in an organisation. Thus, interdependency is an important characteristic of a project.

1.2.2 EXAMPLES OF PROJECTS

Different industries and businesses require taking up different projects. However, following are some of the most common types of projects:

- **Construction or civil engineering projects:** Such projects involve the development of houses, buildings, trade towers, roads, sports clubs, housing complexes, dams, Metro, etc.
- **Demolition projects:** Generally, demolition projects are a part of large construction projects. For example, construction companies buy old or decaying buildings at low prices, demolish the previously built deteriorating constructs, remove debris, clear the land and start-off with fresh construction, etc.
- **Petrochemical projects:** Such projects involve setting up of refineries and petrochemical complexes for the production of various petroleum products. For example, Indian Oil is expected to commission a new polypropylene facility, at Paradip, by the end of June 2018.

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- **Mining projects:** These are projects that create facilities for exploration and mining of minerals, metals or precious stones. Mineral or matter such as coal, gold, silver etc. are unearthed from mines and processed into various forms. For example, in November 2017, Industrial Development Corporation of Odisha Ltd. (IDCOL) and the Indian Rare Earths Ltd. (IREL) entered into a `450 crore joint venture sand mining project.
- **Quarrying projects:** Quarrying refers to an activity involving the removal of rock, sand, gravel or other minerals from the ground, which are used to produce construction materials or other useful items.
- **Manufacturing projects:** These projects involve the production of products such as oil, toothbrush, tyres, packaged food, etc. or may involve the production of equipment and/or machineries meant for other industries. For example, the Karnataka government has approved Boeing India's proposal to set up an avionics manufacturing unit at Aerospace Park in Bengaluru.
- **Management projects:** These projects are intangible in nature. It means that no foreseeable construct such as building is developed in it. Organisations that require professional project management services for managing their small or complex projects take up management projects. For example, organisations usually need well-organised projects when they decide to relocate their offices, develop and introduce new systems and policies, produce product feasibility reports, restructure their organisation, etc.
- **Research projects:** These projects are carried out to seek answers of certain questions or invent certain principles. For example, a research project may be started to find a medicine or procedure that would help in the treatment of an incurable disease such as Leukaemia.
- **Reengineering projects:** Reengineering refers to the redesigning or changing one or more aspects of an organisation. For example, an organisation carries out a reengineering project to replace its existing business processes with new ones with an aim to improve production efficiency.
- **Information Technology (IT) projects:** These projects are carried out to meet specific information technology goals of an organisation. IT projects can be tangible or intangible in nature. Some most common types of IT projects are software development, hardware installation, network upgrade, cloud computing, virtualisation rollouts, development of Artificial Intelligence (AI) systems (such as robots), business analytics and data management projects, IT services implementation, etc. IT projects can be implemented by

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an organisation in-house or by hiring specialised IT consultants. While IT organisations can take care of their IT projects themselves; non-IT organisations usually outsource information technology projects to specialised IT organisations.

SELF ASSESSMENT QUESTIONS

1. ___________ is a pre-determined set of activities with a definite beginning and a definite end.
2. Each project is unique in certain parameters such as scope, objectives, technology used, budget, number of workers employed, etc. This characteristic is known as ___________.
3. All projects follow a well-defined life cycle, which begins with the generation of project ideas. (True/False)
4. Which of these stages of project life cycle marks the beginning of a project?
   a. Identification
   b. Preparation
   c. Appraisal
   d. Presentation
5. ______________ is the final stage and involves reassessing the project to ensure it has been handled efficiently and mas met all project objectives.

ACTIVITY

Give a few examples of projects undertaken by the government of India for improving literacy rates.

1.3 MEANING OF PROJECT MANAGEMENT

The term project management consists of two terms, project and management. Project refers to a process that is temporary in nature and has certain start and end times. Management, on the other hand, is the act of achieving predefined goals through people and other resources. We can also define project management as the execution of knowledge, competency, and equipment to fulfil the requirements of a project.

The success of a project, whether small or big, depends on how well it is planned and executed. All projects have specific objectives that have to be fulfilled within the given time frame. Project management

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helps not only in finishing the project on time, but also in optimising the resource utilisation for an organisation.

Project management is defined in different ways by different sources. The Project Management Institute (PMI), for example, defines project management as *the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements. Project management is accomplished through the appropriate application and integration of the 47 logically grouped project management processes, which are categorized into five Process Groups namely initiating, planning, executing, monitoring and controlling, and closing.*

According to ISO 10006, "*Project management is a unique process consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including constraints of time, cost, and resources.*"

In most organisations, project management only deals with the implementation of planned activities designed during the proposal of a project. However, many management experts believe that project management is more than just executing the project plan into action. Project management is a discipline that deals with various theories and practices of managing projects. It is a functional discipline of management that involves planning, organising, leading, controlling activities, and managing resources so that the objectives of projects are attained using the required tools and techniques. A project manager is a person responsible for proper utilisation of resources and completion of project within the allotted time. A project manager is also responsible for defining the goals and objectives of the project and checking the project quality so that the desired standard of the project is obtained.

Project management provides a systematic and rational approach to mitigate the risks associated with executing a project to ensure the project goals and objectives are achieved through a phased development.

1.3.1 OBJECTIVES OF PROJECT MANAGEMENT

Now that you understand the meaning of project management, it is important to discuss the purpose of project management. Project Management helps in planning, co-ordinating and controlling the complex and diverse activities of various industrial and commercial projects. A project is exposed to risks due to various factors such as change in government policies, change in technology, shortage of funds, decline in the demand for products and services, rise in price of inputs, and so on. Project management enables an organisation to successfully deal with these risks. The purpose of project management is to foresee or predict as many risks as possible and to plan, organise and control ac-

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tivities so that the project is completed successfully. Figure 1.2 shows the objectives of project management:

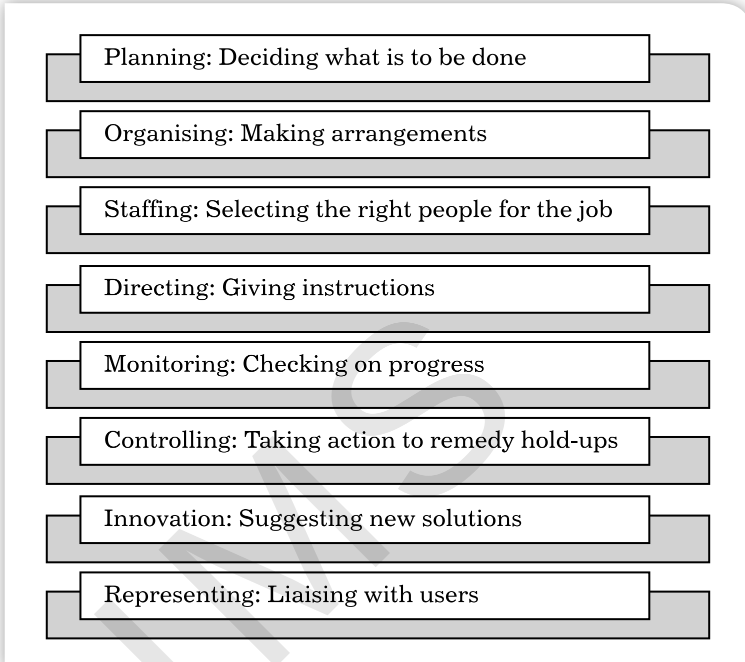

Figure 1.2: Objectives of Project Management

These objectives help in:

- Ensuring timely completion of projects
- Meeting the project schedule
- Maintaining the quality of the deliverables
- Ensuring the completion of project in the given budget
- Ensuring customer satisfaction

Project management offers several advantages to organisations. Let us discuss the advantages of project management in the next section.

1.3.2 ADVANTAGES OF PROJECT MANAGEMENT

Project management helps an organisation in effectively and efficiently carrying out projects through use of tools such as project scheduling and budgeting. According to Tom Peters, co-author of the book, In Search of Excellence, "The *whole discipline and art of project management is going to be the essence of management training, operational excellence, and value added.*"

Project management has a number of advantages. Some of these are as follows:

- It aligns the project with the strategic goals of the organisation.

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- It reduces the project cost by effective planning and management of resources.
- It focuses on performance of the workforce by providing them training.
- It increases the project success ratio.
- It ensures that the pre-stated objectives are achieved.
- It improves the coordination among resources used in a project.
- It reduces risks associated with the project.
- It delivers predictable as well as desired results.
- It aligns expectations of stakeholders with project performances.
- It reduces the project cycle time.

One of the main advantages that project management offers is to add value to a project. Let us understand how project management adds value to a project. An organisation took up a contract for cleaning up a nuclear site. Initially, the organisation was under pressure to execute the project with very limited capital and strict deadlines. However, the organisation set an example by completing the project ahead of schedule with less than the estimated cost by effectively implementing the project management practices, such as reducing the project budget and focusing on the performance. This was possible due to the project management initiative that reduced the cost of the project and increased the efficiency by effectively managing the available money and manpower.

SELF ASSESSMENT QUESTIONS

6. ________________ is the discipline of planning, organizing, and managing resources to bring about the successful completion of specific project goals and objectives.
7. Project management provides a systematic and rational approach to mitigate the risks associated with executing a project. (True/False)
8. A project is exposed to various _____ and project management enables an organisation to successfully deal these.
9. A project manager is also responsible for checking project quality so that the desired standard of the project is obtained. (True/False)
10. List two objectives of project management.

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ACTIVITY

Make a list of factors related to project management that must be documented.

1.4 PROJECT MANAGEMENT FRAMEWORK

Having studied the knowledge areas of project management, you can now learn about Project Management Framework (PMF). Put simply, PMF refers to a tool that helps in planning a project and monitoring its progress. In other words, project management framework is a statement that lays down all the required activities and tasks to be undertaken in a project. In addition, the statement also mentions the timeline for the completion of the tasks and the individuals responsible for each activity. A typical PMF consists of the following steps:

1. Identifying the key steps and project activities for the completion of the project
2. Estimating the required time for each task
3. Updating the document containing the project information and reports
4. Tracking progress of the activities against recorded timeline

The following are the main functions of PMF:

- Supporting the development of the project plan
- Serving as a common reference framework for different individuals involved in the project, which in turn reduces miscommunications
- Streamlining various tools and techniques used in the project to help in the project management process
- Ensuring completion of the project in accordance with the set objectives

1.4.1 PROJECT CONSTRAINTS: 'TRIPLE CONSTRAINTS'

Constraints refer to the limitation of resources. No project has access to unlimited resources. An organisation allocates budget and resources to a project. In addition, the organisation also sets timeline for the completion of the project. Therefore, a project needs to fulfil the set objectives within a given set or resources. In addition, the deadline and the quality of deliverables are also required to be maintained. There are three constraints of a project:

- Scope/Quality
- Resources/Budget
- Schedule/Time

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These constraints are also known as triple constraints. Figure 1.3 shows the balance between the triple constraints of a project:

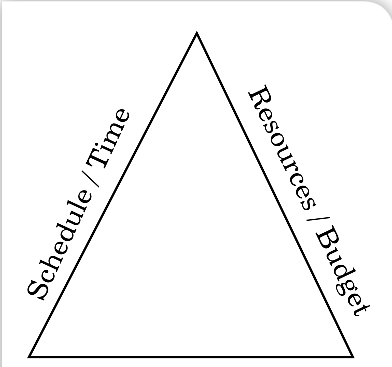

Figure 1.3: Triple Constraints of Projects

Source: http://www.bridging-the-gap.com/working-with-pms-to-juggle-the-triple-constraint/

Let us discuss these constraints in detail:

- **Scope/Quality:** The scope or quality of a project is specifically set before initiating any project. It includes the deliverables of the project and the specifications of the deliverables. For example, the scope of a bridge construction project can be to construct a bridge of certain length and breadth with a certain load bearing capacity. A project cannot compromise on the scope. Consider a mobile phone whose quality based on its utility and longevity. While manufacturing it, the project members need to focus on its long-term prospects so that the mobile phone does not become obsolete soon after its launch in the market. Thus, scope or quality of a project acts as a constraint in project management.
- **Resources/Budget:** Resources are always in limited supply in a project. This is because resources can be procured only by incurring costs and organisations allocate fixed budget for the projects. Resources required in a project depend on the type of the project. For example, a construction project would require bricks, stones, marbles, cement, steel etc. On the other hand, a product development project may not require any of these resources. However, all types of resources involve cost. Therefore, resources are a constraint for any project. Shortage of financial resources hinders a project from its successful completion.
- **Schedule/Time:** It is the timeline for the completion of a project. Organisations cannot continue a project for ever. Every project needs to be completed in a time bound manner. For example, if you want to get a house built, you would give a timeline to the contractor to build the house. On the other hand, if the contractor fails to close the project in time, it will impact both the cost and the scope. Therefore, schedule is a constraint for any project.

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SELF ASSESSMENT QUESTIONS

11. ______________ refers to a tool that helps in planning a project and monitoring its progress.
12. There are three constrains of a project:
    a. __________
    b. __________
    c. __________
13. ____________ is the timeline for the completion of a project.

ACTIVITY

Select any project, say an R&D project prepare a list of various constraints that can arise in such a project. Also, categorise these constraint as being related to time, resource or quality

1.5 PROJECT LIFE CYCLE MODELS

A Project Life Cycle (PLC) is a staged process consisting of a fixed number of stages that is followed by a project manager and his team in order to successfully complete a project. Since every project is unique, the project management life cycle of each project is also unique. However, there are various types of PLC models that define various stages and what is done in those stages. A PLC model depends on the type of industry and the type of project. An organisation can adopt a particular type of PLC model after thoroughly assessing its needs. It is the duty of the project manager to determine the PLC model best suited to its project's needs. Even after adopting a PLC model to be used for a project; the organisation needs to customise its PLC because a standard PLC cannot satisfy every project's needs.

There are four basic types of PLC models that can be used to manage different projects. Each model has different project management style, techniques and practices. They are shown in Figure 1.4:

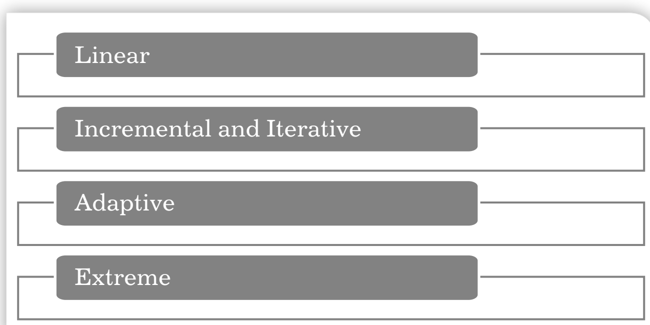

Figure 1.4: Four Types of PLC Models

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According to the PMI's PMBOK, there are five process groups of project management namely: initiating process group, planning process group, executing process group, monitoring and control process group and closing process group.

PLCs are of wide variety and range from predictive or plan-driven (linear) approaches to adaptive or change-driven approaches. In the former category, product and deliverables are clearly defined at the beginning of the project and all scope changes are carefully implemented whereas in the latter category of PLC, deliverables are developed over multiple iterations. Let us now discuss these PLC Models.

- **Linear:** In linear models, the five process groups of project management occur in a linear fashion. It means that a project moves from one phase to another only if the previous phase has been completed fully. There is no scope of backtracking and making changes or conducting activities that were meant to be done in the previous phase. This type of a PMLC model is change intolerant. In linear models, the scope once frozen cannot be changed or modified.
- **Incremental and iterative:** In incremental and iterative models, the product (project deliverable) is designed, implemented and tested in an incremental manner; it means that certain functions or features are added each time. In one go, a basic product is prepared and features or functions are added into it till the product satisfies all customer needs. It is a combination of the waterfall model of software development and prototyping. Iterative models are based on the concept of Agile Project Management. In iterative models also, five process groups occur in a linear fashion but it does so in an iterative manner. It means that once the project gets started, it undergoes all five stages in sequence but after this has been done one time; the second iteration starts and the five stages are repeated again. The anomalies of previous iterations are corrected in the next iteration. In this manner, the project undergoes as much iteration as required to complete the project in a desired manner.
- **Adaptive:** Adaptive model is also an agile project management technique where the project team has to develop a solution or product with the help of minimum information and missing functional aspects. Adaptive, iterative and incremental models are used extensively by software and IT companies. Complex and unique projects can be handled well with the help of adaptive models. The adaptive model is used in situations where there is a high level of uncertainty regarding project deliverables.
- **Extreme:** Extreme model of project management is usually deployed for projects where goals, solutions and the scope is not de-

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fined at all or has been defined vaguely. Such type of model is used in research and development projects that involve a high degree of client involvement.

Irrespective of the PLC model being used, there is a set of stages that can be considered as the simplest or the general life cycle model. You will study about it in the next section.

1.5.1 GENERIC PROJECT LIFE CYCLE MODEL

A PLC refers to the cyclic process consisting of a series of phases through which a project passes from its initiation till its closure. These phases are generally sequential with some overlaps. As mentioned previously, each project is unique and requires a different PLC. The names and numbers of the phases required to complete a project is determined by a management, control needs of organisation, organisations involved and the nature of project. The phases may be decided on the basis of functional or partial objectives, intermediate results (deliverables), milestones, scope of work and financial availability.

A project usually has a scheduled initiation and final closure. Therefore, each phase is also time-bound and has definite start and end times. Each project irrespective of the industry, nature and the PLC model being used; have to undergo five phases from initiation to its final closure. These stages are depicted in Figure 1.5:

Figure 1.5: Five Phases of a Generic Project Life Cycle

In the project initiation phase, the business problem is identified and a business case is prepared. Once the business case has been validated and approved by project owners, it can be taken up and initiated. This phase basically involves the feasibility study of the project so as to decide whether a proposed project should be adopted or dropped. There is always a possibility that a proposed project is initiated but is dropped-off shortly after feasibility reports are found to be negative.

Now, when feasibility reports of the project are found to be positive and the project is finally taken up; the project enters the planning phase. In this phase, the project manager and his team needs to develop a detailed project plan. The project plan details the list of activities that need to be done, their time schedules and resources that are required to complete those activities. Budgeting and scheduling of the project are important tasks in this phase. A project plan is made up of various sub-plans such as resource plan, financial plan, quality plan, risk plan, acceptance plan and the communication plan.

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After setting out a plan as to what needs to be done, when, by whom, with what resources, time and constraints; the project moves into the execution phase. It is the execution phase where the things get done. It is the phase where the deliverables are actually produced. This phase implements what was planned in the planning phase. In the execution phase, the project team needs to carry out activities as planned in the planning phase. The execution phase also entails management of risk, quality, issues, changes, procurement, cost, etc.

All project execution activities are monitored and controlled on a continuous basis. The observations of the monitoring and control phase are fed into the planning phase and necessary changes are made in execution phase activities. The execution phase and its monitoring and control activities are carried out continuously till the desired deliverables are achieved. At this stage, the project enters the closure stage.

In the closure phase, close-out activities such as ensuring the completion of all the activities listed in the project plan are done. In addition, the project is reviewed after completion and all important facts and learning from the project are documented formally.

Now, let us study a few PLC models that are applied in certain industries.

1.5.2 INDUSTRY SPECIFIC PROJECT LIFE CYCLE MODELS

In the preceding sections, you learnt about various PLC models and the generic PLC model. It has already been mentioned that for each project, a unique PLC must be designed. However, there are certain industry specific life cycle models that can be applied to projects belonging to certain industries. Such specific models are usually developed by keeping the generic PLC as base. Here, you will learn about four industry specific PLC models as follows:

- **Construction PLC:** Construction projects such as construction of residential settings, office complexes, metro rail terminals, religious constructs, sports complexes, etc. Construction projects are very labour intensive projects and require a lot of planning. Construction project owners are responsible for acquiring resources and making decisions. Various activities involved in a construction project include idea generation, planning, designing, financing, installing, engineering, etc. A construction project's team includes specialists from various fields such as architects, planners, engineering, constructors, fabricators, etc. Various phases of a construction or civil engineering project are:
  - Idea generation, conceptualisation and feasibility studied
  - Engineering design
  - Contracting and procurement

- Construction
- Commissioning of the facility
- Utilisation and maintenance

- **Research & development PLC:** R&D projects are carried out to bring some innovation (generate new products), introduce improvements in products and processes, etc. In such projects, product requirements and the scope of project changes pretty quickly. There are four basic phases in an R&D project as follows:
  - **Project concept:** In this phase, project goals are defined at an abstract level.
  - **Project planning:** In this phase, project budget, schedule, resources, deliverables, etc. are planned. The R&D project teams usually focus on creating unrealistic plans as they lead to better results.
  - **Project implementation:** In this phase, project activities actually get implemented. There are no strict deadlines because changes may arise and need to be implemented in the project.
  - **Project completion:** In this phase, project deliverables are evaluated to determine whether these conform to project goals or not.
- **IT PLC:** Earlier, IT projects were considered complex and it took a great deal of effort to bring them to success. However, IT projects now focus on developing software quickly and rapidly. Now, IT projects are executed using superior advanced project management methodologies (agile methodologies) as against traditional methods such as the waterfall model. You have studied about the generic project life cycle model. Let us now study the generic project life cycle model applicable for all the IT and software projects. The Software (or IT) Project Life Cycle is usually called Software Development Life Cycle (SDLC). Various stages of SDLC are shown in Figure 1.6:

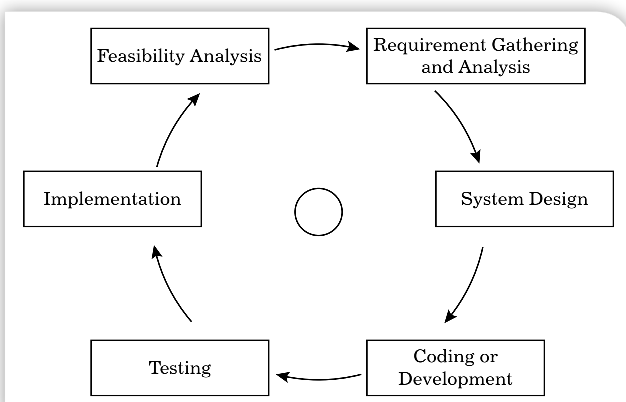

Figure 1.6: Stages of SDLC

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The SDLC starts with feasibility analysis and requirements gathering and analysis phases in which the client and developers (project team) sit together and try to understand the client requirements which need to be translated into the software solution. Once the requirements have been defined properly, the software design is prepared. Now, the project team starts developing or coding for the software. After the coding activity is done, the software so prepared is tested using white box testing followed by black box testing. White box testing is done for unit (module) testing and integration testing. Black box testing is done for functional testing (acceptance testing). When the software has been tested, it is provided to the client for use and feedback. In case, any defects or bugs or missing functionalities are found by the client, it is sent to the development team again that fixes all the errors. The fixed version is sent to the client again. This process continues till the time the client is satisfied with its functionality. The SDLC is a framework for software development and the various phases shown in the figure are indicative. It is not necessary that all software projects would undergo all these phases. At times, the phases can be combined or one phase can be sub-divided into two or more phases. SDLC is a generic model for software project development and management. There are two basic models based on SDLC which include waterfall and agile. These models can be taken up as a base and customised to each project's specific needs. Let us now study these software models as follows:

- **Waterfall model:** It is a rigid type of software development model in which the requirements are identified at the beginning and various phases of the SDLC occur in a sequence. The output of one phase forms the input of next phase. In such a framework, it is very difficult to implement the changes due to stringent deadlines. It is quite impossible to bring to success a software project using waterfall model. Therefore, in practice the requirements, design and coding activities usually start in parallel to save cost and time. Figure 1.7 shows the waterfall model:

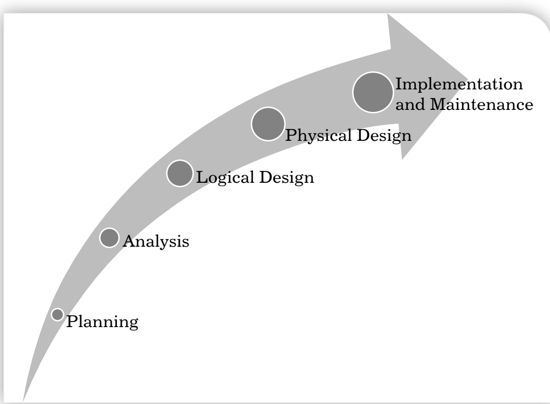

Figure 1.7: Waterfall Model

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- **Agile model:** The agile model of software development is an incremental model which means that it can accommodate changes. In agile project management, the team starts gathering requirements and starts building software. In such a model, focus is on ensuring quality of software so that no unwanted creep into the software. This model of software development is based on the concept that what is needed and is important must be addressed first. All important parts or modules are worked upon first and then non-essential parts are either left out or are worked upon later. This model is applied for development of small software of small applications because they can be developed rapidly. Figure 1.8 shows the agile model:

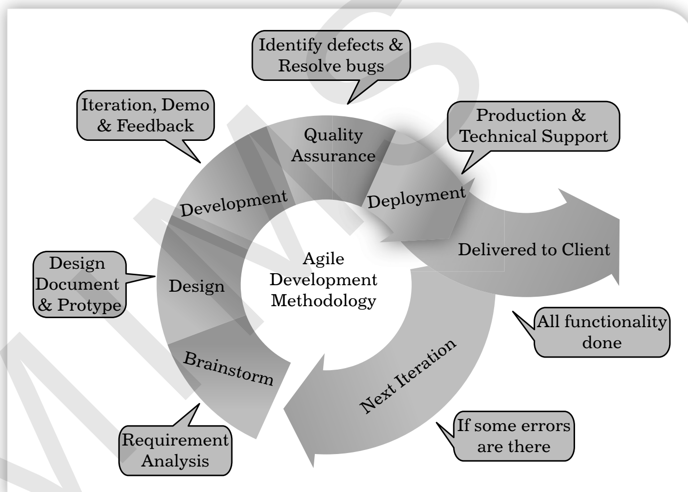

Figure 1.8: Agile Model

Source: https://projectdirectors.org/useful-tips-for-agile-project-management/

SELF ASSESSMENT QUESTIONS

14. What type of project life cycle can be applied in case of R&D projects?

ACTIVITY

Prepare a report on the successful implementation of agile methodology in a project.

1.6 PROJECT MANAGEMENT BODY OF KNOWLEDGE (PMBOK)

Project Management Body of Knowledge or PMBOK sets standards for the successful completion of projects across various industries. PMBOK defines the process of managing an entire project, and the tools and techniques used to reach towards a successful outcome of a project. PMBOK compiles knowledge, practices and processes, which are generally accepted to be the best in the discipline of project management. It is an internationally recognised standard (IEEE std. 1490-2003) that provides fundamental concepts of project management regardless of the type of the project, be it a construction project, a software development project, engineering projector automotive project.

PMBOK was first published by the Project Management Institute (PMI) in 1983. PMBOK identifies 47 processes that are categorised under five basic processes and ten knowledge areas. Figure 1.9 shows the steps involved in the process of a project:

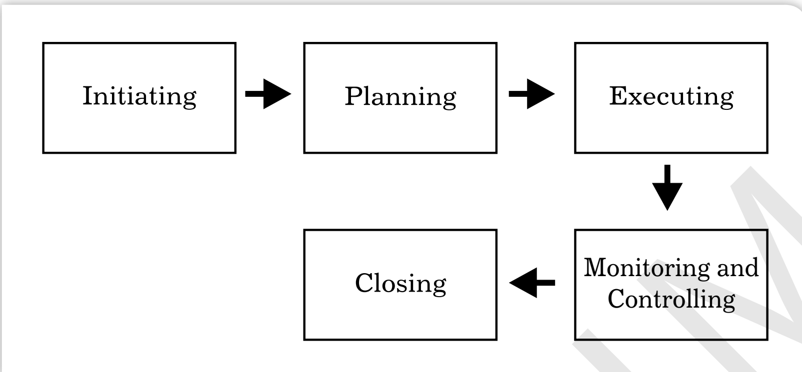

Figure 1.9: Steps in the Processes of a Project

These steps are also referred to as stages of project life cycle. Let us discuss these steps in detail.

1. **Initiation:** It is the first stage of the project where, the concept and objectives of the project are identified. At this stage, the organisation identifies the requirement of a particular project and its nature. Completion of this stage leads a project manager to step towards the following stages.
2. **Planning:** It is the second stage of a project where the project manager designs the project schedule and the required resources to accomplish the objectives of the project. Planning involves preparing budget, identifying, procuring and managing the required resources, etc.
3. **Execution:** It is the third stage, where the project manager starts performing according to the plan laid down in the previous stage. Execution involves putting all the efforts into action to close the project within the given time. The success or failure of a project depends on how well it is executed. For proper execution of a project, you will require proficient workforce, quality materials, financial support, and effective team.
4. **Monitoring and Controlling:** It is the fourth stage where the project manager gauges the progress or drawbacks of a project. In case of any deviation or loopholes, the corrective measures are required

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to be taken by the project manager. Progress, on the other hand, encourages a project manager to go for continual improvement in the project for providing better output to customers/clients.

5. **Closing:** It is the fifth and final stage involved in a project life cycle. When the set goals of a project are achieved within the given time, the project is said to be closed. On completion of a project, the project manager and other resources are released for the next project.

> NOTE
>
> The fifth edition of A Guide to PMBOK defines the concept of project management and also suggests how to manage individual projects. It also describes the life cycle of project management. In its previous edition, PMBOK has mentioned about only nine knowledge areas. However, in its fifth edition (2013), the book has included one more knowledge area, which is Project Stakeholders Management.

Figure 1.10 depicts the ten knowledge areas that are recognised by PMBOK:

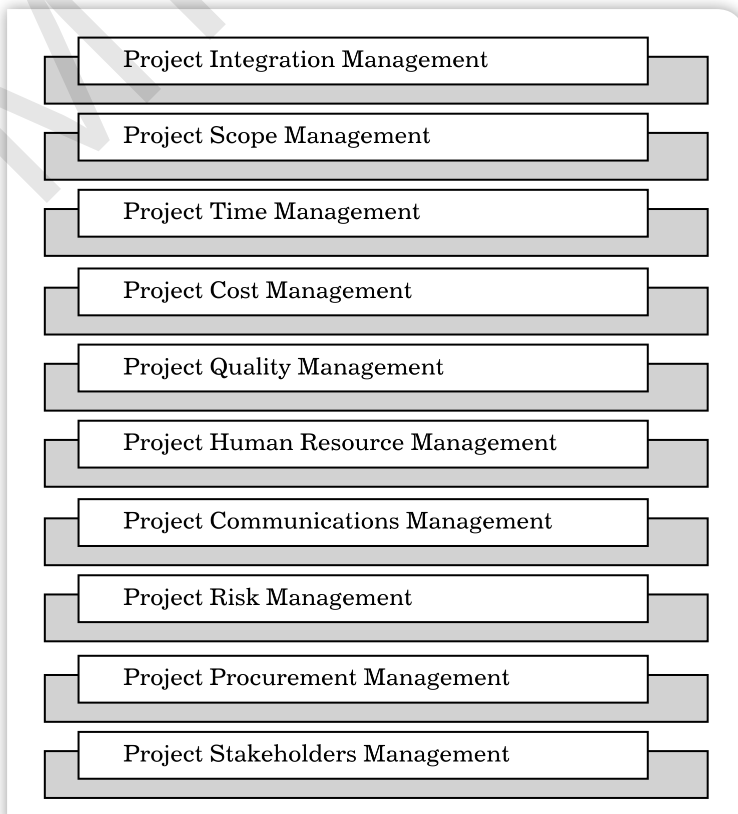

Figure 1.10: Ten Knowledge Areas Recognised by PMBOK

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Each knowledge area includes some or all the processes of project management. The project integration management helps you to develop and execute a project plan. Project time management allows you to estimate the project scheduling and close the project in time. Another important knowledge area of project management is cost management that guides you to close the project within the approved budget. A project is said be successful when it fulfils the quality expectations of customers/clients. Therefore, quality management is considered as a key knowledge area of project management. Project human resource management is also an important knowledge area that helps in managing the right human resources at right time, at right place.

Project communication management tells you how to communicate the project information with stakeholders and team members. In addition, communication management also communicates the information of project performances among various departments. The eighth knowledge area of project management helps you to monitor the risks and take corrective measures to minimise the risk. Procurement management is another important knowledge area that ensures procurement of products and services to complete the project.

In addition to the aforesaid nine knowledge areas of project management, PMBOK has recognised project stakeholders management as tenth knowledge area of project management. Project stakeholders may be the project sponsor, functional management or any other individual who is actively associated with a project. Project stakeholders can guide a project manager by providing result oriented suggestions regarding decision, budgeting, resource utilisation, time management etc. One of the key elements of project stakeholder management is to ensure that the organisation is getting support from the people in terms of positive responds and feedback.

SELF ASSESSMENT QUESTIONS

15. __________ defines the process of managing an entire project and the tools and techniques used to reach towards a successful outcome of the project.

ACTIVITY

Using the Internet, list the main events that led PMI to implement PMBOK.

1.7 PROJECT INTEGRATION MANAGEMENT

Project integration management is needed to coordinate various processes/activities and manage the interdependencies. Project Integration Management can be defined as the process needed to identify, define, combine, unify, and coordinate activities within the project management process. It involves unifying, consolidating, articulating, and integrating the actions critical to project completion. For example, managing stakeholder expectations, and meeting requirements are part of the project integration management. It involves making trade-offs between project objectives and managing interdependencies between knowledge areas. The main activities of project integration management are shown in Figure 1.11:

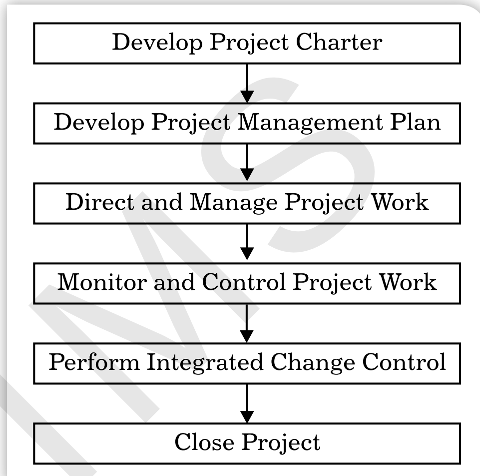

Figure 1.11: Activities in Project Integration Management

Let us discuss each of these activities in detail.

- **Develop Project Charter:** A project charter states the motivation behind the project and explains the reasons for selecting the project. It consists of a document including high level information related to a project such as the background, goals, project authority, project manager, budget, risks, stakeholders, deliverables, approval criteria, etc.

- **Develop Project Management Plan:** A project management plan is a formally documented paper with details on how the project is executed, controlled and closed. It includes all secondary management plans related to the project such as project scope, budgetary and human resource, requirements, possible changes, team configuration, project schedule, quality, process improvement, communication, potential risks, procurement, etc. After a project management plan is validated by key stakeholders, it could be used as a basis for comparing and controlling the project.

- **Direct and Manage Project Work:** This step involves the creation of project deliverables, acquiring and training staff, managing vendors, collecting data and for reporting the project status, approving process improvement plans, etc. In case there are deviations from the approved plan, corrective actions need to be taken. For

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example, if the project manager discovers a defect, he/she would instruct the team to restore the process. However, minor necessary changes can be requested and approved by the project manager.

- **Monitor and Control Project Work:** According to the Project Management Body of Knowledge (PMBOK), "the Monitoring and Control Process Group consists of those processes performed to observe project execution so that potential problems can be identified in a timely manner and corrective action can be taken, when necessary, to control the execution of the project." The project performance is measured regularly against the project plan for ensuring that the project is within acceptable standards of cost, schedule and scope. Project risks and issues are also constantly monitored and corrected as required.
- **Perform Integrated Change Control:** The integrated change control process guarantees that changes resulting from the corrective actions and other controlling factors are managed across the project knowledge areas. Integrated change control takes place all through the project, right from project initiation until project closure.
- **Close Project:** The closure of a project is followed by a Post Implementation Review. Such a review helps in determining whether the project delivered the estimated benefits and customer requirements and was limited to its scope and budget. A project can prove both successful and unsuccessful. It is important to perform staff evaluations, document key learning, and ensuring that the deliverables are included in business operations. Even when a project ends unsuccessfully, the problems and solutions need to discussed and documented for future references.

SELF ASSESSMENT QUESTIONS

16. Project Integration Management involves unifying, consolidating, articulating, and integrating the actions critical to project completion. (True/False)

ACTIVITY

List the important things that should be discussed during a 'post implementation review'.

1.8 DIFFERENT ROLES IN A PROJECT MANAGEMENT

To ensure the success of a project, various people are involved and they play different types of roles. A project usually requires services of different people/teams such as Executive sponsor, project sponsor, people manager, project managers, delivery manager, process consul-

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tant, client/customer, steering team/committee, vendors, project management office (PMO), team lead, project coordinator/project facilitators, etc.

Let us now study these roles as follows:

- **Executive sponsor:** An executive sponsor is the person that has the highest level of interest in a project and its outcomes. The project's budget, schedules and spending all depend upon the executive sponsor. All critical decisions related to the project, its resources and deliverables are taken by the executive sponsor. The executive sponsor is responsible for aligning the project with the organisational strategy.
- **Project sponsor:** In complex and large projects, the executive sponsor may delegate some of his responsibilities to a project sponsor who reports to him/her. The project sponsor helps the project manager in providing information and preparing the project charter. At times, the project sponsor is a part of the steering committee. The role of project sponsor may or may not exist. A project sponsor is usually a senior member of the management. They usually have interest in the project. Project sponsor is one who loses or gains the most as a result of failure or success of the project. The responsibility of the project sponsor is to give a direction to the project and let the project manager manage the project.
- **Project manager:** A project manager plays the most important role in the completion of a project. It is the responsibility of the project manager to carefully steer through the project to its successful end. He is responsible for people management, status reporting, stakeholder management, risk management, etc. He/she serves as a link between the client and the project team.
- **People manager:** In large and complex projects, the project manager may not be able to handle the responsibilities of people management. For this purpose, a new designation called People Manager may be created. A people manager has the responsibility of ensuring that resources required by project team members to carry out their work smoothly are provided to them. However, ensuring the delivery of required results do not fall into the domain of a people manager's duty.
- **Delivery manager:** The project team or the delivery team is managed by a delivery manager. This role decides delivery schedules and the priority of various activities in a project. He/she has to ensure that the project outputs are delivered within the time schedule and are of required quality.
- **Process consultant:** These are the people who have expert knowledge about the internal processes being followed in a project. They are the ones who educate the project delivery team about the correct way to do the things and the processes and the statutory compliances that need to be followed. They are also responsible for

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providing their feedback and suggestions regarding how the business processes can be changed in order to increase the productivity and business value.

- **Client/customer:** The customer or the client is the one for whom the project delivery team is making the required product(s). The client may be an individual or an organisation. The final approval and acceptance of the product comes from the client. The product is approved after the client and his employees actually test and use the product.
- **Steering Committee:** The representatives of the management of the organisation that has undertaken the project along with representatives of all the stakeholders constitute the steering committee. The steering committee serves as the point of contact for the management and project managers to contact each other. They are responsible for providing leadership support and guidance and making policy based decisions.
- **Vendors:** These are organisations that serve as the suppliers of goods and services required by the project team to successfully complete the project.
- **Project Management Office (PMO):** The internal project management processes, standards, procedures and policies for a project are created by the PMO which is a group or department in the organisation that has taken up the project. The PMO provides project management support to the project manager and his/her team. The PMO creates standard templates that are to be used by the project team. In addition, the PMO also collects, preserves (documents) and analyses the project related data for future use. Analysis of data is done so that learning and experience of project teams can be documented and used in future projects. This process helps in decreasing the chances of any mistakes in the future.
- **Team lead:** To complete a project may require formation of various sub-teams under the project team. Each such team is responsible for one or more areas. For example, a film making project involves various individuals and teams such as the team of executive producer(s) and producer(s); team of directors; screenwriters; actors; line producer(s); associate producer(s); production manager; assistant director(s); director of photography; camera operators and assistants; gaffers; grips; electricians and lighting team; digital intermediate technicians; art directors; boom operators; production sound mixers; etc. The team lead has the responsibility of coaching, coordination, problem solving, information sharing, status reporting, and liaison to higher management or administration, etc.
- **Project coordinator / Project facilitator:** These are the individuals or team who are responsible for the smooth flow of information between the teams and individuals in an organisation. It is an important role, especially for those projects that require presence of the project teams at different geographical locations.

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Among all the roles that you have studied, the role played by the project manager and consultants are of utmost importance. Therefore, let us study the role of project manager and consultants in detail in the next sections.

1.8.1 ROLE OF A PROJECT MANAGER

The project manager is the anchor of a project. He or she needs to take result-oriented decisions while ensuring proper utilisation of resources for the fulfilment of project objectives. Figure 1.12 shows the responsibilities of a project manager:

Figure 1.12: Responsibilities of a Project Manager

Let us discuss the responsibilities of a project manager in detail, as follows:

- **Acquiring resources:** As a project manager you are responsible for acquiring the required resources to carry out the project. For example, if you are involved into any car manufacturing project, you would be responsible for acquiring resources like engines, seats, plastics, glasses, rubbers, copper, etc. However, your responsibilities do not stop here; you are also responsible for acquiring quality resources to deliver a quality output in the end.
- **Dealing with obstacles:** Irrespective of the size or scale of a project, as a project manager you should be capable and ready to face challenges of any kind. The project may need your assistance at any stage. It is your responsibility as a project manager to deal with various obstacles such as sudden changes in project plan, technical issues, mishaps at project location, increase in project cost, etc.
- **Taking project decisions**: A project manager is required to make decisions regarding selection of the project, manpower, machine, raw materials, etc. Before taking any decision, the project manager should consider various factors, such as cost and budget of the

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organisation. A single wrong decision may ramp down the entire project of any organisation. This makes decision making a critical responsibility of a project manager.

- **Motivating team members:** Tight schedule and deadline-based work always keep the workers under pressure. This may result in higher level of stress and dissatisfaction among the workers. Therefore, it is the responsibility of a project manager to keep boosting the morale of the team members working on the project. The project manager should motivate his or her team members by acknowledging their performance, rewarding the best performers and listening to their personal and professional concerns. This helps team members to perform efficiently.
- **Negotiating with clients**: The project manager is responsible for dealing with various stakeholders, such as clients, suppliers and financers. Apart from this, the project manager should also interact with customers to identify their needs, tastes and preferences and fulfill them.
- **Resolving conflicts**: The project manager is responsible for managing and controlling the workforce associated with a project. As you know, a project team is comprises various individuals with various personalities, traits, attitudes. Therefore, the possibility of conflict among them is higher. To guard against such conflicting environment, a project manager should come forward to pre-empt and resolve conflicts and develop a better understanding among team members. In addition, the project manager should encourage the team members to focus on project goals rather than individual interests.

EXHIBIT

Project Manager as an Entrepreneur

According to Joseph Schumpeter, "the capabilities of innovating, introducing new technologies, increasing efficiency and productivity, or generating new products or services, are characteristic qualities of entrepreneurs". While most project managers are dedicated to stated guidelines, it is only an entrepreneurial project manager who consciously takes initiatives to ensure project success. Entrepreneurial project managers associate personal equity with the success of a project. These project managers take extra initiatives to ensure a project's completion. Such a mind-set of "personal ownership" is what sets entrepreneurial PM apart from others. An entrepreneurial PM sets higher standards for performance and achievement. They realise the importance of their team's effort and work to deliver inordinate results. They understand the fact that while they themselves do not perform all the tasks and roles on a project, they are ultimately responsible for its success or failure and the consequent impact on stakeholders.

N O T E S

1.8.2 ROLE OF CONSULTANTS IN PROJECT MANAGEMENT

Project management consultants are professionals with knowledge and experience, who assist organisations to improve their project programmmes. The role of project management consultants is complex and requires a deep understanding of the project. Some of the major roles that project management consultants are as follows:

- **Help in achieving the desired return on investment:** Consultants add value by using their skills and expertise to help deliver an outcome while also mitigating the risks to achieve a meaningful 'return on investment' to a client.
- **Increase the speed of a project:** Since consultants are already experienced and trained they can engage promptly with the situation, and quickly become effective in the client organisation.
- **Provide expertise:** Project management consultants provide expertise and leadership to successfully complete a project.
- **Maintain objectivity:** Project management consultants are hired from outside the client organisation and are thus indifferent to organisation politics or culture. They provide a fresh perspective to the team for project completion.
- **Take accountability:** Project management consultants are not only advisors but also practitioners who take the responsibility to manage a project or programme.
- **Measure effectiveness**: A project management consultant works with senior management in the client organisation. He/She is granted some authority and credibility to effect significant changes within the organisation to help in the implementation and completion of a project.

SELF ASSESSMENT QUESTIONS

17. ________________ are professionals with knowledge and experience, who assist organisations to improve their project programs.

ACTIVITY

Give examples of entrepreneurial initiatives taken by project managers.

1.9 SUMMARY

- A project is a pre-determined set of activities with a definite beginning and a definite end.
- All projects have a unique goal and fulfill some specific objectives of an organisation.

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- All projects follow a well-defined life cycle, which begins with the generation of project ideas.
- Project management is a unique process consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including constraints of time, cost, and resources.
- Project management enables the team members to work as per the project plan, project schedule with details about the completion dates for each task within a project phase.
- Project Management Framework (PMF) refers to a tool that helps in planning a project and monitoring its progress.
- There are three constrains of a project—Scope/Quality, Resources/Budget, and Schedule/Time.
- Project Management Body of Knowledge or PMBOK sets the standards for successful completion of projects across various industries.
- Project Integration Management can be defined as the process needed to identify, define, combine, unify, and coordinate activities within the project management process.
- The role of a project manager include acquiring resources, dealing with obstacles, taking project decisions, motivating team members, negotiating with clients, and resolving conflicts.
- Some of the major roles that project management consultants are to help in achieving the desired return on investment, increase the speed of a project, provide expertise, maintain objectivity, etc.
- Different industries and businesses require taking up different projects. Most common types of projects include construction or civil engineering projects; demolition projects; petrochemical projects; manufacturing projects; etc.
- A PLC model depends on the type of industry and the type of project. An organisation can adopt a particular type of PLC model after thoroughly assessing its needs.
- There are four basic types of PLC models that can be used to manage different projects namely: linear, incremental and iterative, adaptive, and extreme.
- Five Phases of a Generic Project Life Cycle include: project initiation; project planning; project execution; project monitoring and control; and project closure.
- Major industry specific PLC models include: construction PLC; research & development PLC; and IT PLC.
- A project usually requires the services of different people/teams such as executive sponsor, project sponsor, people manager, proj-

ect managers, delivery manager, process consultant, client/customer, steering team/committee, vendors, project management office (PMO), team lead, project coordinator/project facilitators, etc.

KEY WORDS

- **Conflict management:** It is the process of preventing the negative aspects of a conflict to restore organisational harmony.
- **Project manager:** An individual responsible for planning and executing project activities.
- **Project sponsor:** One who gains or loses the maximum as per the results of the project. He/she is responsible for ensuring that the project delivers business benefits that were promised by it.
- **PLC Model:** A PLC model refers to the basic or the bare minimum sequence of phases that occur one after the other and a particular set of activities are performed under each phase. The model represents a reference framework that can be customised as per the needs of the user.
- **Agile management:** It is a methodology of project management that prescribes working incrementally in collaboration with all project members and in a flexible manner.
- **Testing:** It is a common process in software project management wherein the software or the applications are executed with an aim of finding the errors or bugs in the software.

1.10 DESCRIPTIVE QUESTIONS

1. Describe various characteristics of a project.
2. Discuss the meaning of project management.
3. What are the 'triple constraints' of a project?
4. Explain the significance of Project Management Body of Knowledge (PMBOK).
5. Describe the process of Project Integration Management (PIM).
6. Explain the role of a project manager.
7. Explain the role of consultants in project management.

1.11 ANSWERS AND HINTS

ANSWERS FOR SELF ASSESSMENT QUESTIONS

Topic	Q. No.	Answers
Defining Project	1.	Project
	2.	Uniqueness

NOTES

Topic	Q. No.	Answers
	3.	True
	4.	a. Identification
	5.	Evaluation
Meaning of Project Management	6.	Project Management
	7.	True
	8.	Risks
	9.	True
	10.	Monitoring; Innovation
Project Management Framework	11.	Project Management Framework
	12.	a. Scope/Quality
		b. Resources/Budget
		c. Schedule/Time
	13.	Schedule
Project Life Cycle Models	14.	Extreme model of project management
Project Management Body of Knowledge (PMBOK)	15.	PMBOK
Project Integration Management	16.	True
Different Roles in a Project Management	17.	Project Management Consultants

HINTS FOR DESCRIPTIVE QUESTIONS

1. Common characteristics of a project include specific purpose, uniqueness, lifecycle, connected activities, specified time and interdependency. Refer to Section **1.2 Defining Project**.
2. Project management is a unique process consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including constraints of time, cost and resources. Refer to Section **1.3 Meaning of Project Management**.
3. There are three constrains of a project; scope/quality, resources/budget, and schedule/time. Refer to Section **1.4 Project Management Framework**.
4. Project Management Body of Knowledge or PMBOK sets standards for the successful completion of projects across various industries. Refer to Section **1.6 Project Management Body of Knowledge (PMBOK)**.
5. Project Integration Management can be defined as the process needed to identify, define, combine, unify and coordinate

NOTES

activities within the project management process. Refer to Section **1.7 Project Integration Management**.

6. The role of a project manager include acquiring resources, dealing with obstacles, taking project decisions, motivating team members, negotiating with clients and resolving conflicts. Refer to Section **1.8 Different Roles in a Project Management**.
7. Some of the major roles that project management consultants help in achieving the desired return on investment, increase the speed of a project, provide expertise, maintain objectivity, etc. Refer to Section **1.8 Different Roles in a Project Management**.

1.12 SUGGESTED READING FOR REFERENCE

SUGGESTED READINGS

- Garland, R. (2009). Project governance (1st ed.). London: Kogan Page.
- Gray, C., & Larson, E. (2008). Project management (1st ed.). Boston: McGraw-Hill/Irwin.
- Meredith, J., & Mantel, S. (1995). Project management (1st ed.). New York: Wiley.

E-REFERENCES

- Chadwick, B. (2014). Role of Project Management Consultants | Daysha Consulting. Dayshaconsulting.com. Retrieved 7 November 2014, from http://www.dayshaconsulting.com/role-project-management-consultants/
- Chung, E. (2013). PMP Certification Study Notes 4 - Project Integration Management - Professional Development- PMP Certification, ITIL v3, Zend PHP. Professional Development- PMP Certification, ITIL v3, Zend PHP. Retrieved 7 November 2014, from http://edward-designer.com/web/pmp-project-integration-management/
- Project Management Documents and Templates,. (2014). Project Monitoring and Control Activities. Retrieved 7 November 2014, from http://www.pmdocuments.com/project-monitoring-and-control-documents/

2

CHAPTER

PROJECT ORGANISATION

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2.1	Introduction
2.2	Concept of Project Organisation
	Self Assessment Questions
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2.3.1	Functional Organisations
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NOTES

INTRODUCTORY CASELET

DEPLOYING A PROJECT MANAGEMENT OFFICE

A US Financial Services Company wanted to establish a PMO due to a lack of IT project portfolio visibility. There were no process to prioritise projects and when done resulted in immature prioritisation and approvals. For this problem, the company hired a professional project management consultant PCube.

The consultant was faced with the task of setting up and delivering a functional Project Management Office (PMO), which would provide a clear picture of all business projects and their relative priorities. This needed to be done in order to enable effective decision making and control. Program and project success can be managed effectively with the help of a PMO because it ensures required planning and control and timely delivery.

PCube sets up the PMO by following a five-stage roadmap as follows:

- **Maturity level 1:** This is an initial or an ad-hoc PMO stage where there is no formal PMO probably because the organisation did not deem it necessary till then or because it had failed in previous implementation.
- **Maturity level 2:** A PMO at level 2 maturity (planned/repeatable PMO) means that it is engaged in strategically important projects in a multi-project environment or that it lays emphasis over best practices to be followed in projects.
- **Maturity level 3:** A PMO at the third level of maturity is a defined or an organised PMO. A defined PMO provides effective mentoring and training to all project managers and teams. In addition, it also performs the oversight function which means that it continually supports current projects.
- **Maturity level 4:** A PMO at the fourth level of maturity is an integrated or a managed PMO. This type of PMO provides proactive support to the organisation's program and projects.
- **Maturity level 5:** A PMO at the fifth level of maturity is the most developed form of a PMO and is an optimised or sustained PMO.

The consultant set up the PMO as a new centre of excellence by following four phases as mentioned:

- **Defining the PMO:** First of all, before a PMO was planned; the organisation was asked to clearly identify its goals and objectives. In addition, it must also identify and define necessary functions, roles, controls and the desired level of PMO maturity.

INTRODUCTORY CASELET

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- **Developing PMO roadmap:** Next, the consultant established a roadmap for the implementation of PMO which involves people, processes and tools. The roadmap was developed keeping in mind the values, capacity and ability of the organisation to implement controls.
- **Implementation and delivery:** After developing a roadmap for PMO implementation, an initial PMO was rolled out in order to gain control of programs and projects. The initial PMO was gradually transformed into a PMO that could support the organisation's program and demands of projects.
- **Consolidation:** After initially deploying a PMO, the consultant knew that its client wanted to achieve a PMO of a Level 2 maturity wherein the PMO could help it in prioritising the projects.

PCube implemented a maturity level 2 PMO for the Financial Company that could capture, prioritise, approve and manage projects within the portfolio of the organisation. As a result of PMO implementation, the project managers use project ranking criteria and pipeline reviews in order to select and accept projects. In addition, the PMO also provides the portfolio and resource visibility with a capacity-demand view of all projects.

N O T E S

LEARNING OBJECTIVES

After studying the chapter, you will be able to:
- Explain the concept of project organisation
- Discuss project organisation structures
- Explain the role of Project Management Offices (PMO)
- Discuss project as a part of a functional organisation

2.1 INTRODUCTION

In the previous chapter, you have studied about project goals, which help an organisation in attaining the desired project deliverables. However, defining project goals only cannot guarantee the success of a project. A proper structure defining the roles and responsibilities of each member of a project team is equally important for a project's success. Such a structure is called the project organisation structure.

A project organisation structure divides, organises and coordinates the different activities of a project. In other words, this framework helps to achieve project goals and objectives by distributing tasks among individuals in a hierarchy. It also determines how business decisions are taken and implemented at different levels of a project. The project organisation structure also improves the efficiency of the project team members by clearly defining their roles and responsibilities in a project. Consider the example of an organisation where project roles are not clearly defined. This situation may result in total chaos in the work process as well as wastage of valuable time and resources. Thus, it is necessary for an organisation to have an appropriate project structure.

There can be different types of project organisation structures used across organisations depending on their size and nature of business, budget, etc. There are two most common organisation structures, namely functional organisation structure and matrix organisation structure. In this chapter, you will study about the concept of project organisation in detail.

2.2 CONCEPT OF PROJECT ORGANISATION

Project organisation is all about the human infrastructure of a project. In an organisation, the successful execution of a project depends on the efficient assignment of jobs involved in a project to people. Here, the role of a project organisation comes into the picture.

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Project organisation is a framework or chart that defines the roles of the members of a project team and relationships among them.

In other words, project organisation defines a governance structure that encompasses key responsibilities, accountabilities, authorities and decision making. It provides a standard set of roles and responsibilities that can be customised for a particular project.

In a nutshell, it can be said that project organisation:

- Defines the terms of reference and accountabilities for all key roles in a project
- Explains clear interfaces at all levels and associated responsibilities
- Defines the ways of working for a project team
- Develops key controls, specific measures of performance and metrics to be used by the project team

Project organisation categorises individuals involved in a project into three different groups, which are as follows:

- **Directors of a project:** This group includes a project manager, project secretary and managing director, who provide strategic direction during the project planning process.
- **Project team:** This comprises a group of individuals who are assigned duties to complete a project within the stipulated time.
- **Steering committee:** This group involves organisational peers, customers, and stakeholders, who provide a strategic direction to a project.

Here, it should be remembered that project organisation can be successfully implemented if project team members are well aware of their roles, responsibilities, and efforts required for each activity. Moreover, the members should know the objectives of the project and how they work as a team so that the project can be accomplished successfully.

SELF ASSESSMENT QUESTIONS

1. Project organisation is all about the ______________ of a project.
2. Project organisation defines a governance structure that encompasses key responsibilities, accountabilities, authorities and decision making. (True/False)
3. Which group involves organisational peers, customers, and stakeholders, who provide a strategic direction to a project?

NOTES

ACTIVITY

Using the Internet, find out project organisation of any road construction project by the Government of India.

2.3 PROJECT ORGANISATION STRUCTURES

The effectiveness of a project organisation structure is the basis for the success of the project planning process. A project organisation structure is a framework of activities performed by the project teams to accomplish the goals of a project. The project organisation structures are temporary structures as they last till the completion of a particular project. These structures comprise individuals from different organisations to complete tasks related to the specified project of the organisation.

The level at which the roles and responsibilities are assigned to individuals to fulfil the goals of a project is also determined in the project organisation structure. In this organisational structure, individuals related to the project coordinate among themselves in a hierarchy to accomplish a common goal. Thus, project organisation arranges its lines of authority and channels of communication and assigns rights and duties to individuals.

The project organisational structure depends on project objectives and strategies followed to attain them. Project Structure Plan (PSP) can be devised to form the project organisation structure, which involves the arrangement of project activities in the form of various sub-tasks. Tabular or structural form shows the relationship amongst the different sub-tasks/activities, which help in deciding the expiration, scheduling and cost planning of the project. The most popular and widely accepted PSP is the tree structure. Therefore, PSP is a hierarchical arrangement of all the sub-tasks or activities of a project, which ensures the proper distribution of resources and employment of team members.

Designing a project organisation structure involves the following steps:

1. Dividing project work into divisions and sub-divisions, and then assigning it to individuals, groups, functional departments and organisational units
2. Classifying people involved in the project into higher, middle and lower levels
3. Identifying global project organisations
4. Defining the basis of grouping at various levels of the organisation

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5. Integrating people, working on the project in terms of communication, coordination, reporting, team-building, conflict management, etc
6. Deciding how authority, decision making, and responsibilities are delegated within the project organisational structure

The following criteria should be considered while determining the structure of a project organisation:

- Strengths and weaknesses of different project organisational forms
- Legal aspects of all available project organisational structures
- Growth patterns of the project organisation
- Decision-making roles and accountabilities
- Relationships between a manager and his/her subordinates
- Flow of information and the frequency of communication
- Number of subordinates under a manager
- Autonomy given to employees at various levels of the project organisation
- Flexibility and need for innovation

Project organisations can have different types of structures that may vary according to the type of a project and other aspects, such as budget and duration of the project and availability of resources. The two most common types of project organisation structures are functional organisation and matrix organisation. Let us discuss these two structures in the subsequent sections.

2.3.1 FUNCTIONAL ORGANISATIONS

In this type of project organisation structure, grouping of individuals is done on the basis of their functional roles. Here, individuals with similar functional areas or skills are grouped in separate units, which are directly controlled and coordinated by the top management of the organisation. Thus, the functional organisation structure is suitable for organisations that handle a single project. This structure works well in a steady environment where there are lesser changes in business strategies. However, the functional organisation structure is also suitable for large-scale organisations having a limited number of products.

Usually, the specialised units in a functional organisation structure directly report to the top management, as sharing of a superior's expertise with subordinates maximises the level of performance. Each aspect of a project is handled by a separate functional unit, which, in

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turn, is coordinated by the top management. Figure 2.1 shows an example of a functional organisation structure:

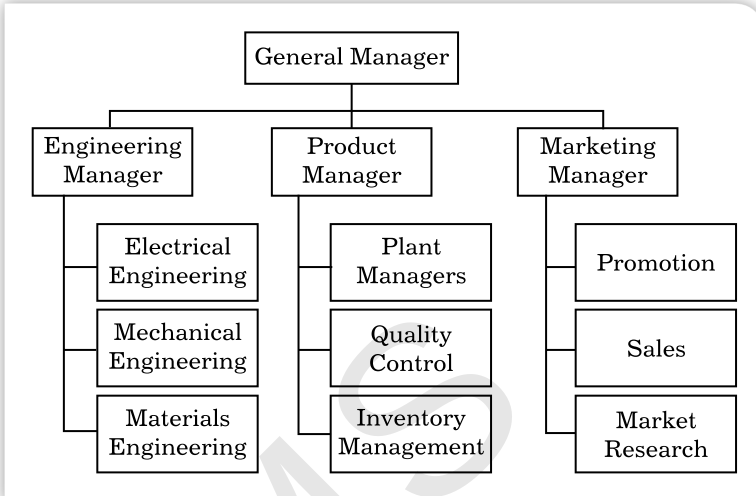

Figure 2.1: Functional Organisation Structure

The functional organisation structure offers greater operational efficiencies for employees as it is formed on the basis of various functional areas like IT, finance, and marketing. Employees having similar roles form departmental units and the projects are accomplished inside these units. The efficiency of employees tends to increase with the shared skills and knowledge. For example, accounting, marketing, finance, and human resources departments are brought together to perform a certain task based on the functions they perform. Suzlon, which is one of the world's leading wind turbine suppliers, is an example of an organisation having a functional structure.

There are certain limitations found in the functional organisation structure. As the functional units report directly to the top management, it sometimes leads to complicated communication and decision-making processes. Consequently, the project completion process becomes more bureaucratic and takes longer to accomplish.

2.3.2 PROJECTIZED ORGANISATIONS

A projectize organisation structure, also called pure project organisation, is a type of structure in which a project is separated from the parent organisation. A project evolves as an independent entity with its independent technical staff and administration and is connected with the parent organisation by links. It should be noted that such type of organisational structure is an ad-hoc arrangement and has a limited lifespan. Once the project or assignment gets completed, the project team is disbanded, and the project team members are either called back to the parent organisation (if it exists) or are terminated from their jobs (in case of contractual jobs). Therefore, in such a structure, team members feel uncomfortable and insecure due to the fear of loss of job. Organisations that majorly support projects as the major form of business use this organisational structure. Such organisations usually take up or plan for various projects. The top most management of the parent organisation selects the project manager for each project and provides financial and administrative resources. However, all other responsibilities and authorities lie with the project manager. In such cases, each project is considered to be an independent unit under the parent organisation. The project team comprises a project manager and a set of employees which are usually involved in the project on a full-time basis.

In this type of structure, the project manager is given sole authority for a limited period of time in order to solve a problem and achieve project goals. Therefore, the main advantage of this approach is that the authority is centralised. Though the full responsibility of the project lies with the project manager, he/she may have to report to the top management of the parent organisation regarding the progress of the project. Construction of a mall can be an example of pure project organisation.

Projects that follow the projectize structure have the following advantages:

- Authority and responsibility of a project rest solely with the project manager, which means there is a clear unity of command.
- Quality of communication improves as the project manager can directly co-ordinate with concerned managers and/or employees.
- Time spent on decision making is shortened considerably.
- There are fewer instances of conflicts due to resource constraints.
- The level of integration is increased.

In addition, there are a few disadvantages of the projectize structure. They are:

- As each project is managed by a different project manager and team, there may be inconsistency in project management approaches and policies. To mitigate this risk, all projects should be managed by a single PMO or a program manager.
- A projectize structure is disastrous for organisational learning as all projects run separately and project managers and employees hardly get a chance to meet and discuss about project objectives, difficulties, specialities and achievements.
- The projectize structure may also lead to duplication of efforts in case the parent organisation takes up two projects (say, for two different clients) that have similar nature of deliverables.

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- A projectize structure has a horizontal form as shown in Figure 2.2:

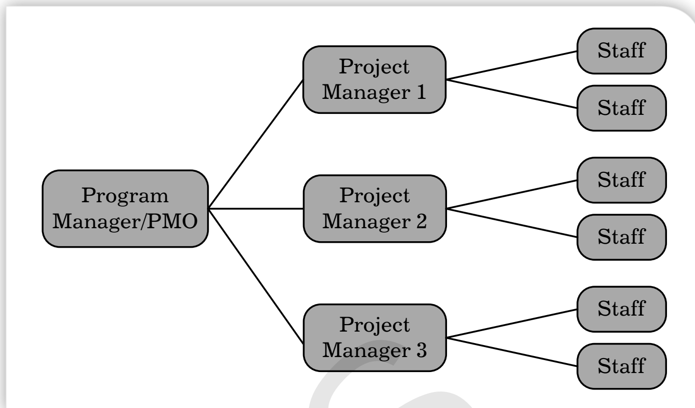

Figure 2.2: Projectize Project Structure

2.3.3 MATRIX ORGANISATIONS

In the matrix organisation structure, employees from different departments of an organisation temporarily work together for completing a project. For example, a machinery development project requires specialists from different departments, such as finance, engineering, and research and development.

The matrix structure does not follow any definite direction of authority and responsibility. In this structure, command may be issued from two different sources to a single subordinate at the same time.

Figure 2.3 shows an example of a matrix organisation structure:

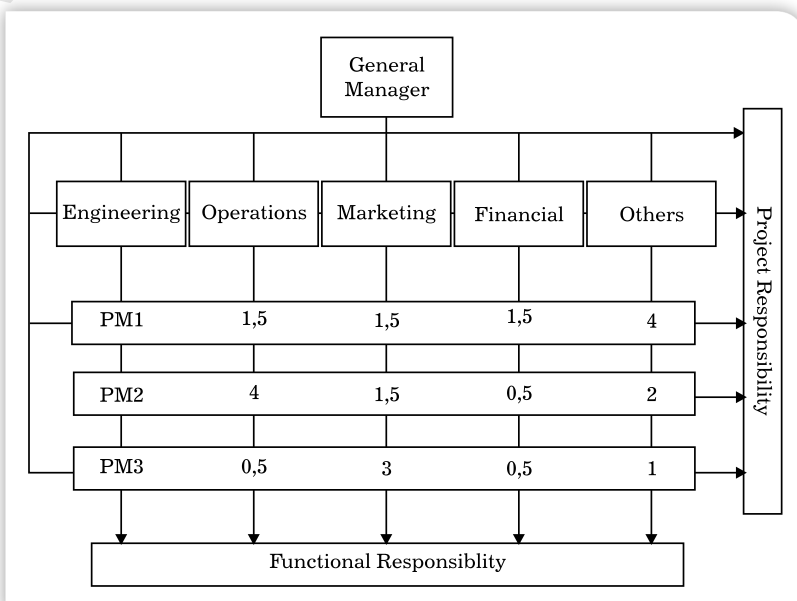

Figure 2.3: Matrix Organisation Structure

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Two or more organisation structures like functional organisation structure and pure project management organisation structure combine to form a matrix organisation structure. In this structure, the organisation is divided into various functions like purchase, production, R&D, etc., and each function is headed by a functional manager like purchase manager, production manager, marketing manager, etc.

Apart from functional division, the organisation is also divided on the basis of various on-going projects. Each project has a separate project manager. The project team members work under two authorities and report to them simultaneously.

Therefore, in this organisational structure, the functional manager and project manager together share the responsibility of accomplishing a project. On one hand, the project manager decides which tasks need to be done, what should be the time schedule, etc. On the other hand, the functional manager decides which individual would be suitable to work on the project and the technologies that will be used in the project. In other words, the functional managers are responsible for the project managers' staffing and for directing the administrative work needed for project team members. The project managers direct the bulk of the work done by employees.

In the case of functional manager, the authority flows horizontally, whereas in the case of project manager, the authority flows vertically. General Electric, Citibank, Dow Chemicals, Shell Oil, etc., are some organisations that have such type of organisational structure. Let us now discuss the features of a matrix organisation structure:

- **Hybrid structure:** The matrix organisation structure is a hybrid of two or more organisation structures. Therefore, it has both merits and demerits of the component structures.
- **Problem of unity of command**: In the matrix organisation structure, the subordinates receive orders from two different heads, namely project manager and functional manager, thus, there exists a problem of the unity of command. This sometimes results in confusion, disorder, disruption, inefficiency, etc., which, in turn, reduce the productivity of the project.
- **Specialisation:** The matrix organisation structure works as a specialised structure. The project manager looks after the administrative aspects of a project, while the functional manager deals with the technical aspects of the project.
- **Suitability:** The matrix organisation structure is suitable for organisations that deal in multiple projects. It is mostly used by large construction organisations that work in different locations at the same time. Each project is handled by a project manager who is supported by the functional managers and employees of the organisation.

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One of the advantages of a matrix organisation structure is that the main focus is on the project. As a result, the client's needs are addressed faster. In case of multiple projects, the matrix structure facilitates better utilisation of resources of the organisation. This structure is recommended for those projects where the integration of inputs from different functions is required.

However, there are several limitations found in the matrix organisation structure. It is one of the most complex organisation structures with very high work load. In this organisation structure, apart from regular work, managers and employees have to do additional work related to other projects. Moreover, it incurs a high operational cost as it involves a lot of paperwork, reports, meetings, etc. The matrix structure also lacks a unity of command. Sometimes, because of the power struggle between the project manager and the functional manager, it becomes difficult to balance responsibilities assigned by them simultaneously.

SELF ASSESSMENT QUESTIONS

4. The project organisation structure lasts till the completion of a particular project. (True/False)
5. ________ can be devised to form the project organisation structure, which involves the arrangement of project activities in the form of various sub-tasks.
6. The efficiency of planning and controlling functions of a project can be enhanced by developing the PSP at the starting phase of the project. (True/False)
7. In which of the following organisational structures do employees from different departments of an organisation temporarily work together for completing a project?
   a. Functional organisation b. Matrix organisation
   C. Projectized organisation d. None of these
8. The matrix organisation structure is a hybrid of two or more organisation structures. (True/False)

ACTIVITY

Give a few examples of Indian organisations using functional and matrix structures.

2.4 PROJECT MANAGEMENT OFFICES (PMOs)

In the previous section, we have discussed about various types of organisational structures. You have learned how the structure of an organisation affects its functioning and operation. It should be noted

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that irrespective of its size and structure, every organisation undertakes various projects in the course of its business. However, just as merely appearing in an exam does not guarantee that a student will pass it; similarly, implementing a project is not sufficient to achieve the desired outcome. On many occasions, the project undertaken by an organisation fails to achieve the desired goal, which results in the loss of valuable resources of the organisation. Therefore, to ensure proper utilisation of resources, it is of utmost importance to control the project failure rate of an organisation.

The responsibility of increasing the success rate of projects in an organisation is assigned to an organisational body called Project Management Office (PMO). PMO is a branch of an organisation that determines and maintains the standard of a project. This is similar to a sales team in an organisation, which is responsible for increasing the sale of products/services.

Project Management Institute (PMI), one of the world's largest non-profit membership associations for project management professionals, defines PMO as "an organisational body or entity that is assigned various responsibilities related to the centralised and coordinated management of those projects under its domain. The responsibilities of PMO can range from providing project management support functions to actually being responsible for the direct management of a project."

The ultimate objective of PMO is to ensure that each and every project of an organisation yields the desired result. PMO makes continuous improvements in order to make an organisation capable of successfully managing its project.

The following are some of the functions of PMO:

- **Maintains consistency:** PMO keeps track on the performance of a project, and thus maintains consistency and efficiency of the project. Moreover, it tries to ensure that the project undertaken by an organisation is in line with its corporate objectives.
- **Eliminates the duplication of efforts:** PMO helps in eliminating the duplication of efforts by efficiently distributing project workload in an organisation.
- **Defines goals and objectives:** PMO helps in the proper execution of a project by clearly defining the goals and objectives of a project.
- **Maintains knowledge database:** PMO makes efforts for the continuous improvement of an organisation by preparing and maintaining a knowledge database regarding the performance of various projects undertaken by the organisation. The database maintained by PMO contains project related information that can be used for designing project organisation in the future. The knowledge database comprises information such as project performance, difficul-

ties and constraints faced in a project, etc. Such information can later be utilised for making improvements in future projects.

- **Assists in managing project finances:** PMO regulates the progress of a project in order to ensure its completion within the prescribed budget and financial means. Moreover, by keeping track of the progress of the project, it assists the management in making informed decisions.
- **Provides templates:** PMO provides various standardised documents, such as risk logs, issue logs, etc., to an organisation, which save the time and efforts of project managers in creating these documents.
- **Establishes metrics:** PMO helps in establishing the metrics of a project, which assists an organisation in measuring the performance of a project.

NOTE

- **Metrics:** A measurement standard, used for evaluating the efficiency of a process, plan or product
- **Risk log:** A document that provides information regarding various types of risks associated with a project
- **Issue log:** A document that contains a list of project issues (both on-going and closed) of an organisation

It should be noted that PMO is mainly of three types, as depicted in Figure 2.4:

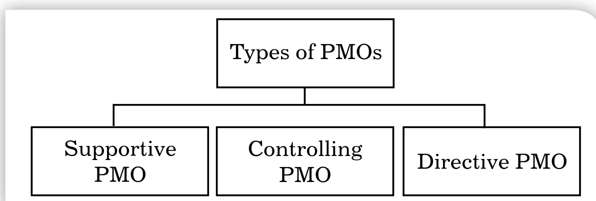

Figure 2.4: Types of PMOs

Let us discuss these three types of PMOs in detail in the subsequent section.

2.4.1 SUPPORTIVE PMO

Supportive PMO provides templates, best practices, on-demand expertise, etc., to an organisation in successfully implementing a project. This type of PMO is mainly beneficial for those organisations that do not require additional control and have successfully completed projects in a controlled manner. A supportive PMO assists in the following:

- Planning and scheduling of a project

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- Preparation and administration of contracts
- Administrative and financial services
- Tracking, reviewing and auditing of a project
- Management of documents
- Defining project metrics

2.4.2 CONTROLLING PMO

A controlling PMO acts as a central governance office for monitoring on-going projects in an organisation. It is beneficial for those organisations that aim at governing their documentation, processes, and other project-related activities. This type of PMO demands an organisation to comply with governance and to adopt certain methodologies, forms and templates.

A controlling PMO usually performs the following activities:

- Identification of best practices
- Standardisation of projects
- Enhancement of the competency of project manager
- Project metrics benchmarking
- Training and internal consulting

2.4.3 DIRECTIVE PMO

Directive PMO provides the resources and management experience required for managing a project in an organisation. In directive PMO, a professional project manager is assigned to give proper direction to projects. Each project manager reports directly to directive PMO, thereby ensuring a high degree of consistency and quality across all organisational projects. Directive PMO usually performs the following activities:

- It directs stakeholders, and assigns and supervises their work.
- It reports project outcome to executives focusing on how capable they are for running a project.
- It assists an organisation by ensuring that projects are completed and deliver acceptable results on time and within the specified budget.

SELF ASSESSMENT QUESTIONS

9. PMO regulates the progress of a project in order to ensure its completion within the prescribed budget and financial means. (True/False)
10. ____________ provides the resources and management experience required for managing a project in an organisation.

NOTES

ACTIVITY

List the functions of a directive PMO in a new project of an IT company.

2.5 PROJECTS AS A PART OF FUNCTIONAL ORGANISATIONS

As discussed earlier in the chapter, a functional organisation is a form of project structure in which all activities of an organisation are grouped into functions such as production, marketing, finance, and human resource management. When a project is implemented in a functional organisation structure, it is made a part of one of the functional divisions of the organisation; usually, the function that could play a major role in ensuring the success of a project. For example, in an installation project of a new production machine, the old machine is replaced with the new machine. In such a case, the most probable way to run the project would be involving and assigning the main responsibility of a project to the manufacturing division of the organisation where the production system is located.

Although the project responsibility in the functional structure is assigned to a single function based on the skills and knowledge required for project completion, the project is not always independent of the other functions of an organisation. For example, if the manufacturing division of an organisation handling a project requires the expertise of a person from the human resource division, the head of the manufacturing division could make a formal request to the head of the human resource division for the same. The human resource head could then provide the manufacturing division with the required human resource to assist on the project. This has been illustrated in Figure 2.5:

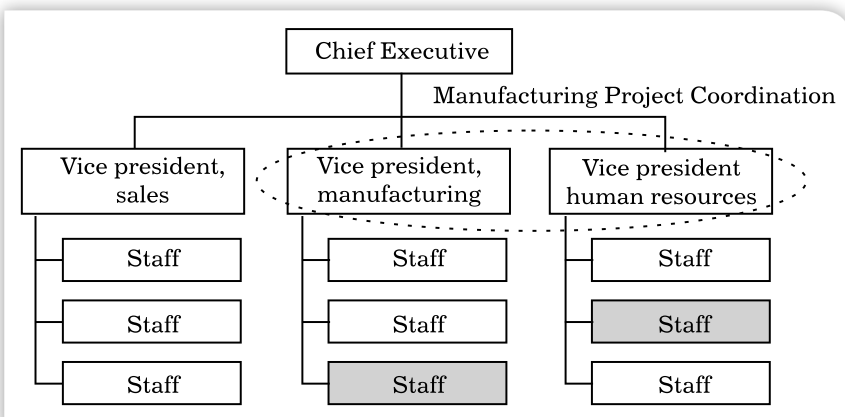

Figure 2.5: Relationship with other Functions

Source: http://www.dummies.com/how-to/content/using-the-functional-structure-to-administer-proje.html

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In a functional structure, the line of authority extends through each group to the group head and finally to the project head. This makes it easier for the project head in overseeing and coordinating project activities. Apart from this, there are many advantages of implementing a project in a functional organisation. Some of these advantages are as follows:

- Functional organisations offer maximum flexibility in the use of the organisation's staff. Experts from various divisions within an organisation are temporarily assigned work responsibility. After the completion of their tasks, these experts can immediately resume their routine assignments.
- Functional organisations are the reservoirs of skills and knowledge in their areas of expertise. Project team members are selected on the basis of their technical knowledge and skills, which are continued to develop through their project assignments.
- Functional organisations have well-established communication processes leading to timely decision-making and continuous support to team members.
- Functional organisations provide team members with a focused and supportive work environment. A project in a functional organisation is assigned to co-workers with similar professional interests. The established interpersonal relationships among members help in collaborative work efforts.

However, there are certain limitations of implementing projects in a functional organisation, which are as follows:

- The primary limitation of this arrangement is that the project is not the focal point as the functional unit (handling the project) has its own work to accomplish. This might compromise the performance of team members and affect the successful completion of the project.
- A project in a functional organisation may lack support from other functional groups. This is because each function within an organisation could initiate its project without consulting other functions. For example, people working in the marketing division may be reluctant to support a project going on in the human resource division if the project does not address their needs.
- In such arrangements, there is a tendency to sub-optimise a project. If project issues are not within the interest area of a functional unit, they could be dealt with less determination and responsibility.
- Projects in a functional group do not facilitate a holistic approach to the project.
- There could be a lack of motivation to complete a project. This is because the project is not the mainstream activity of team members. Often, team members view projects as professional deviation.

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SELF ASSESSMENT QUESTIONS

11. A project in a functional organisation is assigned to co-workers with similar professional interests. (True/False)

ACTIVITY

Give examples of a few projects undertaken by organisations which involve the contribution of more than one division.

2.6 SUMMARY

- In an organisation, the successful execution of a project is accomplished with the help of project organisation, which is a crucial part of project planning and scheduling.
- The project organisation categorises the individuals involved in a project into three different groups, which are directors of a project, project team, and steering committee.
- A project organisation structure is a framework of activities performed by project teams to accomplish the goals of a project.
- The level at which the roles and responsibilities are assigned to individuals to fulfil the goals of a project is also determined by the project organisation structure.
- PSP is the hierarchical arrangement of all sub-tasks or activities of a project, which ensures the proper distribution of resources and employment of team members.
- In the functional organisational structure, grouping of individuals is done on the basis of their functional roles. This structure is suitable for organisations that handle a single project.
- In the matrix organisation structure, employees from different departments of the organisation temporarily work together for completing a project.
- PMO is a department or branch of an organisation that determines and maintains the standard of a project. The ultimate objective of a PMO is to ensure that each and every project of an organisation yields the desired result.
- Although in a functional organisation, the project responsibility is assigned to a single function based on the skills and knowledge required for its completion, projects are not always independent of the other functions in the organisation.

KEY WORDS

- **Project expiration:** It refers to the termination of a project due to various reasons, such as lack of management support, unrealistic or unclear goals and technical difficulties.
- **Project schedule:** It refers to a tool for communicating tasks to be performed, resource utilisation and timeframes with regard to a project.
- **Project methodology:** It refers to a set of tools and templates for assisting a project manager in maintaining consistency and completion of project workload.
- **Unity of command:** It refers to the basic principles of management that no subordinate in an organisation should report to more than one superior.
- **Pure organisational structure**: It refers to a business model where project managers have total control over assigned projects.
- **Project metrics benchmarking:** This refers to a project evaluation technique involving real-time project performance in graphical and tabular forms against a large sample of projects from reputable organisations.

2.7 DESCRIPTIVE QUESTIONS

1. Explain the concept of project organisation.
2. Differentiate between the functional and matrix organisational structures.
3. Why do organisations need PMO?
4. Explain the three main PMOs in an organisation.
5. Write a short note on projects as a part of functional organisations.

2.8 ANSWERS AND HINTS

ANSWERS FOR SELF ASSESSMENT QUESTIONS

Topic	Q. No.	Answers
Concept of Project Organisation	1.	Human infrastructure
	2.	True
	3.	Steering committee

N O T E S

Topic	Q. No.	Answers
Project Organisation Structures	4.	False
	5.	Project Structure Plan
	6.	True
	7.	b. Matrix organisation
	8.	True
Project Management Offices (PMO)	9.	True
	10.	Directive PMO
Projects as a Part of Functional Organisations	11.	True

HINTS FOR DESCRIPTIVE QUESTIONS

1. A project organisation structure defines the sequence of project activities. Refer to Section **2.2 Concept of Project Organisation.**
2. In functional organisations, grouping of individuals is done on the basis of their functional roles whereas in matrix organisations, employees from different departments of an organisation temporarily work together for completing a project. Refer to Section **2.3 Project Organisation Structures.**
3. The responsibility of increasing the success rate of projects in an organisation is assigned to an organisational body called Project Management Office (PMO). Refer to Section **2.4 Project Management Offices (PMO).**
4. Supportive PMO provides templates, best practices, on-demand expertise, etc., to an organisation in successfully implementing a project. Controlling PMO acts as a central governance office for monitoring on-going projects in an organisation. Directive PMO provides necessary resources and management experience required for managing a project in an organisation. Refer to Section **2.4 Project Management Offices (PMO).**
5. When a project is implemented, it is made a part of one of the functional divisions of the organisation usually the function that could play a major role in ensuring the success of the project. Refer to Section **2.5 Projects as Part of Functional Organisations.**

2.9 SUGGESTED READINGS FOR REFERENCE

SUGGESTED READINGS

❑ Garland, R. (2009). Project governance (1st ed.). London: Kogan Page.

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- Gray, C., & Larson, E. (2008). Project management (1st ed.). Boston: McGraw-Hill/Irwin.
- Meredith, J., & Mantel, S. (1995). Project management (1st ed.). New York: Wiley.

E-REFERENCES

- Projectsmart.co.uk,. (2014). Three Types of Project Management Organizations | Project Smart. Retrieved 14 October 2014, from http://www.projectsmart.co.uk/forums/viewtopic.php?f=2&t=730
- Sites.google.com,. (2014). 2.2. Functional project organization - Organizing Projects within a large Organization - Managing Relationship between Projects and other parts of Organization. Retrieved 14 October 2014, from https://sites.google.com/site/organizingprojects/organization-structure/2-2-functional-project-organization
- Small Business - Chron.com,. (2014). The Advantages of Functional Project Organizational Structure. Retrieved 14 October 2014, from http://smallbusiness.chron.com/advantages-functional-project-organizational-structure-2739.html

3

C H A P T E R

PROJECT SELECTION

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3.2	Feasibility Analysis
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INTRODUCTORY CASELET

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FEASIBILITY STUDY FOR GALAXY MINING COMPANY

Galaxy Mining Company is an Indian mining company with about 50 mines located at approximately eight states in the country. The miners are exposed to various health and safety risks while working in these mines. The company decides to operate a Special Provident Fund (SPF) for the miners in addition to the employee provident fund that they already benefitted from. The intention of the SPF was to quickly distribute some compensation to the miners before the EPF is released. The mine in-charge would deduct SPF instalments from each miner on a monthly basis and deposit the same with the Central Special Provident Fund Commissioner (CSPFC). The CSPFC in turn would maintain all details about the SPF instalments collected from the miners. However, the CSPFC charges high fees for the services and also does not maintain records regularly. Galaxy Mining Company employe a reputed software vendor, Adventure Software Inc., to undertake the task of developing software for automating the maintenance of SPF records of the miners. The organisation realise that besides saving manpower on bookkeeping, the software would also help in speedy settlement of claims. The project cost was ₹1 million.

However, the project manager of Adventure Software insists on carrying out a feasibility study of the project. The main problem in the implementation of the project was the scattered database owing to several miners working at different mines. The project manager identifies two main approaches to solve the issue. One of these is to have a central database which could be accessed and updated through a satellite connection at different mine stations. The other approach is to have local databases at every mine station and updating the local data on the central database using a dial-up connection. With more research and experimentation, the project manager concludes that with the given project resources and money, the second approach is more affordable and convenient to adopt.

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LEARNING OBJECTIVES

After studying the chapter, you will be able to:

- Describe the concept of feasibility analysis along with its components
- Explain the various approaches to project screening and selection
- Discuss various project selection methods
- Explain the risks associated with project selection

3.1 INTRODUCTION

In the previous chapter, you studied about project organisation along with three major types of project organisations. The chapter also introduced you to the concept, use and types of Project Management Offices (PMOs). In this chapter, you also studied how projects function as a part of an organisation. This chapter will introduce you to various concepts of project selection.

You studied about five basic phases of project life cycle in an earlier chapter which include: project initiation, project planning, project execution, project monitoring and control and project closure. In the initiation phase of a project, after the preliminary documents such as project charter and business case have been developed; the project team carries out the project feasibility study and prepares the project feasibility document. A project feasibility study involves a comprehensive study regarding various aspects of the project such as financial viability, environmental clearances, social impact, technology required, etc.

Whenever an organisation is faced with multiple projects pouring in from miscellaneous sources; the organisation must select only a limited number of projects that it can undertake. This is done using project screening and selection methods. Projects can be selected by using one or more methods such as Net Present Value, Scoring Methods, etc. Project selection methods can be financial or non-financial, numeric or non-numeric.

Selecting one or more projects from a larger number of projects is not an easy task. It usually involves various risks. For example, vaguely defined scope, cost risks, schedule overruns, etc. To take care of risks, the project team establishes a risk management plan that describes various risks and what steps should be taken to mitigate them when realised.

In this chapter, you will learn about four major aspects of a project viz. feasibility analysis, project screening and selection, project selection methods and risks involved in project selection.

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3.2 FEASIBILITY ANALYSIS

Feasibility analysis, also called feasibility study, is a study that helps in assessing the positive and negative aspects of a project. Feasibility study is a broad term and used to assess the strengths and weaknesses in a number of areas. The nature and the different components of a feasibility study depend on various factors such as the project and industry type, geographical location, etc.

Feasibility analysis is important to evaluate the feasibility of a project in order to determine its technical, economic and operational feasibility in addition to estimating whether it can be completed within the estimated cost or not. Economic or financial feasibility is one of the most important parts of a feasibility study.

A project feasibility study helps in discovering different variables that affect the project and can potentially have an impact on the project's success. Project feasibility study is usually carried out in the initiation phase of a project and is the second document that is created after the creation of the business case.

EXHIBIT

Six Laws of Project Feasibility Assessment

There are six laws of project feasibility assessment that can be used for double checking a feasibility study. The six laws are as follows:

1. **Law of positive and negative forces:** As per this law, a project is not favourable if the positive forces in favour of the project are smaller than the negative forces that are against the project.
2. **Law of project dependencies:** As per this law, the more the number of project dependencies among the project tasks, the more vulnerable the project will be. High level of project interdependencies means a project is highly susceptible to time and cost overruns.
3. **Law of points of vulnerability:** The project feasibility is directly proportional to the total vulnerabilities facing a project and it also varies according to the intensity of remedial actions. The chances of a project's success decrease if it is facing a large number of vulnerabilities. Similarly, if the actions taken to mitigate the vulnerabilities are weak, the chances of project success decrease and vice versa.
4. **Law on the forces of production:** When in a project, non-controlled forces of production are greater than the controlled forces of production, the project's chances of success decrease.

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5. **Law on conflicts:** Project feasibility decreases with an increase in the number and level of conflicts among various stakeholders.
6. **Law of complexities:** As per this law, the probability of project failure increases with the increase in the complexity of the project. The more complex a project is, more risks it entails and more number of risks in turn point towards decrease in project feasibility.

3.2.1 OPERATIONAL FEASIBILITY

An operating feasibility study enables an organisation to evaluate the potential of a project to achieve the desired goals and objectives. Through operational feasibility, an organisation assesses the level to which a project is suitable to meet organisational objectives in an existing business environment. Operational feasibility helps organisations to:

- Assess the potential of a project to fulfil organisational goals
- Analyse and handle any opposition from various sectors, such as management, team, and individuals
- Evaluate the probable impact of the project on the environment
- Implement the project efficiently
- Review the implemented project periodically
- Analyse the impact of the project on end users
- Utilise economical resources judiciously

An organisation decides to conduct operational feasibility after considering various factors. These factors are shown in Figure 3.1:

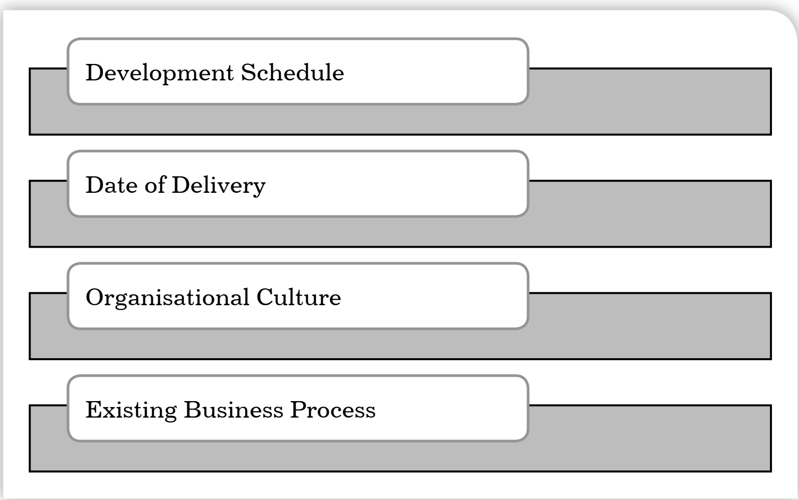

Figure 3.1: Factors Affecting Operational Feasibility

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Let us understand these factors in detail.

- **Development schedule:** Suppose you intend to drive a new destination but you neither know the way nor the distance and the time required to reach there. In such a situation, it would be very difficult for you to reach there. Undertaking such a journey without having any idea of how to reach the destination is pretty similar to working on a project without any schedule. A project schedule can be defined as a timetable or more specifically a plan to develop a project. The project schedule keeps track of all the activities in a project and tracks its progress.
- **Date of delivery:** The date on which a project is scheduled to be delivered to a client is known as its date of delivery. The delivery date is met if all activities associated with a project are performed according to the project plan.
- **Organisational culture:** It is also known as the corporate culture, and consists of norms, values, common perceptions and unwritten codes of conduct of an enterprise. Every organisation has its own unique organisational culture, which defines the standards of acceptable behaviour and guides the conduct of its employees.
- **Existing business process:** It can be defined as a method that is used by an organisation to achieve a crucial objective. A business process if broken up into smaller processes forms a series of individual events that must be performed in a sequential order. Figure 3.2 shows an example of a real-world business process:

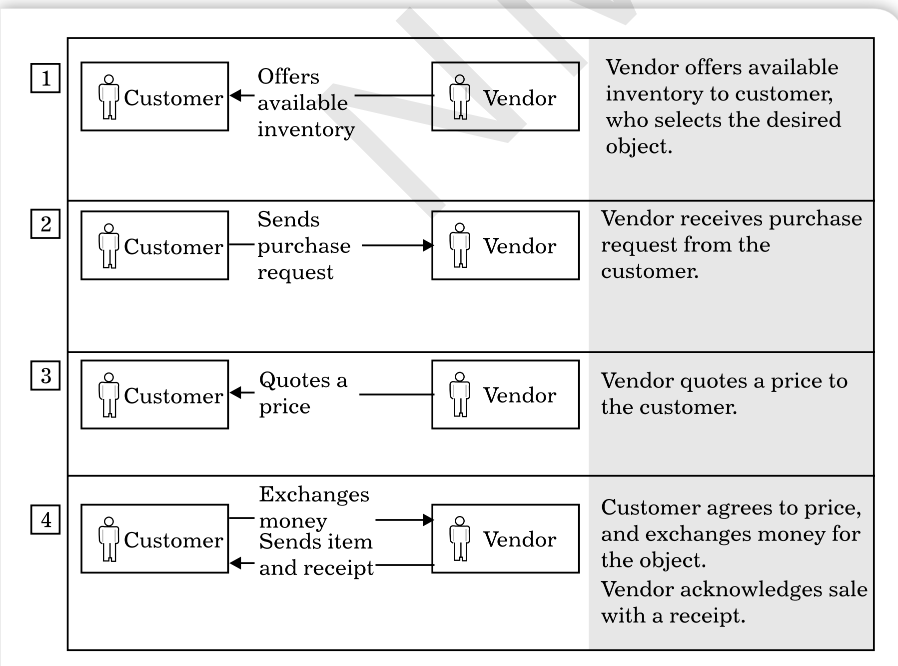

Figure 3.2: An Example of a Business Process

Source:http://publib.boulder.ibm.com/infocenter/dmndhelp/v6rxmx/index.jsp?topic=/com.ibm.wbit.help.bpel.ui.doc/concepts/cunder.html

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If a project is in conformity with the project schedule, date of delivery, organisational culture, and the existing business process of an organisation, then the project is said to be operationally feasible. The operating feasibility of a project can also be predicted with the help of the following questions:

- Will workers/employees require training to accomplish the project? If yes, is the organisation ready to provide training to the workers/employees?
- Will the project require changes in operations? Will the performance of the organisation be hampered by the project?
- Will the project have any adverse effect on customers?
- Will the project hurt the goodwill and image of the organisation?
- Will the schedule and date of delivery conflict with other priority projects of the organisation?
- Will the project be socially accepted?
- Are the management and the users encouraging the project?
- Are there any legal issues related to the project?

3.2.2 MARKET FEASIBILITY

Market feasibility is a study that focuses on the marketing plan and the course of action of a project. This study is aimed at judging whether or not a project would be able to satisfy customer's needs or not because if a project delivers results that do not satisfy customer needs, the project would not be a success.

During a market feasibility study, a lot of information is collected and analysed. Information required includes:

- Needs of customers that have not been met yet and the product or service that may be developed to fulfil those needs.
- Demand for new products or services in the market.
- Customer groups on which the project should focus.
- Competitor's possible reaction when a new product or service is introduced.
- Design of new product or service in order to meet the customer's needs in the best possible manner.
- Means and medium on which the marketing, advertising and promotion of the product or service can be done in the most effective manner.
- Possible barriers for introducing new products or services.

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The study of market helps in demand forecasting and market planning. The relation between market and demand analysis is shown in Figure 3.3:

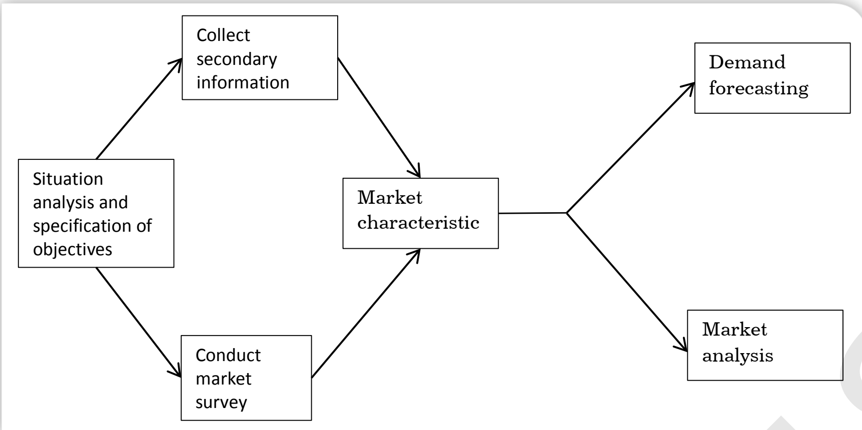

Figure 3.3: Relation between Market and Demand Analysis

In the situation analysis and objective specification stage, the following information is gathered:

- Who is/are the buyer(s) of the proposed product or service?
- What is the expected demand of the product?
- What are the criteria for selecting a market segment?
- What units of the product must be sold for breaking even?
- What price is the customer willing to pay?
- What will be the aspects of the product that can be worked upon in order to differentiate the product from similar products of the competitors?
- What channels will be used to distribute products and what will be its estimated cost?
- What are relevant policies, laws and regulatory initiatives in the industry?

The person who is given the responsibility of collecting secondary data can do so by looking for various sources such as census, national sample survey, Niti Aayog reports, statistical abstract, economic surveys, etc. Now, the project team evaluates the secondary data on the following basis:

- Who has gathered the information?
- When was the information gathered?
- What is the objective of gathering this information?
- What is the target population and how the sample was chosen?

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- How well was the information analysed and reproduced in form of tables or graphs?

After this stage, a market survey is conducted. The survey is aimed at estimating the total demand of different products in different segments of the market. In addition, the income and price elasticity of demand is also calculated. The survey is also used to evaluate the satisfaction level of customers w.r.t. the existing products and what are the unsatisfied needs of customers. In addition, the survey also aims to find the attitude of customers towards various products, socio-economic characteristics of the buyers, etc. A survey can be carried out by the following steps:

1. Define the target population
2. Select the sampling scheme and sample size
3. Prepare the questionnaire
4. Train and send field investigators so that they can get the questionnaire filled up by the sample of respondents.
5. Analyse the information carefully and convert it into a form that can be easily understood by the ultimate decision makers who derive important results and conclusions.

After the secondary data and the primary survey data has been analysed, the market is characterised in the terms of:

- Effective demand levels in past and present
- Breakdown of demand by segments
- Price
- Distribution methods
- Sales promotion methods
- Consumers
- Supply and competition
- Government policy

All this data is analysed in order to evaluate market feasibility of the proposed product.

3.2.3 TECHNICAL FEASIBILITY

The technological requirements of a project must be analysed in detail to evaluate its technical feasibility. Organisations can acquire the same product or service by using different technologies. For example, electricity could be generated using solar energy, thermal energy, hydraulic energy, nuclear energy, etc. In order to run a successful project, it is important to weigh all available alternative technologies and

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select the one that is most appropriate in the prevailing circumstances. The feasibility of a technology can be measured on the basis of the following:

- Specifications of a product/service
- Uncertainties and interdependence on other technologies
- Developmental imperatives such as employment opportunities, maximum use of indigenous resources, reduction in income disparities, etc.
- Project schedule
- Relevance of the technology with project objectives
- Ease of availability
- Indigenous availability of relevant technology
- Dependence on non-renewable sources of energy
- Organisation's capacity to adopt the technology
- Operational parameters required to adopt the technology
- Timely availability of manpower with required skill set for installation, operation and maintenance of the technology
- Cost of acquiring, installing and maintaining the technology
- Safety parameters of using the technology
- Requirement or availability of research and development in the organisation
- Obsolescence of technology

The selected technologies also need to be assessed with respect to their acquisition aspects. These aspects include the available modes of procuring the technology and associated costs. Some important questions that organisations should seek to answer before adopting a technology for a project are as follows:

- Is the technology available as a technical know-how, a technical collaboration, or a joint venture?
- Are any patents, trademarks or licences involved in the adoption of the technology?
- What are the terms and legal obligations for adopting the technology?
- Does the technology need to be procured from a specific country or company?

Assessing the selected technologies on this basis would help an organisation in finalising a particular technology for its projects.

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3.2.4 ECONOMIC & FINANCIAL FEASIBILITY

In a feasibility study, most important criterion for accepting or rejecting a project is based on economic and financial feasibility analysis of the project. Financial and economic analyses are two separate types of analysis. The financial analysis of a project is used to document a rate of return on investment that can be expected from the project. On the other hand, economic analysis of a project is carried out in order to evaluate the impact of the project on the society as a whole.

Financial analysis of a project is concerned with the following:

- Taking care of investor's perspective.
- It is based on market prices.
- It must take into account the relevant taxes, tariffs, subsidies, etc.
- It does not include externalities.

Economic analysis of a project is concerned with the following:

- Economic analysis evaluates the impact of project on the society.
- Economic analysis applies prices such as taxes, tariffs, subsidies etc. in order to evaluate the project and its impact on society.
- Economic analysis incorporates both positive and negative externalities in monetary terms.

Financial feasibility of a project includes the following activities:

- Financial feasibility analysis helps in estimating costs and determining the accuracy of cost estimates.
- Determining the suitability of the proposed means and medium of financing
- Evaluates the general soundness of the capital structure.
- Determine the total cost of project including the contingency and management reserves.

Various types of financial feasibility checks used to evaluate a project are as follows:

- **Past track record:** This includes evaluation of the sponsor company's past performance statistics in terms of total installed/operational capacity, sales, operating profit, capacity utilisation, dividend policy, sources of finance, etc.
- **Present financial position:** Sponsor's audited balance sheet and P&L accounts of last three years along with important ratios such as debt-equity ratio, current ratio, return on assets, profit margins, etc. along with company's capital structure, depreciation method used, contingent liabilities, pending suits, remarks of the auditors, etc. are considered before evaluating the financial position of the sponsor company.

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- **Project incentive:** This includes evaluating whether the project will incur any incentives or not. Incentives may include support from government, hedging open positions, enforceable security packages, mitigation of major risks facing a project, etc.
- **Working capital requirements:** The project team needs to assess the total working capital requirements of the project which includes evaluating the maximum requirement at the beginning of the project or in the first year. The project team also needs to assess whether one or more banks need to be contacted for providing the necessary working capital and how this business would be shared between different banks. The project team also needs to evaluate whether they will be able to fulfil the working capital requirement in excess of what has been estimated.
- **Marketing:** The project team needs to evaluate marketing trends such as sales prospects and its underlying assumptions. In addition, the following aspects are also estimated:
  - Estimating demand on the basis of past demand, supply and the general position of the industry.
  - Explore the selling price trend and whether it is affected by government controls, quota, etc.
  - Export obligations
  - Availability of marketing organisations, selling agents, terms of arrangement, etc.
- **Funds flow analysis:** The project team must analyse the funds flow and categorise it into short and long term funds. Funds flow may increase or decrease the working capital requirement as a result of long-term surplus or deficit/movements in current assets & operational cash flow.
- **Projected balance sheet:** The project team prepares a projected balance sheet that shows expenditures and revenues for the entire duration of the project. The projected balance sheet must be analysed to ensure that all projected values have been derived accurately and are represented well in the projected balance sheet.
- **Security, margin and Rate of Interest (ROI):** There can be instances wherein the project requires financing in return of security or collateral. In such cases, analysts need to prepare a detailed report regarding the guarantors of loan. Also, analysts need to evaluate how well the sponsor can cover its short-term debt obligations with assets (margin). Lastly, the security cover and the margin should be adequate and satisfactory. The sponsor must also have a stable credit rating.
- **Government consents and incentives:** All relevant consents and incentives that are applicable in the given project must be evaluated for. Consents may include approval for collaboration, technical

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know-how arrangements, import clearances, approval for making payments, various approvals or no objection certificate from miscellaneous local authorities.

- **Group companies:** The sponsor may have one or more subsidiary or associate companies and in such cases, the extent to which these group companies are dependent on the parent company must be evaluated. In addition, the liability of the parent company w.r.t. partly paid shares in the subsidiary companies also needs to be evaluated.
- **Managerial competency:** The analysts also need to evaluate the composition of the Board of directors, who the CEO of the sponsor is, quality of company's management, etc.

After making these preliminary financial checks, the project is quantitatively evaluated by using certain financial models such as break-even analysis, sensitivity analysis, net cash flows, pay-back period, accounting rate of return, etc. You will study these financial models of evaluation in the later part of this chapter.

3.2.5 LEGAL AND REGULATORY FEASIBILITY

The legal feasibility study is carried out in order to determine whether the proposed project may violate any laws and regulations or not. In other words, legal feasibility study is conducted to determine whether a proposed project conflicts with legal and/or regulatory requirements or not. Legal requirements can be of diverse types such as zoning laws, data protection acts, or social media laws. For example, a cigarette making company wants to expand and set up another factory in Southern India. The project sponsor expresses his wish that he wants to set up the new plant in Coimbatore, northern Tamil Nadu as it can be used to reach and spread its distribution network in the entire southern India. Upon legal analysis, it is found that the production and sale of Tobacco products is banned in the entire Tamil Nadu. This analysis is extremely useful for the company because now, they can look for options that are legally viable. Let us look at another example. Assume that an organisation wants to set up a new office at some location A but upon legal feasibility study, it is revealed that location A falls into a zone that is considered unsuitable for the type of business the organisation wants to set-up.

Ideally, all projects should undergo legal appraisal or legal feasibility analysis. At times, projects might have been completed and the legal issues crop up later.

The legal feasibility of a project is checked by using the legal due diligence process. A due diligence process is usually aimed at ensuring that a project is carried out in accordance with legal and regulatory requirements both at domestic and international terms. Due diligence also ensures that the important legal aspects of the project have been analysed. A legal due diligence study is usually carried out using the three steps as shown in Figure 3.4:

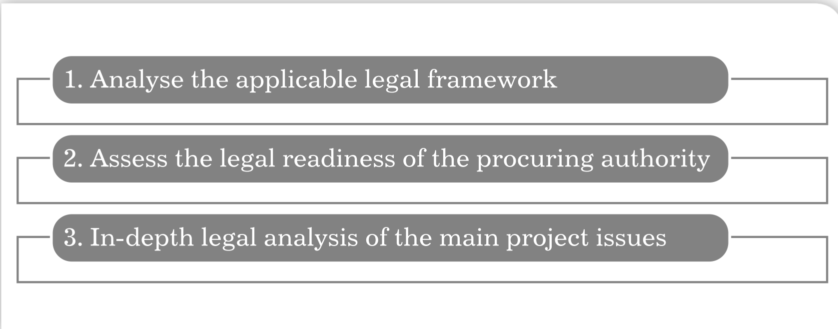

Figure 3.4: Steps in Legal Due Diligence

Let us now study these three steps in detail as follows:

1. **Analyse the applicable legal framework**

   In this step, the project team needs to identify and analyse all the relevant laws and regulations that can potentially affect the project. Some important legal and regulatory aspects that must be analysed include:

   - Certain minimum capital value and contract durations are imposed on some industry specific projects such as public private projects. These must be analysed to ensure adherence.
   - Specific laws governing procurement and contracts.
   - Laws relating to foreign investments, property and labour.
   - Laws related to the use of particular lands.
   - Laws related to environment.
   - Industry or project specific laws.
   - Laws related to dispute resolution and intellectual properties.
   - Laws applicable in case of disputes.
   - Laws related to intellectual properties.
   - Laws related to the treatment of revenues that are generated from sources that were procured using government concessions.

   After evaluating a project's legal feasibility on the above-mentioned grounds, the project team should develop a complete list of requirements for the project.

2. **Assess the legal readiness of the procuring authority**

   In this step, the legal readiness of all organisations involved along with the promoting agency must be checked. These entities must have necessary approvals from authorised agencies. In some countries, it is required by law that certain official feasibility exercises should be conducted. The legal feasibility report must mention the authorities that should be involved and to what extent they would be involved.

3. **In-depth legal analysis of the main project issues**

   The last step in legal due diligence is an in-depth analysis of various project issues such as use of land and other assets, rights of other users, tax and accounting issues, etc.

The three important objectives of carrying out legal feasibility study are:

- Ensuring that a project is legally doable.
- Facilitating risk management under which all prospective risks are studied and a mitigation plan is developed for the same.
- Avoiding all problems that could arise in the preparation and implementation of a project to the maximum possible extent.

3.2.6 ENVIRONMENTAL FEASIBILITY

You have already studied the importance of market feasibility, operational feasibility and technical feasibility in the successful management of a plant or project. Another major factor to be considered while setting up a project facility such as a plant is assessing its impact on the environment. For example, an industrial project that involves the use of chemicals may produce poisonous gases and other hazardous solid and liquid wastes that can cause environmental pollution. In addition, machines used in the project may also produce sound, heat and radiation, which can be harmful for living organisms. Therefore, before selecting the location of a plant, the organisation must properly examine the environmental impact of the project. Environmental feasibility assesses the impact that a project might potentially have on its surrounding environment. Organisations need to consider the following issues before selecting the location of a project:

- The types of waste materials produced
- Provisions for the decomposition of waste materials
- The impact of poisonous gases and other wastes on the environment
- Alternatives to minimise the hazardous effect of wastes

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3.2.7 SOCIAL FEASIBILITY

Whenever a project is carried out, it also affects various other entities and individuals. A project must be assessed in terms of the impact it will possibly have on the lives, livelihood, work, health or property of individuals or organisations that fall under project's area of influence. The social impact of a project depends entirely on the type and industry of the project. For example, the construction projects usually involve the use of land and may also require environmental clearances. Many a time, the land on which a project has been proposed is already inhabited by some people who need to be uprooted from there by giving compensation and another location to settle down. In addition, the acceptance and no objection of these people is also required. This is a case of project where the social impact of the project can be easily forecasted and measured upon realisation. However, there exist certain cases where social impact of the project is usually not clearly visible. This usually happens in the case of IT and software development projects. For example, Facebook was initially introduced as a social study tool by Mark Zuckerberg as a part of his project at Harvard. When it was introduced, it was largely limited to a small number of university students, but with time it became a rage and grew immensely. This project had both positive and negative social impacts. The positive benefits of social media platforms such as Facebook include ease of communication with friends, family and professional contacts. It addition, it also makes it easier to connect with new people and communicate at cheaper rates using calling or messaging facilities. The negative impact of these social media projects can include reduced privacy, increase in cybercrimes, new methods of fraud, etc.

A social feasibility analysis should specifically focus on the threats and negative impacts it can have on the society. In case, a social feasibility report states that a project would most probably have a negative impact on society, the sponsor should drop the project or look for ways in which such impact can be negated.

A social impact may also be related with environment. For example, construction of a resort in a private forest area may demand uprooting of a large number of trees which may have negative impact on the air quality in neighbouring areas. In such cases, despite the fact that the forest is the private property of an individual; the state or any other appropriate authority can stop individuals from carrying out the project or may instruct it to limit the deforestation activity to a particular level.

A social feasibility analysis reduces the overall risk of a project and resistance, generates support for the project and increases an understanding of costs and benefits of the project.

N O T E S

An exhaustive or full-scale social feasibility analysis can be expensive and time consuming; therefore, it is not recommended for all projects. A full scale social feasibility study should be ordered only after the initial project review shows possible social impacts.

NOTE

At times, the project feasibility study is also called project appraisal.

SELF ASSESSMENT QUESTIONS

1. Through __________ feasibility, an organisation assesses the level to which a project is suitable to meet the organisational objectives in an existing business environment.
2. The delivery date of a project is met if all activities associated with it are performed according to the project plan. (True/False)
3. A project is said to be operationally feasible if it conforms to the project schedule, date of delivery, organisational culture and existing business process of an organisation. (True/False)
4. After the selected technologies are compared and ranked on different aspect, they have to be assessed with respect to their _______________.
5. Cost of acquiring, installing and maintaining technology is not an important criterion in assessing technological feasibility of a project. (True/False)
6. _______ incorporates both positive and negative externalities in monetary terms.
   a. Economic analysis
   b. Financial analysis
   c. Social analysis
   d. Both (b) and (c)
7. Assume that a project team member is collecting information such as demand for new products or services, design of new products or services, needs of customers, etc.; he is possibly engaged in a __________ feasibility study.

ACTIVITY

Study a case based on the technological feasibility of a project. After studying the case, prepare a short report on it.

3.3 APPROACHES TO PROJECT SCREENING AND SELECTION

Many a time, an organisation is faced with a situation in which it has two or more interesting, challenging and lucrative projects (say n proj-

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ects) for its consideration but it can pick only a limited number of projects (say m projects) and m<n. In such a situation, it becomes important for the organisation to find a project that can utilise the project team's skillset and competence, has good chances of success and most importantly is rewarding in financial terms.

When an organisation can select all projects facing it; it usually selects all of them. However, in case an organisation has to select 'm' number of projects from the given 'n' number of projects (where m<n); it needs to use some methods to screen and select projects that should be pursued. This activity is termed as project screening and selection.

Project screening is a process under which all projects under consideration are assessed and classified into two categories namely projects that can be considered further and the projects that should be dropped. Project screening involves a preliminary examination of all the individual project applications in order to determine whether a more detailed, costly and time-consuming activity of business case development is required or will be reasonable to do so.

Project screening helps in generating preliminary indications for decision making and whether or not they should pursue given project opportunities. The organisation or the individual that screens projects utilises the special screening criteria using which different projects can be divided into suitable (matching the criteria) and unsuitable (not matching the criteria). All unsuitable projects are screened out and are not considered further. One of the most common screening methods is the project screening matrix. In the project screening matrix, all projects are listed down against all the screening criteria. In addition a qualitative statement regarding all the projects is also made. Each project is given certain points for meeting a particular criterion. The total score of all the projects along with the qualitative scores are compared. In this manner, the most suitable projects are taken up whereas all the others are dropped off.

Project screening is succeeded by the project selection stage. In the project selection stage, the most lucrative and beneficial projects are chosen. The project selection activity involves the use of a set of techniques. These are known as project selection methods. You will study about these methods in the upcoming section.

SELF ASSESSMENT QUESTIONS

8. An organisation 'A' is an infrastructure development company that usually develops different kinds of facilities for government agencies. It received proposals for development of certain infrastructure from five different government agencies. However, it can take up only three projects as per its manpower and management restrictions. In such a case, organisation 'A' will use the process of ________ to decide which projects it should take up.

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ACTIVITY

Make criteria for project screening and selection in software development projects.

3.4 PROJECT SELECTION METHODS

Project selection methods are broadly classified into two groups as shown in Figure 3.5:

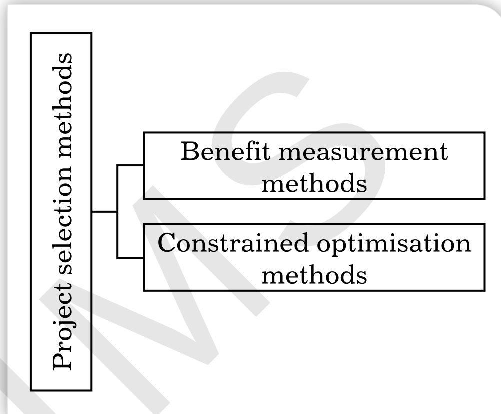

Figure 3.5: Classification of Project Selection Methods

Benefit measurement methods are those methods under which the prospective net benefit that would accrue from different projects under consideration are calculated and compared to each other. Projects that result in maximum benefit are selected by the project organisation. Benefit measurement methods include techniques as shown in Figure 3.6:

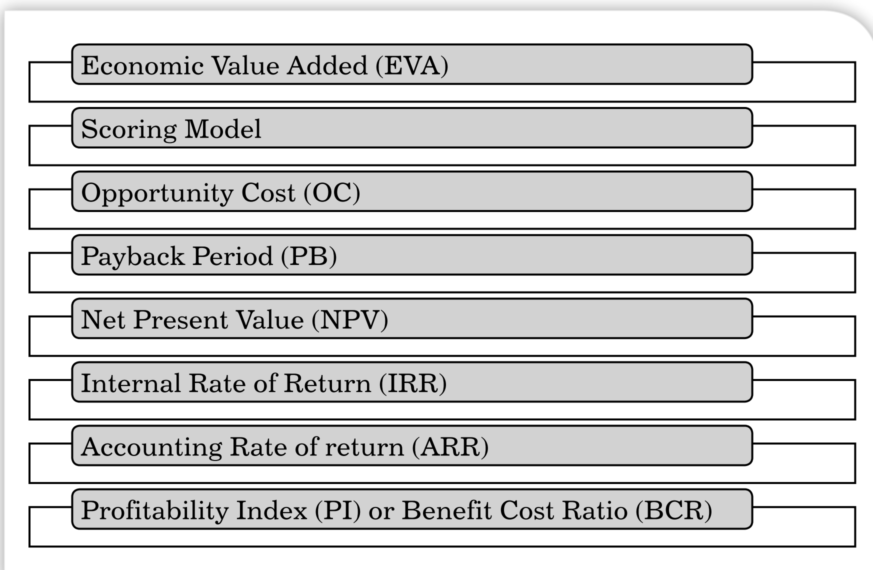

Figure 3.6: Benefit Measurement Methods

N O T E S

The benefit measurement methods can be broadly divided into two major categories namely financial models and non-financial models. Financial models of project selection include NPV Method, IRR Method, PB Method, ARR Method and Profitability Index (PI) Method. You will study these methods in detail in the upcoming sections. Let us now discuss the rest of benefit measurement methods briefly as follows:

ECONOMIC VALUE ADDED (EVA)

Earned Value Analysis (EVA) is the most widely used method of determining the progress of a project. It is also known as performance measurement, management by objectives, budgeted cost of work performed and cost schedule control system. This method is named as earned value because it integrates the expected performance with estimated cost and time. The EVA method helps the project manager to check for project performance at the early stage of the project life cycle and control them. This method is also used to determine project performance in future and the date of completion of the project. The EVA method determines the actual performance of the project and provides the project manager with an insight to assess potential risks involved in the project and prepare risk mitigation plans. In addition, it also evaluates the cost and time spent in relation to the amount of work done.

According to **Englert and Associates, Inc.**, *EVA is a method for measuring project performance. It compares the amount of work that was planned with what was actually accomplished to determine if cost and schedule performance is as planned.*

Project Magazine defined EVA as, *a methodology used to measure and communicates the real physical progress of a project taking into account the work complete, the time taken and the costs incurred to complete that work.*

The following three key elements of project information are used in EVA:

- **Planned Value (PV):** It is the budgeted cost to be incurred at a particular point of time for the planned work schedule. Therefore, it is also called the budgeted cost of work scheduled (BCWS).
- **Actual Cost (AC):** It is the money spent for the work actually accomplished. Hence, it is also called the actual cost of work performed (ACWP).
- **Earned Value (EV):** It is expressed as a percentage of the total budget actually completed at a particular point of time. It is also known as the budgeted cost of work performed (BCWP). EV is calculated by the following formula:

  EV=% of work completed × total budget.

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For example, consider a project for the installation of 700 computers in an office in 10 days. Only 455 computers are installed in 6.5 days. This means that 65% of the work (455/700) has been completed at 65% of the total time allocated. If the planned value or the budgeted cost for the project is ₹ 3, 00,000, the EV at 65% completion would be ₹1, 95,000 (0.65 × 3, 00,000). Now, if the actual cost or the time taken for 65% completion of the project is more than the EV calculated at 65%, there is a deviation, which needs to be corrected. In simple terms, the project can be considered to be on track as 65% of the time is used to complete 65% of the work within 65% of the budget.

SCORING MODEL

Under the scoring model of project selection, a group or committee is formed. The committee consists of various stakeholders and preferably experiences project managers. The committee members make a list of various criteria that they deem necessary for project selection. The committee then affixes a weightage with each criterion according to its relative importance and priority among all the criteria. Next, the committee adds all the weighted values and in this way, a score is assigned to each project. The project(s) with the highest score(s) are selected and pursued.

Let us understand this method clearly using an example. Let the project selection committee uses five criterion which includes profitability, technical difficulty, resource strain, risk and stakeholder support. The committee decides that profitability is the most important criterion and assigns weightage of 50% to it. Resource restrain is assigned 20% weightage and rest three criteria are assigned 10% weight each. Now, assume that the organisation has five projects under consideration. Here, the project committee needs to assign a score against each criterion for each project. It must be remembered that the sum of the scores assigned to each project must be equal to 100. This is shown in Table 3.1:

TABLE 3.1: WEIGHTAGE ASSIGNED TO EACH CRITERION ACCORDING TO SCORING MODEL

Criterion / Project	Profitability (50%)	Technical Difficulty (10%)	Resource Strain (20%)	Risk (10%)	Stakeholder Support (10%)
A	20	20	30	20	10
B	30	10	10	25	25
C	5	10	20	25	40
D	25	25	25	15	10
E	40	20	10	15	15

Let us now calculate the weighted scores for each project as follows:

Score of A = (0.5 × 20) + (0.1 × 20) + (0.2 × 30) + (0.1 × 20) + (0.1 × 10) = 10 +2 + 6 + 2 + 1 = 21

Score of B = (0.5 × 30) + (0.1 × 10) + (0.2 × 10) + (0.1 × 25) + (0.1 × 25) = 15 +1 + 2 + 2.5 + 2.5 = 23

Score of C = (0.5 × 5) + (0.1 × 10) + (0.2 × 20) + (0.1 × 25) + (0.1 × 40) = 2.5 +1 + 4 + 2.5 + 4 = 14

Score of D = (0.5 × 25) + (0.1 × 25) + (0.2 × 25) + (0.1 × 15) + (0.1 × 10) = 12.5 +2.5 + 5 + 1.5 + 1 = 22.5

Score of E = (0.5 × 40) + (0.1 × 20) + (0.2 × 10) + (0.1 × 15) + (0.1 × 15) = 20 +2 + 2 + 1.5 + 1.5 = 27

Therefore, here the project committee will select projects in order: E, B, D, A and C.

This method is used by organisations that place more weightage to some aspects of a project than other aspects. The weightage assigned by the organisation to different criterion depends heavily on prevailing conditions and may change over time. For example, if the organisation's stakeholders believe strongly in the management of an organisation, more weight will be assigned to stakeholder support. Similarly, if the organisation is facing a staff shortage, it will assign more weightage to resource constraints.

NOTE

When the project managers are usually faced with the task of selecting a few projects out of given number of projects; then, the project manager should keep in mind these three things:

1. Projects that are selected must be in line with goals and objectives of the organisation.
2. Projects selected should maximise the return on investment of the organisation.
3. Opportunity cost of projects must be a minimum.

OPPORTUNITY COST (OC)

Opportunity cost refers to the loss of potential future returns from projects that were not selected. It is that profit that an organisation will not incur when one project is selected over other projects. For example, assume that an organisation can choose only two projects out of five projects that result in profit of ₹10,000, ₹20,000, ₹15,000, ₹17,000 and ₹25,000 respectively. In this case, the organisation would choose second and fifth projects and leave the rest of the projects. Here, the opportunity cost for the organisation will be equal to sum of first, third and fourth project profits, i.e. ₹42,000.

Apart from the above numeric methods, certain non-numeric/non-financial methods can also be used for project selection. These include

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market share, client retention, skills requirement and availability, environmental clearances, statutory compliances, SWOT analysis, safety of employees and public, entry into a new product line or an entirely new market, availability of manpower and motivation, availability of suitable technology, interest of the nation at large, tax benefits, etc.

Constrained optimisation methods of project selection are also known as mathematical models or decision models. Constraint optimisation methods are usually based on five algorithms namely linear programming, non-linear programming, integer programming, dynamic programming and multiple objective programming.

Some methods under the constrained optimisation methods include decision trees, forced choice, analytical hierarchy process, logical framework analysis, etc. The study of these methods is beyond the scope of this book.

EXHIBIT

Concepts of Capital Budgeting and Time Value of Money

CAPITAL BUDGETING

Capital budgeting is a method of planning that is used to calculate the value of a long-term investment in a project. It involves recognising, assessing and choosing lasting investments in factory or equipment. It assists in calculating expenses and profits from a project. If the capital invested in a project does not yield profits, it is of no use to the organisation.

Important aspects of capital budgeting include:

- Growth of organisation
- Risks
- Arrangements of funds
- Irreversibility of investment decisions

TIME VALUE OF MONEY

Capital budgeting uses various methods, such as NPV and IRR, to calculate real expenditure and income received from different projects and evaluate the difference vis-à-vis profitability of the project. To know the real expenditure and income of a project, it is essential to be familiar with the concept of Time Value of Money (TVM).

TVM is based on the theory that the value of the present money is more than that of the equal amount of money in future. In other words, the actual worth or power to buy a particular amount of money decreases with time. For instance, the purchasing power of ₹100 might change after a year. Similarly, if various projects produce similar profits at various time intervals, the project with the earliest return is preferred. The value of money actually decreases with time because the available capital is used to derive profits from projects. Nevertheless, it is not easy to immediately invest in a project because the capital is yet to come. For instance, if there is a profit of ₹50,000, it can be used in potentially profitable projects. However, if the project receives this sum after two years, then the chance of investment is lost for those years.

Future the value of cash flows relates to the actual value of a cash flow or a chain of cash flows in future. For example, a project generates a profit of ₹1000. If this profit is invested in another project, which ensures a return at the rate of 5% per year, then the amount received will be ₹1050 next year. Therefore, the future value of ₹1000 will become ₹1050 after a year at the rate of 5% per annum.

FUTURE VALUE OF A SINGLE CASH FLOW

The future value of a single cash flow is the actual value of forthcoming money in future. For instance, a project needs an investment of ₹1000. The project will return a profit after one year at the rate of 5% per annum. Then, the earning from the project after a year will be the future value of money invested in the project.

Therefore, money received after one year = Principal + Interest

$= 1000 + (1000 \times 0.05)$

$= 1000 + 50 = 1050$

The future value of ₹1000 is ₹1050 at the rate of 5% per annum. Similarly, if ₹1050 is re-invested for the year to come, then the cash received will be ₹1102.5 in the following year.

Therefore, money received after two years = Principal + Interest

$= 1050 + (1050 \times 0.05)$

$= 1050 + 52.50 = 1102.50$

Assume P is the principal amount, I is the annual rate of interest, n is the number of years before pay off and F is the future value of the sum invested.

Then, the formula to calculate the future sum is as follows:

$F = P + I$

The future value after one year is:

$F_1 = P + P \times I = P\,(1+I)$

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The future value after second year is:

$F_2 = F_1 + F_1 \times I = F_1\,(1+I) = P\,(1+I)\,(1+I) = P\,(1+I)^2$

After three years, the future value will be equal to:

$F_3 = P\,(1+I)^3$

Therefore, the future value of an amount P after nth year will be:

$F_n = P\,(1+I)^n$

FUTURE VALUE OF ANNUITY

An annuity is a fixed and regular cash flow over a period. The future value of annuity is the real value of fixed and regular cash flows for a given period. It helps you to estimate the future value of the entire investment made in a project.

Let us calculate the future value of ₹100, which is being invested each year at the rate 10% interest per annum for a period of three years. Here, you cannot determine the future value of money with the formula for calculating the future value of single cash flow. This is because at the end of the initial year, the investment of ₹100 will give an interest for two years. At the end of the second year, an investment of ₹100 will give an interest for one year. Similarly, if ₹100 is invested at the end of the third year, it will not give any interest.

The future value of annuity of ₹100 is ₹331 at the end of the third year. This is derived from the following formula:

$F_3 = A\,(1+I)_2 + A\,(1+I)_1 + A\,(1+I)_0 = A\,[(1+I)_2 + (1+I)_1 + (1+I)_0]$

Therefore, the equation to calculate the future value of annuity is as follows:

$F_n = A\,[(1+I)^n{}_{-1}]/I$

Here,

F is the future value of annuity

A is the annuity amount

I is the annual rate of interest

n is the number of intervals

Here, $[(1+I)^n -1]/I$ is called the Compound Value Factor of an Annuity (CVFA).

PRESENT VALUE OF CASH FLOWS

Present value of cash flows is the existing value of the future cash flow over a period at a particular rate of return. The current value of cash flow is always less than the future value of cash flow. In other words, an amount of money received today will always have more value than the same amount in future. For example, a project is expected to yield ₹50,000 after three years. In this case, the actual worth of 50000 received after three years would be less than its worth today. Therefore, it is essential to determine the existing value of a project's returns to determine the real gains of the project.

A project may yield profits at different periods. In these situations, you can calculate the current value of the total profits from the project by determining the total current value of all annual returns. Let us determine how to evaluate the current value of a single cash flow and annuity.

PRESENT VALUE OF A SINGLE CASH FLOW

The present value of a single cash flow relates to the existing value of money to be received in the future. On the other hand, the future value of a single cash flow is the future value of money available at present. In the last section, you determined that for the current value of ₹1000, the future value ₹1050 is generated with the interest rate of 5% per annum at the end of the initial year and ₹1152.5 are generated at the end of the second year.

To calculate the current value of a single cash flow you can use the formula for calculating the future value of a single cash flow as follows:

$F_n = P + P \text{ X } I - P(1+I)^n$

Hence, the formula for assessing the present value of a single cash flow is:

Present Value (P) = $F/(1+I)$

Similarly, the present value of a single cash flow after n number of years would be:

$P = F_n[(1+I)^{-n}]$

PRESENT VALUE OF ANNUITY

The present value of annuity relates to the current value of all cash flows received or expected in future at equal intervals. The current

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value of annuity can be calculated by using the present value of single cash flow of each year. For instance, a project is expected to generate a profit of ₹100 at the end of each year for the next three years at the interest rate of 10% per annum. After three years, the current value of ₹100 would be:

100/(1+0.10)3 = 75.13

Likewise, the current values of ₹100 after two years and 1 year are 82.64 and 90.91, respectively. Therefore, the cumulative current value is:
90.91 + 82.64 + 75.13 = 248.68.

Present Value (P) = $A/(1+I) + A/(1+I)^2 + A/(1+I)^3 + \ldots + A/(1+I)^n$

$= A\,[1/(1+I) + 1/(1+I)^2 + 1/(1+I)^3 + \ldots + 1/(1+I)^n]$

3.4.1 FINANCIAL MODELS OF PROJECT SELECTION

NPV Method, IRR Method, PB Method, ARR Method, Profitability Index (PI) Method and BCR Method constitute financial project selection models. Let us study them as follows:

NPV METHOD

The NPV method is widely used to assess the profitability of a project. NPV is the variation between current cash inflows and outflows in a given project. NPV can be calculated as:

$NPV = C_1/(1+r) + C_2/(1+r)^2 + C_3/(1+r)^3 + \ldots + C_n/(1+r)^n - I_0$

$$NPV = \sum_{(t-1)}^{n} \frac{C_t}{(I+r)^t} - I_o$$

Where:

C_t = Net cash received at the end of year t
I_0 = Initial investment outlay
r = Discount rate/The required minimum rate of ROI in a project
n = Time duration of the project (in years)

Steps involved in the calculation of NPV are discussed as follows:

1. **Forecasting cash flows:** In this step, you calculate cash inflows and outflows in a particular period of the project. The estimated cash flows will assist you in calculating the actual profitability of the project.
2. **Estimating required rate of return:** In this step, you calculate the required rate of return of a project at which the current cash flow value is estimated. The opportunity capital cost is usually assumed as the required rate of return.

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3. **Calculating the present value of cash flows:** In this step, you determine the current value of cash inflows and outflows by using a discount rate.
4. **Finding out NPV:** In this step, you verify the NPV of the project by subtracting the current cash outflows value from the current value of cash inflows. If the NPV is positive (NPV>O), then the project should be accepted, and if it is negative (NPV<O), then it should be discarded.

Rule of thumb for accepting or rejecting a project according to the NPV technique:

- Accept when NPV > 0
- Reject when NPV < 0
- May Accept or Reject when NPV = 0

In conclusion, the NPV method is a result-oriented technique that helps to select a project efficiently. However, it also has a major disadvantage that it is based on predicting cash flows occurring throughout the project lifecycle. In real life, it is not easy to predict such cash flows.

Illustration 1: Project (A) costs ₹5000 and is expected to generate cash flows of ₹1800 in the 1st year, ₹1600 in the 2nd year, ₹1400 in the 3rd year, ₹1200 in the 4th year, and ₹1000 in the 5th year. The cost of capital or the required rate of return is 10%. You are required to check whether Project (A) should be accepted or rejected using the NPV technique. You are given that the present value of ₹1 at 10% is given to be 0.909 for the 1st year, 0.826 for the 2nd year, 0.751 for the 3rd year, 0.683 for the 4th year and 0.621 for the 5th year.

Solution: NPV can be calculated as shown in Table 3.2:

TABLE 3.2: CALCULATION OF NPV

Year	Cash Inflows (₹) (I)	Present Value Factor @10% (II)	Present Value of Cash Inflows (₹) (III = I × II)
1	1800	0.909	1636.20
2	1600	0.826	1321.60
3	1400	0.751	1051.40
4	1200	0.683	819.60
5	1000	0.621	621.00
Total Present value (PV) of Cash Inflows			5450
(-) Initial Investment/Cost			5000
Net Present Value (NPV)			450

N O T E S

The NPV of the project is positive (+ ₹450). This implies that it will increase the owner's wealth; therefore, it should be accepted.

IRR METHOD

The IRR method is a time-based method used to assess capital investment decisions and choose potentially profitable projects. The internal profit rate is the discount rate that makes NPVs of all cash flows equal to nil. In other words, IRR stands for the rate of interest at which the NPVs of all expenses made on a project (cash outflow) equals to the NPVs of all revenues earned out of the project (cash inflow).

For example, an organisation is planning a new project. The current cost of the project is ₹2, 00,000. The income expected from the project is:

- ₹12,000 at the end of the first year
- ₹10,000 at the end of the second year
- ₹8,000 at the end of the third year

Let us assume that the discount rate r will make NPV of the project equal to zero.

Therefore, $12000/(1+r) + 10000/(1+r)^2 + 8000/(1+r)^3 - 200000 = 0$

Here, r = IRR of the project

Here, we can determine r by solving the equation, we can find out the IRR of the project, which would make the NPV of the project equal to zero. If the IRR of the project is greater than the cost of capital of the project, the project is accepted. However, a project must be rejected if the IRR of the project is less than the cost of capital of the project. In this method, the profitability of a project is represented as a percentage, which is easy to compare with the cost of capital or the capital expenses.

PB METHOD

The Payback Period (PB) method is a traditional method to assess investment in a project. The payback period refers to the time consumed to retrieve the earlier expense of the project.

The fundamental theory of the PB method is that if the initial expense of a project is earned quickly, then the project is considered to be profitable. This method grades projects according to the time taken for recovering the investment (length of the payback period). The projects that take less time to recover initial costs are graded higher than the projects that take more time for payback. The payback period is usually expressed in years and can be calculated using the following formula:

Payback Period = Investment required for the project/Net annual return or cash inflow

For example, the starting expense of a project is ₹1, 20,000 and the return anticipated is 15,000 each year for a period of 15 years. The payback period of the project comes to 120000/15000 = 8 years. Hence, you can recover the initial investment of the project, i.e., ₹1, 20,000 in eight years.

The PBP method is objective and simple in nature; therefore, it saves time and cost. This method is also useful in measuring the liquidity of a project as it shows the time period in which the initial cost of a project is recouped. In addition, the payback period method helps project managers to make project selection decisions easily. However, the main limitation of this method is that it does not take the TVM factor into account; therefore, the exact profitability of the project is not measured. This method makes it easy for managers to select a potentially profitable project. However, a drawback of this method is that it does not consider the TVM factor and therefore, cannot measure the exact profitability of a project.

ARR METHOD

The Average Rate of Return (ARR) method is also called the Accounting Rate of Return or Return on Investment (ROI) method. It is a traditional method of assessing the investment done on a project. This method is considerably different from other methods of choosing a project because it deals with the accounting gains of a project instead of cash flows. The ARR method does not consider the time period, which is used to calculate the rate of return of cash flow. The mathematical formula for calculating ARR is as follows:

ARR = (Average Income/Average Investment) × 100

Here, the average income is defined as Earnings Before Interest and Taxes (EBIT). EBIT relates to the total gain from a project before the payment of interest on capital and taxes. The average investment is calculated as follows:

Average Investment = (Book value at the beginning of the project + Book value at the end of the project life)/2

For example, an organisation takes a project that needs an investment of ₹60,000. The project will give Earnings Before Depreciation, Interest and Taxes (EBDIT) of ₹15000, 18000, 21000, 24000 and 30000 per year, respectively, for the next five years. Assume that depreciation is

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based on a straight line and rate of interest is 40%. Table 3.3 depicts the estimation of ARR of the project:

TABLE 3.3: CALCULATION OF ARR

	First Year	Second Year	Third Year	Fourth Year	Fifth Year	Average
EBDIT	15000	18000	21000	24000	30000	108000/5=21600
Depreciation	12000	12000	12000	12000	12000	12000
EBIT	3000	6000	9000	12000	18000	9600
Taxes at 40%	1200	2400	3600	4800	7200	3840
[EBIT(=I-T)]	1800	3600	5400	7200	10800	5760
Book value of investment						
Beginning	60000	48000	36000	24000	12000	
Ending	48000	36000	24000	12000	0	
Average	54000	42000	30000	18000	6000	30000

Hence, the ARR = (5760/30000) ×100 = 19.2%

You can grade various projects based on their ARR. The project with the highest ARR is graded as the highest and the one with the least ARR is graded as the lowest.

The ARR method can be used to do accounting of data. Hence, there is no need to calculate the single cash flow. The ARR method considers the accounting profit rather than cash flows while evaluating the profitability of a project. This also involves items where cash is not required. Hence, it is not considered right to accept or discard a project based on accounting profit. Also, the method does not consider the TVM factor. In this situation, it is not possible to show the actual value of a project by calculating the productivity.

PROFITABILITY INDEX (PI) METHOD

Profitability Index (PI) is another time-based method used for evaluating investment proposals. This method is also known as benefit-cost ratio. The Benefit/Cost Ratio refers to the ratio between the Present Value of Inflow to the Present Value of Outflow (or the cost invested in a project). This gives the value of return from a project. Projects that have a higher Benefit Cost Ratio (or lower Cost Benefit Ratio) are generally chosen over other projects.

NOTES

The formula used to calculate the profitability index or the benefit-cost ratio is as follows:

PI = PV of cash inflows /Initial cash outflow or initial investment

As with other methods, such as the NPV and the IRR, the acceptance rule exists in the case of the PI method too. Following are the rules of acceptance in PI:

- A project is accepted if the PI is greater than 1
- It is rejected if the PI is less than 1
- It may or may not be selected if the PI of the project is equal to 1

Note that projects with positive NPV have positive PI and the projects with negative NPV have negative PI. Let us study the PI method with the help of a suitable example.

The initial investment of a project (X) is ₹2,20,000 and it generates cash inflows of ₹80,000 in the 1st year, ₹60,000 in the 2nd year, ₹1,00,000 in the 3rd year, and ₹40,000 in the 4^{th} year. The cost of capital is given to be 10%. It is further given that the present values of Re.1 at 10% are 0.909 for the 1^{st} year, 0.826 for the 2^{nd} year, 0.751 for the 3^{rd} year, and 0.683 for the 4^{th} year. You have to determine whether the project should be accepted or rejected on the basis of the PI method. The present value of cash inflows can be calculated as shown in Table 3.4:

TABLE 3.4: CALCULATION OF THE PRESENT VALUE

Year	Cash Inflows (₹) (I)	Present Value Factor @10% (II)	Present Value of Cash Inflows (₹) (III = I × II)
1	80,000	0.909	72,720
2	60.000	0.826	49,560
3	1,00,000	0.751	75,100
4	40000	0.683	27,320
Total Present Value of Cash Inflows			2,24,700

Therefore,

PI = 224700/220000 =1.0214

Now, since the PI is greater than 1, the project is recommended to be accepted.

Some of the advantages of PI are as follows:

- Takes the TVM factor into consideration.

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- Emphasises on shareholder's wealth maximisation. If a project with PI greater than 1 is accepted, then as you have come across, it would have greater NAV. This implies that such projects increase shareholder's wealth.
- Considers all cash flows of the project.

Apart from these advantages, there are disadvantages of the PI too. If two projects have different useful lives, it is difficult to calculate the PI in such a case. In addition, it is difficult to estimate the cost of capital.

SELF ASSESSMENT QUESTIONS

9. For calculating the ARR, one must know the average income and average investment of a project. Average investment is calculated as the mean of ________ at the beginning and end of the project.
10. There are two projects A and B having IRR of 20% and 22% respectively. The cost of capital for A and B is 25% and 15% respectively. In this case, the project selectors should:
    a. Select both A and B
    b. Reject both A and B
    c. Select A and reject B
    d. Select B and reject A

ACTIVITY

Prepare a case study on the relative efficiency, effectiveness and use of different financial project selection models. Also describe which method is the best one after thoroughly evaluating their pros and cons.

3.5 RISKS INVOLVED IN PROJECT SELECTION

Irrespective of how accurately you predict the operations of a project, there exists a possibility that the project may diverge from the prediction operation. This divergence of the economic operation of a project from the predicted operation is called a risk involved in project selection. There can be various types of risks involved in project selection, such as shortage in requirements, unbalanced flow of cash and high price rise. For example, the requirement of a product depends on the financial atmosphere. If there is sudden financial growth, the product requirement may go high, and during economic decline, it can go down. Therefore, an organisation can earn more revenue or face a major loss depending on the market atmosphere. This implies that

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risks involved in project selection are responsible for probable risks affecting the delivery of the project.

Figure 3.7 shows some common types of project risks:

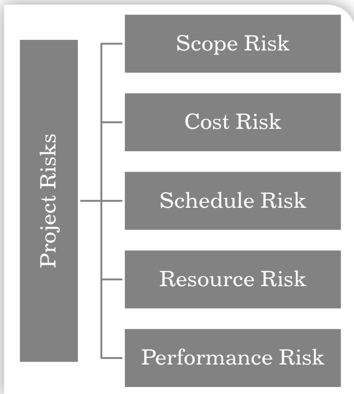

Figure 3.7: Types of Project Risks

Let us discuss each risk in detail:

- **Scope risk:** This risk is related to the tasks that need to be executed. Such risks influence all the facets of a project, especially the expenses, resources, agenda and value of the project. A solid scope is the basis of success for a project. If the scope is not properly defined, then the project is likely to fail.
- **Cost risk:** The expenses of a project increase with time. If the scope and schedule of a project are miscalculated, then the project productivity and feasibility suffer. Projects that extend over many years are more vulnerable, as the future expense of the project, which is calculated in the initial stages, may increase substantially due to price rise and decrease the buying power. To prevent this risk, organisations repeatedly monitor and control their large projects. A considerable financial support comes from debts and high interest. If prices go up, the balanced debt increases, pressurising the business profits.
- **Schedule risk:** This risk happens as activities may take time beyond expectation. Slippage in schedule by and large increases the prices and also holds up/lessens the profits as anticipated. This type of risk is critical when various groups are doing the same project and dependent on each other.
- **Resource risk:** The most common and vital resources invested in a project are people. If a project has unskilled, untrained and ineffective staff, then it is likely to fail. A project is also in jeopardy if resources like revenue, equipment and raw materials are not readily available.
- **Performance risk**: This is a risk that incurs when a project's results are not consistent with the particulars of the project. Even if

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a project finishes on time and gives the complete work, it is unsuccessful if a deliverable is not as expected. Performance does not depend only on the technical specification or measurable parameters. Customers' satisfaction, experience and insight also matter.

Let us consider an example to understand the types of risks. A leading construction company in India called Trimiti Developers has won a contract to build an 'A' level divider road in a city. According to the initial estimates, Trimiti will complete work in 18 months at the cost of ₹10 crores. However, they failed to include the time it would take for the construction company to acquire the land from the farmers on the side of the road. Two months after the project started, the government gave permission to Trimiti to acquire land from the farmers.

However, it was easier said than done. Trimiti had no experience in the field of bulk land attainment. The construction project was delayed as the company got embroiled in long-winding negotiations with the farmers, who were asking for a higher cost than the market to sell their farms. Consequently, the project was delayed by 4 months due to the land attainment exercise. During that period, the rates of steel and cement shot up by 15%, thereby, impacting the cost of the project. To compensate for the delayed time, Trimiti calculated that it had to work in three shifts as well as overtime. However, it could not arrange workers who could work in three shifts. So, it decided to make half of the road available, while the other half was being constructed. Despite these extra means, it could not arrange workers for the whole project site. It had to carry on work in various stages. Finally, it took 27 months to complete the work, which was 11 months more than the initial estimated time, at the cost of ₹16 crores, which was ₹6 crores more than the initial estimated cost.

3.5.1 CONCEPT OF RISK MANAGEMENT PLAN

There should be a plan to manage risks involved in a project. Such a risk management plan helps to avoid and/or mitigate project risks. The purpose of a risk management plan is to determine the method, strategy and actions to identify reduce, and remove the potential risks in the project. The primary objectives of a risk management plan are as follows:

- To identify risks in a project
- To help in finishing the quantitative and qualitative evaluation of a project
- To analyse planning for responding to risks
- To monitor risks
- To assess the life of a project with continued activities related to risk management

NOTES

The level of risk management planning varies from project to project. For instance, a non-complicated project with less effort involves low level of planning as compared to a complicated, urgent project. If you under-plan a risk management plan, then it can result in overstating of the risk. On the other hand, if you inadequately plan for risks, then it can result in the project failure. Figure 3.8 shows the relation between project priority and level of risk planning:

Figure 3.8: Relationship between Project Priority and Risk Planning

According to Figure 3.8, the level of risk planning increases with the growing priority of a project.

Risk management planning should consider the following characteristics:

- **Methodology:** Refers to the process of risk management and how to take care of the ensuing changes.
- **Roles and responsibilities:** Refers to the ownership of risk management. Although the manager is responsible for the entire risk management process, the actual owners vary from one activity to another. Each responsibility should be adequately explained and supervised.
- **Budgeting:** Refers to the budget for the project activities. It is not enough to just calculate the possibility of a budget. Risk management should also consider the procedure for safeguarding any extra budget.
- **Scheduling:** Refers to a detailed timeline; it defines which activities will be done when.
- **Risk analysis scoring:** Refers to a branch of planning that indicates which risk has more weight and therefore, needs a prompt action. Risk management planning depends on the scoring of risks.
- **Threshold:** Refers to the reaction of a risk. Thresholds can be fixed before a risk occurs so that the response to the risk can be launched on schedule and not after the risk has occurred and caused a damage.

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- **Reporting formats:** Refer to risks related to communication. The content and/or occurrence of reporting formats may vary among different stakeholders. Their expectations should be recorded as part of risk management planning.
- **Tracking/Monitoring:** Refers to a document that tracks or monitors the ongoing activities of the project.

3.5.2 EXECUTING RISK MANAGEMENT PLANNING

Before implementing a risk management plan, it is important to formulate a team for risk management. Each member of the team should be assigned specific roles and responsibilities. In many organisations, these roles are predefined to inspire risk management planning, implementation of relevant decisions and participation of project members.

A project manager must know his/her strength and sovereignty regarding the project. For instance, he/she prepares a risk management plan and identifies the appropriate responses to the project risks outlined in the plan.

It is also important to identify the key stakeholders of the project. Although the project manager is the leader, the stakeholders examine his activities and performance. This is because the project manager executes the project on behalf of sponsors and key stakeholders. Therefore, he/she is required to work with the limitations of the organisational structure and authorisation of stakeholders.

3.5.3 PARTICIPANTS IN RISK MANAGEMENT PLANNING

Risk management planning starts at the initial stage of a project. First, a context is established, which fixes the infrastructure of the risk management plan. Then, people are enrolled to participate in risk management planning. It is important to enroll appropriate participants in this planning to ensure the success of the project.

As an example, consider the Tata Nano project in Unit 1 and the controversy linked with it. In 2006, Tata Motors declared that it would manufacture Nano car in Singur, West Bengal.

The company started talks regarding land acquirement with the state government. Soon, there was a controversy regarding forceful acquirement of land of the farmers for constructing a new factory. Tata Motors did not expect that the local farmers would be one of the stakeholders. This controversy turned into a political battlefield. Various political parties targeted the Nano project by either supporting or opposing the plant. Hence, the acquirement of the land and setting up of the factory were delayed.

NOTES

Now the question arises: What was the main reason of this controversy? Tata Motors management in fact did not acknowledge the local farmers, who were suffering due to the construction of the factory, since they were the important stakeholders.

There are two types of stakeholders:

- Positive stakeholders, who profit from the project or inspire positively
- Negative stakeholders, who are affected by the project or inspire negatively

Normally, the stakeholders who are positive are included in the risk management planning and their interests or risks alone are selected. However, the Nano project proved costly for the negative stakeholders. The impact of this case was so much that Tata Motors closed the Nano project in West Bengal and moved it to Gujarat. Actually, still after 8 years, the consequence of the incident can be felt, as the matter regarding land allotment is still in the course.

Let us see and consider what the management could have exclusively done. Assume that the planning is underway, and the manager needs to recognise the members. The stakeholder register document registers the members in a document that has all the information regarding the stakeholders. The project identifies the positive and negative stakeholders. It is important to identify negative stakeholders because they can augment the risk greatly, just as the farmers in the Nano case. Until all the stakeholders are recognised, one cannot envisage the influence they have and the risks involved.

However, a question arises whether that is a need to employ all the stakeholders in the risk management planning. Simply, the answer is, 'No'. There is no need for all stakeholders to participate. In many cases, this is not viable. And even if it had been possible, it would have been quite unruly. For instance, they all possess different nature and their purpose of involvement is also different. Some of them require more income along with high risk, while some demand moderate income with no risk involved. Then, there may be some stakeholders who would want to participate in the project. In this situation, if all stakeholders are allowed to participate in this process, then joint decision cannot be taken. Therefore, only few are included during planning.

The project manager must make sure that the stakeholders are recognised accurately and their intentions and purpose are signified. This helps him/her to make decisions regarding the roles and responsibilities of stakeholders. These roles and responsibilities are used for recognising groups and persons who would participate in the leadership and be a part of every activity classified in the plan. In some cases, the team not belonging to the project may possess more practical, impartial method of recognising the risk, effect and risk management in general, as compared to the real team.

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3.5.4 STEPS IN RISK MANAGEMENT PLANNING

Risk management planning has different steps than the risk management process. The steps in planning help in determining and reorganising the risk management process. Figure 3.9 shows the risk management planning process:

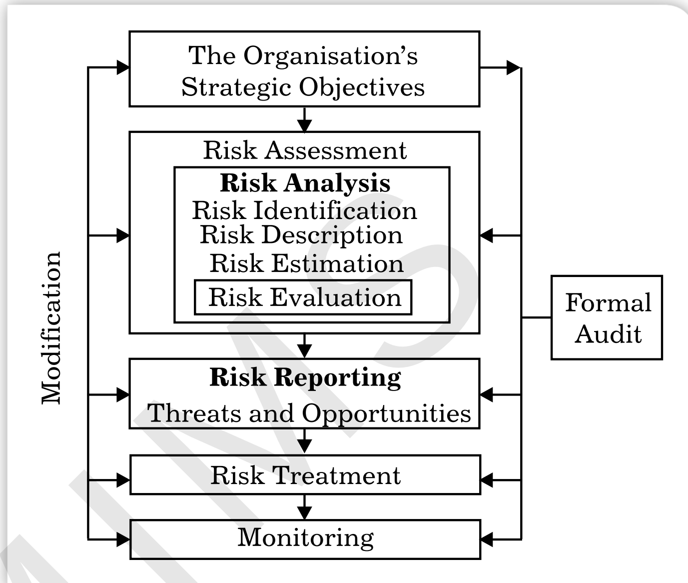

Figure 3.9: Risk Management Planning Process

The steps taken in the risk management planning process are as follows:

1. **The organisation's strategic objectives:** In this step, the project manager describes and understands the strategies of the organisation and how they are associated with the project. This enables him/her to establish the context of risk management, which aims to avoid any risk to the project. After understanding the organisation's strategic objectives, the project manager aims to complete the project successfully and manage the risks linked with the project expenses. A part of this planning is to identify a core team for risk management and define their roles and responsibilities. On the basis of the strategic goal and the budget of the project as a whole, the manager sets a lump sum amount for managing the project. The amount can be based on the rule of thumb (specific proportion of the entire budget), past data (contingency budget set aside for historical projects of similar type) or a standard of industry (standardising the expenditures).
2. **Risk assessment**: In this step, the project manager calculates and assesses a risk. He/she evaluates the risk assessment requirements, equipment, budget, resources and governance model. Risk assessment can be quantitative or quantitative, and resources should be available for either type. For quantitative

risk assessment, the project manager requires expensive software and system equipment. For qualitative risk assessment, the project manager needs to hire subject matter advisors and experts. The risk management team collects inputs from the concerned people and prepares high-level expense and schedule estimates for the risk assessment stage.

3. **Risk reporting:** Risk reporting is a complementary step with regular reporting of the project status. In this step, the risk management team prepares a report of threats and opportunities. They prepare more than one format to report the risk level and then send these templates to the beneficiaries for their approval. After they have accepted the reports, the reports are finalised and filed in the risk management plan. The risk management plan also includes the ownership and accountability information of the risk reports. The plan also documents the procedure of spontaneous reporting and communication. It includes situations and circumstances where communication regarding risk is needed, as well as channels/modes of communication. Finally, the plan may include an escalation matrix, which is prepared and distributed within the project team to make them aware about the escalation hierarchy in case a risk happens and the response is not enough. On the basis of this risk reporting step, the risk management team evaluates whether a risk is acute and needs a plan for alleviation.
4. **Risk treatment:** It is hard to express how to respond to or treat risks. Therefore, they should be planned during the initial stage of the project itself. Risk treatment depends on the incidents reported. Still, a risk management plan can include a generic guideline of risk treatment. For instance, if risk treatment involves 'add more manpower to speed up work', then the plan can include corresponding actions for the project manager to remove the risk.
5. **Monitoring:** This is a significant stage of risk management. When all is going well, then there are fewer risks, however, they need to be closely monitored. The risk management plan should include the controls and checks, and balances used in the monitoring stage. Actually, risk monitoring and controlling work in tandem with risk reporting. In risk reporting, the manager reports potential risks and their status. If these risks are monitored thoroughly, it becomes easy to report them.
6. **Modifications and audit:** These stages finish the feedback cycle and continuous improvement of the risk management process. The risk management plan should explain the situations where the process would be modified and how. An important part of the risk management process is audit, which can be internal and external. An internal audit is a good practice within an organisation that offers a third party's view on the risk management process.

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An external audit is a mandatory exercise from the compliance perspective or as a customer requirement. The risk management plan should clearly outline the requirements and frequency for external and internal audits.

3.5.5 DEFINING THE METRICS, TOOLS AND BEST PRACTICES

The steps in the previous section comprise the risk planning process. However, there is one step that covers the entire risk plan. This step is about defining the metrics, tools and best practices of risk management planning.

DEFINING THE METRICS

Assume that you want to define metrics in the qualitative risk assessment step. To do so, you can use the risk probability and impact matrix, which is shown in Figure 3.10:

		Impact		
		Low	**Medium**	**High**
Probability	**High**	low	medium	high
	Medium	low	medium	medium
	Low	low	low	low

Figure 3.10: Risk Probability and Impact Matrix

Courtesy: http://stevestedman.com/2012/03/risk-assessment-matrix-for-sql-server-upgrades/

PROBABILITY

- **High (H):** Greater than <70%> probability of occurrence
- **Medium (M):** Between <30%> and <70%> probability of occurrence
- **Low (L):** Below <30%> probability of occurrence

IMPACT

- **High (H):** Risk that has the potential to greatly impact the project cost, schedule or performance

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- **Medium (M):** Risk that has the potential to slightly impact the project cost, schedule or performance
- **Low (L):** Risk that has the least impact on the project cost, schedule or performance

DEFINING THE TOOLS

Similarly, you should define and list the equipment required during the risk management process in the planning phase. This will help you to easily choose and use the most appropriate tool to mitigate risks.

DEFINING THE SYSTEMS

In this phase, you also report the best systems appropriate for the project. They are like the points of reference or the first steps whenever a risk happens.

KEY INPUTS IN RISK PLANNING

Let us summarise the key inputs used in risk planning:

- **Project charter:** It provides a high-level objective and scope of the project.
- **Organisation's risk management policies:** These are predefined policies and methods that were prepared by some organisations for risk analysis and response. These policies are then customised according to the needs of the project.
- **Defined roles and responsibilities:** They refer to distinct roles and responsibilities along with their stages of authority that help in successful risk planning of projects.
- **Stakeholder risk tolerances:** They help to identify appropriate responses to different risk levels.
- **Risk management plan template:** It is a formal template of a risk management plan. An organisation should fill all the sections of this template.
- **Work Breakdown Structure (WBS):** It is the smallest unit of measurement of work that helps to achieve a good level of granularity in risk planning.

SELF ASSESSMENT QUESTIONS

11. Which risk in project management depends on the skills and training of manpower?
    a. Scope risk
    b. Resource risk
    c. Schedule risk
    d. Cost risk

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12. Which stage in risk management planning identifies threats and opportunities in a project?
    a. Organisation's strategic objectives
    b. Risk assessment
    c. Risk reporting
    d. Risk treatment
13. The level of risk planning increases with the growing _______ of a project.
14. Controls, checks and balances are used in the _________ stage of project risk management planning.

ACTIVITY

Using the Internet, identify the various risks involved in construction projects.

3.6 SUMMARY

- Feasibility analysis is also called feasibility study. It is a study that helps in assessing the positive and negative aspects of a project. Feasibility study is a broad term and used to assess the strengths and weaknesses in a number of areas.
- Through operational feasibility, an organisation assesses the level to which a project is suitable to meet the organisational objectives in an existing business environment.
- Market feasibility is a study aimed at judging whether or not a project would be able to satisfy customer's needs or not.
- In order to run a successful project, it is important to weigh all the available alternative technologies and select the one that is most appropriate in the prevailing circumstances.
- Financial analysis of a project is used to document a rate of return on investment that can be expected from the project.
- Economic analysis of a project is carried out in order to evaluate the impact of the project on the society as a whole.
- Legal feasibility study is conducted to determine whether a proposed project conflicts with legal and/or regulatory requirements or not.
- Environmental feasibility assesses the impact that a project might potentially have on its surrounding environment.

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- Social feasibility assessed in terms of the impact it will possibly have on the lives, livelihood, work, health or property of individuals or organisations that fall under project's area of influence.
- In case an organisation has to select m number of projects from the given n number of projects (where m<n); it needs to use some methods to screen and select the projects that should be pursued. This activity is termed as project screening and selection.
- Project selection methods are broadly classified into two groups: benefit measurement methods and constrained optimisation methods.
- Benefit measurement methods are those methods under which the prospective net benefit that would accrue from the different projects under consideration are calculated and compared to each other.
- Benefit measurement methods include: Economic Value Added (EVA), Scoring Model, Opportunity Cost (OC), Payback Period (PB), Net Present Value (NPV), Internal Rate of Return (IRR), Accounting Rate of return (ARR) and Profitability Index (PI) or Benefit Cost Ratio (BCR).
- Irrespective of how accurately you predict the operations of a project, there exists a possibility that the project may diverge from the prediction operation. This divergence of the economic operation of a project from the predicted operation is called a risk involved in project selection.
- Some common types of project risks include: scope risk, cost risk, schedule risk, resource risk and performance risk.
- A risk management plan helps to avoid and/or mitigate project risks.
- Before implementing a risk management plan, it is important to formulate a team for risk management.
- There are two types of stakeholders in a project: positive stakeholders and negative stakeholders.
- Steps taken in the risk management planning process include: organisation's strategic objectives, risk assessment, risk reporting, risk treatment and monitoring.
- Key inputs used in risk planning: project charter, organisation's risk management policies, defined roles and responsibilities, stakeholder risk tolerances, risk management plan template and Work Breakdown Structure (WBS).

KEY WORDS

- **Business environment:** It refers to the combination of all the external and internal factors that influence a business.

N O T E S

- **Development schedule:** It refers to a schedule containing information regarding the various tasks and the time required to complete those tasks. A schedule usually lists various tasks along with start and end dates.
- **Due diligence:** It refers to a process of scrutiny applied to an individual, business or contract to validate the information provided by them.
- **Installed capacity:** It refers to the maximum amount of production that can be generated from a plant or factory if it operates with its maximum capacity.
- **Organisational culture:** Organisational culture refers to a system of shared assumptions, values, and beliefs in an organisation. People in the organisation behave differently under different cultures. Organisational culture directly impacts the performance of employees.
- **Rate of Return on Investment (ROI):** ROI refers to the percentage return or benefit accrued to an individual or organisational investor as a result of investment of some resource.

3.7 DESCRIPTIVE QUESTIONS

1. Describe the concept of feasibility study.
2. Explain the various components of a feasibility study.
3. Discuss the concept of project screening and selection.
4. Describe any two financial models of project selection with illustration.
5. Explain the various types of risks involved in project selection.
6. List and explain the steps involved in risk management planning.

3.8 ANSWERS AND HINTS

ANSWERS FOR SELF ASSESSMENT QUESTIONS

Topic	Q. No.	Answers
Feasibility Analysis	1.	operational
	2.	True
	3.	True
	4.	acquisition aspects
	5.	False
	6.	a. Economic analysis
	7.	market

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Topic	Q. No.	Answers
Approaches to Project Screening and Selection	8.	project screening and selection
Project Selection Methods	9.	book value
	10.	d. Select B and reject A
Risks Involved in Project Selection	11.	resource risk
	12.	c. Risk reporting
	13.	priority
	14.	monitoring

HINTS FOR SELF ASSESSMENT QUESTIONS

1. A project feasibility study helps in discovering the different variables that affect the project and can potentially have an impact on the project's success. Project feasibility study is usually carried out in the initiation phase of a project and is the second document that is created after the creation of the business case. Refer to Section **3.2 Feasibility Analysis.**
2. Various components of a feasibility study include: operational feasibility, market feasibility, technical feasibility, economic & financial feasibility, legal and regulatory feasibility, environmental feasibility and social feasibility. Refer to Section **3.2 Feasibility Analysis.**
3. Project screening is a process under which all the projects under consideration are assessed and this assessment helps in classifying the projects into two categories namely projects that can be considered further and the projects that should be dropped. Project screening is succeeded by project selection stage. In the project selection stage, the most lucrative and beneficial projects are chosen. Refer to Section **3.3 Approaches to Project Screening and Selection.**
4. NPV Method, IRR Method, PB Method, ARR Method and Profitability Index (PI) Method (BCR Method constitute the financial project selection models. NPV is the variation between the current cash inflows and outflows in a given project. The internal profit rate is the discount rate that makes the NPVs of all cash flows equal to nil. Refer to Section **3.4 Project Selection Methods.**
5. Common types of project risks include: scope risk, cost risk, schedule risk, resource risk and performance risk. Refer to Section **3.5 Risks Involved in Project Selection.**
6. Steps taken in the risk management planning process include: organisation's strategic objectives, risk assessment, risk reporting, risk treatment and monitoring. Refer to Section **3.5 Risks Involved in Project Selection.**

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3.9 SUGGESTED READINGS & REFERENCES

SUGGESTED READINGS

- Kim Heldman. (2011). PMP Project Management Professional Exam Study Guide (6th ed.). New York: Wiley.
- Gregory T. Haugan. (2002). Project Planning and Scheduling. Management Concepts Inc.

E-REFERENCES

- Capital Budgeting. Retrieved from http://accountingexplained.com/managerial/capital-budgeting/
- Capital Budgeting Techniques. Retrieved from http://www.cliffsnotes.com/more-subjects/accounting/accounting-principles-ii/capital-budgeting/capital-budgeting-techniques

4
CHAPTER

COST ESTIMATION AND BUDGETING

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INTRODUCTORY CASELET

THE EDEN PROJECT BUDGETING

Eden Project is a visitor attraction that was developed as a recreation of rainforest in an area that was previously a worked out China Clay quarry. It has an area of approximately 35 acres and it houses great domes that are 300 ft. in height each. These domes are filled with thousands of plants and trees. Two major domes emulate the environmental conditions of a rainforest and Mediterranean biomes. Rainforest dome is the largest one. Apart from these great domes, there are other things or structures such as sculptures, play areas, vegetable gardens, etc. The core message of the Eden Project is environmental conservation, education and sustainability.

The Eden Project was conceived by Tim Smit. The project construction was started in 1998. Eden is located near Cornwall, England. The Eden project had to be developed into a visitor attraction from a large clay pit.

Source: https://www.activitysuperstore.com/days-out/eden-project-entrance-for-two/product-index-nedn

It was a large scale project and was completed with the help of the following project team members:

- Nicholas Grimshaw (Architect)
- Anthony Hunt and Associates (Engineering firm)
- Davis Langdon (Project Management)
- Sir Robert McAlpine and Alfred McAlpine (Construction)
- MERO (Design and building of biomes)
- Arup (Services engineer, economic consultant, environmental engineer and transportation engineer)

The project was completed in 2000 and it was opened up to public in 2001. The most important aspect of this project was that it was

INTRODUCTORY CASELET

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an extensive and large scale project that was completed without any excessive and adverse variance from the projected budget. It was a huge success because most capital infrastructure projects usually face large cost overruns and are not completed within the budget.

Usually, the operating budget or the sales budget and the estimated daily expenses of a project are more accurate than the overall capital budgets. However, the operational budget of the Eden Project for the first year was less accurate as compared to its capital budget. The number of visitors experienced by the Eden Project was much higher than expected. Due to this reason, the sales revenue was about 250% of the budgeted figure. In addition, the wage bill that was estimated to be £4 million turned up to be £9 million. The budgeted and actual costs of the Eden Project were as follows:

Item	**Budgeted Amount (in £ million)**	**Actual Amount (in £ million)**
Purchase of site and car parks	10	10
Reshaping of ground	5	8
Construction of domes	20	25
Soil, plants and nursery	6	5.5
Buildings and exhibits	19	19
Services	6	7
Design, Engineering, Legal Services, etc.	6	9
Wages and training expenses	2	2.5
Total	74	86

Previously, it was decided that the 50% of the project amount would be granted by the Millennium Commission. The remaining 50% were to be acquired through European Union and some other regional organisations and through loans. Now, when the Millennium Commission came to know that there has been a cost overrun, it increased its grant to £43 million. The total cost overrun was £12 million of which £6 million was granted by Millennium Commission. The Eden Project was able to arrange the rest of the amount of £6 million because the site was opened to the public before final completion and the number of visitors was approximately 1.6 times than what was estimated and a steady stream of revenues kept pouring in.

The main reason for the cost overruns during the construction of the project was 43 gallons of rain received within 3 months.

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INTRODUCTORY CASELET

The construction had to be halted for these 3 months. In addition, such a project was a challenge in itself because no such project had been undertaken in the past. The project team managed to complete the project as per the schedule.

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LEARNING OBJECTIVES

After studying this chapter, you will be able to:
- Describe various types of costs involved in a project
- Discuss the methods used to estimate the costs
- Explain the steps involved in creating a project budget
- Explain the meaning and importance of developing budget contingencies

4.1 INTRODUCTION

In the previous chapter, you studied about the basic concepts of project feasibility analysis, project screening and project selection. The chapter focussed majorly on different types of feasibility analysis and models of project selection.

This chapter will focus on the estimation of costs incurred on different parts of the project. All projects incur various types of costs such as expenditure on procuring resources, financing, etc. Various types of costs incurred in a project include direct cost, indirect cost, fixed cost and variable cost. Cost serves as an important factor in gauging the viability of a project. Thus, it is of utmost importance for a project manager to estimate and manage project costs carefully as any negligence in cost estimation may have adverse effect on the project's performance.

Project cost management refers to an umbrella process which involves planning, estimating, budgeting and controlling the costs of a project. The cost estimation process involves making cost's estimates for all projects' activities using various tools and techniques such as top-down and bottom-up estimating.

In this chapter, you will study about methods that are used to estimate costs. Next, you will learn about steps involved in creating a project budget. The later section of this chapter would describe the necessity of developing budget contingencies.

4.2 TYPE OF COSTS

The field of Project Management often involves the activity of Project Cost Management. Project cost management helps in the administration of all project costs. According to Project Management Book of Knowledge (PMBOK), the Project Management is divided into ten knowledge areas and each knowledge area has its defined inputs, tools and techniques (to process the inputs) and outputs. Each knowledge area also involves various processes. One important area under Project Management is Project Cost Management. Project Cost Manage-

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ment ensures that the project is completed within the given budget. Processes involved in project cost management include planning project costs, estimating costs, determining budget and controlling costs.

Before a project team can start planning project costs; it is important to describe different types of costs involved in a project and required for performance of different project activities. In a project, there are two major types of costs. They are as follows:

- **Direct cost:** The costs of items or labour or any other object that are required directly for the execution of a project are called direct costs. Direct costs include cost of raw materials, cost of machine and equipment, etc. Direct costs per unit of production remains uniform and may/may not vary with the rate of output. Direct costs include salaries of the project team members; cost of materials, supplies and equipment; cost of travel; cost of subcontracting one or more parts of the project; etc.
- **Indirect cost:** Indirect costs are those that are not attributable or associated with a single activity, event, or other cost objects of a project. However, they are required for the completion of the project. Indirect costs majorly include overhead costs and general administrative costs. Overhead costs are costs incurred over products and services or the outputs of the project that cannot be allocated directly. These include employee benefits, office rent, cost of supplies, cost of furniture, cost of other equipment, etc. Administrative costs are the costs that are incurred for keeping the organisation operational. These include general accounting and legal services.

Dividing costs into direct and indirect costs is a usual practice. However, project costs can also be divided into capital costs, operating costs and maintenance costs. Capital cost includes one-time fixed costs such as the cost incurred on purchasing or leasing a land, building, equipment, etc. Operating costs are the costs that are incurred on a day-to-day basis and are essential for smooth running of a business. Operating costs can be divided into fixed and variable costs. Fixed operating costs include salaries, rent, taxes, etc. Variable costs such as cost of raw materials vary according to a level of production. The last category of costs, maintenance costs include all the costs incurred on the maintenance and service of the machinery and equipment.

NOTE

Fixed costs do not vary in accordance with the level of production whereas variable costs vary according to the number of units produced.

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EXHIBIT

Exhibit: Overview of the Project Cost Management Processes

Process Name	**Input(s)**	**Tools and Techniques**	**Output(s)**
Plan cost management	❑ Project management plan ❑ Project charter ❑ Enterprise environmental factors ❑ Organizational process assets	❑ Expert judgment ❑ Analytical techniques ❑ Meetings	❑ Outputs ❑ Cost management plan
Estimate costs	❑ Cost management plan ❑ Human resource management plan ❑ Scope baseline ❑ Project schedule ❑ Risk register ❑ Enterprise environmental ❑ factors ❑ Organizational process assets	❑ Expert judgment ❑ Analogous estimating ❑ Parametric estimating ❑ Bottom-up estimating ❑ Three-point estimating ❑ Reserve analysis ❑ Cost of quality ❑ Project management software ❑ Vendor bid analysis ❑ Group decision-making techniques	❑ Activity cost estimates ❑ Basis of estimates ❑ Project documents updates
Determine budget	❑ Cost management plan ❑ Scope baseline ❑ Activity cost estimates ❑ Basis of estimates ❑ Project schedule ❑ Resource calendars ❑ Risk register ❑ Agreements ❑ Organizational process assets	❑ Cost aggregation ❑ Reserve analysis ❑ Expert judgment ❑ Historical relationships ❑ Funding limit reconciliation	❑ Cost baseline ❑ Project funding requirements ❑ Project documents updates
Control costs	❑ Project management plan ❑ Project funding requirements ❑ Work performance data ❑ Organizational process assets	❑ Earned value management ❑ Forecasting ❑ To-complete performance ❑ index (TCPI) ❑ Performance reviews ❑ Project management software ❑ Reserve analysis	❑ Work performance ❑ information ❑ Cost forecasts ❑ Change requests ❑ Project management plan ❑ updates ❑ Project documents updates ❑ Organisational process assets updates

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SELF ASSESSMENT QUESTIONS

1. List an example each of direct and indirect costs.

ACTIVITY

Make a list of direct and indirect costs that are involved in a construction project.

4.3 COST ESTIMATIONS

Estimating cost is another important process under project cost management. It is carried out during the initiation and planning stage of project management. Cost estimation is a critical aspect of cost management as it is acts as the first step towards creation of the project budget. Cost estimation activity helps in comparing the expected benefits and costs of the project. Project managers are usually well aware of the total amount of money and resources that they have which they can compare against the expected costs and decide whether they have the required funds to complete a project.

The process of cost estimation involves forecasting of the project resources required for the production of the deliverables. Estimates for various activities or costs involved in a project are summed up to arrive as the cost estimate for the entire project. However, each such individual estimate must be arrived at carefully and the project manager must ensure that it falls where there is an acceptable range of variance or deviation attached along with every estimate. In addition, the estimator must clearly specify the assumptions made along with the conditions under which estimates were made. For example, an estimator may assume that approximately (3000 ± 5%) units of electricity will be used in the month of March when the plant is operated at 90% of its installed capacity.

A good cost estimate clearly specifies:

- the project deliverable(s)
- the duration for which cost estimate is valid
- the project cost based on the current information

Cost estimates are important output of the estimate costs process (of the Project Cost Management). Cost estimation is based on three major types of estimates:

- **Ball park estimates:** It is also known as Rough Order of Magnitude (ROM estimate), guesstimate, a swag or broad gauge. This estimate is used when the project is in a very early stage or when it has not started officially. This estimate is used by project managers to make project selection decisions. The accuracy of this estimate is usually –50% to +100%.

- **Budgetary estimates:** A lot of organisations develop budgets two years ahead of the project completion. This type of estimate is used to allocate money into an organisation's budget. The accuracy of this estimate is usually -10% to +25%.
- **Definitive estimate:** Such an estimate provides an accurate estimate of the costs. Definite estimate is also called bottom-up estimate. This type of estimate is used for making the purchasing decisions that require accurate estimates. They are also used in developing the final project costs. Definitive estimates are made one year prior to the project completion. In order to prepare a definite estimate, the project manager must take the help of the Work Breakdown Structure (WBS). A project manager requires a WBS for preparing a definite estimate because a project manager needs to account for the cost of each and every deliverable. A WBS is a breakup of project scope that is oriented towards deliverables. This is the most accurate estimate with an accuracy of -10% to +25%.

It is important to conduct the activity of cost estimation so that the required amount of money can be allocated to the project at the right time.

4.3.1 METHODS FOR COST ESTIMATION

The different tools and techniques used for cost estimation are as follows:

- **Expert judgement:** A person or a professional body (having experience in managing similar projects) provides cost estimates for project activities based on past experience along with some historical data.
- **Analogous estimating:** This method of estimation makes use of cost data derived from previous similar projects in order to generate current estimates. It is also called **top-down approach** to cost estimation. This type of estimation involves expert judgement and is less expensive as compared to other estimating tools. However, this method is less accurate too.
- **Parametric estimating:** This method of estimation involves determining the overall cost using the unit cost or duration and the number of units required for a project or activity.
- **Bottom-up estimating:** This type of estimation makes use of WBS and calculates cost for each activity and then aggregates all estimates to derive the overall cost estimate.
- **Three-point estimating:** This type of estimate is based on three values of an activity's cost namely most likely, optimistic and pes-

simistic estimates. Alternatively, mean value (cost) can also be determined.

- **Reserve analysis:** While calculating cost estimates, a project manager includes two types of reserves. A contingency reserve that can be used in the case of realisation of identified risks. Also, a management reserve which is also included in the case of realisation of unidentified risks. The amount of the contingency reserve is calculated by various risk management techniques such as percentage of a project's cost; expected monetary value; decision tree analysis; and Monte Carlo simulation. The amount of management reserve is not calculated using any mathematical technique rather it is decided in accordance with the management's policy. Estimating contingency reserve and management reserve requirements are a part of reserve analysis.
- **Project management software:** Specialised software packages and applications for project management can be used to simplify cost estimation.
- **Vendor bid analysis:** The data regarding responsive bids received from the vendors can be analysed to derive cost estimates.

NOTE

The outputs of the cost estimation activity are activity cost estimates.

4.3.2 CASH FLOWS

In a project, the project sponsors spend money for acquiring project resources such as labour, materials, plant and equipment. After successful completion of a project, the organisation and project sponsors start receiving revenues generated by the project. You can see that during the entire course of a project and after it is completed, money changes hands and moves in and out of the project. The movement of cash or money in and out of the project is called as cash flow. The Project Manager must carefully watch the movement of money in and out of a project because it helps in determining the profitability of the project. If the net inward movement (revenues) is greater than the net outward movement (expenses); then, the project is profitable and vice versa. During the cost estimation activity, costs are estimated or forecasted and the forecasted cash flows form the basis for selecting or rejecting a project.

Cash flows are also required for various purposes such as commanding better credit facilities from suppliers, procuring materials at competitive rates, avoiding project delays due to shortage of funds, avoiding the effects of inflation when projects are completed on time, etc.

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Project cash flows can be classified into three types, initial outlay, operating cash flow and terminal cash flow. They can be classified further from the viewpoint of overall investment and from the perspective of shareholders/owners. Table 4.1 lists cash flows with respect to the overall investment in a project:

TABLE 4.1: TYPES OF CASH FLOWS

Type of Project Cash Flow	Characteristics
Initial outlay	• Fixed investment + working capital • Generally outflow • Generally in 0^{th} year
Operating cash flow	• Earnings Before Interest and Tax (EBIT)– tax +depreciation • Generally inflow • From 1^{st} year to n^{th} year
Terminal cash flow	• Salvage value + working capital • Generally inflow • From n^{th} year

Note that depreciation is always computed by the written down value method by default. The initial outlay is investment before the initiation of a project. However, when there is capacity enhancement or an increase in sales, additional outlay is employed in the subsequent years.

The working capital should be made available one year in advance. For example, if the working capital of `2 million is needed in the second year of the project, the available working capital of `1.5 million in the first year along with `0.5 million through cash inflows should be reserved as an advance for the second year.

The operating cash flow is calculated without considering interest as an expense. Terminal cash flow is calculated at the end of the project's life and it takes into account the net salvage value received at the end of the project or sale of the asset. The different types of project cash are recorded in the form of a statement, which is called cash flow statement. An example of project cash flow statement is as follows:

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Fixed Investment	–7000000	–	–	–	–	–
Working Capital	–2100000	–300000	–300000	300000	300000	–
Initial Outlay	**–9100000**	**–300000**	**–300000**	**300000**	**300000**	
Sales	–	7000000	8000000	9000000	8000000	7000000
Raw Material	–	–2450000	–2800000	–3150000	–2800000	–2450000

N O T E S

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Other Variable Cost	–	–700000	–800000	–900000	–800000	–700000
Overhead Allocation	–	–350000	–400000	–450000	–400000	–350000
Fixed Cost	–	–500000	–500000	–500000	–500000	–500000
Contribution Loss	–	–300000	–300000	–300000	–300000	–300000
Depreciation	–	–1750000	–1312500	–984375	–738281	–553711
EBT	–	950000	1887500	2715625	2461719	1846289
TAX	–	–285000	–566250	–814688	–738516	–553887
EAT	–	665000	1321250	1900938	1723203	1292402
Operating Cash flow	**–**	**2415000**	**2633750**	**2885313**	**2461484**	**2446113**
Salvage Value	–	–	–	–	–	1700000
Working Capital	–	–	–	–	–	2100000
Bad Debt	–	–	–	–	–	–300000
Terminal Cash flow	**–**	**–**	**–**	**–**	**–**	**3500000**
Overall Project Cash Flows		**2415000**	**2633750**	**2885313**	**2461484**	**3500000**

Figure 4.1 shows an example of projected cash flows of a project:

Weekly Cash Flow Projection

Smith Family Kitchen Renovation

	Pre-Startup EST	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Final Week	TOTAL
Cash on Hand (beginning of month)	$ –	$ 20,000	$ 4,000	$ 5,000	$ 1,000	$ 4,500	$ 500	$ 4,500	$ 4,500	
CASH RECEIPTS										
Deposit Due from Client	$ 20,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 20,000
Payment Due from Client	$ –	$ –	$ 10,000	$	$ 10,000	$ –	$ 10,000	$ –	$ 10,000	$ 40,000
TOTAL CASH RECEIPTS	$ 20,000	$ –	$ 10,000	$ –	$ 10,000	$ –	$ 10,000	$ –	$ 10,000	$ 60,000
Total Cash Available (before cash out)	$ 20,000	$ 20,000	$ 14,000	$ 5,000	$ 11,000	$ 45,00	$ 10,500	$ 45,00	$ 14,500	$
CASH PAID OUT										
Gros wages	$ –	$ 3,000	$ 3,000	$ 3,000	$ 3,000	$ 3,000	$ 3,000	$ 3,000	$ 3,000	$ 24,000
Payroll expenses (taxes, etc.)	$ –	$ 450	$ 450	$ 450	$ 450	$ 450	$ 450	$ 450	$ 450	$ 36,00
Large Supplies	$ –	$ 12,000	$ 5,000	$ –	$ 2,500	$ –	$ 2,000	$ -	$ 3,000	$ 24,500
Small Supplies	$ –	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500	$ 4,500
Mescellaneous	$ –	$ 50	$ 50	$ 50	$ 50	$ 50	$ 50	$ 50	$ 50	$ 400
TOTAL CASH PAID OUT	$ –	$ 16,000	$ 9,000	$ 4,000	$ 6,500	$ 4,000	$ 6,000	$ 4,000	$ 7,000	$ 56,500
Cash Position (end of week)	$ 20,000	$ 4,000	$ 5,000	$ 1,000	$ 4,500	$ 500	$ 4,500	$ 500	(PROFIT) $ 3,500	(PROFIT) $ 3,500

Figure 4.1: Example of Projected Cash Flows of a Project

Source: http://smartbusinesscashflow.com/wp-content/uploads/2012/09/Weekly-Cash-Flow-Projection1.jpg

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Two types of cash flows namely cash inflow and cash outflow are as follows:

CASH INFLOW

Cash inflow refers to the movement of cash into a business or project. Some activities that lead to cash inflows are as follows:

- **Operating activities:** These activities include cash inflows from customer payments, interest on shares, dividend receipts, receipts of loans, etc.
- **Investing activities:** These activities include cash inflows from the sale of debt and equity instruments, sale of productive assets, financing activities, issuance of long-term debt and issuance of equity securities.
- **Miscellaneous activities:** These activities include cash inflows from shares of project purchased by investors, sale of property, scrap, or equipment, and loans from financial institutions.

CASH OUTFLOW

Procurement of resources such as raw materials, manpower, equipment, etc. required for completing a project, results in the movement of cash outside a business or project. Such movement of cash is called cash outflow. In other words, it is the cost of completing a project. Some activities that lead to cash outflows are as follows:

- **Operating activities:** These activities include cash outflows for the payment made to suppliers and employees (payments), interest payments, payment of income taxes, other operating cash payments, etc.
- **Investing activities:** These activities include cash outflows for the purchase of productive assets, purchase of debt and equity instruments, making loans, financing activities, payment of dividends, repayment of amounts borrowed, etc.

4.3.3 LEARNING CURVES IN COST ESTIMATION

In most organisations and projects, the management fixes a set of processes that must be followed. It means that organisations now use processes that are fairly standardised. The employees, labour and other staff are required to do one or more tasks repeatedly. It is a known fact that in any kind of environment when an employee is assigned the responsibility of performing one or more tasks repeatedly; then, with time, the performance of the employee improves and the time required to do the tasks decreases till a point where the time to perform a task can be standardised. It just means that the time to perform the task decreases but it cannot decrease continuously and it will hit a threshold where the time to perform a task cannot be decreased.

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Alternatively, we can say that as the experience of the employees' increases, cost per unit of output decreases.

When data related to the time required for performing a task over a period of time is collected and plotted over a graph; it shows a decrease in the effort per unit for repetitive tasks and a curve emerges. This curve is known as the **learning curve or experience curve** and is critical in cost analysis, cost estimation and efficiency study. The learning curve usually indicates that if a task is performed over and over again, then less time is required each time. It has been observed that whenever production is doubled, labour time required decreases by approximately 10-15%. Learning curve and learning curve analysis is used by organisations in production planning, cost forecasting and fixing delivery schedules.

Figure 4.2 shows a learning curve:

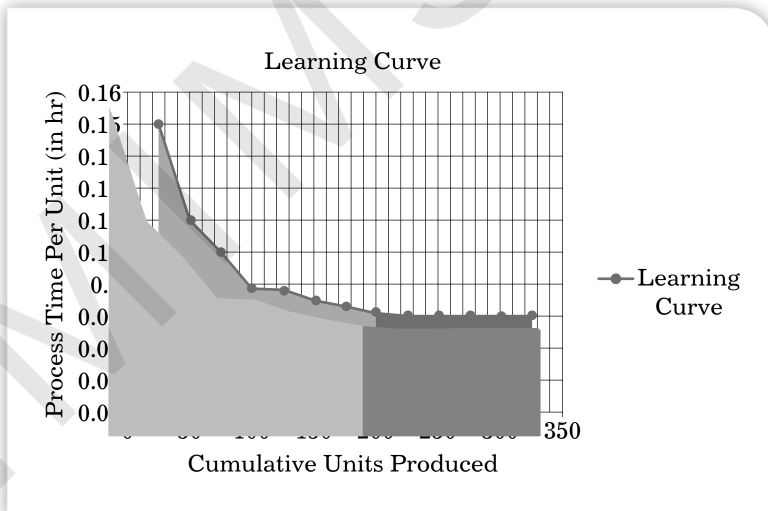

Figure 4.2: A Learning Curve

4.3.4 PROBLEMS WITH COST ESTIMATION

For any project manager, one of the most demanding and gruelling tasks is to develop estimates (such as cost, time, resource estimates) for project or development work. However tedious this task may be, cost estimation is a necessary evil and must be carried out. Estimation is not a one-time activity; it is carried out throughout the project. Estimation is done at the time of pricing and scoping; at time of changing orders throughout the project; and periodic estimates given to customers. Developing estimates give a project manager (or estimator) the ability to think and focus better over the possible tasks and the level of effort that would be required. The estimator becomes better at developing estimates with experience and develops expertise. However, having experience and expertise does not guarantee that the esti-

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mator would develop good estimates each time. He may, at times, also fail.

However accurately the estimator may develop estimates, some things or errors may creep in inadvertently. Some of the problems associated with project cost estimation are as follows:

- **Poorly defined scope of work:** Cost estimation activity can be easily pushed in a negative direction when the planners have not effectively broken down the work into smaller units or when the smaller units are misinterpreted.
- **Omissions**: Cost estimation activity may also be affected drastically when certain important elements are excluded. For example, when a project involves five processes and the cost estimation is done by including the cost of only the four processes, it will lead to errors in cost estimation.
- **Rampant optimism**: At times, the project managers may unwittingly base all their cost estimations on an all-success scenario. It means that they do not make any provisions for risks realisation.
- **Padding:** At times, the estimator includes certain factors of safety without the knowledge of the project manager. The safety factor is included to ensure that task can be performed in a manner that can meet or beat the estimate.
- **Failure to assess risk and uncertainty**: When the estimator does not include risks and uncertainty into account, it can lead to unrealistic estimates.
- **Time pressure**: Whenever the estimators are given the task of estimating costs early in the life of a project, they may regard this exercise as unnecessary and may come up with estimates that are erroneous from the beginning.
- **Different skill levels:** The estimation activity is done by an estimator whereas the actual task would be performed by another person. There are differences in the skill levels of different people. It is possible that the task performer has greater, lesser or equal work proficiency as compared to estimator. Therefore, during the cost estimation activity, the skill level of the task performer(s) must be taken into the account.
- **External pressure**: At most occasions, the project managers are given instructions from management well in advance that the specific targets of cost, schedule, quality, or performance must not exceed the given values. They are also asked to ensure that the actuals do not exceed the estimates. At such instances, the estimators should clearly communicate with the management that unrealistic estimates are bound to be defeated while the actual work is in progress.

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SELF ASSESSMENT QUESTIONS

2. __________ is required so that a project can be completed within the approved budget.
3. Determining budget is an important process under project cost management. (True/False)
4. List any two methods of cost estimation.
5. What is the output of the cost estimation process?
6. _______ is the first step towards creation of the project budget.
7. Choose the odd one out:
   a. Ball park estimates b. Budgetary estimates
   c. Indefinite estimate d. Definitive estimate
8. When the data related to the time required for performing a task over a period of time is collected and plotted over a graph; it shows a decrease in the effort per unit for repetitive tasks and the ___________ emerges.
9. List any two problems associated with cost estimations.

ACTIVITY

Prepare a synopsis of a real-life case study on the use of learning curves in a project.

4.4 CREATING A PROJECT BUDGET

Creating a project budget is an important activity under Project Management. A project manager can develop good cost estimates only if he/she thoroughly studies project details such as:

- Project scope
- Project and task dependencies
- Project constraints
- Which employees will do the different types of tasks?
- What is the skill level of different employees?
- What kind of support the project management and sponsor provides?
- Are the project employees experienced or novice?
- How many unknowns are there?

Initially, a high-level project budget is developed when a project is initiated and as the project progresses and reaches a particular phase, budget is refined and detailed. A budget usually includes costs related

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to staff labour, materials procurement, ongoing operating costs and other direct costs such as travel or training.

Good cost estimates usually lead to a better project budget. The project manager must make provisions for managing contingencies when developing project budgets. In addition, the project manager must ensure that the given budget will be used as a reference point to compare the actuals. Therefore, it is important that the estimator or the employee who is developing the estimates and the budget do their respective works in a systematic manner so that they can develop a fully-costed project.

The steps involved in developing a project budget are as follows:

1. **Identify the scope elements that require costing:** Project manager must identify all scope elements and the individual work tasks or packages defined under the Work Breakdown Structure whose cost estimates must be included in the budget.
2. **Carry out cost management planning:** The project manager must clearly establish a set of processes and procedures that should be followed while planning and managing project costs. In addition, all the documentation requirements must be stated clearly.
3. **Carry out work package costing:** The entire Work Breakdown Structure (WBS) is broken down into work packages and cost management planning is applied to each work package.
4. **Combine project schedule and project cost estimates:** Costing activity is carried out after the project schedule has been prepared. At this stage, the cost of each work package is calculated and these are linked to the project schedule in order to develop a schedule of cost requirements.
5. **Produce the project budget as per the standardised templates:** Various organisations have standardised templates for representing the project budget. The budget must be represented in the predefined template.
6. **Make provisions in the budget for contingencies:** The project budget must be adjusted so that provisions for project contingencies, dependencies and constraints are made.
7. **Review the budget:** After the budget has been prepared, it must be thoroughly reviewed to ensure that all the work packages have been costed and that all the project dependencies and constraints have been accounted for.

It is important to develop a project budget in a systematic manner. All projects are unique and some projects may be difficult to scope. It is not unusual for projects to face conditions of cost overruns and unexpected events may also occur during the project lifecycle. Therefore,

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in order to ensure that the project budget does not get affected extremely, the project managers must include change control processes.

A low-level or detailed budget is useful in various ways as mentioned below:

- It provides the project sponsor with the best estimate of how much a project would cost.
- It can be used to handle unexpected events and exceptions.
- It can be used to develop a cost benefit analysis.
- While the project is being executed, it is used as a reference to determine whether the project costs are being incurred as a plan or not.

The activity of creating the project budget is usually done by a project manager, project sponsor and a project team.

EXHIBIT

Steps to develop a detailed budget using a high-level budget

1. **Refer the high-level budget:** Use the high-level budget as the starting point for developing the detailed budget.
2. **Refer the budget information for similar projects:** The members involved in the project who have worked on similar projects must be consulted by the project manager and his team because they can help greatly in identifying the costs.
3. **Determine the labour costs:** Using information such as labour rates, detailed list of tasks, staff efforts and the duration of the tasks, the total labour costs are determined. The costs should include project management costs and costs of acquiring staff as well.
4. **Identify material costs:** Costs such as those incurred on equipment, material and other non-staff resources must be taken into account.
5. **Identify the operating costs:** Operating costs such as customer support costs, network costs, software and licensing costs that must be incurred for the production of the product or service must be identified.
6. **Identify specific costs:** Costs other than those mentioned in steps 3, 4, and 5 such as training and travel costs should be identified.
7. **Contingency planning:** The person carrying out the activity of budgeting must take into consideration all the possible risks or unknowns in a project. Depending upon the severity and the probability of occurrence of the risks and unknowns,

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a contingency margin or a reserve is created for each major task of the project and in this way, an overall contingency reserve is created for the project. The overall contingency of the project depends on the types of risks but it is usually 20-30%.

In a project, project managers develop the budgets in order to prepare a financial roadmap of the project. Budgeting is an important business function. A project budget can be prepared in a day or it may take several weeks depending on the length, complexity and size of the work involved in the project. The activity of budgeting (preparation of a budget) can be done using different budgeting techniques such as the top-down technique, bottom-up technique and the activity based budgeting. Let us study these techniques in the upcoming sections.

4.4.1 TOP-DOWN BUDGETING

When the project budgeting activity starts at the top levels of an organisation and makes its way downwards, it is known as top-down budgeting. The top most management sets the budgeting guidelines and instructs the lower-management on how to make the budget and related calculations. A top-down budget is developed only after the top management decides how much the total project should cost. The total decided cost is then divided into smaller components till the costs for all the WBS work packages have been calculated.

A top-down budgeting method is structured and promotes a particular kind of organisational culture. Organisations that practise centralised management also promote top-down budgeting in their projects. In such a budgeting procedure, the inputs and suggestions of the lower-level employees are not sought and it may make them feel less valuable as human resources of the organisation.

In such projects,management first decides its final amount that it can spend on the project. After this, the project manager allocates the costs of the different processes by keeping in mind that the combined cost should not exceed the total amount authorised by the management. Within each process, the costs are allocated to different activities. If the budget allocated to a process is not able to cover all the activities, the project manager may decide to cut or merge some activities.

4.4.2 BOTTOM-UP BUDGETING

In the bottom-up budgeting, the total cost of the project is determined by adding up the costs of all the individual inputs, activities and economic resources. In such a budgeting activity, the managers may seek the advice and suggestions of the employees. The individuals or employees who are directly involved in the project usually have a good understanding of the methods and inputs required for completing the

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different parts of the project. It means that in bottom-up budgeting, the inputs of lower-level management individuals are incorporated.

Different departments or units determine the costs and budgets for their respective departments. However, the top-management decides the guidelines and the process of developing the budgets. The budget prepared by individual departments is sent to the top management for review and approval. If the management finds that the budget is fine, it is approved and in case the management thinks that the budget has not been made appropriately, it is sent back to the concerned department for revision.

4.4.3 ACTIVITY BASED BUDGETING

The Activity based budgeting is a type of budgeting that is based on Activity Based Costing. Under this method, costs are assigned to different activities in a project. The cost assigned to different activities depends in the volume of that activity. Activity based budgeting helps in improving business practices and productivity. However, the disadvantage of this method is that the employees may feel that they are being subjected to undue scrutiny.

In activity based costing, the overhead costs are thoroughly analysed and researched. The costs are allocated to the different activities accordingly.

SELF ASSESSMENT QUESTIONS

10. _________ usually lead to a better project budget.
11. In order to ensure that the project budget does not get affected extremely by cost overruns and unexpected events; the project managers must include_______________.
12. A high level budget is more detailed than a low-level budget. (True/False)
13. In a _________ budgeting procedure, the inputs and suggestions of the lower-level employees are not sought.

ACTIVITY

Present an example to demonstrate the process of activity based costing and budgeting.

4.5 DEVELOPING BUDGET CONTINGENCIES

When there are a lot of unknowns in a project or when there are a lot of uncertainties involved in a project budget; the project managers

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can cope with such a condition by using contingency planning. Contingency planning is a practice of setting aside a particular amount of the fund that is meant to be used in case risks realise or when some unknown and unexpected problems crop up. The total amount of money that is set aside to deal with uncertainties is known as the contingency fund or the contingency reserve. The amount of contingency reserve is added to the amount of budget. The amount or the percentage of the budget reserved as contingent funds depend on the level of risk associated with a project.

In generating a particular estimate of the contingency amount, the project manager uses the initial budget that is created at the time of project initiation in addition to the list of risks or the risk register. Lastly, project manager and his/her team can also determine the contingency amount on the basis of their experience in other similar projects. The amount of contingent reserves increases with an increase in the level of risks in the project. The organisations, at times, use a particular formula for calculating the contingency amounts for all the projects they take up. However, there can be no single formula that can be used to calculate the contingency amounts.

To effectively calculate the amount of contingency reserves, the manager must ponder upon a range of project aspects in addition to a thorough analysis of the project risks. At times, in complex, technology oriented or 'one of a kind' projects, it might be difficult for the project manager and his team to determine or estimate a contingency reserve. In such circumstances, the project manager may resolve to keep about 10% of the total budget as contingent reserves.

The project manager may also calculate the amount of contingency by taking into account all the major tasks involved in a project instead of all the tasks. The contingency amount allocation in such cases must be based on the level of risk involved in it. A contingency fund is added to the main budget but cannot be spent until and unless the approved amount for an activity has been expended and only after taking the required permission. Now, after the project activity has been done and the cost of this activity comes out to be more than what was initially allocated to it, the project manager also can assess how much amount is appropriate for future references. There can be instances when a contingency reserve was allocated to particular activities but remained unspent. In such cases, all the unspent money should be showed as not spent and returned back to the organisation. All the contingency funds that are used must be reported to the organisation.

SELF ASSESSMENT QUESTIONS

14. A project manager can use contingency funds when ________.

ACTIVITY

Describe the major practices followed by project managers during contingency planning.

4.6 SUMMARY

- Project cost management helps in administration of all project costs.
- In a project, there are two major types of costs viz. direct costs and indirect costs.
- Project costs can also be divided into capital costs, operating costs and maintenance costs.
- Cost estimation is a critical aspect of cost management as it is acts as the first step towards creation of the project budget.
- Cost estimates are an important output of the estimate costs process.
- Three major types of estimates include: ball park estimates, budgetary estimates and definitive estimate. Ball park is the least accurate estimate whereas definitive estimate is the most accurate estimate.
- The different tools and techniques used for cost estimation include: bottom-up estimating, three-point estimating, top-down approach, reserve analysis, project management software, vendor bid analysis, etc.
- The movement of cash or money in and out of the project is called as cash flow. Two types of cash flows are cash inflows and cash outflows.
- Cash inflow refers to the movement of cash into a business or project. Movement of cash outside a business or project is called cash outflow.
- When data related to the time required for performing a task over a period of time is collected and plotted over a graph; it shows a decrease in the effort per unit for repetitive tasks and a curve emerges. This curve is known as the learning curve.
- Some of the problems associated with project cost estimation are: poorly defined scope of work, omissions, failure to assess risk and uncertainty and time pressure.
- Initially, a high-level project budget is developed when a project is initiated. A budget usually includes costs related to staff labour, materials procurement, ongoing operating costs and other direct costs such as travel or training.

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- The activity of budgeting (preparation of a budget) can be done using different budgeting techniques such as the top-down technique, bottom-up technique and the activity based budgeting.
- Contingency planning is a practice of setting aside a particular amount of fund that is meant to be used in case risks realise or when some unknown and unexpected problems crop up. The total amount of money that is set aside to deal with uncertainties is known as contingency fund or contingency reserve.

KEY WORDS

- **Deliverable:** It refers to the product or service or a thing that must be provided to the ultimate client after the project has been completed.
- **Estimator:** An estimator is a person who carries out the activity of estimation. Estimation is usually carried out by the project manager.
- **Operating costs:** It is also known as operational costs and includes costs that are necessary for the day-to-day operations of the business or a project.
- **Responsive bid:** A responsive bid or a responsive proposal refers to the bid or proposal received which has been prepared and sent as per the prescribed procurement procedures and requirements.
- **Salvage value:** It refers to the approximate value a thing can be sold at after its useful life has expired.
- **Work Breakdown Structure (WBS):** A WBS is a structure that represents the entire project in a hierarchical and incremental manner and decomposes the entire project into various sub-components. The smallest unit of work that is represented in a WBS is the Work Package.

4.7 DESCRIPTIVE QUESTIONS

1. Describe the major categories of costs associated with a project.
2. Describe the three major types of estimates used for cost estimation.
3. List and explain the different tools and techniques used in cost estimation.
4. Describe the steps involved in creating a project budget.
5. Explain in detail the three types of budgeting.
6. Explain the importance of developing budget contingencies in a project.

N O T E S

4.8 ANSWERS AND HINTS

ANSWERS FOR SELF ASSESSMENT QUESTIONS

Topic	Q. No.	Answer
Types of Costs	1.	Cost of raw materials (direct); Office rent (indirect)
Cost Estimations	2.	Project cost management
	3.	True
	4.	Analogous estimating, bottom-up estimating
	5.	Activity cost estimates
	6.	Cost estimation
	7.	c. Indefinite estimate
	8.	learning curve
	9.	Failure to assess risk and uncertainty; Rampant optimism
Creating a Project Budget	10.	Good cost estimates
	11.	change control processes
	12.	False
	13.	top-down
Developing Budget Contingencies	14.	risks realise

HINTS FOR DESCRIPTIVE QUESTIONS

1. In a project, there are two major types of costs. They include direct cost and indirect cost. Direct costs include cost of raw materials, cost of machine and equipment, etc. Indirect costs include overhead costs and general administrative costs. Refer to Section **4.2 Types of Costs.**
2. Cost estimation is based on three major types of estimates: ball park estimates, budgetary estimates and definitive estimate. Refer to Section **4.3 Cost Estimations.**
3. The different tools and techniques used for cost estimation include expert judgement, analogous estimating, parametric estimating, bottom-up estimating, etc. Refer to Section **4.3 Cost Estimations.**
4. Initially, a high-level project budget is developed when a project is initiated and as the project progresses and reaches a particular phase, budget is refined and detailed. The steps involved in developing a project budget are1.Identify the scope elements that require costing; 2. Carry out cost management planning; 3.

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Carry out work package costing; 4. Combine project schedule and project cost estimates; 5. Produce the project budget as per the standardised templates; 6. Make provisions in the budget for contingencies; and 7. Review the budget. Refer to Section **4.4 Creating a Project Budget.**

5. Three types of budgeting include: top-down budgeting, bottom-up budgeting and activity based budgeting. Refer to Section **4.4 Creating a Project Budget.**

6. The total amount of money that is set aside to deal with uncertainties is known as contingency fund or contingency reserve. The amount of contingency reserve is added to the amount of budget. The amount or the percentage of the budget reserved as contingent funds depend on the level of risk associated with a project. Refer to Section **4.5 Developing Budget Contingencies.**

4.9 SUGGESTED READINGS & REFERENCES

SUGGESTED READINGS

- Kerzner, H. (2003). *Project management workbook to accompany Project management - a systems approach to planning, scheduling and controlling, eighth edition*. New York: Wiley.
- Kloppenborg. (2014). *Contemporary Project Management*. Cengage Learning.

E-REFERENCES

- *Create a Project Budget Using the Top-Down Approach - dummies*. (2018). *dummies*. Retrieved 6 January 2018, from http://www.dummies.com/careers/project-management/create-a-project-budget-using-the-top-down-approach/
- *What is Contingency Reserve in a Cost Estimate?*. (2018). *Project Control Academy*. Retrieved 6 January 2018, from https://www.projectcontrolacademy.com/cost-contingency/

5

C H A P T E R

PROJECT DECISIONS AND PROJECT PLANNING

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INTRODUCTORY CASELET

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RESPONSIBILITY ASSIGNMENT WITH RACI MODEL

RACI refers to a responsibility assignment model and it is an abbreviation for Responsible, Accountable, Consulted and Informed Model. The abbreviations of the RACI model can be explained as: Responsible (R) is a person whose work is required for the successful completion of the task; Accountable (A) is a person who is answerable and ensures that the deliverables are appropriate and acceptable; Consulted (C) are those persons who share their opinion on various tasks or activities of the project; and Informed (I) are those persons who are affected from project deliverables.

There is no thumb rule regarding the total number of persons required for RACI analysis. Generally, it is considered that there only one responsible person is sufficient for one activity because the presence of more than one responsible person for one activity creates ruckus in the whole project. In other words, one responsibility cannot be assigned to many individuals. Similarly, there should be only one person accountable for a particular activity because he/she is a person to whom responsible person reports. Consulting person may be an individual or a group of Subject Matter Experts who share information about the project. Generally, there can be one or a few informed persons. These people are only advised and once the deliverables are produced then they cannot hold up the approval of the project.

An FMCG Company Hypothetical manufactures certain products. It was observed that the products had a very low demand for the month of July 2017. Hence, the top management executives decided to close manufacturing plant for one week in the month of July. The management decided to get the plant repaired during this period. The RACI model for the plant repair project is depicted in the following Table:

TABLE: RACI MODEL FOR PLANT REPAIR & MAINTENANCE PROJECT

ACTIVITIES AND DIVISIONS	FACILITIES	PLANT MANAGER	HUMAN RESOURCE TEAM	SECURITY	PROJECT MANAGER
Listing of contractors	C	-	-	-	R
Arrange contractor visits and quotations	I	-	-	-	R

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INTRODUCTORY CASELET

ACTIVITIES AND DIVISIONS	FACILITIES	PLANT MANAGER	HUMAN RESOURCE TEAM	SECURITY	PROJECT MANAGER
Review of quotations and contractor selection	A	I	I	_	R
Finalisation of contract and plant shut down week	I	I	-	-	R
Communicate the project with plant crew	I	I	R	I	I
Provide security gate access to repair crew of contractor	I	-	A	R	I
Supervision of the project and ensuring the timely completion of project	A	I	I	-	R

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LEARNING OBJECTIVES

After studying this chapter, you will be able to:
- State various types of project decisions
- Explain the concept of project planning
- Describe the concept of project charter
- Analyse the Work Breakdown Structure (WBS)
- Discuss the RACI/RAM model
- Describe the concept of project planning estimation

5.1 INTRODUCTION

Every organisation makes a number of decisions during its course of projects it undertakes. In the initiation phase of the project, a project manager has to decide whether to invest in a particular project. The project manager has to take this decision according to various factors such as significance of the project, scope of the project, schedule of the project and budget of the project. However, the process of project decision proceeds from the planning phase and then moves into the implementation phase. Project planning is one of the most important areas under project management. Decision making in any project is not only about choosing a right solution but it also involves a planned process to implement key decisions. Efficient project planning and making carefully thought-after project decisions are the keys to project success.

An American writer, Dr. Tom Peter once quoted that, “the more time you spend on planning, the less time you will need to spend on implementation”. It means that the effectiveness of project planning decides the success or failure of a project. Any inaccuracy at the planning stage may lead to customer dissatisfaction which in turn can lead to project failure. In the modern business environment, organisations need to plan their projects to gain a competitive edge in the market. The project planning process initiates with the development of a project plan, which defines the scope and goals of a project and resources required to complete it. Moreover, it enables an organisation to complete a project within the stipulated time and specified budget.

The next important step of project planning is accurate estimation. Project planning estimation is a method of projecting time, cost and resources required to complete a project. It serves as the standard to compare the actual and planned performance of the project, identify loopholes, and rectify them, which result in the successful completion of a project. Planning estimation is performed by using various tools and techniques. Three-point estimation and base and contingency estimation are the two most commonly used estimation methods.

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In this chapter, you will study about project decisions and planning. Further, the chapter explains project charter, scope statement, business cases and milestones schedule with acceptance criteria. The chapter also describes the concept of project planning and the steps involved in it. Next, the chapter explains the concept of Work Breakdown Structure (WBS) and RACI/RAM model. Towards the end, the chapter discusses project planning estimation, purpose of estimation, and estimation tools and approaches.

5.2 PROJECT DECISIONS

Every project in an organisation needs to be carried out in a structured manner. A project involves carrying out various activities such as strategy formulation, planning, resource allocation, scheduling, monitoring and controlling. A project manager has to make many significant decisions in a project. These decisions are usually related to various factors such as number of people required, technology to be used, cost factors, etc. A project manager should ensure that all these decisions must be taken in an efficient and careful manner because any wrong decision may result in project failure. Decision making is an intellectual process of selecting the most appropriate course of action from all available alternatives. It aims to find out the best and most effective solution for a given problem. Effective decision making ensures that a project is being executed in an organised manner. Project decisions depend on the requirements of the organisation and they differ from organisation to organisation. Some important project decisions are explained as follows:

- **Project identification:** It is one of the major decisions taken for any project. An organisation needs to select the right project at the right time. For this, the organisation needs to analyse various alternatives and examine whether it has sufficient resources to meet the desired quality standards.
- **Idea generation and promoter selection:** It involves creating maximum ideas from the available options, so that the final decision can be taken. When there are more ideas, there is a need of better analysis and consideration of problems from different prospects. After generating ideas, an organisation needs to select the promoter for the project. A promoter is a person who encourages people to invest into a project. An investment banker, an underwriter, or a stock promoter may, completely or partially, execute the task of a promoter.
- **Opportunity and feasibility studies:** This is another important project decision made by an organisation. Before selecting any project, an organisation needs to analyse opportunities associated with a particular project. After that, the organisation needs to check the viability of the project in terms of the following:
    - Accessibility of land and site

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- Availability of water, power, transport and communication facilities.
- Accessibility of servicing amenities, such as machine shop, electric repair shop, etc.
- Laws to be adhered to for the project.
- Availability of the required workforce.
- Approachability of the required technology.

- **Project selection:** After making different decisions, the final decision of project selection is made by an organisation. The project that best meets the requirements is selected.

SELF ASSESSMENT QUESTIONS

1. ________ can be defined as decisions related to multiple activities of a project.
2. ________________ is an intellectual process of selecting most appropriate course of action from all available alternatives.
3. Project decisions in all organisations are the same instead of organisational requirements. (True/False)
4. A ________________ is a person who encourages people to invest into a project.
5. Before selecting any project, an organisation needs to analyse opportunities associated with a particular project. (True/False)

ACTIVITY

Suppose you are a project manager of a reputed real estate developer company. In this scenario, list some key factors that you will consider to initiate a new group housing project.

5.3 PROJECT CHARTER

Project charter refers to a document in which scope, objectives and participants of a particular project are determined. It is also known as initiation form or project authorisation document. It authorises the project manager to initiate the project. This document can be used by the project manager, team members and other stakeholders to view information regarding the duration of the project, cost of the project, need and importance of the project, benefits of the project, resources required to complete the project, etc. A sample project charter is shown in Figure 5.1:

N O T E S

Part I: Project Overview

Project Name	Website Redesign		
Project Charter Author	Amanda Etches & Randy Oldham		
Creation Date	Nov 12, 2012	**Last Revision Date**	February 3, 2013
Project Requestor	Randy Oldham	**Project Manager**	Randy Oldham
Project Charter Status (Pending/Approve/Reject)	Approved		
Project Sponsor Signature	Amanda Etches and W&IA Cross-Functional Team	**Date of Project Approval**	January 2013
Proposed Project Start & End Date	Start: December 2012 End: January 2014		

Part II: Project Details

Project Description	The library website redesign project will include the following activities: - redesign the home page around users' critical tasks - redesign the site architecture and navigation to improve findability and usability - implement Drupal as our Content Management System (CMS) to improve site governance and infrastructure and introduce decentralized content maintenance - implement the existing university template to meet campus branding requirements - develop a content strategy to improve existing and new site content - phase out dependent infrastructure (e.g. InSite applications) to make the site content and functionality fully integrated on a single CMS
Project Purpose	The current library website is in dire need of a user-centred redesign, reduction in size, architectural overhaul, updated and intuitive navigation structure, accessibility compliance, and coherent content strategy. This project aims to address all these needs and result in a library website that is, first and foremost, a tool to enable student success.
Project Goals & outcomes	The outcomes of this project will be: - a library website that is designed primarily around user needs and

Figure 5.1: Sample Project Charter

Source: http://www.viplinkek.info/business-charter-template-sample/business-charter-template-sample-8-project-charter-templates-free-sample-example-format-printable/

In the PMBOK Guide, the Project Management Institute (PMI) defines a project charter as *a document issued by the project initiator or sponsor that formally authorises the existence of a project and provides the project manager with the authority to apply organisational resources to project activities*.

Generally, a project charter is divided into two parts which are Part I – Project Overview and Part II – Project Details. Project overview contains primary information such as project name, author of project charter, creation date, revision date, project requester, project manager, approved/unapproved status of project charter, etc. about the project. Project details contain detailed information such as project description, purpose, goals and outcomes of the project, project scope, benefits, project team, stakeholders, communication plan, timeline, etc. about the project. Let us now discuss some of the major components of project charter which are as follows:

- **Purpose of the project:** The Purpose Section includes information regarding the purpose and goals of the project. This section of project charter also explains the need of the project. It relates to the importance of project related to the current organisational situation.
- **Project scope:** The Project Section describes potential achievements or benefits that would result from the successful completion

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of the project. This section includes details of items that are going to be built under or after project completion. It also includes the objective of the project.

- **Budget of the project:** The Budget Section of the project charter describes the estimated cost of the completed project. It shows the total amount of money allocated to the project at initiation.
- **Risks:** All projects possess a number of known and unknown risks. The risk section of a project charter lists all risks involved in a project. This section gives the management an overview of all risk factors that affect the working of a project.
- **Milestones:** Any project can be completed effectively if it the overall project is divided into various smaller components such as phases, tasks and sub-tasks. Each project can be considered as a collection of various sub-tasks. In projects, when one or more pre-decided subtasks are completed, it is said that a milestone has been achieved. While planning a project, milestones and the related activities are carefully decided in order that the project is completed within the allotted time limit. These milestones are also reflected in the **Gantt chart** of the project.
- **Authority level of project manager:** The authority level of a project manager can be measured in terms of project tolerance. Project tolerance refers to the acceptable variation in the quality requirement of the project and determines the range of acceptable results. Project tolerance of a project can be classified into two categories namely:
  - **Tolerance on budget:** It shows the acceptable level of variation in the budget of a project. For example, project manager has 10% tolerance on budget. It means that the project manager can complete the project even if its cost increases by 10%.
  - **Tolerance on schedule:** It shows the acceptable variation in the time schedule or deadline of the project. For example, the project manager has 15% tolerance on schedule. It means that a project manager can complete the project even if it is completed at a date that is 15 % in excess of the scheduled time. For example, initially planned days were 100, then the project manager can complete the project in 115 days.

5.3.1 THE SCOPE STATEMENT

The project scope statement is one of the most significant documents in project management. Scope is a broad concept for any project and there is a need to create a separate scope statement for the overall project. The scope statement is a written confirmation of potential results of the project. The scope statement also contains the set of rules, restrictions, limitations and assumptions of the project under which the project team works. It is important that all related parities (i.e.,

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initiators, developers, promoters, project team, etc.) must be agreed upon the scope statement before the execution of the project. Let us now discuss section-wise major components of project scope statement as follows:

- **Justification of the project:** Project justification is also reflected in project charter under the project purpose section. Project justification elaborates on business requirements or the purpose of the project. In order gauge business performance after project completion, business requirements of a project must be communicated to all the related parties of the project.
- **Scope description:** The next section of project scope statement is scope description which includes all relevant features of the product, service or outcomes to be delivered under the project. Scope description usually includes details regarding the product, service or desired outcomes of the project.
- **Acceptance criteria:** The scope statement also contains a section on acceptance criteria which refers to the criteria that must be met to ensure that the given deliverables are complete. When all the given criteria are met by the product/service/deliverable, it can be accepted by the client and the management team. The acceptance criteria can be stated in qualitative and/or quantitative terms.
- **Project deliverables:** Deliverables are those products/service/desired outcomes that must be achieved by a project. This section of project scope briefly describes all project deliverables. More details can be added to project deliverables during the project lifecycle.
- **Constraints:** Constraints refer to limitations associated with a project. These limitations must be communicated to all related parties to ensure successful completion of the project. Project constraints of a project are usually in the form of cost, schedule time, availability of space and technology and resources.
- **Assumptions:** Assumptions of a project includes all those uncertain factors or beliefs which we consider to be true but these factors are not verified as true. This section includes a detailed list of assumptions of a project that are used to control uncertainty and mitigate risks.

5.3.2 THE BUSINESS CASES

Business case is a document that describes the reason or the value of the project that is being executed. It is an important document used for the selection of a project from all the available alternatives. A business case contains all information required for the authorisation of a project. It contains information such as problem description, alternatives available, expenses and benefits of each option, recommended solutions or options, reasons for recommendations, etc.

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Business case plays a critical role in all projects especially in large and complex projects. A business case serves as a tool to measure all benefits, costs, uncertainty and risks of alternatives available for a specific project. It works as a benchmark to guide the design, management and evaluation of the project. The main idea behind the creation of a business case is to determine whether resources such as money, time, effort, etc. would be able to fulfil business needs. A business case can be analysed by various related parties to perform their part in the project decision-making process. The business case serves many purposes and following are some main purposes served by a business case:

- Business case enables project managers to think about a project in a systematic and organised manner.
- It specifies the requirements of a project.
- It summarises key benefits or savings of a project.
- It provides a framework to ensure that the project under consideration can be completed on time and within the budget.
- It justifies costs and risks associated with the implementation of a project.

A business case can be developed in various formats. However, there are some important elements which must be included in any business case. Let us now discuss some of the important elements of a business case:

- **Executive summary:** Executive summary shows all important elements of a project concisely. It should not be more than one or two pages. It includes all the important project details such as problem statement, reasons, objectives, proposed alternative solutions, benefits, costs, time schedule, etc.
- **Mission statement:** Mission statement of a business case states what an organisation wants to achieve by completing the project.
- **Strategic case:** Strategic case provides a background report about a project and presents reasons why the project is required. In simple words, a strategic case justifies the need for a project to deal with the prevailing situation.
- **Expected benefits:** This section contains an overview of expected benefits (in comparison to current situation) that would accrue as a result of project completion. It also contains information regarding the negative aspects of the project.
- **Timescale:** Timescale section of business case summaries the project plan and reflects the total time required for the implementation of the project.
- **Costs:** This section provides an overview of estimated project costs extracted from the project plan.

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- **Expected return on investment:** It reflects monetary benefits over a period of time after the completion of a project. It can be in the form of increase in sales, increase in capacity, decrease in costs, savings, etc.
- **Risks:** This section summarises the current and expected risks of a project. It also reflects the impact of risks on the project.

5.3.3 MILESTONES SCHEDULE WITH ACCEPTANCE CRITERIA

Incorporating milestones in a project plan helps a project team monitor key dates and deadlines, external dates and deliveries. Milestones enable the project team to ensure timely completion of the project. One of the most significant duties of a project manager and project team is to monitor the project progress by using various tools. Gantt charts and milestone charts or schedules are the most commonly used and widely accepted tools to measure the project progress. A milestone schedule represents the entire life cycle of a project underlining activities and steps required for project implementation. The schedule generally represents milestones that should be achieved after each major activity or group of activities. Apart from this, it indicates the expected dates on which the milestone will be achieved. However, these dates are tentative and there is always a scope of change which may affect the milestone schedule. For example, milestones in the installation of new plant may include location selection, inviting tenders, appointment of executives or management team, supplier selection, project execution, etc. The sample of milestone schedule or chart is depicted in Table 5.1:

TABLE 5.1: SAMPLE MILESTONE SCHEDULE

Production Activities	January	February	March	April	May	June	July	August
Activity 1 (Project initiation activities	1	2	3					
Activity 2			4	5	6	7		
Activity 3			8	9	10	11		
Activity 4							12	13
Activity 5					14	15	16	
Activity 6				17	18	19	20	
Activity 7			21	22	23	24		
Activity 8						25	26	
Activity 9 (Project closure and business opening activities)							27	28

Note: The numbers written in cells refer to the milestones to be achieved.

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Acceptance plan is one of the most significant plans under the project management. Acceptance plan includes various milestones of a project that needs to be achieved within a given period of time. It also lists various deliverables produced under the project. Acceptance refers to the approval of project deliverables by the client which means that the project has gained an agreement from the client. For gaining client acceptance, project must meet criteria set by the client. Acceptance criteria includes those conditions which must be fulfilled in order that the project deliverables are accepted by the client.

A project manager creates charts and tables that depict milestones, deliverables and acceptance criteria as shown in Table 5.2:

TABLE 5.2: MILESTONE, DELIVERABLES AND ACCEPTANCE CRITERIA

Acceptance Milestone	Deliverable	Acceptance Criteria
Complete project baseline plan	Gantt chart and WBS updated; deliverables identified	WBS and Gantt chart include all the details as discussed in the project kick-off meeting
Complete subcontractor plan	Subcontractor management plan	Project sponsor and steering committee review
Complete risk management plan	Risk management plan	Steering committee members review
Project charter completed	Project charter document	Charter should identify project needs, cost, duration and creates acceptance to begin the project

After creating this preliminary table, a table containing the milestone schedule with acceptance criteria is created which is shown in Table 5.3:

TABLE 5.3: MILESTONE SCHEDULE WITH ACCEPTANCE CRITERIA

Milestone	Deliverable	Date	Acceptance Review Criteria and Methods Used	Reviewers Name	Date
Complete project baseline plan (Milestone 1)	Gantt chart and WBS updated; deliverables identified	dd-mm-yyyy	WBS and Gantt chart include all the details as discussed in the project kick-off meeting	Project Manager, Functional head	dd-mm-yyyy

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Milestone	Deliverable	Date	Acceptance Review Criteria and Methods Used	Reviewers Name	Date
Milestone 2	-	dd-mm-yyyy	-	-	dd-mm-yyyy
Milestone 'n'	-	dd-mm-yyyy	-		dd-mm-yyyy

SELF ASSESSMENT QUESTIONS

6. _____________ enables the project manager with the authority to initiate the project.
7. Which of the following component is not included in part I of project charter?
   a. Project name
   b. Author of project charter
   c. Creation date
   d. Benefits
8. The _____________ is a written confirmation of potential results of the project and due to this it is considered one of the most significant and essential document of any project.
9. Which of the following component elaborates the business requirement or the purpose of the project?
   a. Scope description
   b. Project justification
   c. Acceptance criteria
   d. Constraints
10. ___________ refers to the approval of a project by the client which means that the project has gained an agreement from the client.

ACTIVITY

Suppose you are the project manager at a sports equipment manufacturer MNC named Sporto Sports Limited and your company got an offer to supply specialised shoes for athletes in an upcoming international sports event. Sporto assigns you the task of creating a project charter for promoters of this sports event. Develop and present the project charter for the same.

5.4 CONCEPT OF PROJECT PLANNING

In your everyday life, you have to plan out tasks the way you want them to perform. For instance, you make a plan for studying for exams

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according to the subjects and the time each subject takes to prepare. Similarly, a working person makes a monthly budget allocation plan to stay away from any financial crises. A plan is made in almost every field as it enables individuals to attain their goals in the right manner. The field of project management is also not untouched by planning. In this section, let us study about project planning in detail.

A project is taken up by an organisation for a long term. To get the desired results, a project plan needs to be formulated by organisations. A project plan is a route map to execute project activities from initiation to completion of a project. It enables an organisation to determine what needs to be done, when it needs to be done, how it is to be done, and by whom it needs to be done. Project planning is a systematic process of developing a project plan that states the objectives and scope of the project, resources required, budget, and so on.

Good planning leads to successful completion of a project as it reduces the number of errors and failures that may occur in a project. However, the effectiveness of planning depends on its elements. Figure 5.2 lists some vital elements of planning:

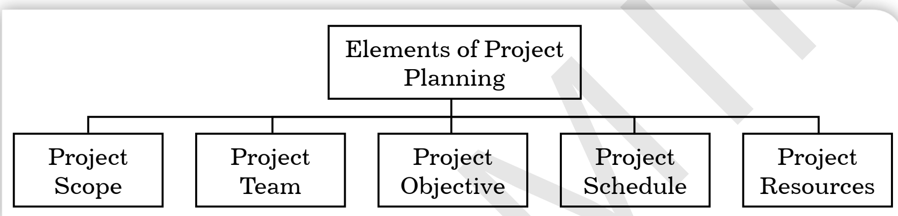

Figure 5.2: Elements of Project Planning

These elements are discussed as follows:

- **Project scope:** It states the main purpose of selecting a specific project, its legality, and significance.
- **Project team:** It represents a group of individuals to whom the tasks of completing a project is delegated. These individuals are responsible for performing project activities as per the set project standards. Project team members are given training from time to time with an aim to improve their skills and abilities.
- **Project objectives:** They provide a detailed description of the desired results of a project. Project objectives also include mission and value of the project and information about the general goals, such as profitability and competitive position of the project.
- **Project schedule:** It is a roster that states the allocation of tasks and resources to team members so that a project can be completed within the stipulated time. The allocation should be done in an organised manner.

- **Project resources:** These are the means available to an organisation for the completion of a project. These resources can be physical or financial. For the project to be completed successfully, it is essential that resources should be used optimally.

When consistent planning of the project is missing, project delays can happen. This may lead to huge financial losses for an organisation.

5.4.1 STEPS IN PROJECT PLANNING

Project planning is not a subjective procedure and includes a series of steps. Appropriate implementation of each step is vital for completing a project successfully. Figure 5.3 shows the steps involved in project planning:

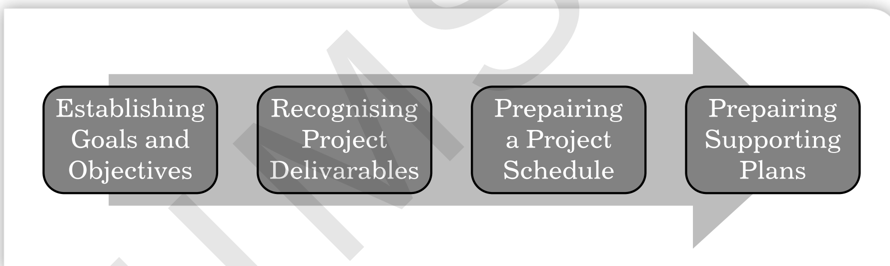

Figure 5.3: Steps of Project Planning

These steps are discussed as follows:

1. **Establishing goals and objectives:** This is the first step in planning wherein the desired output is determined and stated. When the goals and objectives are set, the organisation must ensure that due importance is given to shareholders' requirements and desires.
2. **Recognising project deliverables:** This step involves preparing a list of outcomes to be delivered to customers within the specified time period.
3. **Preparing a project schedule:** This step involves formulating the agenda of activities to be performed for completing a project. This helps an organisation to collect information on resources and total time required for completing project activities; thereby attaining the desired goal.
4. **Preparing supportive plans:** This relates to the last step of planning, where the organisation makes an attempt to work out certain plans in order to sustain the project objectives. These plans can include risk management plan, communication plan, human resource plan, etc.

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5.4.2 PROJECT PLANNING TOOLS

To ensure the effectiveness of project planning, project managers make use of different tools and methods. These tools and techniques not only help managers in developing an efficient plan but also enable them to improvise the current procedures of the organisation. Figure 5.4 shows some of the important tools of project planning:

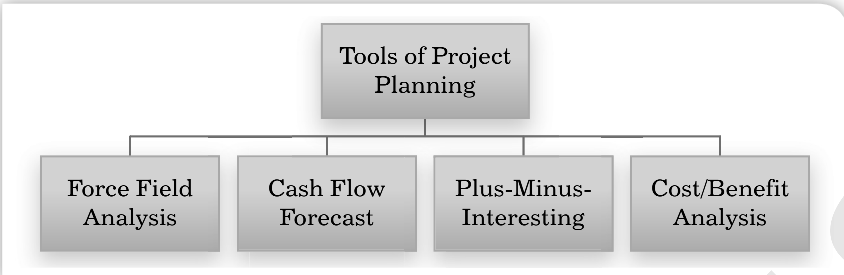

Figure 5.4: Project Planning Tools

These tools are explained as follows:

- **Force field analysis:** This project planning tool was created by a famous psychologist, Kurt Lewin. Force field analysis is performed to evaluate the positive and negative forces associated with a project. In other words, force field analysis involves recognising and ascertaining the different aspects of a project. For instance, an organisation wishes to start its factory upgrade project. The positive forces associated with this project can be high volume of output, low maintenance expense, customer satisfaction, etc., while the negative ones that may not support this upgradation can be high cost of installation, unwillingness of employees to use new machines, and so on.
- **Cash flow forecast:** It is a tool that helps in calculating the cash inflow (capital) and cash outflow (expenditure) of a project over a period of time. Cash flow forecast helps in administering project expenditures; thereby preventing the situations of over budgets and ensuring the economic productivity and liquidity of projects.
- **Plus-minus-interesting:** It is a tool used for recognising the positive and negative effects of a course of action; thereby helping managers to decide whether to select that action. For instance, if the result of positive forces is more than the negative ones, project managers can continue with a particular course of action.
- **Cost/benefit analysis:** A project manager can use this tool to compare expenses linked with the implementation of a project and the profit anticipated therein. This helps project managers to determine the productivity of a project.

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SELF ASSESSMENT QUESTIONS

11. A ______________ is a route map to execute project activities from initiation to completion of a project.
12. Project team represents a group of individuals to whom the tasks of completing a project is delegated. (True/False)
13. ____________ tool is used to compare expenses linked with the implementation of a project and the profit anticipated therein.

ACTIVITY

Select any organisation of your choice. Now using the Internet, search some real life examples of project planning tools used by this organisation and make a report on any one of these project planning tools.

5.5 WORK BREAKDOWN STRUCTURE (WBS)

Work Breakdown Structure (WBS) is also known as Contract Work Breakdown Structure (CWBS). WBS is developed along with the preparation a project schedule. During WBS development, each project activity is divided into achievable and smaller tasks.

As the term breakdown suggests, WBS can be defined as the technique that divides the whole project into smaller components or activities and activities into sub-activities. WBS framework splits complex activities of a project into smaller and simple activities required to produce required project deliverables. WBS is used by project managers to simplify various elements of the project such as planning, cost estimation, effort estimation, project execution, project scheduling and project supervision.

A WBS template is presented in Figure 5.5:

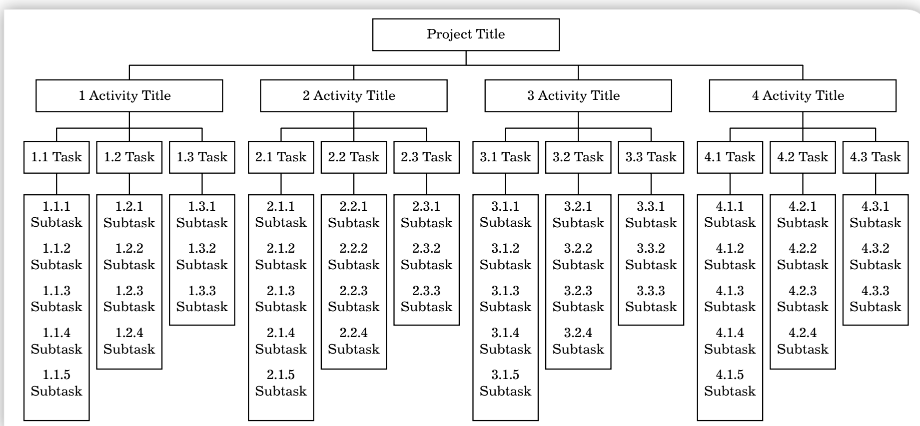

Figure 5.5: WBS Template

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The importance of WBS can be assessed from the following points:

- WBS ensures the proper assignment of project team responsibilities.
- It defines the total scope of work to be carried out.
- It defines all project milestones and control points of the project. As a result, it makes a complex project simple and understandable.
- It defines the relation between work, organisation and cost.
- It enables management to estimate the cost, time and risks of deliverables more accurately.
- It enables management to estimate performance measurement and control more accurately.

CONSTRUCTION OF WBS AND WBS DIAGRAM

The construction of WBS structure starts with the identification of key deliverables of a project. Key deliverables of any project are generally identified by project managers and Subject Matter Experts (SMEs) or task leaders involved in the project.

Once the project deliverables are identified, the next step is to break high level complex tasks into simple and smaller ones. Under this step, project managers or task leaders break complex tasks into various sub-tasks. Activities can be broken-down depending upon the type of project and management style followed in an organisation. However, at times project managers can lay down their own rules for determining the smallest sub-activity in a WBS. For example, a project manager of a large and complex project may develop a 'two-week' rule for determining WBS sub-activities. According to this rule, a WBS sub-activity should not exceed duration of two weeks. Another rule that is commonly used for creation of WBS is 8/80 rule. 8/80 rule states that the smallest activity of a WBS should have minimum duration of 8 hours (one work day assuming one work day = 8 hours) while the largest WBS task should not have duration more than 80 hours (ten work days).

The next step is to construct the WBS structure or diagram which is also known as the graphical representation of project scope. The diagram starts with a graphic box at the top and this box represents the project as a whole. After that sub-components (activities) of a project are reflected in the diagram. Each component is further broken down into yet other components (sub-activities, sub-sub-activities, and so on). This process of breaking an activity into smaller sub-activities is carried out till the time deliverables of a project can be represented in the WBS diagram. A deliverable is produced on the successful completion of certain activities and sub-activities and ensures the achievement of deliverables.

N O T E S

WBS is applicable in almost all projects such as manufacturing, electricity generation, mining, infrastructure development projects, construction projects, information technology projects, etc. WBS serves as an input for Gantt charts which is used to track the task-wise progress of the project. WBS diagram is most widely used in Information Technology (IT) projects. The sample IT software project WBS is shown in Figure 5.6:

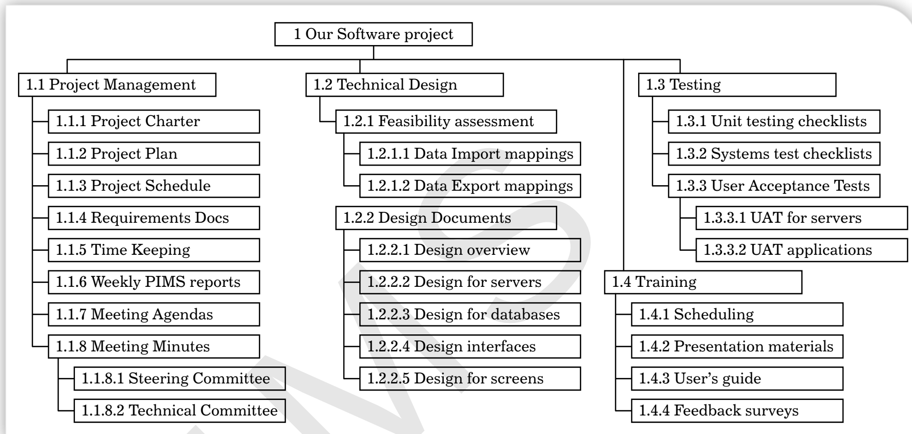

Figure 5.6: Sample of WBS for IT Software Project

Source: https://www.tutorialspoint.com/management_concepts/work_breakdown_structure.htm

SELF ASSESSMENT QUESTIONS

14. ____________can be defined as the framework that breaks or divides the whole project into smaller components or activities.
15. Key deliverables of any project are only identified by the project manager. (True/False)

ACTIVITY

Suppose you are a project manager at a reputed construction company named 'XYZ Realty Infrastructure Limited'. Your company got an offer to construct a dam and reservoir on a river. Now as the project manager, you are required to prepare a WBS diagram for the same.

5.6 RACI/ RAM MODEL

The successful completion of any project can be ensured by the involvement of all members of a project team. Proper involvement of all human resources can be ensured if the project manager possesses good human resource planning skills in order to efficiently delegate

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authority to all team members. Identification and delegation of roles and responsibilities for a project is also an important task. The project manager is also responsible for setting the expectations of all the members of project team.

Responsibility Assignment Model (RAM) is also known as Responsible, Accountable, Consult, Inform Model (RACI) and Linear Responsibility Chart (LRC). The RAM matrix refers to the organisational chart related with human resource planning in a project. RAM defines roles and responsibilities for each member of a project team.

In other words, RAM is used to provide a clear picture of the expectations and the level of participation of each member. RAM determines the role of each team member in the completion of project activities and sub-activities (i.e., WBS elements). The main purpose of this chart is to fix the responsibility and accountability of team members. RAM is a matrix in which WBS elements (in various phases of project life cycle) are listed in rows while designations of human resources are listed in columns. Under this process, various tasks, activities, milestones and decisions of a project are delegated to each team member. Every member of a project team is assigned a specific role according to the level of hierarchy in the RACI model (Responsible, Accountable, Consulted and Informed). Let us now discuss the definitions of RACI Model as follows:

- **Responsible:** It signifies the person whose work is required for the successful completion of an activity. These persons have responsibility to get the work done or for the decision to be made. Application developer, architect, business analyst and market researcher are some examples.
- **Accountable:** It signifies the person who holds the power to give approval to the responsible person for getting the work done. This person is accountable for correct, detailed and careful completion of the deliverable. Project manager and project executives are examples.
- **Consulted:** It refers to those people who provide information and share their opinion on the project through a two-way communication process. These persons are consulted regarding the issue but they are not directly involved in carrying out the task.
- **Informed**: It refers to those people who need to be up to date regarding the progress of a project and they are affected by the outcome of a project. They are informed regarding the deliverables of every task or activity through one-way communication. For example, the project sponsor, project promoter and project developer must be informed.

NOTES

A sample RAM chart is shown in Table 5.5:

TABLE 5.5: SAMPLE OF RAM CHART

Function	Project Sponsor	Business Analyst	Project Manager	Software Developer
Initiate project	C	-	AR	-
Establish project plan	I	C	AR	C
Gather user requirements	I	R	A	I
Develop technical requirement	I	R	A	I
Develop software tools	I	C	A	R
Test software	I	R	A	C
Deploy software	C	R	A	C

SELF ASSESSMENT QUESTIONS

16. RAM is a matrix in which phase-wise elements of ____________ are listed in rows while the designations of human resources are listed in columns.
17. According to the RACI model, which of the following refers to those people who provide information and share their opinion on the project through a two-way communication process?
    a. Responsible
    b. Accountable
    c. Consulted
    d. Informed

ACTIVITY

Suppose you are going to visit any hill station along with your three friends. There are various activities that you have planned to do during this tour. It includes packing, ticket booking, hotel booking, cash handling, cabin reservation, etc. Prepare a RACI model for this trip.

5.7 PROJECT PLANNING ESTIMATION

Project planning estimation is the most important element for a project to be successful. Estimation is a process of anticipating cost, time and resources required for a project. When the estimation is precise, it means that the activities of the project are going on smoothly, which leads to successful project completion. For instance, the precise esti-

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mation of time needed for the completion of a project helps the organisation prevent project delays.

In an organisation, individuals from different departments and backgrounds are selected to perform project planning estimation. They perform estimation by consulting industry experts; comparing the present project activities with the similar projects completed in the past; and breaking the project activities into smaller tasks or work packages.

The following are some commonly used methods of performing project planning estimation:

- Task breakdown
- Delphi method
- Task examination
- Results documentation
- Historical data examination
- Parametric estimating
- Structured planning
- Educated assumption
- Dependencies identification

5.7.1 PURPOSE OF ESTIMATION

The contemporary market is characterised by tough competition among different business organisations. In order to be ahead, each organisation is making every effort to use time judiciously. This leads organisations to skip the estimation process. Although this may let the organisation to save time and expenditure in the beginning, this can prove to be one of the major causes of project failure. The following points explain the purpose of estimation:

- Estimation helps in obtaining resources needed for project deliverables.
- It helps in keeping track of the project's development.
- It assures the execution of followers who have a part in the accomplishment of a project.
- It evaluates time and money required to complete a project.

5.7.2 ESTIMATION TOOLS

Project managers use a number of estimation tools based on the nature and needs of a project. For example, some tools are utilised particularly for estimating the duration of a project. In the same way, some

N O T E S

tools are used exclusively for estimating project cost. The following are some commonly used estimation tools:

- **Nominal Group Technique (NGT):** This is a technique used for estimating the time duration of a project. In this technique, project team members are asked to specify individual task durations. The estimated task durations given my each member are listed in a tabular form and the average shortest range of task duration is evaluated.
- **Expert advice:** This tool is used for estimating the time duration of a task given by consultants, sellers, or other technical experts.
- **Expert opinion:** This tool is utilised for estimating the cost of the project based on the expertise and understanding of an expert concerning the type of project given.
- **Estimating equations:** This tool is used for estimating the cost of the project based on mathematical models. Through this method, a link is made between the input and output of the project.
- **Decomposition:** Through this tool, the cost of a project is estimated by dividing the whole project in different small tasks. The organisation is able to estimate the cost concerning each small task, which helps the organisation to estimate the total cost linked with the whole project.
- **Three-point estimation:** This is an estimation method that includes the utilisation of normal and distribution models. Three-point estimation is considered to be the most popular and favoured method of estimation. The following are the three kinds of estimates used for calculation:
  - a= best case estimate, also known as Optimistic (O)
  - m= most likely estimate, also known as Most Likely (M)
  - b= worst case estimate, also known as Pessimistic (P)

  In this kind of estimation, the unpredictability and improbability stands for Standard Deviation (SD) and the weighted average by E. The following formulae are used to find out the value of E and SD:

  - $E = [a + (4m) + b] /6$
  - $SD = (b - a)/6$

  For preparing the estimates of a project using the three-point estimation method, the manager needs to do the following:

  - Plan WBS.
  - Assess E and SD for each activity of the project.

- Establishing E for the whole project. For calculating E, the following formula must be used:

  E (Project Work) = Σ E (Task)

- Ascertain SD for the whole project. For calculating SD, the following formula must be used:

  SD (Project Work) = √Σ SD (Task)

After the values of E and SD have been calculated, the manager of the project must change the estimates into a confidence level using the following rules:

- Confidence Level in E value is approximately 50%
- Confidence Level in E value + SD is approximately 70%
- Confidence Level in E value + 2 * SD is approximately 95%
- Confidence Level in E value + 3 * SD is approximately 99.5%

NOTE

Remember that WBS helps an organisation in representing complicated tasks and activities in uncomplicated and effortless way by breaking the complicated tasks into distinctive and controllable activities.

- **Base and contingency estimation:** This method of estimation is said to be the substitute of three-point estimation. It is fitting for times when the information for estimation is limited. This technique is less methodical as compared to the three-point estimation method and does not generally provide confidence levels.

The base and contingency technique consists of two elements, base and contingency. Base relates to the time limit expected by the project according to the plan; while contingency relates to the trust shown after taking into consideration all the risks linked with the base. Contingency is expressed as the percentage of base.

Through the separating of base and contingencies of a project, a manager is able to make estimation of the project in particular. A base figure can be attained if the risks linked with the concerned task are overlooked. Alternatively, contingencies can be calculated by working out risk assessment of a similar task. The contingency level of a task is 10% to 20%. Nevertheless, the contingency level can go up to 50% or more for an unsafe project.

5.7.3 ESTIMATION APPROACHES

Different organisations use different approaches for estimation. The following are two types of approaches used for estimation:

- **Bottom-up approach:** This relates to the method based on WBS. This approach is also called definite estimate or micro estimate. In

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this approach, different sub-work packages linked with the project are recognised. Subsequently; every sub-work package is estimated and combined to create a higher level of WBS. For instance, a group of people may want to make use of the bottom-up approach for estimating and creating a fresh product. In such a situation, this group of people prepares a list of activities to be performed to create the needed product. Later these activities are divided into different groups. Later, these groups are further divided into top level groups. For example, this group may decide in which category of product design they would put the colour, size, etc. of the product. However, the main drawback of the bottom-up approach is that it is time consuming.

- **Top-down approach**: In top-down approach, the estimation is done by correlating the same type of projects undertaken in the past. This kind of approach is also called budget estimate, or macro approach of estimation.

The estimation in this approach is done based on the judgement and experience of senior and junior level managers. In this kind of approach, the whole project is divided into different sub-activities. Later, these activities are estimated and accumulated for the estimation of the whole project. An organisation tries to divide a single task into many small tasks.

SELF ASSESSMENT QUESTIONS

18. ______________ is a process of anticipating cost, time, and resources required for a project.
19. Three-point estimation is a tool wherein the cost of a project is estimated by dividing the whole project into different small tasks. (True/False)
20. Earthquake, fire, drought, cyclones, spillage and various other accidents are some of the examples of __________.
21. What is the confidence level for E value + 2 * SD?
    a. 50 per cent
    b. 90 per cent
    c. 95 per cent
    d. 99.5 per cent

ACTIVITY

Hold a discussion with the project manager of an organisation of your choice. Discuss the factors that need to be considered in project planning estimation.

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5.8 SUMMARY

- A project manager has to make many significant decisions in any particular project and these decisions are related to various factors such as number of people required, technology required, cost factors involved, etc.
- Effective decision making ensures that a project is executed in an organised manner. Project decisions depend on the requirements of organisation and due to this they differ from organisation to organisation.
- Project charter refers to the document in which scope, objectives, participants of a particular project are determined and it is also known as initiation form or project authorisation document.
- Generally project charter is divided into two parts which are: Part I – project overview and Part II – project details.
- Project overview contains primary information (i.e. project name, author of project charter, creation date, revision date, project requester, project manager, approved/unapproved status of project charter, etc.) about the project and project charter.
- Project details part contains detailed information (i.e. project description, purpose, goals and outcomes of the project, project scope, benefits, project team, stakeholders, communication plan, timeline, etc.) about the project.
- The scope statement of a project is the document which allows the project manager to elaborate the project scope in a broad manner.
- The scope statement is a written confirmation of potential results of the project. Business case is a document that describes the reason or the value of the project that is being executed. A business case serves as a tool to measure all the benefits, costs, uncertainty and risks of alternatives available for a specific project. Acceptance plan includes various milestones of a project that needs to be achieved within a given period of time.
- Force field analysis, cash flow forecast, plus-minus-interesting (PMI) and cost/benefit analysis are some important project planning tools.
- During WBS development, this process all each project activities activity are is divided into achievable and smaller tasks. The construction of WBS structure starts with identification of key deliverables of a project. Key deliverables of any project are generally identified by project managers and Subject Matter Experts (SMEs) or task leaders involved in the project. Responsibility Assignment Model (RAM) determines the role of each team member in the completion of project activities and sub-activities (i.e. WBS elements).

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- Project planning estimation is a process of anticipating cost, time, and resources required for a project. When the estimation is precise, it means that the activities of the project are going on smoothly, which leads to successful project completion.
- The contemporary market is characterised by tough competition among different business organisations. In order to be ahead, each organisation is making every effort to use time judiciously.
- Some of the essential factors of estimation are contingencies, participation of a project team, risk assessment and independence.
- Nominal Group Technique (NGT), expert advice, expert opinion, estimating equations, decomposition, three-point estimation, base and contingency estimation, etc. are some important tools used for estimation.
- There are two approaches for project estimation namely bottom-up approach and top-down approach.
- Bottom-up approach is also known as definite estimate or micro estimate and under this approach, different sub-work packages linked with the project are recognised.
- Top-down approach also known as budget estimate or macro approach of estimation and under this approach the estimation is done by correlating the same type of projects undertaken in the past.

KEY WORDS

- **Constraints:** Limitations of the project that must be communicated with all related parties to ensure the successful completion of the project.
- **Delphi method:** Method used to make forecasts based on the results of questionnaires received from industry experts.
- **Investment:** Putting money into a project with an expectation of profit generation in future.
- **Milestone:** A significant stage or phase in the development of a project.
- **Project charter:** Authorisation document that enables project manager to initiate the project.
- **Project deliverables:** Deliverables are also known as the objectives of the project and it includes product, service or desired outcomes to be achieved by the project.
- **Project management life cycle**: Organised process of structuring project activities.

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- **Project tolerance:** Acceptable variation in the quality requirement of the project and it determines the range of acceptable results.
- **Project:** A set of interrelated tasks which are necessary to achieve a predetermined goal.
- **Standard deviation:** Statistical method of measuring the degree of variation from the mean.

5.9 DESCRIPTIVE QUESTIONS

1. Explain the meaning of project decisions in context of project management. Also explain its types.
2. Explain Project Charter with the help of an example.
3. Write short note on the components of a Project Charter.
4. Describe the concept of a project scope statement. Also explain the need to create separate document for scope of the project.
5. Write a short note on the importance of project planning and its elements.
6. Explain the stages of project planning along with the commonly used project planning tools.
7. What is Work Breakdown Structure (WBS)? Explain the construction of WBS with the help of an example.
8. Describe the concept of RACI model?
9. Write a short note on the various approaches used in project estimation.

5.10 ANSWERS AND HINTS

ANSWERS FOR SELF ASSESSMENT QUESTIONS

Topic	Q. No.	Answers
Project Decisions	1.	Project decisions
	2.	Decision making
	3.	False
	4.	Promoter
	5.	True
Project Charter	6.	Project charter
	7.	d. Benefits
	8.	Scope statement
	9.	b. Project justification

N O T E S

Topic	Q. No.	Answers
	10.	Acceptance
Concept of Project Planning	11.	Project plan
	12.	True
	13.	Cost/benefit analysis
Work Breakdown Structure (WBS)	14.	Work Breakdown Structure
	15.	False
RACI/ RAM Model	16.	Work Breakdown Structure
	17.	c. Consulted
Project Planning Estimation	18.	Estimation
	19.	False
	20.	Contingencies
	21.	c. 95 percent

HINTS FOR DISCREPTIVE QUESTIONS

1. All those independent decisions which need to be made for the successful completion of a project are known as project decisions. Idea generation, promoter selection, opportunity study, feasibility studies and project selection are some of the important type of project decisions. Refer to Section **5.2 Project Decisions.**
2. Project charter refers to the document in which scope, objectives, participants of a particular project are determined. It is also known as initiation form or project authorisation document. Refer to Section **5.3 Project Charter.**
3. Purpose of the project, project scope, budget of the project, risks, milestones and authority level of project are major components of project charter. Refer to Section **5.3 Project Charter.**
4. Scope is a broad concept for any project and there is a need to create a separate scope statement for the overall project. The scope statement is a written confirmation of potential results of the project. Refer to Section **5.3 Project Charter.**
5. A project plan is a route map to execute project activities from initiation to completion of a project. It enables an organisation to determine what needs to be done, when it needs to be done, how it is to be done, and by whom it needs to be done. Project scope, project team, project objective, project schedule and project resources are some major elements of project planning. Refer to Section **5.4 Concept of Project Planning.**
6. There are four stages of project planning and these stages are establishing goals and objectives, recognising project deliverables, preparing a project schedule and preparing

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supportive plans. Force field analysis, cash flow forecast, plus-minus-interesting (PMI) and cost/benefit analysis are some of the important type of project planning tools. Refer to Section **5.4 Concept of Project Planning.**

7. Work Breakdown Structure (WBS) is also known as Contract Work Breakdown Structure (CWBS). WBS refers to the process which takes place during the preparation a project schedule and under this process all project activities are divided into achievable and smaller tasks. Refer to Section **5.5 Work Breakdown Structure (WBS).**
8. Project manager is also responsible to set the expectations of all the members of project team. Responsibility Assignment Model (RAM) also known as Responsible, Accountable, Consult, Inform Model (RACI) refers to the organisational chart related with the human resource planning. Refer to Section **5.6 RACI/RAM model.**
9. There are two approaches of project estimation namely bottom-up approach and top-down approach. Bottom-up approach is also known as definite estimate or micro estimate and under this approach, different sub-work packages linked with the project are recognised. Top-down approach also known as budget estimate or macro approach of estimation and under this approach the estimation is done by correlating the same type of projects undertaken in the past. Refer to Section **5.7 Project Planning Estimation.**

5.11 SUGGESTED READINGS & REFERENCES

SUGGESTED READINGS

- Berkun, S. (2015). *Making things happen*. Sebastopol: O'Reilly Media.
- Garrett, D. (2012). *Project pain reliever*. Ft. Lauderdale, FL: J. Ross Pub.
- PROJECT MANAGEMENT INSTITUTE. (2017). *A GUIDE TO THE PROJECT MANAGEMENT BODY OF KNOWLEDGE*. [S.l.]: PROJECT MANAGEMENT INST.
- Taylor, P. (2015). *Lazy project manager, 2nd edition*. [Place of publication not identified]: Infinite Ideas Limited.

E-REFERENCES

- *Business case | APM*. (2018). *Apm.org.uk*. Retrieved 17 January 2018, from https://www.apm.org.uk/body-of-knowledge/delivery/integrative management/business-case/

N O T E S

- *Project Charter*. (2018). *www.tutorialspoint.com*. Retrieved 17 January 2018, from https://www.tutorialspoint.com/management_concepts/project_charter.htm
- *RACI Matrix | Roles and Responsibilities with a Real-Life RACI Matrix Example - Master of Project Academy Blog*. (2018). *Master of Project Academy Blog*. Retrieved 17 January 2018, from https://blog.masterofproject.com/raci-matrix-roles-responsibilities/
- *The Business Case Project Management*. (2018). *2020projectmanagement.com*. Retrieved 17 January 2018, from http://2020projectmanagement.com/2015/05/the-business-case/
- *The Responsibility assignment matrix Project Management*. (2018). *2020projectmanagement.com*. Retrieved 17 January 2018, from http://2020projectmanagement.com/2013/10/the-responsibility-assignment-matrix-ram/
- *The Work Breakdown Structure Project Management*. (2018). *2020projectmanagement.com*. Retrieved 17 January 2018, from http://2020projectmanagement.com/2013/10/the-work-breakdown-structure-wbs/
- *Why a Business Case is part of Project Management*. (2018). *Blog.method123.com*. Retrieved 17 January 2018, from http://blog.method123.com/2010/05/09/why-a-business-case-is-so-important/#!prettyPhoto
- *Work Breakdown Structure (WBS) in Project Management*. (2018). *Gantt Chart GanttPRO Blog*. Retrieved 17 January 2018, from https://blog.ganttpro.com/en/how-to-create-a-work-breakdown-structure-wbs-with-project-planning-templates/

6 CHAPTER

PROJECT SCHEDULING AND RESOURCE ALLOCATION

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INTRODUCTORY CASELET

APPLICATION OF PROJECT SCHEDULING SYSTEM

Project scheduling can be defined as the tool to ensure that all tasks (activities) of a project are completed within minimum time or at minimum cost. There are two main objectives for project scheduling which are to identify and eliminate the cause of possible delay, and ensure effective allocation of resources in the project.

ABC Ltd. deals in office and home interior designing solutions. Its main product is carpet installation for which they have hired some trade contractors and service vendors. ABC Ltd. has good relationships with these contractors and service vendors. The communication and collaboration process is done using telephone and fax. ABC Ltd. has a dedicated team of project superintendents to handle all collaborations and project coordination.

Project scheduling was not proper in ABC Ltd. because there were only a few levels of process controls. It also lacked in maintaining real-time target deadlines and as a result customers suffered. The project system at ABC Ltd. was also not effective because it only shares information when the job is already delayed. In simple words, the system was not proactive. This approach was erroneous which led to rework and multiple trips for contractors. These entire situation led to various other process problems such as multiple attempts to schedule customer service, wastage of resources or improper resource utilisation, difficulty in maintaining deadlines and due dates, lack of proactive information delivery, delayed services, dissatisfied customers and vendors, etc.

ABC Ltd. took many steps in order to resolve and address all these problems. A dedicated system was set-up to ensure better project coordination. Under this system, various retailers are assigned to each vendor or contractor based on their capacity. Vendors have also signed a Service Level Agreement (SLAs) with retailers to meet their requirements. The company also installed retailer resource planning system through which vendors were allowed to input and maintain retailer's capacity. Under this system, all job durations of specific project are computed. This enables the company to maintain a standard product lead time. All these steps also bring many other positive results for the company such as better lead time data from vendors, efficient flow of information, proactive and electronic notification, real-time order update, easy to meet the process and customer deadlines, better customer service, more satisfied customers, less time in scheduling jobs, increase in revenue with same resource utilisation, proper utilisation of vendors, better capacity utilisation, decrease in costs, etc.

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LEARNING OBJECTIVES

After studying this chapter, you will be able to:

- Explain the concept of project scheduling
- Define the importance of estimating time
- Discuss the methods of project network analysis
- Discuss the Gantt chart
- Discuss the GERT chart
- Define the concept of resource scheduling
- Explain the process of resource scheduling

6.1 INTRODUCTION

In the previous chapter, we discussed the concepts related to project planning and decision making in a project. In this chapter, we will discuss various aspects of project scheduling and allocation of resources.

Imagine you have to start a long road trip to an unfamiliar destination without a map or navigation software/system. You are sure you have to make some turns here and there, but you have no idea when or where or how long it will take to get there. Eventually, you may arrive, but there is always the risk of your getting lost and feeling annoyed during the trip.

Driving without having any idea of how you are going to get there is similar to working on a project without a schedule. No matter the size or scope of your project, the schedule is a key part of project management. The schedule tells you when each activity is supposed to be done, what has already been done and the sequence in which things need to be completed.

As there are some uncertainties involved, the schedule is reviewed regularly. Revisions are often done while the project is in progress. It continues to develop as the project moves forward. The schedule essentially transforms the project from a vision to a time-based plan.

This project schedule is considered to be a tool that specifies what task needs to be performed, which resources of the organisation will perform the work and the time frames in which that work needs to be performed.

In this chapter, we discuss various aspects of project scheduling in detail. The chapter begins by discussing the concept of project scheduling. It then explains the various methods used in estimating the time taken to complete a project. The chapter also explains project network analysis which includes CPM model, the PERT model, the GERT model and the Gantt chart. Towards the end, the chapter explains various components of resource scheduling such as resource loading, resource levelling and resource allocation.

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6.2 CONCEPT OF PROJECT SCHEDULING

A project contains various activities. Yet, in the implementation stage of a project, all these activities cannot be on track concurrently from the start of the project. So, all these activities need to be arranged in a proper sequence. Project scheduling entails establishing a logical sequence for the various activities of a project and optimising the complete period of the project. The process of project scheduling commences with the formulation of a project schedule, which mentions the sequence of activities that should be followed all through the implementation phase of the project. The project schedule acts as an essential function in the successful completion of different project activities. For instance, any inaccuracy in the project schedule can lead to excessive consumption of resources and time, which may prove disastrous for the project. As a result, a project manager must be extremely vigilant while formulating the project schedule. Two important factors related to the activity of project scheduling include developing a project network and estimating the time for the entire project activity. These two factors are explained in the forthcoming sections of this chapter.

A simple project can be administered as a series of activities. A project schedule generally provides the following details of each task:

- Initiation and completion of the project
- Time period of each task in the project
- Data regarding dependent and independent tasks
- A graph or Gantt chart that shows the dates of the tasks as bars over a period of time

A well-made, accurate project schedule plays an essential part in the successful completion of a project. However, to attain the required objectives, a project schedule must contain definite features. Some of these features are as follows:

- Periodic updating of the schedule. The period could be daily, weekly or monthly.
- Equal value of the Estimate at Completion (EAC) and the baseline.
- Proper distribution of invested efforts among team members.

Some important applications of a project schedule are as follows:

- A project schedule helps in researching the project plan. This entails a series of tasks and dependencies among the tasks, date ranges of all the tasks and a graphical visualisation of the time frames of every activity on the Gantt chart.
- Resource scheduling facilitates assignment of tasks as per the available resources. This enables the team to know the tasks that

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have been planned for the members and when they are due. Resource levelling permits the project manager to make sure that adequate and proper resources are provided at desirable levels across different tasks and other projects.

- A project schedule is used as a source for assigning the timelines of different project activities to stakeholders and team members of the project. The graphical nature of the Gantt chart makes it simple to comprehend the current project tasks.
- A project schedule requires to be restructured on a regular basis. The updating is to be performed all through the project cycle. The current project status is compared against the baseline snapshot to facilitate the project manager to follow the project's progress.
- Task dependencies permit the project manager to analyse the impact of delays in one task on the remaining planned tasks. The project schedule permits visibility of this impact.

6.2.1 DEVELOPING A PROJECT NETWORK

A project network can be described as a visual representation of various individual activities of the project in a logical manner by using nodes and arrows. It helps in scheduling and sequencing various individual activities and administering the total time required for finishing the project. It even enables an organisation to analyse the relationships among different project activities. Based on the character of the activity to be done, network diagrams can be complicated or simple to build and organise. The following is a description of the various types of activities in a network diagram:

- **Left to right flow:** The activity flow signifies the chronological flow of activities. Usually the flow of a network diagram is from left to right. That is, the network diagram commences from the left side and progresses towards the right.
- **Distinct coding of activities: Distinct coding for every activity in a project** is required for the exclusive identification of every activity by relating the activity with a letter, number or code. The related letter, number or code is used to refer the specific activity in the diagram. For instance, various activities can be expressed as activity A, B, C or activity 1, 2, 3 in the network diagram.
- **Preceding and succeeding activities:** The predecessor and successor activities of an activity are known as **preceding and succeeding activities respectively**. Each activity except the start and finish activities must have a preceding and successor activity. No activity can have the same predecessor and successor. Every preceding activity must be finished prior to initiating the next activity. Thus, it is relevant to set up a logical sequence of various activities in a project.

N O T E S

Table 6.1 displays the coding and logical sequence of different activities in a construction project:

TABLE 6.1: ACTIVITIES IN THE XYZ CONSTRUCTION PROJECT		
Activity Code	**Activity Name**	**Predecessor**
A	Constructing the base of the building	------
B	Constructing the framework	A
C	Plastering the walls	B
D	Installing electrical wiring	C
E	Installing plumbing	C
F	Decorating the interior	D, E
G	Completing the exterior	C

- **Arrows (→):** Usually, in a network diagram, arrows refer to activities of a project. A single arrow shows only one specific activity. The description and duration of the activity is mentioned along the arrow. The arrows used in the network diagram are also called arcs. These arrows show the logical precedence of tasks. The length and breadth of an arrow have no significance in the diagram. The arrow tail indicates the initial point of an event and the arrow head indicates the completion point. Two arrows can be interconnected in a network diagram. The use of an arrow is shown in Figure 6.1:

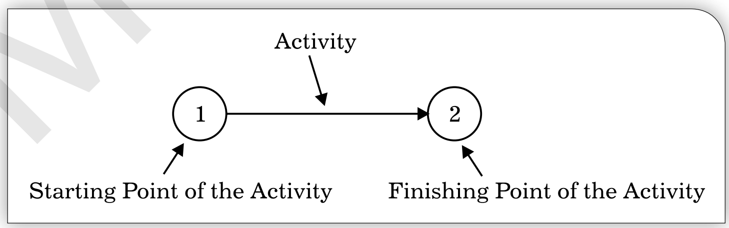

Figure 6.1: Arrows in a Network Diagram

- **Usage of nodes (O):** A node indicates the start or finish of an activity. Nodes are also called events. Every node is characterised by a number. Every succeeding event is given a higher number than the one preceding it. All arrows in a network diagram begin from a node and finish at another node. There is just one initial and one terminal node in a network. The use of nodes is shown in Figure 6.2:

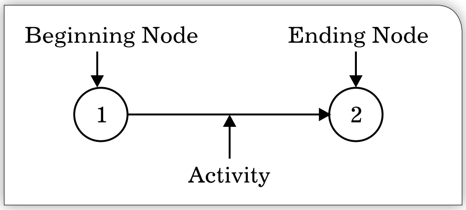

Figure 6.2: Nodes in Project Network

- **Merge event:** A merge event refers to the node showing the completion of more than one activity. A merge event is shown in Figure 6.3:

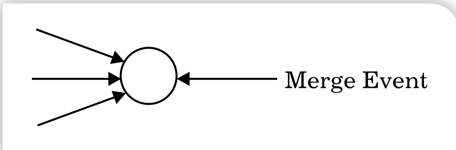

Figure 6.3: Completion of Activities in a Merge Event

- **Burst event:** A burst event signifies the node that shows the starting point of more than one activity. A burst event is shown in Figure 6.4:

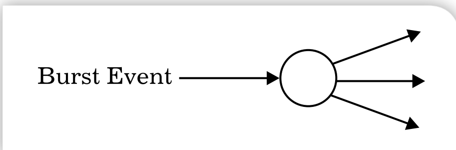

Figure 6.4: Initiation of Activities Represented by a Burst Event

- **Dummy activity:** A dummy activity refers to an imaginary activity that consumes no time or resources. It is used in the network diagram to show a dependency relationship or connectivity between two or more activities. A dummy activity is shown by a dotted arrow. Figure 6.5 shows a dummy activity:

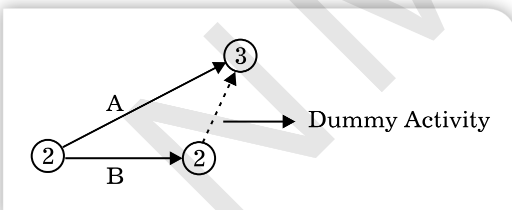

Figure 6.5: Network Diagram with a Dummy Activity

The project network of XYZ Construction is shown in the Figure 6.6:

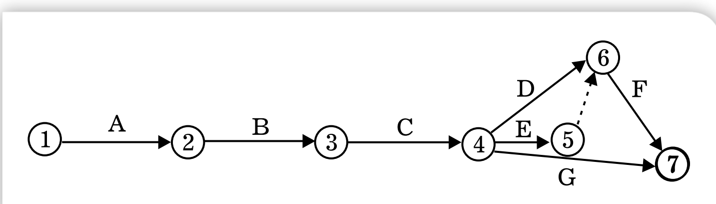

Figure 6.6: Network of a Construction Project

In a project network environment, many network diagrams may show activities and their relationship with each other by using a method called Activity-On-Node (AON) or the Precedence Diagramming

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Method (PDM). Alternatively, in older project network diagrams, project activities and their inter-relationships were shown using the Activity-On-Arrows (AOA) method, also called Arrow Diagramming Method (ADM). We discuss PDM and ADM network diagrams in the following sections.

PRECEDENCE DIAGRAMMING METHOD (PDM)

Precedence Diagramming Method (PDM) is one of the most popular and frequently used approaches for scheduling activities of a project visually. In PDM, many project activities are positioned within circular enclosures termed as nodes. The nodes are linked by arrows. In PDM, the relationships and interdependencies of work packages are shown with the help of arrows. A simple network diagram using PDM is shown in Figure 6.7:

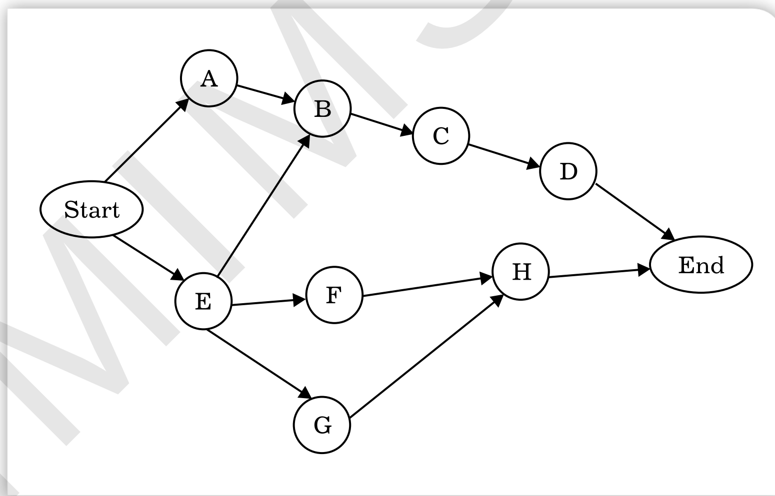

Figure 6.7: Network Diagram Using PDM

Note that the relationships shown by the activities in a PDM can be of four types, as shown in Figure 6.8:

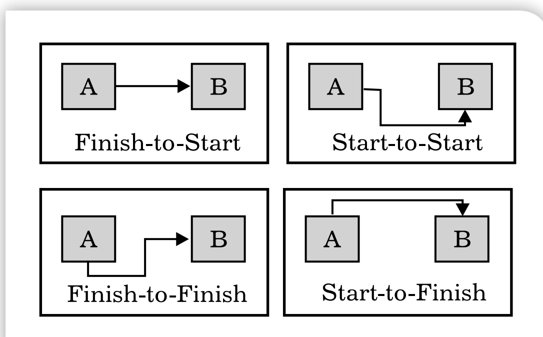

Figure 6.8: Relationships between Activities in a PDM

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The different types of activities shown in Figure 6.8 can be explained as follows:

- **Finish-to-Start (FS):** This is one of the most common relationships of PDM. Here, task A must be finished before the beginning of task B. For instance, while constructing a shed, the foundation must be constructed before starting the framing activity.
- **Start-to-Start (SS):** In this type of relationship, task A must be started prior to task B. In such a relationship, both the activities can happen simultaneously. For instance, you may regard a scenario wherein a group of painters are painting a house. In this task, task A could be to scrape the house, while task B could be to prime the house. In this situation, it is crucial for the workers to commence scrapping the house before beginning the priming. However, it is not necessary to finish the scrapping of the complete house before beginning the priming process.
- **Finish-to-Finish (FF):** In this relationship, task A must be finished before the completion of task B. Preferably, though not necessarily, both task A and task B should be finished simultaneously. For instance, suppose two people are working together to set up fresh telephone cables in a building by the end of Thursday. Task A is to pull the cable to each office while task B is to link those cables to wall jacks, and to link the telephones. So, in order to finish activity B, it is crucial to first finish activity A. Furthermore, both activities must be finished almost at the same time, that is, by Thursday, so as to make the phones of the building functional.
- **Start-to-Finish (SF):** This relationship is rare and infrequent in PDM. These relationships can be commonly seen in construction and manufacturing processes. It is also called Just-In-Time (JIT) scheduling. In this type of relationships, it may require task B to be completed for initiating task A. In other words, predecessor (A) must start before successor (B) can finish. Stated another way, in this relationship, the successor activity cannot finish until the predecessor activity has started. For example, f activity A denotes 'start using new software' and activity B denotes 'phase out old system'. Assuming that new and old software cannot be used simultaneously, activity B (use of new software) cannot be started before activity A (stop using old software).

ARROW DIAGRAMMING METHOD (ADM)

Arrow Diagramming Method (ADM) is another method that is used to sequence the various activities linked with a project. In this method, the activities of a project are shown with the help of arrows and are linked to nodes. Note that only finish-to-start relationships are used in this kind of method. In a few cases, the relationship between two activities is shown with the help of dummy activities. As explained ear-

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lier, a dummy activity is an activity that is shown with dashed arrows between two nodes. An ADM network diagram is shown in Figure 6.9:

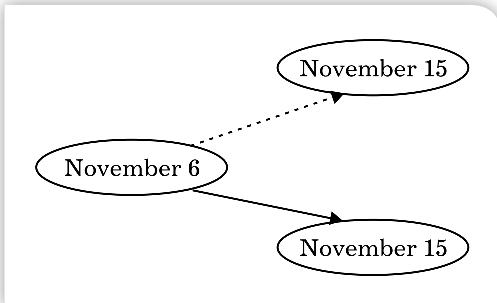

Figure 6.9: Network Diagram Using ADM

SELF ASSESSMENT QUESTIONS

1. ______________ entails establishing a logical sequence for activities of a project and optimising the complete period of the project.
2. In Precedence Diagramming Method (PDM), activities positioned in circular enclosures are termed as nodes. (True/False)
3. Which of the following indicates the start or finish of an activity?
   a. Node
   b. Dummy activity
   c. Arrow
   d. Program
4. Burst event refers to the node showing the completion of more than one activity. (True/False)
5. Usually, the chronological flow of activities in a network diagram is
   a. Right to left
   b. Left to right
   c. Top to bottom
   d. Bottom to top

ACTIVITY

Visit the project manager of a service-based organisation and ask him to share one of his project schedules. Study the schedule and prepare a similar one by providing details of a fictitious project.

6.3 ESTIMATING TIME

Exact estimation of time is an important skill in project management and plays a vital role in the completion of a project. Estimation of time permits an organisation to find the duration of the project, which in turn, assists in the preparation of an effective project schedule by an organisation. For time estimation to be accurate and reliable, it should involve the following steps:

- **Understanding the requirement:** In this first step of time estimation, an organisation should try to recognise the work to be performed in the project. This can be done with the help of work breakdown structures, gap analysis and business requirement analysis.
- **Sequencing:** Here, an organisation should make a sequence of all the activities that are required to be executed in the project.
- **Deciding the participants:** In this step, an organisation decides the requisite participants in the project.
- **Estimating:** This is the concluding step of time estimation where, rather than estimating the time for the full project, the organisation must concentrate on estimating the time necessary to finish each of its project activities. Furthermore, the organisation must make sure that it takes all the necessary assumptions, information sources and constraints into consideration while framing the time for the project.

Throughout time estimation, the organisation should assign an estimated time for each activity of the project. In a project, time is estimated on the basis of the normal working approach of the organisation. There are a various approaches for estimating time. Some of the main ones are shown in Figure 6.10:

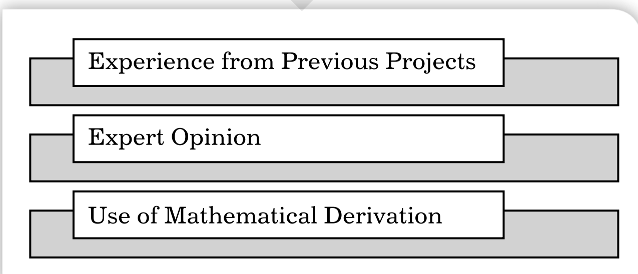

Figure 6.10: Methods of Time Estimation

These approaches can be explained as follows:

- **Experience from previous projects: In this approach,** the time taken in past projects is considered for estimating the time for the current project. In case an organisation undertakes a project that is similar to a past project, it expects the activities to take almost

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the equal amount of time to finish as the past project. However, the approach is not very dependable as the duration of past projects is not comparable to the current project given the ever-changing business environment.

- **Expert opinion:** Expert opinion refers to the technique of time estimation as suggested by experts for the conclusion of a specific activity or the entire project. Time estimation using expert opinion is considered to be very important and is taken seriously by an organisation.
- **Use of mathematical derivation:** Time estimation using mathematical derivation is one of the most objective approaches of estimating time. In this approach, probability distribution is used to estimate three different values of time as follows:
  - **Optimistic time (t0):** It refers to the minimum time in which an activity can be finished under the most favourable circumstances.
  - **Most likely time (tm):** It refers to the time period in which an activity has most chances of completing.
  - **Pessimistic time (tp):** It refers to the time in which an activity is likely to finish under the most adverse circumstances.

After determining the three estimates of time, the expected time of completion of each activity is determined by using the following formula:

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

Where,

t_e = Expected Time

t_0 = Optimistic Time

t_m = Most Likely Time

t_p = Pessimistic Time

Let us consider the example of a construction project. The estimated optimistic, most likely, and the pessimistic time durations of the activities of the project are displayed in Table 6.2:

TABLE 6.2: ESTIMATED TIME OF ACTIVITIES IN A CONSTRUCTION PROJECT

Activities	Codes	Optimistic (t_0)	Most Likely (t_m)	Pessimistic (t_p)
Constructing the base of the building	A	3	5	5

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Activities	Codes	Optimistic (t_0)	Most Likely (t_m)	Pessimistic (t_p)
Constructing the framework	B	12	14	15
Plastering the walls	C	4	5	6
Installing electrical wiring	D	1	1.5	2
Installing plumbing	E	1	1.5	3
Decorating the interior	F	2	3	4
Completing the exterior	G	3	5	8

One can compute the expected time (te) of every activity by using the formula given above.

The computation of expected time (te) is shown in Table 6.3:

TABLE 6.3: EXPECTED TIME OF PROJECT ACTIVITIES

Activities	Codes	Optimistic (t_0)	Most Likely (t_m)	Pessimistic (t_p)	Expected time (t_e)) $=(t_0 + 4t_m + t_p)/6$
Constructing the base of the building	A	3	5	7	5
Constructing the framework	B	12	15	18	15
Plastering the walls	C	4	5.5	10	6
Installing electrical wiring	D	.5	2	3.5	2
Installing plumbing	E	1	1.5	5	2
Decorating the interior	F	2	3	4	3
Completing the exterior	G	2	5	8	5

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The expected activity time of every activity is written along the arrow representing the activity in a network diagram. The expected time of the activities is shown in the form of a network diagram in Figure 6.11

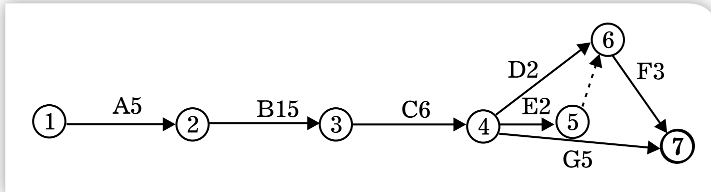

Figure 6.11: Expression of Time in a Network Diagram

SELF ASSESSMENT QUESTIONS

6. Which of the following is the first step in estimating the time of a project?
   a. Sequencing
   b. Estimate
   c. Decide participants
   d. Understanding the requirement
7. ____________ method involves talking to professional and experienced people for the conclusion of a specific activity or the entire project.
8. Which of the following represents the time an activity takes to finish in adverse conditions?
   a. Optimistic time
   b. Pessimistic time
   c. Most likely time
   d. Expected time
9. ___________ refers to the minimum time an activity takes to finish in most favourable circumstances.

ACTIVITY

Visit a nearby construction company and meet the project manager responsible for civil works. Prepare a template based on the table mentioned in this section and fill it in consultation with the manager. Then calculate the expected time accordingly and get it verified by him.

6.4 PROJECT NETWORK ANALYSIS

Network analysis refers to a collection of certain techniques used for the planning, management and control of projects. In a project net-

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work or network diagram, individual activities of a project are shown in a logical sequence. A project network is shown in Figure 6.12:

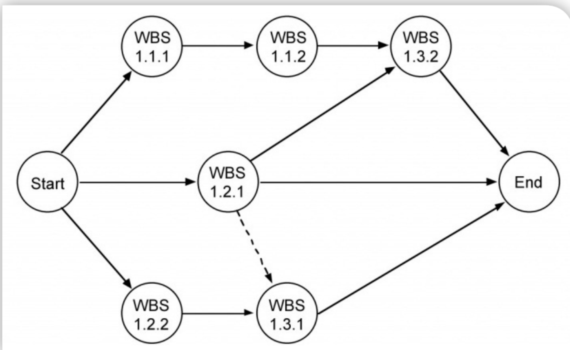

Figure 6.12: A Project Network

In Figure 6.12, the nodes represent the activities which are denoted by the activities listed in the Work Breakdown Structure created for the project.

You are by now aware that network analysis is the study of the nature and structure of relationships within a network. Moreover, networks consist of activities represented with the help of nodes and arrows. There are three methods of developing network diagrams. They are:

- **Top down:** Starting with wide categories, you work your way down, breaking up the activities into their basic elements and mapping every element's relationship with other elements.
- **Over time:** Here, you map the relationships as they expand, over a period of time.
- **Opportunistically:** In this method, you document the present relationships. In a project network, the key tasks are set as per their relationships with other tasks or activities. A network diagram helps the project team and stakeholders to understand relationships between different activities. A network diagram also helps in administering a project by:
    - Providing an obvious prioritisation of tasks
    - Allowing you to know when to start some activities before the completion of other existing activities that currently going on, thereby speeding up the schedule.
    - Offering a central point for a discussion on the various activities of the project.
    - Offering a comprehensible perceptive to all team members and stakeholders on what requires to be done, when, and why.
    - Facilitating the project manager to calculate start and end dates, apportioning resources and personnel, and analysing scheduling choices.

N O T E S

There are several ways to generate a graphical representation of a project network diagram. For example, a project network diagram can be created by using the left-to-right progression of activities. In this type of a diagram, the initial point is displayed on the left side, while the ending point is depicted on the right side. In addition to the use of the left-to-right progression, you can also organise a project network diagram by formulating a chart of activities, roughly in sequential order, with verbal notes about the dependencies.

A project network diagram is frequently used by project managers to compute the ES (Early Start), EF (Early Finish), LS (Late Start), and LF (Late Finish) dates as well as the critical path, of a project. The ES is the initial time for a project while the EF is the earliest date at which a project can finish.

The LS is the later date at which a project or project step can start without causing a delay, while the LF is the latest date at which a project or project step can finish without causing a delay.

As discussed previously, a project network diagram represents project activities and their relationships in a logical sequence. The conclusion of tasks in a certain progression is termed as dependency. Dependencies are the outcomes of constraints present within the tasks. According to Wysocki, inter-task constraints can be categorised into four groups or types:

- **Technical constraints:** Such constraints show the basic relationship that exists between the tasks of a project. In this type of constraint, a task cannot be started until another task is finished. Technical constraints demand that the tasks be completed in a particular sequence. The tasks connected by a technical constraint generally create a critical path of the project.
- **Management constraints:** In this type of constraint, management anticipates some amendments or decisions, thus holding off a process. Management constraints are reversible in nature and can be amended by the management.
- **Inter-project constraints:** These constraints are more or less identical to technical constraints. These constraints allow the tasks of one project to be finished only if the outcome of the second project is accessible.
- **Date constraints:** There are three types of date constraints:
  - The first type of constraint does not allow a task to end before a particular date.
  - The second type of constraint does not allow a task to end before later that a particular date.
  - In the third type of constraint, a task must end on the particular date.

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Date constraints limit the elasticity of a project schedule. All these constraints have a major effect on the progress of a project. Technical and inter-project constraints impact the sequence of tasks, whereas date constraints are used to set the timeline of the tasks. Management constraints require careful planning from the project manager. The project manager should have a contingency plan in place in case the management decides to keep a certain process on hold or reschedule it.

During the designing of a project network, the designers invariably commit mistakes.

Some common mistakes can be explained as follows:

- **Looping:** It is also called a looping error, looping refers to an error in which the designer creates continuous iterations of steps in a network diagram. A loop can be formed in a network diagram in case an activity is being represented as going back in line. Figure 6.13 shows a network diagram containing a looping error:

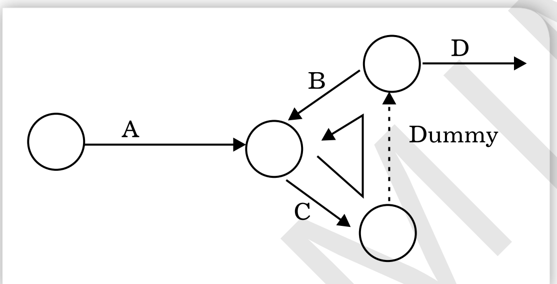

Figure 6.13: Network Diagram with a Looping Error

- **Dangling:** It is a type of error in which an activity is disconnected from the project network before the completion of all the activities in the network diagram. Figure 6.14 displays a project network diagram with dangling error:

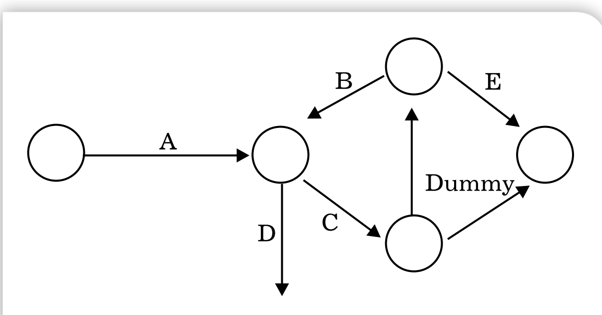

Figure 6.14: Network Diagram with a Dangling Error

- **Redundancy:** It is a type of error in which the network designer needlessly inserts a dummy activity in the network diagram.

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Figure 6.15 shows a project network diagram having the error of redundancy:

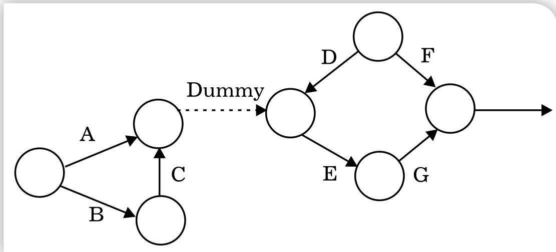

Figure 6.15: Network Diagram with Redundancy Error

To avoid these errors, the person creating the network diagram should follow certain rules. These rules can be listed as follows:

- Arrows that cross each other should be ignored.
- Straight arrows should be used.
- Unless and until all the previous activities are finished, no event should take place.
- No event can occur more than one time
- An activity that succeeds an event can be initiated only after that event ends.
- Arrows should be used from left to right. However, vertical and standing arrows should also be used if necessary.
- Dummies should be used only in case they are absolutely necessary.
- A network diagram should consist of one entry point and one terminal point.

DIFFERENCE BETWEEN AON AND AOA NETWORKS

The major differences between AON and AOA networks are listed in Table 6.4:

TABLE 6.4: DIFFERENCES BETWEEN AON AND AOA NETWORKS

AON Network	AOA Network
Does not require dummy activities.	Uses dummy activities.
Is simple to draw and comprehend.	Is more difficult to comprehend than the AON network.
Exhibits four kinds of relationships finish-to-start, start-to-start, finish-to-finish, and start-to-finish.	Exhibits only one kind of relationship, that is, the finish-to-start relationship.
Allows overlap representation.	Generally does not allow overlap Representation.
An activity can start even if its predecessors have not finished.	An activity can start only after the completion of all its predecessors.

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Now that you have studied project networks and the two types of project networks, let us now understand AOA and AON networks with the help of an example.

Illustration 1: Consider the following table and draw AOA and AON networks.

TABLE: PROJECT ACTIVITIES

Activity	Immediate predecessors activity
A	-
B	-
C	A
D	A, B
E	C
F	C
G	D, E
H	F, G

Solution:

Activity on Node (AON) Network is represented in the Figure 6.16:

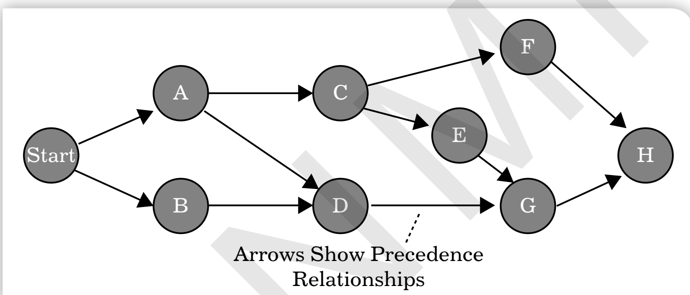

Figure 6.16: AON Network

Activity on Arrow (AOA) Network is represented in the Figure 6.17:

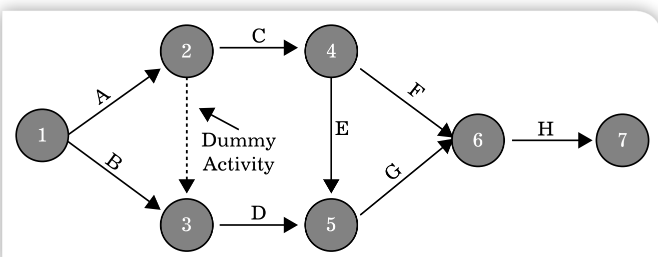

Figure 6.17: AOA Network

6.4.1 GANTT CHART

Gantt chart is one of the most extensively used techniques for project scheduling. It provides a graphical representation of the duration of all

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individual project activities in the form of a bar chart. The Gantt chart had been initially used as a scheduling tool in shipbuilding projects. However, over a period of time, it has been increasingly used in many other projects. In a Gantt chart, the progresses of all the scheduled and planned activities of a project are depicted graphically. Note that various time-related charts like PERT are based on the foundation prepared by a Gantt chart. Gantt charts can be used as an alternative to the CPM and PERT methods for scheduling a project. Similar to CPM and PERT networks, Gantt charts illustrate the logical relationships among the individual activities. A Gantt chart is an important tool for planning, scheduling and managing a project. It also helps in monitoring and controlling the progress of the project at any point of time. The two main uses of a Gantt chart are as follows:

- **Scheduling:** Entails creating a sequence of the occurrence of the individual activities in a project. A Gantt chart illustrates the preceding and succeeding relationships between various individual activities in a project. It also displays the expected completion time of the project.
- **Monitoring:** Refers to the task of tracking the progress of a project at any given point of time. A Gantt chart instantly displayed the percentage of activities completed in a project and the status of each activity. It helps in recognising the delays in a project and its performance as per the scheduled time. In case the project gets delayed, the project manager can take the required course of action to compensate for the delay. Thus, the Gantt chart provides a tool for monitoring the progress of the project.

Gantt charts are not very useful for large projects. This is because it provides relatively less information per area of display. The chart may be useful for smaller projects, but in real life most projects are too complicated to be presented in a Gantt chart. A basic Gantt chart is shown in Figure 6.18:

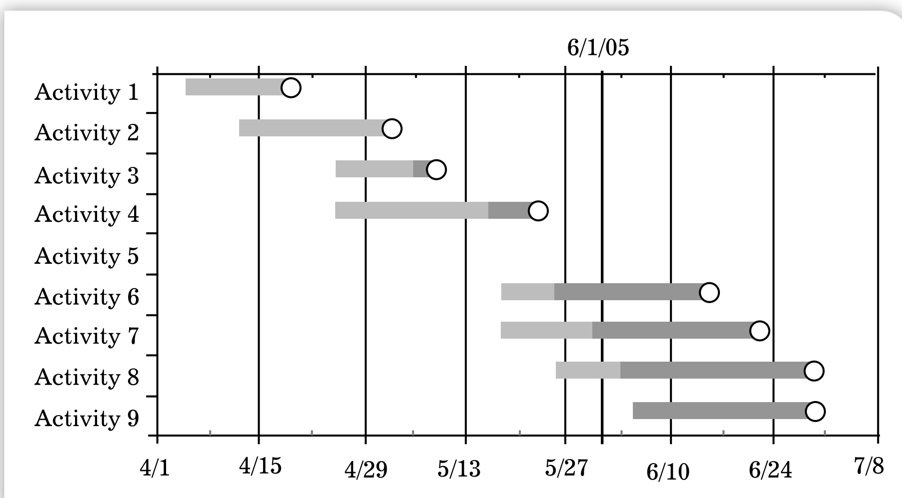

Figure 6.18: Gantt Chart

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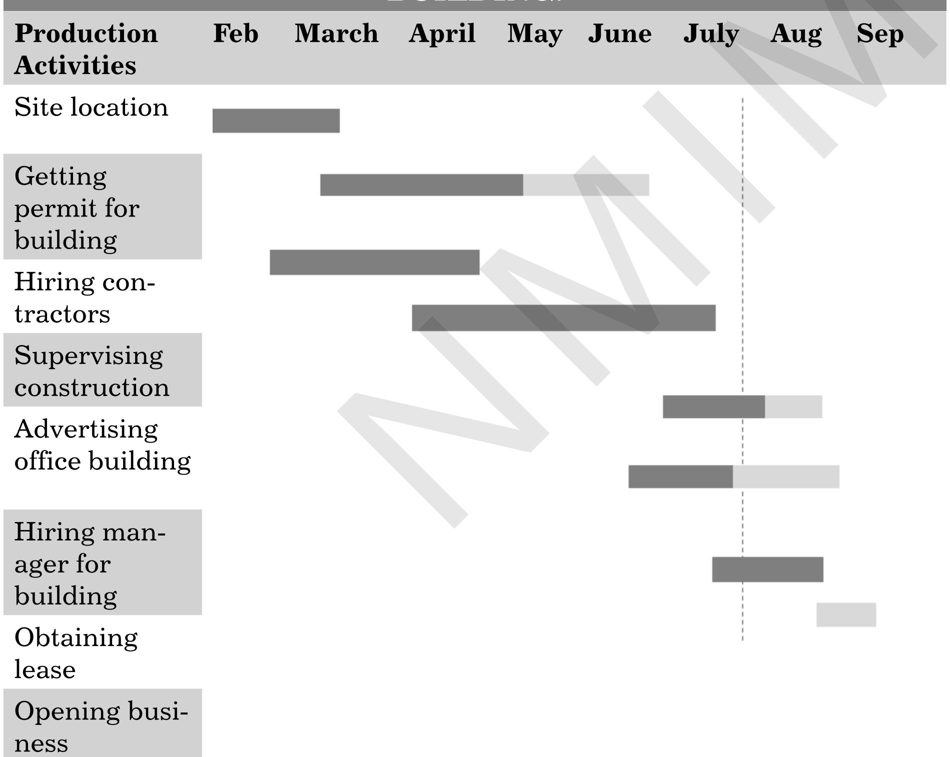
A Gantt chart consists of two axes, the vertical axis and the horizontal axis. The vertical axis represents all the activities in the project, and the horizontal axis represents the time scale. The time scale is shown either in absolute time or in relative time, depending on the initial event of the project. Months and weeks are two most widely used units of time. In a Gantt chart, the beginning and ending of activities are shown the rows of bars. If the bars overlap one other, it means that multiple activities are being performed in parallel with one another, or an activity has been started before the completion of another activity.

The current point of time can be represented by drawing a vertical line on the chart. The status of each activity can be indicated by shading the bars with different colour codes. Let us take an example to understand the use of the Gantt chart. Table 6.5 shows a Gantt chart depicting information related to the opening of a small office building:

TABLE 6.5: GANTT CHART FOR THE OPENING AN OFFICE BUILDING:



In the Gantt chart, you can see that many project activities are represented by rectangular boxes. The project manager uses these boxes to start the schedule of the project. With the finishing of each activity, the equivalent rectangular box is shaded by the project manager. For example, in case the lease is not obtained for the project, it would be declared behind schedule. Note that Gantt charts are also used to depict dependent and independent activities. For instance, in Table 6.5, the activity of hiring contractors is a dependent activity as it is based on securing the permit for the building. Alternatively, obtaining the lease even before the completion of the building can be regarded as an instance of an independent activity.

6.4.2 CPM MODEL

Critical Path Method (CPM) is one of the most widely used models of project scheduling. This model was developed by Morgan R. Walker of Du-Pont in 1957 to solve maintenance problems in chemical factories. The model was also used in the Manhattan project. Nowadays, CPM is used in all types of projects, including construction, software development, research, product development, engineering, plant operation, and maintenance.

The CPM model or technique schedules a project by:

- Identifying the activities in the project
- Determining the dependency and sequence of the activities
- Developing the network diagram
- Estimating the duration of an activity
- Computing the earliest and latest start times of the activities
- Computing the earliest and latest finish times of the activities
- Determining the float of the activities
- Identifying the critical path

The most vital feature of the CPM model is that it helps in prioritising project activities by sorting out the critical activities from non-critical ones. Critical path analysis helps a project in the following areas:

- Estimating the complete duration of the project
- Establishing a logical sequence of the project activities
- Keeping track of the progress of the project
- Identifying potential delays
- Recognising the probability of fast-tracking the project
- Preparing contingency plans
- Undertaking cost benefit analysis
- Undertaking risk-reduction measures

The CPM model uses four steps, which are computation of the forward pass, computation of the backward pass, determination of the critical path, and computation of floats. Let us understand these steps with the help of the example of a project, the details of which are shown in Table 6.6:

TABLE 6.6: ACTIVITIES OF A PROJECT

Activity	Duration	Immediate Predecessors
A	4	-
B	9	-
C	10	-
D	5	A
E	8	B
F	12	B
G	6	B
H	8	C
I	4	E, D
J	7	F, H
K	8	I, G

The project network of the project is shown in Figure 6.19:

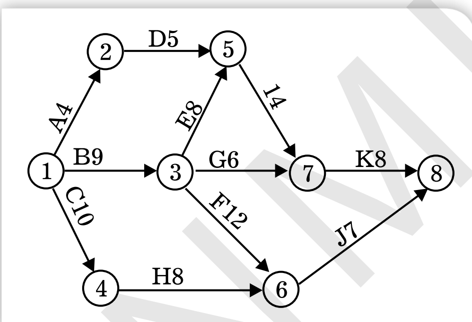


Figure 6.19: Project Network

Let us now discuss the steps involved in CPM in detail.

FORWARD PASS CALCULATION

Forward pass calculation includes determining the Earliest Start (ES) and Earliest Finish (EF) times of every activity. ES refers the earliest time when an activity can be planned while EF refers the earliest time in which an activity can be finished. The approach is known as forward pass as the computation is initiated from the first node and ends at the terminal node of the project network. The first event of the project is assigned a value of 0 (zero), and each of the activities starting from the first node is considered to start at time 0. The EF time of each activity is computed by augmenting the time duration of the activity to its ES time. Every succeeding activity requires to be initiated as soon as the predecessor activities are completed. Thus, the ES time of an activity would be similar to the largest value of the EF time of the preceding activities. The ES and EF times of any activity are

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displayed within brackets on the top of the arrow that represents the activity. The ES and EF times of the activities of the previous example are shown in Figure 6.20:

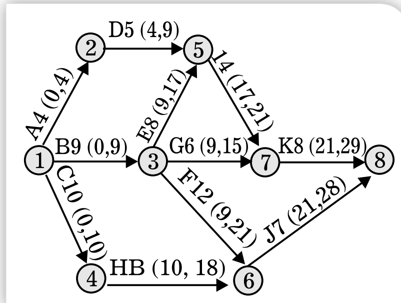

Figure 6.20: Calculation of ES and EF

As displayed in Figure 6.20, the ES time of all the initial activities (A, B, C) is equal to zero. One can compute the EF time of A, B and C by adding the respective duration of the activities to the ES time of the activities. So, the EF of the activities will be 4, 9, and 10, respectively. The ES and EF time of the subsequent activities can be computed in the similar fashion.

BACKW ARD PASS CALCULATION

Backward pass calculation is opposite to the forward pass computation. This approach is used to determine the Latest Start (LS) and the Latest Finish (LF) time of an activity. LS refer to the latest time at which an activity can be initiated. Alternatively, LF refers to the latest time an activity must complete. In this approach, the terminal or last event of the network is assigned the latest time and the LS and LF of each activity of the project is computed by rolling backward. This is the reason the approach is known as backward pass calculation. The terminal event is assigned the largest value of the EF time of the activities integration at the terminal event. The LS and LF times of the activities of the previous example are shown in Figure 6.21:

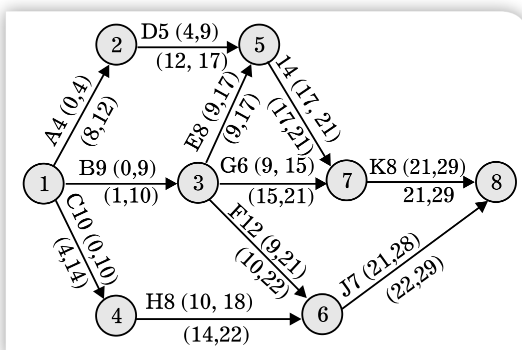

Figure 6.21: Calculation of LS and LF

In Figure 6.21, you can see that J and K are the terminal activities of the project. The EF time of J and K is 28 and 29, respectively. Thus,

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we have assigned the value 29 (as it is larger of the two values) to the terminal event of the project. The LF time of activities J and K is 29. The LF time of an activity can be computed by subtracting the duration of the activity from the LS time of the successive activity. The LF time of an activity is equivalent to the smallest value of the LS of all its successors.

DETERMINATION OF THE CRITICAL PATH

After computing the earliest and latest start and finish times of each activity in the network, one can compute the least time necessary for finishing the project. A path in the network implies an on-going sequence of events that starts from the initial node, travels through the network, and ends at the terminal node. There can be numerous paths in a network. The length of a path is the summation of the duration of all the activities in the path. The longest of all the paths is used to find out the total duration of the project. This path is known as the critical path of the project. There may be several critical paths in a network. Let us reflect on the previous example. The various paths in the network are shown in Table 6.7:

TABLE 6.7: DETERMINATION OF THE CRITICAL PATH

Path	Activities in the Path	Length
1-3-5-7-8	B, E, I, K	29
1-2-5-7-8	A, D, I, K	21
1-3-6-8	B, F, J	28
1-3-7-8	B, G, K	23
1-4-6-8	C, H, J	25

In Table 6.7, you can see that the first path (1-3-5-7-8) is the longest of all the paths. Thus, the first path is the critical path of the project. The activities on the critical path of the project are known as critical activities, as any delay in completion of these activities would impact the complete project. In this example, B, E, I and K are the critical activities. All other activities are non-critical. The critical activities are shown in Figure 6.22:

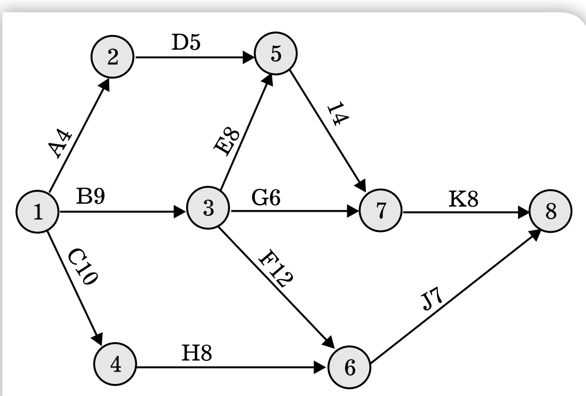

Figure 6.22: Critical Path and Critical Activities

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CALCULATION OF FLOATS

Floats refer to the flexibility of scheduling an activity. Alternatively, we can define a float as the free time at hand for an activity, which can be used without delaying the project. In backward pass and forward pass computations, it was observed that a critical activity in the network has the same ES and LS times. The critical activities in a project network demonstrate no flexibility in scheduling as any delay in the critical activities would delay the overall project. Yet, the non-critical activities in the network may benefit from a certain amount of flexibility as some of the activities may have diverse ES and LS times. Some non-critical activities can be delayed without impacting the duration of the project. So, while controlling the duration of the project, it is important to know the amount of flexibility that exists in scheduling the non-critical activities in the network. This flexibility is known as the float or slack of the activity. There are generally four types of floats. They are:

- **Total float:** Implies the time an activity can be delayed without any impact on the total duration of the project. Total time is the present free time in the activity. The free time can be utilised before, during or after the completion of the activity. Total float is similar to the difference between the amount of time present for the completion of the activity and the required time for the completion of the activity. The following formula can be used for computing the total float of an activity:

  Total float of an activity = LF–EF = LS-ES

  The total float of the activity H of the previous example would be LF-EF = 22-18=4

  The total float of all other activities in the network can be computed in the similar way. The total floats of all the critical activities are zero as the LF and EF of a critical activity are similar. In case the delay in an activity is less than or equal to the total float of the activity, then the total duration of the project has no impact. Thus, in case the total delay in any activity exceeds the amount of total float of the activity, the entire project gets delayed.

- **Interfering float:** Refers to the part of the total float of an activity that leads to the reduction in the total float of the succeeding activities. The total float of different activities may not be present independent of one another. So, in case the float time of any activity in the network is used, it limits the float time of the successors. For instance, the total float of an activity C is 14-10=4, and the total float of the succeeding activity H, is 4. Currently, if activity C is delayed by two days, it would finish at the end of the 12th day rather

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than the 10th day. In such a situation, the total float of H would be 22-20 =2. Thus, the total float of H is reduced by two days. It can be observed that using the total float of C interferes with the total float of H. An interfering float is the difference between the LF of an activity and the ES of the succeeding activity, or zero, whichever is larger. Thus, the interfering float of activity C is 14-10 =4.

- **Free float:** Refers to the part of the total float that can be used without limiting the total floats of the successors. Free float is the consumable float of an activity. If the delay of an activity is equal to or less than its free float, the floats of the succeeding activities are not affected.

  The free float of an activity can be computed by using the following formula:

  Free Float = ES of the immediate successor – EF of the activity

  The free float of activity G = ES of activity K – EF of activity G = 21-15 =6

- **Independent float:** Refers to the part of the float time of an activity that can be used without impacting the initial and terminal events of the network. Independent float is the amount of float time that can be used when the LF of the preceding activities and the ES of the succeeding activities are not impacted. Independent float can be computed by using the following formula: Independent float = ES of successor-LF of predecessor-Duration of the activity. The value of the independent float may be negative. In such a situation, the value of the independent float is known to be zero. For instance, the independent float of activity H = ES of activity I – LF of activity C – Duration of activity H = 21– 14-8 = -1. Thus, the independent float of activity H would be known to be zero. Now, let's take an example to understand the concept of float better.

  Example 2: A project constitutes nine tasks, that is, A, B, C, D, E, F, G, H and I. The precedence relationships among these tasks are as follows: A < D; A < E; B < F; D < F; C < G; C < H; F < I; G < I. Using the above information, illustrate a network diagram, and find out the least time necessary to finish the project. The times necessary for each task are as follows:

Tasks: A B C D E F G H I

Time: 16 20 16 20 32 34 36 28 18

Also, find out the critical path of the project.

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Solution: The project network diagram from the above information is shown in Figure 6.23:

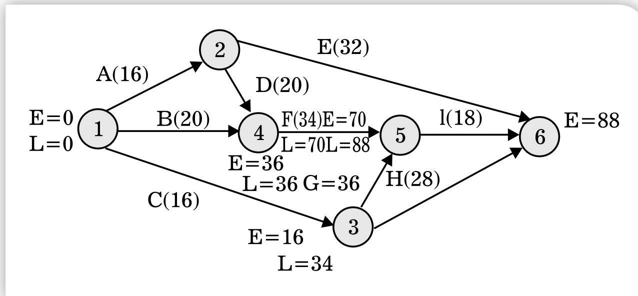

Figure 6.23: Network Diagram of the project

In the network diagram shown in Figure 6.23, we can see that activities A, B and C have no predecessors. Thus, each of these activities starts from the initial node. In the same way, activities E, H and I have no successors; thus, they merge at the project's end node. To find out the least completion time of the project, let us suppose that event 1 happens at zero time. Now, the earliest finish time (E) and latest finish time (L) of each event can be computed as follows:

E1= 0

E2 =E1+t12= 0 + 16 = 16

E3 = E1 + t13 = 0 + 16 = 16

E4 = Max. [0 + 20, 16 + 20] = 36

E5 = Max. [36 + 34, 16 + 36] = 70

E6 = Max. [16 + 32, 70 + 18, 16 + 28] = 88

In the same way,

L6=E6= 88

L5 =L6- = 88 - 18 = 70

L4 = L5- = 70 - 34 = 36

L3 = Min. [88 – 28, 70 - 36] = 34

L2= Min. [88 - 32, 36 - 20] = 16

L1 = Min. [16 – 16, 34 - 16, 36 - 20] = 0

Now, let us find out the critical path.

The various paths and their durations are shown in Table 6.8:

TABLE 6.8: PATH AND DURATION OF PROJECT ACTIVITIES

Path	Duration (Days)
1-2-6	48

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Path	Duration (Days)
1-2-4-5-6	88
1-4-5-6	72
1-3-5-6	70
1-3-6	44

After observing Table 6.8, we can see that path 1-2-4-5-6 takes the longest time, that is, 88 days. Thus, the critical path of the project activities is 1-2-4-5-6, and is displayed by double lines, as shown in Figure 6.24:

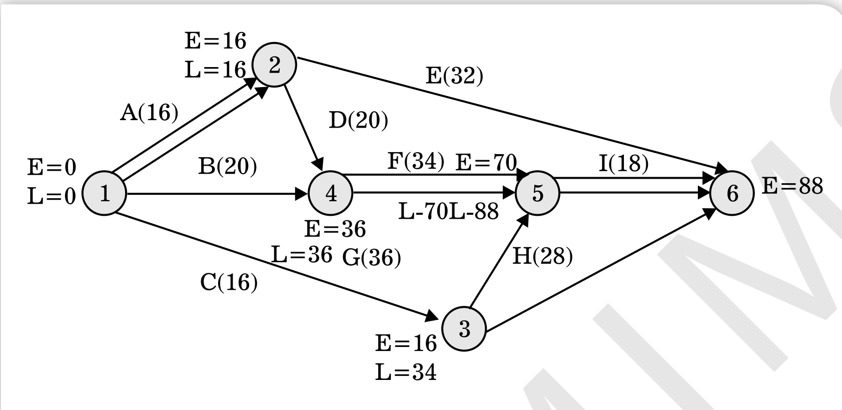

Figure 6.24: Critical Path of the Project

FAST TRACKING

Fast tracking is a time-saving technique that is used to lessen the duration of a project. The fast-tracking technique focuses on conducting various activities concurrently. In this technique, the original schedule is rearranged and rescheduled so that various project activities can be conducted in parallel. Fast tracking of a project reduces the number of tasks in a schedule, which results in reducing the frequency of revisions necessary in a project. While executing fast-tracking, an organisation should try to recognise the longest duration tasks on the critical path. The longer is the duration of a task, the greater will be the potential for reduction in the timeline. Though fast tracking limits the duration of a project, it includes certain risks. In a project, fast tracking may have an unfavourable impact on the timeline, quality and scope of the project. In this scenario, an organisation will have to consider the following options:

- Overrunning of the project time
- Compromising on the quality of the project
- Changing the scope of the project

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A variety of activities run side by side in a fast track project. Consequently, it is comparatively more difficult to manage a fast track project when a normal project. Moreover, fast tracking can include risks that could result in enhanced costs. For instance, suppose you are designing and building a software application. You want to fast track the activities by starting the preparation of the modules before the design is finalised. In case there are amendments to be made in the design before it is finalised, it may require some rework on the modules that have already been constructed. While fast tracking a project, you should ensure that it has gone through the following stages:

- **Understanding needs and capabilities:** In this stage, an organisation tries to understand the reasons for fast tracking the project. The organisation also considers whether it has the capability or expertise to manage the project when it is on fast track.
- **Analysing the schedule of the project:** At this stage, the current schedule of the project is evaluated to identify the soft-dependent, hard-dependent, and simultaneous tasks.
- **Determining opportunities for fast-tracking the project:** At this stage, an organisation requires to cut down the duration of the tasks by rescheduling them. Here, the organisation should try to get rid of the dependent tasks in the project by breaking the soft-dependent tasks into sub-sets.
- **Recognising fast track alternatives:** After rescheduling the project, the organisation considers the various options available to it for fast tracking the project. These options are outsourcing the project, changing the scope of the project, imparting additional hours, adding additional resources, etc.
- **Making informed decisions:** In this case, various fast track options of the previous stage are analysed. During the analysis, an organisation generally considers issues like anticipated cost and advantages of the options.
- **Consensus:** After analysing the fast track options, the organisation seeks the consent of the concerned stakeholders for making the final decision.
- **Tracking the progress and problems of the project:** This is the final stage of the fast track process. After deciding on the fast track, the schedule of the project will progress at a faster speed. Thus, in order to ensure the success of the project, it is important that the organisation continually monitors the progress of the project.

CRASHING

In order to reduce the duration of a project, organisations often allocate additional resources to the project task. This technique of as-

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signing additional resources to reduce the project duration is termed as crashing. According to BusinessDictionary.com, schedule crashing is "Reducing the completion time of a project by sharply increasing manpower and/or other expenses."

In schedule crashing, aspects such as number of labourers, hours necessary to finish a task, and calendar time required to accomplish a task, are linked to each other by a mathematical formula. For example, in case a person require 5 days to finish a 40-hour task (40 hours/one person * 8 hours/day=5 days), then, according to schedule crashing, the same task will be finished in a single day in case it is performed by 8 people (40 hours/5 people*8 hours/day=1day).

Note that though schedule crashing helps in lessening the duration of the project, it includes certain risks. For instance, factors like dependency of project tasks, increased costs, and safety risks may make schedule crashing impractical. In order to find out the viability of crashing, a project manager should focus on the following factors:

- **Position of the task:** the project manager should find out whether the task is in the critical path or not. if it is, it will impact the duration and delivery of the project, and vice versa.
- **Duration of the task:** the duration of the tasks also plays a vital role in the success of schedule crashing. Crashing is more likely to be effective in long tasks. in short tasks that do not replicate in the project, crashing will not have any significant impact.
- **Availability of appropriate resources:** in order to ensure success in crashing, the project manager should have the appropriate resources available for the project.
- **Completion stage:** the timing of executing crashing plays a vital role in the success or failure of the crashing process. Frequently, people resort to crashing when the project is near its completion stage, and when it is apparent that the project will not meet its desired objectives. However, a project manager should preferably execute crashing when the project is less than half-finished.

In case the project manager thinks that crashing the project schedule is not the best solution for the project, he/she may consider the following:

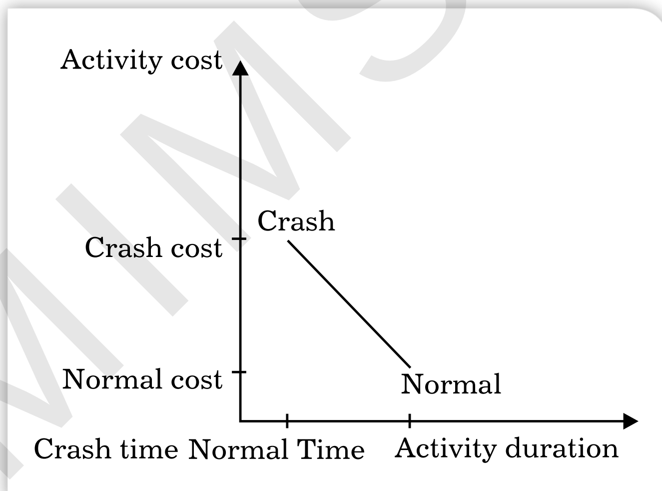
- **Increasing the working hours:** the project manager may ask the team members to put in extra hours for a short duration.
- **Increasing efficiency:** introducing new timesaving tools may increase the productivity of the team 10% to 50%.
- **Accepting the schedule:** in some cases, the result of a delayed delivery may be more satisfactory than crashing the schedule.

N O T E S

EXHIBIT

Time-Cost Trade-Offs in Crashing

As discussed earlier, crashing is a technique for shortening the schedule of a project by deploying additional resources such as utilising overtime, hiring additional temporary resources, using special equipment and machinery, etc. the time-cost trade-off in crashing specially focuses on finding out the extent to which each project activity should be crashed so that the anticipated project duration gets curtailed to the desired value. The data required to determine the portion that should be crashed from each activity is provided in the time-cost graph of the activity. A typical time-cost graph is displayed in the following Figure:



In the figure, you will notice that there are two key points, that is, Crash and Normal. The normal point indicates the cost and time incurred by an activity when it is being conducted under normal conditions. Alternatively, the crash point refers to the cost and time consumed by the activity when it is fully crashed.

In most applications, when an activity crashes partially, it is assumed that the combination of cost and time of that activity will lie on the line segment between the normal point and crash point. For instance, in case an activity crashes at the half portion, the cost and time combination of the activity will be in the middle of the normal and crash points. In the outcome of this simplified approximation, the data necessary to estimate time and cost of an activity gets reduced to only two conditions, that is, normal point and crash point.

NOTES

EXHIBIT

Difference between Fast Tracking and Crashing

- **Fast Tracking:** Fast tracking is a technique that tries to reduce the duration of a project schedule by conducting various activities simultaneously. Fast tracking has minimal impact on the cost of the project. Thus, because the activities that were originally scheduled to be performed in a sequence are now performed in parallel, fast tracking increases the risks linked with the project.
- **Crashing:** Crashing refers to a technique that tries to reduce project duration by employing additional resources in the critical path of the project. Crashing focuses on studying the trade-offs between the cost and the schedule of the project.

6.4.3 PERT MODEL

Project Evaluation and Review Technique (PERT) is a model for scheduling and studying various activities involved in a project. PERT was developed in 1957 by the US Navy for planning and scheduling the Polaris Nuclear Submarine project. It is used in projects where the time for finishing the project is given priority over the cost of the project. Also, the drawbacks of the CPM model are addressed by the PERT model. CPM model uses a single time estimate for each individual activity in the network. A single time estimate is computed from three initial time estimates (optimistic, most likely and pessimistic) of each activity. Thus, CPM does not answer the variability in project duration due to alteration in the duration of any activity. The variability of the project duration is addressed by the PERT model.

In the PERT model, variance or standard deviation is used for measuring variability of the project duration. The average squared difference of a set of numbers from their arithmetic average is called the variance of a set of numbers. For instance, let's consider a set of numbers 1, 2, and 3. The arithmetic average of the numbers is $(1+2+3)/3 = 2$. The differences of the numbers from their arithmetic average are -1, 0, and 1, respectively. Thus, the variance of the numbers would be $\sqrt{(1+0+1)/3} = \sqrt{(2/3)}$. The following steps are followed for computing the standard deviation of the duration of the critical path in a network:

- Computing the standard deviation of the duration of each critical activity
- Computing the standard deviation of the total duration of the critical path

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The following formula is used in computing the standard deviation of each activity:

$\sigma = (t_p - t_0)/6$

Where, σ = Standard Deviation

t_p = Pessimistic Time

t_0 = Optimistic Time

Variance is computed by squaring the standard deviation. The probability distribution of various critical activities is considered to be independent. Thus, the sum of the variance of the critical activities would be the variance of the duration of the critical path. If the critical activities of a project are 1, 2, k, then,

$T_e = t_{e1} + t_{e2} + t_{e3} + \ldots\ldots + t_{e4}$

Where, T_e = Expected project duration

t_{ek} = Expected duration of the critical activity k

And, VT or $\sigma^2_T = \sigma^2_1 + \sigma^2_2 + \sigma^2_3 + \ldots\ldots\ldots + \sigma^2_k$

Where, VT = Variance in the project length

σ^2_k = Variance in the critical activity k

The Central Limit Theorem, a fundamental theorem in statistics, states that the summation of various independent variables tends to be normally distributed. So, it can be assumed that the critical path duration (sum total of all critical activity durations) tends to be normally distributed. The normal distribution curve looks like a bell and is thus called a bell curve. It is a symmetric curve with a single peak. A normal distribution curve is shown in Figure 6.25:

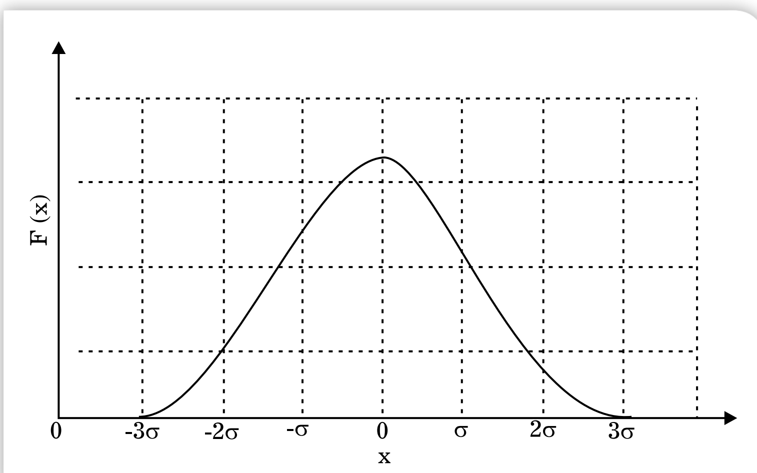

Figure 6.25: A Bell Curve

Table 6.9 shows the probability of values within a certain range in a normal distribution curve:

TABLE 6.9: PROBABILITY IN VARIOUS RANGES	
RANGES	**PROBABILITY**
$\mu - \sigma \leq X \leq \mu + \sigma$	0.6827
$\mu - 2\sigma \leq X \leq \mu + 2\sigma$	0.9545
$\mu - 3\sigma \leq X \leq \mu + 3\sigma$	0.9974

Where,

μ = Mean and σ = Standard deviation

The formula for computing the probability is as follows:

$Z = (D - T_e)/V_T$

Where, Z= The value of standard deviation by which Te exceeds the specified future date (D).

Let us take an example to understand PERT better.

Example 3: The manager of a manufacturing organisation is planning to install a new computer system for accounting and inventory control. One computer company provides the following information about the installation of the computer system:

Activity	Description of Activity	Immediate Predecessor	Time (in days)		
			Most Optimistic	Most Likely	Most Pessimistic
A	Selection of Computer Model	-	8	12	16
B	Designing of Input/Output System	A	10	14	30
C	Designing Monitoring System	A	8	16	24
D	Assembling Computer Hardware	B	30	40	50
E	Developing Main Programs	B	20	36	52
F	Developing Routines of Input/Output	C	16	18	32
G	Creating Database	E	8	16	24

NOTES

Activity	Description of Activity	Immediate Predecessor	Time (in days)		
			Most Optimistic	Most Likely	Most Pessimistic
H	System Installation	D, F	2	4	6
I	Testing and Implementation	G, H	12	14	16

On the basis of the given information, answer the following:

a. Find out the critical path by constructing an arrow diagram. Also, state the expected completion time of the project.

b. Find out the probability that the project will be finished within 110 days.

Solution:

a. The arrow diagram for the information given in the preceding table is shown in Figure 6.26:

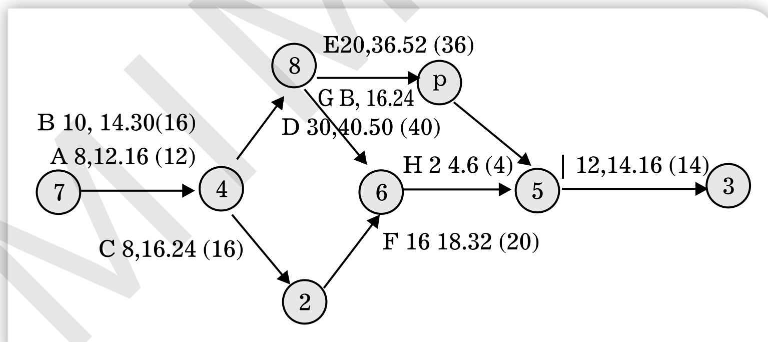

Figure 6.26: Arrow Diagram of the Project

Now, let us find out the expected times and variances for the project. Table 6.10 shows the values of expected times and variances:

TABLE 6.10: VALUES OF EXPECTED TIMES AND VARIANCES

Activity		Time (In Days)			t_{ei} $\frac{a+4m+b}{6}$	σ_i $\frac{b-a}{6}$	σ^2_i
		a	m	b			
A	1-2	8	12	16	12	8/6	16/9
B	2-3	10	14	30	16	20/6	100/9
C	2-4	8	16	24	16	16/6	64/9
D	3-6	30	40	50	40	20/6	100/9
E	3-5	20	36	52	36	32/6	256/9
F	4-6	16	18	32	20	8/6	16/9

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Activity		Time (In Days) a	m	b	$t_{ei} = \frac{a + 4m + b}{6}$	$\sigma_i = \frac{b - a}{6}$	σ^2_i
H	6-7	2	4	6	4	4/6	4/9
I	7-8	12	14	16	14	4/6	4/9

Now, let us find out the duration of various paths of the project, as follows:

Path	**Duration (Days)**
1-2-3-5-7-8	94
1-2-3-6-7-8	86
1-2-4-6-7-8	66

We can see that path 1-2-3-5-7-8 consumes the maximum time and is thus the critical path of the project. The critical path of the project is illustrated by double lines, as shown in Figure 6.27:

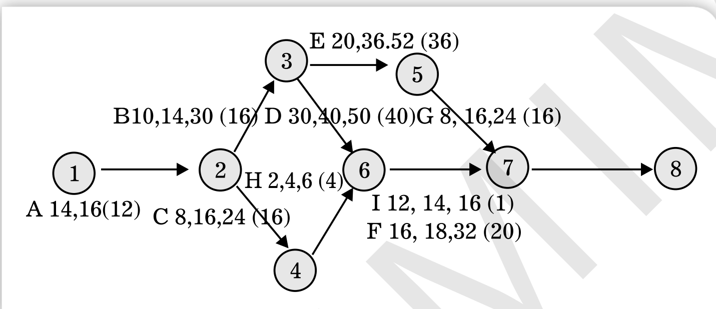

Figure 6.27: Critical Path of the Project

Thus, the expected length of the project is:

12+16+36+16+14= 94

And the variance of project length is:

$$V_r = \frac{16}{9} + \frac{100}{9} + \frac{256}{9} + \frac{64}{9} + \frac{4}{9} = \frac{440}{9}$$

b. Now, while the duration of the project is distributed normally with the mean (Te) = 94 days and standard deviation

$$\sigma = \sqrt{V_T}$$

$$= \sqrt{\frac{440}{9}}$$

= 6.992, we can find out the probability of completing the project in 110 days. The probability of the project would be equal to the area that lies to the left of X = 110, as shown in Figure 6.28:

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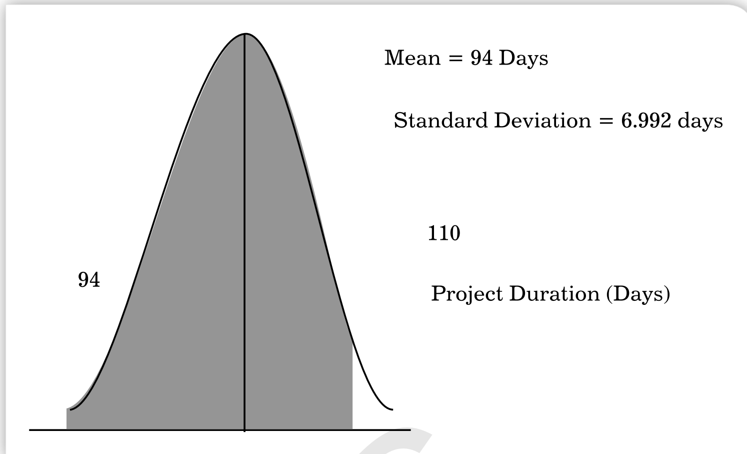

Figure 6.28: Distribution of Project Duration

We have $z = \frac{110 - 94}{6.992}$

$= 2.29$

For the normal area table, the area between the mean and z= 2.29 under the normal curve is found to be 0.4890. Therefore, the required probability = 0.5 + 0.4890 = 0.9890.

EXHIBIT

Difference between PERT and CPM

The main differences between PERT and CPM are listed in the following table:

PERT	CPM
It is event oriented.	It is activity oriented.
It is probabilistic in nature.	It is deterministic in nature.
It concentrates exclusively on time variable.	It involves analysis of time/cost trade-offs.
It treats activity as a random variable.	It requires a single deterministic time value for each activity.
It is used in non-repetitive projects.	It is used in repetitive projects.
It can be analysed statistically.	It cannot be analysed statistically

BETA DISTRIBUTION CURVE

On the basis on the values of the optimistic time, most likely time and pessimistic time, the expected time or weighted average of an activity as well as the estimate of the completion time for the entire project

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can be calculated. The following equations are used to calculate the mean (μ) and variance (σ^2), respectively, of each activity:

$$\mu = (a + 4m + b)/6$$

$$\sigma^2 = \left(\frac{b-a}{6}\right)^2$$

For example, assume a task has the following estimated durations:

Optimistic (a) = 10 days

Most likely (m) = 13 days

Pessimistic (b) = 25 days

Using the formula given above, the expected time (μ) can be calculated as follows:

$$\mu = (10 + (4 \times 13) + 25)/ 6$$

$$\mu = 14.5 \text{ (rounded up to 15 days)}$$

Figure 6.29 shows the beta distribution curve of the preceding example:

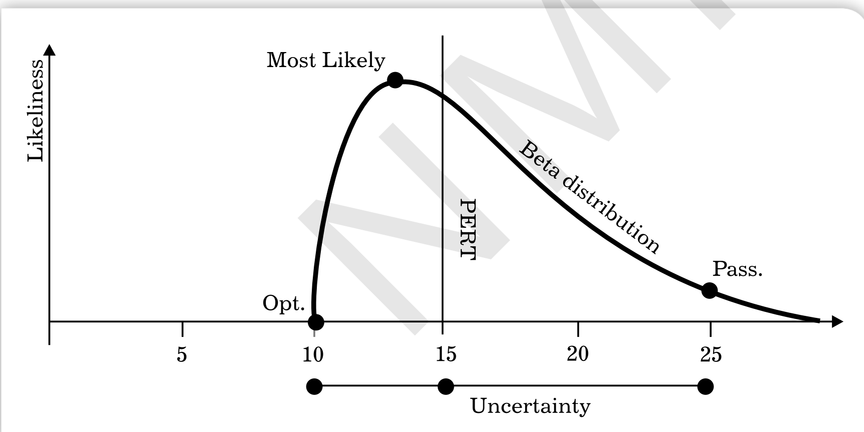

Figure 6.29: Beta Distribution Curve

6.4.4 GERT MODEL

In earlier sections, you studied about PERT and CPM which are significant network modelling techniques in the field of project planning. These two techniques are widely used for planning and control purposes of various projects. However, both PERT and CPM have certain limitations due to which these techniques cannot be used for developing complex network models.

On the other hand, Graphical Evaluation and Review Technique (GERT) is a network tool that is used to build networks for complex

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projects. GERT includes many advanced features such as network looping, probabilistic branching, multiple node realisation (repeat events), multiple sink nodes, etc. All these features are unavailable in PERT and CPM. These features enable the user to analyse complex project systems in a general form. GERT is a project scheduling and analysis technique that is used rarely. It combines various network analysis techniques (i.e. flow graph theory, probabilistic networks, PERT, CPM, and decision trees) into a common framework. After the evaluation of GERT network, a user gets access to the probability of each node and the elapsed time between all nodes. Let us now discuss some important features of GERT, which are:

- GERT is a project network analysis technique which allows both network logic and activity duration estimated technique.
- GERT is a combination of probability theory, network theory and simulation technique.
- GERT uses probabilistic branching nodes.
- Each branch is assigned with a probability under the GERT technique.
- When probability is not given the probability for each branch is assumed as one.
- GERT represents a probabilistic output.

It generally includes two components which are logical nodes (vertices) and directed arcs (branches, edges, transmittances). There are two parameters associated with branches; probability and distribution function. Probability (p) signifies the chance of given arc to be realised (selected) whereas the distribution function reflects the time (t) consumed in the completion of each activity, which the branch represents. If the branch is not a part of the network realisation then the time consumed in the completion of activity is zero and hence, time (t) can also be a random variable.

A node in a GERT network consists of input and output functions. In the input and output sides, three and two types of logical relations are considered respectively. This yields six types of nodes which are described in Table 6.11.

TABLE 6.11: NODE CHARACTERSTICS AND SYMBOLS

Output \ Input	Exclusive-or	Inclusive-or	and
Deterministic			
Probabilistic			

NOTES

Let us now discuss different types of inputs and outputs as follows:

- **Exclusive-or:** It implies that the realisation of any particular branch into a node results in the realisation of node also. However, only one forward branch out of all the given branches can be realised at a given time.
- **Inclusive-or:** It implies that the realisation of any particular branch into a node results in the realisation of node also. The time of realisation is the smallest time among the completion times of all activities that lead into the inclusive-or node.
- **And:** It implies that a node is realised only when all branches leading into that particular node are realised. Realisation time is the highest time from among the completion time of all the activities leading into the And node.
- **Deterministic:** All branches must occur if the node is realised.
- **Probabilistic:** Only one of the branches may occur if the node is realised.

SELF ASSESSMENT QUESTIONS

10. According to Wysocki, the ________ constraints can be categorised into four types.
11. In which of the following types of constraints can the management anticipate some amendments that may result in holding off a process?
    a. Technical constraints b. Inter-project constraints
    c. Date constraints d. Management constraints
12. Which of the following is not a method of network developing?
    a. Opportunistically b. Expected efficiency
    c. Over time d. Top-down
13. Which of the following is not a type of float?
    a. Interfering float b. Free float
    c. Total float d. Expected float
14. ____________ a type of error in which an activity is disconnected from the project network before the completion of all the activities in the network diagram.
15. GERT is a project scheduling and analysis technique that is rarely used and combines various network analysis techniques (i.e. flow graph theory, probabilistic networks, PERT, CPM, and decision trees) into a common framework. (True/False)

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ACTIVITY

Draw a beta distribution curve for the following values:

Optimistic time (a) = 8 days

Most likely time (m) = 10 days

Pessimistic time (b) = 12 days

6.5 RESOURCE LOADING, RESOURCE LEVELLING AND RESOURCE ALLOCATION

Sufficient resources help in the completion of a project. Thus, a project manager needs to be careful while scheduling the resources. The project scheduling process consists of three stages, as shown in Figure 6.30:

Figure 6.30: Stages of Resource Scheduling

The stages involved in the resource scheduling process are explained in detail in the subsequent sections.

6.5.1 RESOURCE LOADING

Resource loading, also known as resource aggregation, refers to finding the process of finding the resources required to finish a project. Resource loading is all about recognising and quantifying the need for different resources at different points of time in a project. Resource loading involves the following activities:

- Specifying the kind of resources required
- Determining the quantity of resources
- Aggregating the quantity of resources

Note that resource loading is completed at the activity level. The requirement of resources for each activity is identified and aggregated. The total amount of resources required is presented in the form of a histogram. There are separate graphs for separate resources. The aggregation can be done on a daily, hourly or weekly basis. Figure 6.31 shows how resources are loaded in a project:

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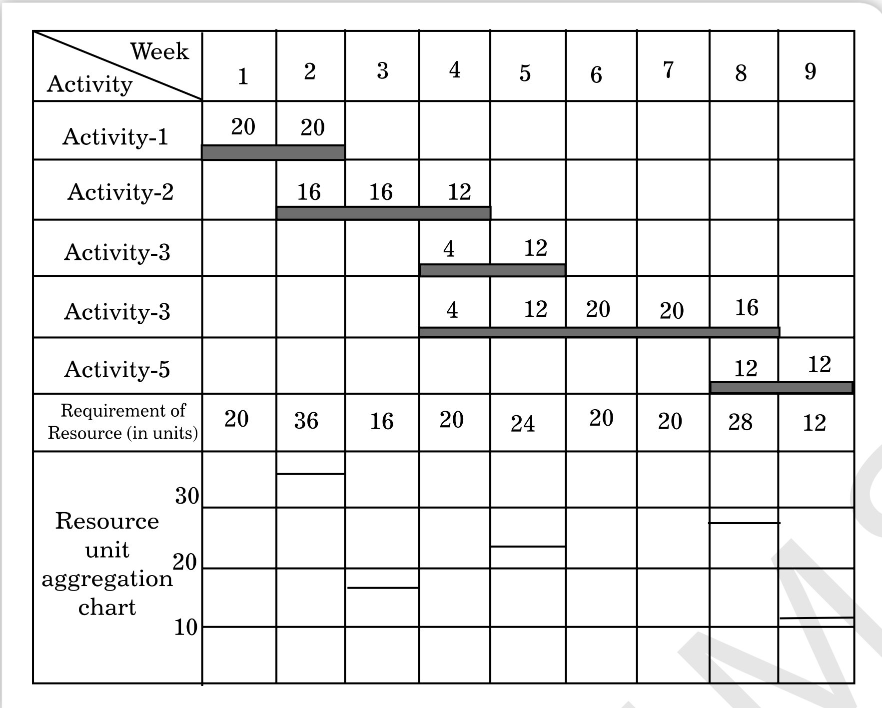

Figure 6.31: Resource Loading Chart

The upper part of the resource loading chart illustrates the requirement of resources in each week of the project. The lower part of the chart shows a graphical representation of the requirement of resources in each week. It should be noted that the need of the resources is not steady across the life of the project.

6.5.2 RESOURCE LEVELLING

At times, the demand for a specific resource can be more than its availability. Usually, a project manager requires to maintain a steady supply of resources. He/she strives to utilise the resources efficiently. This helps to lessen the idle time. Resource levelling is concerned with making sure that the demand for resources does not go beyond its availability. Resource levelling is also known as resource smoothing. The requirement of resources should be steady, so that the project can progress effortlessly. Similar to project crashing, resource levelling also involves reallocation of resources. However, in crashing, the aim is to lessen the duration of the project, whereas in resource levelling, the goal is to maintain steadiness in the utilisation of the resources.

A resource-levelling graph can be used to compare demand and availability of resources. The starting time of the activities in a project can be adjusted to level the requirement of the resources across the life of a project. Each resource can be utilised on a day-to-day basis. At times, resources fall short of their demand. In other words, there is a

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mismatch between the demand for the resource and its availability, as shown in Figure 6.32:

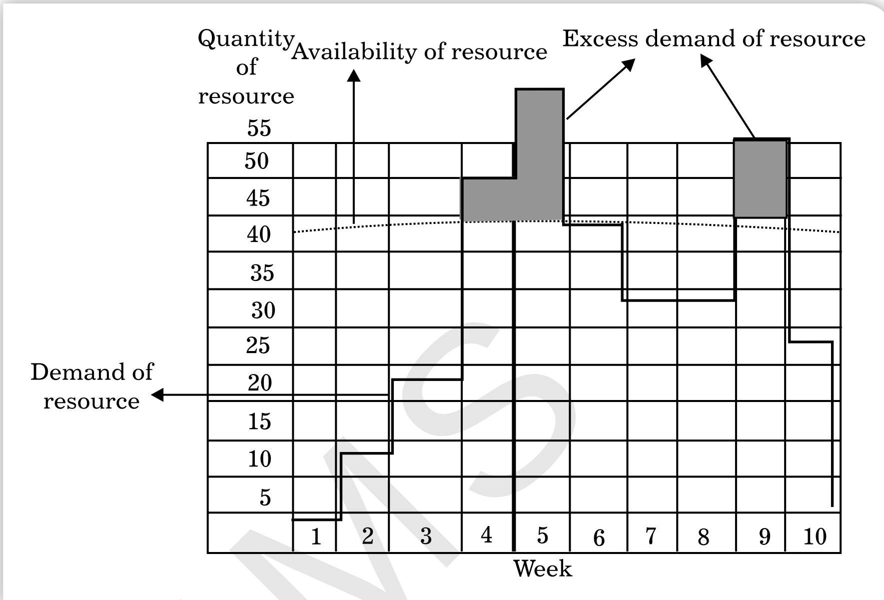

Figure 6.32: Resource Levelling

Let us consider an example to understand the concept of resource levelling better. A project network of a hypothetical project is shown in Figure 6.33:

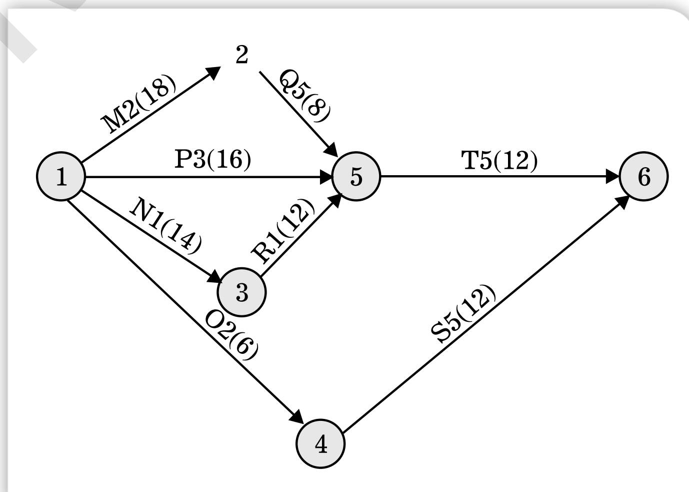

Figure 6.33: Project Network

The values inside the brackets illustrate the number of labourers for a particular project activity. The critical activities are M, Q, and T. All the project activities require to be shown in a time schedule for the

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purpose of resource levelling. Figure 6.34 shows project activities in a time schedule:

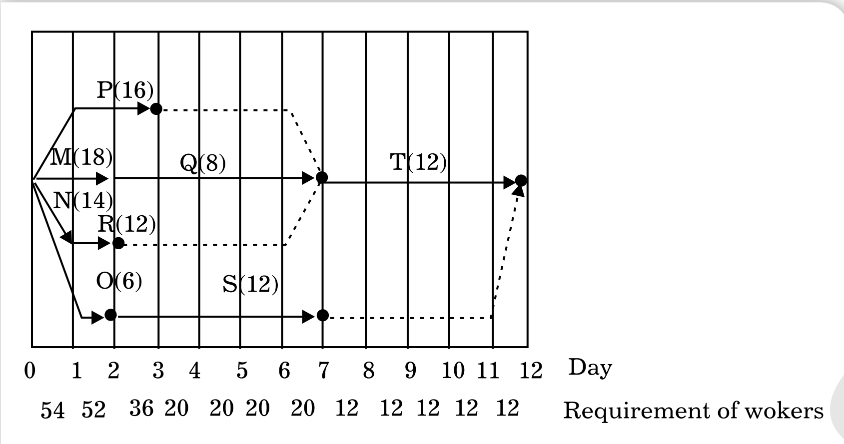

Figure 6.34: Time Schedule

The time schedule also shows the number of workers needed each day, throughout the life of the project. It can be observed that there is a large variation in the need of workers on each day. In Figure 6.35, we can see that more workers are required in the initial days as compared to the last few days of the project:

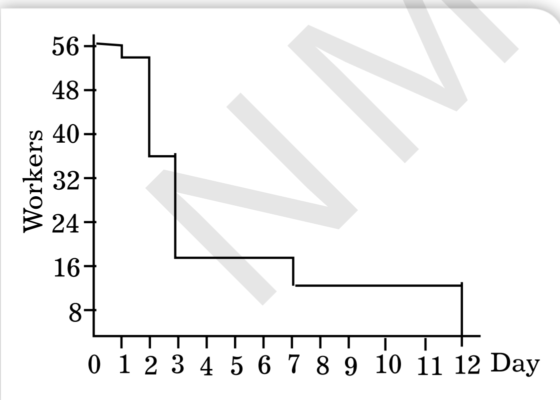

Figure 6.35: Daily Requirement of Workers

We require rescheduling of project activities to lessen the variation in the number of workers. The critical activities cannot be rescheduled without impacting the duration of the project. However, the non-critical activities can be rescheduled by utilising the floats of the activities.

The need for manpower can be reduced in the earlier days and increased in the latter days by rescheduling the non-critical activities. The rescheduling of non-critical activities is illustrated in Figure 6.36:

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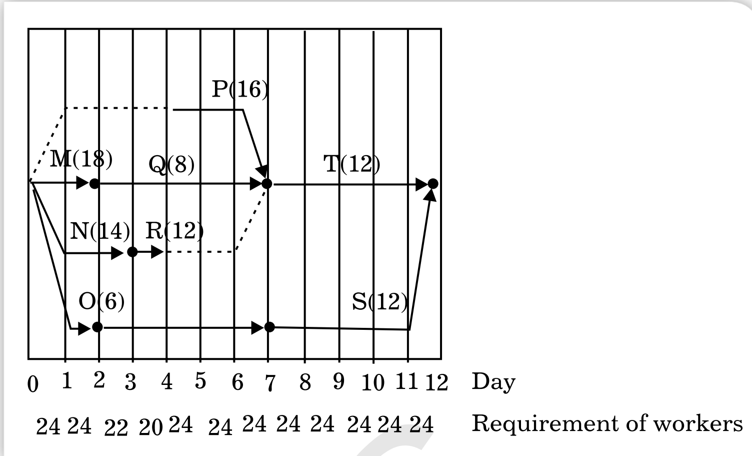

Figure 6.36: Revised Schedule of Project Activities

The need for manpower is balanced after rescheduling the non-critical activities. The impact of the rescheduling on the requirements of workers is shown in Figure 6.37:

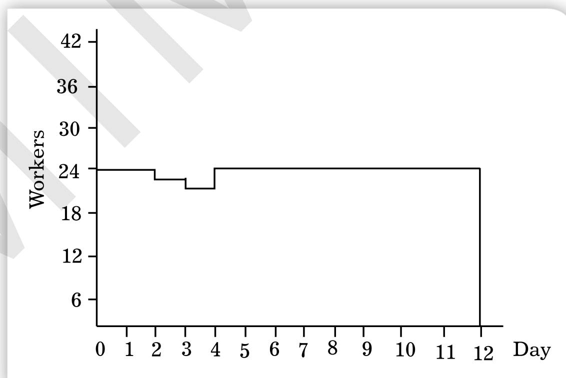

Figure 6.37: Levelling the Requirement of Workers

6.5.3 RESOURCE ALLOCATION

Resource allocation entails assigning of the available resources for various activities of a project. A project cannot be completed if the resources are insufficient. The allocation of resources starts by exploring whether there are sufficient resources available to finish the project on time or not. In case the resources are inadequate, some of the activities may require to be initiated after their Latest Start (LS) time.

In such cases, if the project activities start after the LS time, the overall project would get delayed. Usually, resources are allocated on the basis of the float time available for the activities. The activity with the least float gets priority over the other activities. If two activities have the same amount of float, the activity with a lower duration is scheduled first. The shorter activity is scheduled first only for shortening the waiting time of the other activities following that activity.

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One can evaluate the need for resources by analysing the project network and studying the demand for resources. In case all the activities initiate from their respective ES (Earliest Start) times, resource overlaps may be observed in various places. If the demand for the resources is in surplus as compared to their supply, then some of the activities need to be rescheduled. The alternate activity scheduled is prepared after considering the present slack time of the activities. For instance, consider the network shown in Figure 6.38:

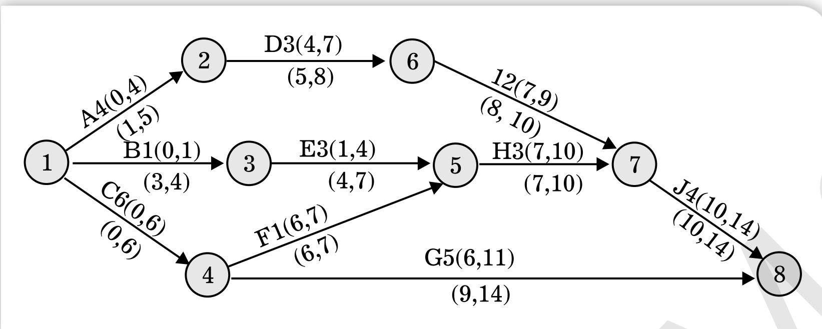

Figure 6.38: Project Network

In Figure 6.38, let us suppose that the activities H, I and J need the use of the same machine. The machine cannot be employed in all the activities at the same time. Therefore, project manager requires to determine which activity should be undertaken first to lessen the project duration. In the Figure 6.38, you can see that J can be done only when I and H are finished. Yet, I can be executed before or after H, as I and H do not have any logical relationship. Therefore, it requires to be decided which one of the two activities (I or H) should be performed first. Both activities have the same ES times. However, the scheduling of project activities depends on the float of the activities. Activity I has a float of one day, whereas activity H does not have any float. However, activity I should be performed after activity H. Activity H uses the machine for three days. But activity I can start only after 10 days, and as a result, activity J would also start on the 13th day. The whole project would get delayed by two days.

From the example, we can conclude that the duration of a project based on the number of machines available. The project could have been finished on time in case there had been two machines. In the same way, if the various activities of a project need a specific kind of labour, then project duration would be based on the number of available workers.

We should keep in mind that the schedule of a project should be based on its start date. In case the real start date of a project deviates from the planned start date, all ensuing project scheduling activities like resource loading, resource levelling, and resource allocation will also have an impact. This will extend the overall schedule of the project. It

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should be noted that resource scheduling can be effectively performed by using a technique called Goldratt's CCPM, which is explained in detail in the subsequent section.

EXHIBIT

Heuristic Analysis in Resource Scheduling

While resource levelling a project, a project manager can take the help of various heuristics to prioritise activities and prepare the schedule for the project resources. The following are some heuristics that should be taken into account by the project manager during resource scheduling:

- **Activities with the smallest slack:** This simply means that while allocating resources for project activities, the first choice is given to activities having the least amount of slack. To understand this, let us consider two activities A and B having a slack of 4 days and 6 days, respectively. In this case, the project manager should give preference to activity A over activity B while allocating the resources.
- **Activities with the shortest duration:** This means that activities having the limited duration should be given preference during the allocation of resources. For instance, suppose there are two activities A and B, and the quantity of time required to complete A is 5 days, and the time required for the completion of B is 4 days. In such a scenario, the project manager should schedule B ahead of A during the allocation of resources.
- **Activities with the lowest identification number:** It implies that activities commencing at an earlier period in WBS should be given preference during resource scheduling than activities starting at a later period. For example, if two activities A and B begin on day 2 and day 6 respectively, then, the project manager should allocate resources to activity A.
- **Activities with the most successor tasks:** This means that, during resource scheduling, a project manager should also consider the number of successor tasks linked with the project activities. While allocating resources, the project manager should give preference to activities having the highest number of successor tasks. For instance, in case two activities A and B have 6 and 8 successor tasks, respectively, the project manager should assign resources to B first, leaving A to be scheduled with the remaining resources.
- **Activities requiring the most resources:** It implies that while resource scheduling, the project manager should give preference to activities that need the maximum quantity of resources. For instance, suppose there are two activities, A and B.

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- To complete activity A, 6 people and 3 machines are required, while 3 people and 2 machines are required to finish activity B. In this case, the project manager should give preference to A during resource scheduling. Activity B should be scheduled only after the allocation of resources to activity A.

SELF ASSESSMENT QUESTIONS

16. Under________________, the requirement of resources for each activity is identified and aggregated.
17. Which of the following activities is not a part of resource loading?
    a. Specifying the kind of resources required
    b. Determining the quantity of resources
    c. Aggregating the quantity of resources
    d. Ensuring the demand of resources
18. Which of the following is concerned with making sure that the demand for resources does not go beyond its availability?
    a. Resource loading
    b. Resource levelling
    c. Resource allocation
    d. Resource aggregation
19. Resource levelling involves reallocation and steady supply of resources. (True/False)
20. _____________ refers to the assigning of the available resources for the various activities of a project.
21. If the project activities start after the ES time, the overall project would get delayed. (True/False)

ACTIVITY

Visit a construction site and meet the site manager. Discuss with him the steps followed by his company in procuring and allocating resources. Classify the steps into the three stages of the project scheduling process.

6.6 SUMMARY

- A project contains various activities. Yet, in the implementation stage of a project, all these activities cannot be on track concurrently from the start of the project. So, all these activities need to be arranged in a proper sequence.

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- Project scheduling entails establishing a logical sequence for the various activities of a project and optimising the complete period of the project.
- The process of project scheduling commences with the formulation of a project schedule, which mentions the sequence of activities that should be followed all through the implementation phase of the project.
- Two important factors related to the activity of project scheduling include developing a project network and estimating the time for the entire project activity.
- A project network can be described as a visual representation of various individual activities of the project in a logical manner by using nodes and arrows. It helps in scheduling and sequencing various individual activities and administering the total time required for finishing the project.
- Usually, in a network diagram, arrows refer to activities of a project. A single arrow shows only one specific activity
- A node indicates the start or finish of an activity. Nodes are also called events. Every node is characterised by a number.
- Merge event refers to the node showing the completion of more than one activity.
- Burst event signifies the node that shows the starting point of more than one activity.
- Dummy activity denotes an imaginary activity that consumes no time or resources.
- Estimation of time permits an organisation to find the duration of the project, which in turn, assists in the preparation of an effective project schedule by an organisation.
- Generally there are four steps in time estimation of a project and these steps are: understanding the requirement, sequencing, deciding participants and estimating.
- A project network diagram represents project activities and their relationships in a logical sequence.
- There are three methods for developing a network diagram for a project and these methods are, top down, over time and opportunistic.
- A project network diagram is frequently used by project managers to compute the ES (Early Start), EF (Early Finish), LS (Late Start), and LF (Late Finish) dates as well as the critical path, of a project.
- Gantt chart is one of the most extensively used techniques for project scheduling. It provides a graphical representation of the duration of all individual project activities in the form of a bar chart.

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- Gantt charts can be used as an alternative to the CPM and PERT methods for scheduling a project. It illustrates the logical relationships among the individual activities.
- A Gantt chart consists of two axes, namely vertical axis and horizontal axis. The vertical axis represents all activities in the project and the horizontal axis represents the time scale.
- Critical Path Method (CPM) is one of the most widely used models of project scheduling. This model was developed by Morgan R. Walker of Du-Pont in 1957 to solve maintenance problems in chemical factories.
- Nowadays, CPM is used in all types of projects, including construction, software development, research, product development, engineering, plant operation and maintenance.
- Project Evaluation and Review Technique (PERT) is a model for scheduling and studying various activities involved in a project. PERT was developed in 1957 by the US Navy for planning and scheduling the Polaris Nuclear Submarine project.
- The following formula is used in computing the standard deviation of each activity:

  $\sigma = (tp - t0\ )/6$

  Where, σ = Standard Deviation

  t_p= Pessimistic Time

  t_0 = Optimistic Time
- PERT and CPM have certain limitations due to which these techniques are not capable to develop network model complex projects.
- Graphical Evaluation and Review Technique (GERT) is a network modelling tool which is developed to handle more complex situations in project management.
- A project manager needs to be careful while scheduling resources and the project scheduling process consists of three stages (i.e. resource loading, resource levelling and resource allocation).
- Resource loading, also known as resource aggregation, refers to finding the process of finding resources required to finish a project.
- Resource levelling is concerned with making sure that the demand for resources does not go beyond its availability.
- Resource allocation ensures the sufficient amount resources required to complete a project.

N O T E S

KEY WORDS

- **Constraints:** These refer to the dependencies that have to be factored in while estimating the completion time of a project.
- **Crashing:** This is a technique that is commonly used to shorten the schedule of a project.
- **Estimation:** In the context of a project, estimation refers to the process of calculating the time period necessary to execute individual activities or tasks of the project.
- **Fast tracking:** This is a time-saving technique used to shorten the duration of a project
- **Floats:** These refer to the flexibility one has of scheduling an activity of a project.

6.7 DESCRIPTIVE QUESTIONS

1. Explain the concept and process of project scheduling.
2. What is project network? Explain different activities involved under the project network.
3. Explain the Arrow Diagramming Method (ADM).
4. What do you mean by time estimation? Write short notes on various steps used in time estimation.
5. Explain the methods used in time estimation.
6. What is a Gantt chart? Write short notes on its main uses.
7. Discuss the various methods that are used to develop a network diagram.
8. Explain the meaning and applications of the GERT model.
9. Write short notes on three stages of project scheduling.

6.8 ANSWERS AND HINTS

ANSWERS FOR SELF ASSESSMENT QUESTIONS

Topic	Q. No.	Answers
Concept of Project Scheduling	1.	Project scheduling
	2.	True
	3.	a. Node
	4.	False
	5.	b. Left to right
Estimating Time	6.	d. Understanding the requirement

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Topic	Q. No.	Answers
	7.	Expert opinion
	8.	b. Pessimistic Time
	9.	Optimistic Time
Project Network Analysis	10.	inter-task
	11.	d. Management Constraints
	12.	b. Expected efficiency
	13.	d. Expected float
	14.	Dangling Error
	15.	True
Resource Loading, Resource Levelling and Resource Allocation	16.	Resource loading
	17.	d. Ensuring the demand of resources
	18.	b. Resource levelling
	19.	True
	20.	Resource allocation
	21.	False

HINTS FOR DISCREPTIVE QUESTIONS

1. The process of project scheduling commences with the formulation of a project schedule, which mentions the sequence of activities that should be followed all through the implementation phase of the project. Refer to Section **6.2 Concept of Project Scheduling.**
2. A project network can be described as a visual representation of various individual activities of the project in a logical manner by using nodes and arrows. It helps in scheduling and sequencing various individual activities and administering the total time required for finishing the project. Refer to Section **6.2 Concept of Project Scheduling.**
3. Arrow Diagramming Method (ADM) is a method that is used to sequence several activities associated with a project. In this method, the activities of a project are shown with the help of arrows, which are further linked to nodes. Refer to Section **6.2 Concept of Project Scheduling.**
4. Estimation of time permits an organisation to find the duration of the project, which in turn, assists in the preparation of an effective project schedule by an organisation. The main steps involved in time estimation are: understanding the requirement, sequencing, deciding the participants and estimating. Refer to Section **6.3 Estimating Time.**

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5. Three methods of time estimation are experience from previous projects; expert opinion; and use of mathematical derivation. Refer to Section **6.3 Estimating Time.**
6. Gantt chart provides a graphical representation of the duration of all individual project activities in the form of a bar chart. In a Gantt chart, progresses of all scheduled and planned activities of a project are depicted graphically. Refer to Section **6.4 Project Network Analysis.**
7. The three methods to develop network diagrams are top down, over time and opportunistically. Refer to Section **6.4 Project Network Analysis.**
8. Graphical Evaluation and Review Technique (GERT) is a network tool that is flexible enough to build networks for complex projects also. GERT is a network modelling tool which is developed to handle more complex situation in project management. GERT includes many advanced features such as network looping, probabilistic branching, multiple node realisation, multiple sink nodes, etc. Refer to Section **6.4 Project Network Analysis.**
9. Three main stages under resource scheduling are resource loading, resource levelling and resource allocation. Refer to Section **6.5 Resource Loading, Resource Levelling and Resource Allocation.**

6.9 SUGGESTED READINGS & REFERENCES

SUGGESTED READINGS

- HELDMAN, K. (2018). *PROJECT MANAGEMENT JUMPSTART*. [S.l.]: WILEY SYBEX.
- Kerzner, H. (2013). *Project management*. New York: John Wiley.
- Taylor, P. (2015). *Lazy project manager, 2nd edition*. [Place of publication not identified]: Infinite Ideas Limited.
- Heerkens, G. (2015). *Project management*. [Place of publication not identified]: Mcgraw-Hill Education.

E-REFERENCES

- Al-Naimi. (2018). *(Aoa) and (aon) networks*. *Slideshare.net*. Retrieved 22 January 2018, from https://www.slideshare.net/DrMahmoudAlNaimi1/aoa-and-aon-networks-69802018
- *GERT analysis - graphical evaluation and review technique*. (2018). *Pmi.org*. Retrieved 22 January 2018, from https://www.pmi.org/learning/library/gert-graphical-evaluation-review-technique-5716

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- *Resource Loading Vs.. Resource Leveling: What's the Difference?*. (2018). *Brighthub Project Management*. Retrieved 22 January 2018, from http://www.brighthubpm.com/resource-management/14763-the-difference-between-resource-loading-and-resource-leveling/
- *What is resource scheduling? | APM*. (2018). *Apm.org.uk*. Retrieved 22 January 2018, from https://www.apm.org.uk/body-of-knowledge/delivery/schedule-management/resource-scheduling/

7 CHAPTER

MONITORING AND CONTROLLING A PROJECT

CONTENTS

7.1 Introduction
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INTRODUCTORY CASELET

FAILURE OF PROJECT CONTROLLING

Vinay was a key stakeholder of the New Financing System Project of Heysang Enterprises. The existing accounting system of the company resides on a mainframe, and some of the programs used to process data are more than 15 years old. His company decides to hire a contract software services firm to install a thin-client, browser-based version of the accounting system so that the mainframe programs could be retired. He assigned a senior programmer to act as the project manager on behalf of the company.

After a few days after the starting of the project, Vinay was a little worried because some of the key project team members came to him confidentially to inform him of the progress of the project. After further investigation, he discovered that the project manager changed the database from SQL to Oracle midway and did not inform anyone except the project team. However, the project scope stated specifically that project development required a SQL database. The change in database products changed the project scope.

This change caused schedule delays because the project team members had told him that they need to be trained to use the new database development tools before they can proceed. Additionally, many of the programs had already been written to interface with SQL, not Oracle, and were needed to be modified. To add insult to injury, the database switch impacted the project budget in two ways. First, purchasing the Oracle database involved substantially more money than purchasing the SQL database, and it required the purchase of new development tools for the programming team. Second, several members of the programming staff had to attend multiple training sessions on the new database product to fully integrate the programs and system. Training was currently running at US$ 2,200 per session per person.

As Vinay was a key stakeholder, he decided to bring this information out into the open at the next project status meeting. Additionally, he planned to meet the project sponsor and the procurement department to determine what alternatives were there. Moreover, he requested the contracting firm to realign the project in order to meet original contractual requirements. However, he was concerned about the fact that he is the single project manager who gave the orders to change the database. Although such control measures improved the performance of the project, it incurred huge cost for the company. The company would not have borne such huge costs if controlling had been done at every stage of the project.

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LEARNING OBJECTIVES

After studying the chapter, you will be able to:
- Explain the planning-monitoring-controlling cycle
- Discuss project monitoring
- Describe the project controlling process

7.1 INTRODUCTION

Project controlling and monitoring are important aspects of the project management process. Monitoring is a process of determining the actual performance of a project against the planned performance. The chief idea is to enhance the performance of a project by evaluating possible risks and recognising the root cause of problems that may take place during the lifecycle of the project.

On the other hand, project controlling is an activity that utilises the information from the monitoring level to take corrective actions against gaps in project performance. Project control can be of three types, namely feed-forward, concurrent and feedback control. A controlling system must be adaptable, cost-effective, exact, simple, and result oriented. The tools used for controlling are financial control, quality control, marketing control, budgetary control, and human resource control.

In this chapter, you will study about the planning-monitoring-controlling cycle and its various levels. Also, the designing of the monitoring system is explained in detail in the chapter. The chapter also describes the procedure of data collection and analysis. At the end, the chapter explains project controlling.

7.2 PLANNING-MONITORING-CONTROLLING CYCLE

In project management, the planning-monitoring-controlling process plays an important role in the success of a project. The process is all about ensuring that the approved project is performed within its scope, time, and budget. Moreover, it supervises that all tasks and metrics necessary to undertake a project are in place.

In addition, the planning, monitoring, and controlling process involves comparing the desired performance of a project with its actual performance and taking corrective actions in case of gaps. Thus, this process is performed continuously throughout the life of the project and is called the planning-monitoring-controlling (PMC) cycle. The PMC cycle is a closed-loop process that aims at minimising errors in

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a project and managing risks. It involves five stages, which are listed in Figure 7.1:

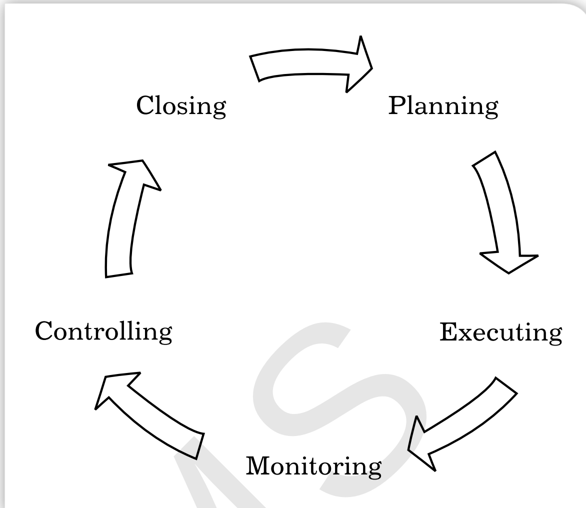

Figure 7.1: The PMC Cycle

All the five stages of the PMC cycle are closely related to each other. Any mistake at any stage may lead to ineffectiveness of other stages, which ultimately results in the failure of the planning-monitoring-controlling process. For example, if a plan is not put into practice correctly, it would be difficult to assess the actual performance of a project. The first four stages of the PMC cycle are together called plan-do-check-act cycle. Let us now discuss these five stages in detail:

1. **Planning (Plan):** A plan is produced to determine the sequence of activities performed in a project in order to assess their performance. Also, it decides what has to be done ahead.
2. **Executing (Do):** At this stage, the project plan is put into action in order to attain the fixed goals and objectives.
3. **Monitoring (Check):** This stage involves overseeing the performance of a project by comparing the actual performance with the desired one. It also recognises the ambiguity in the performance of the project.
4. **Controlling (Act):** This stage involves taking remedial measures against the loopholes identified at the monitoring stage so that continuous good performance of the project can be ensured.
5. **Closing:** This stage includes concluding the activities of the project after the project has achieved its defined goals and objectives.

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SELF ASSESSMENT QUESTIONS

1. The PMC cycle is a __________ process that aims at minimising errors in a project and managing risks.
2. The first four stages of the PMC cycle are together called the plan-determine-check-analyse cycle. (True/False)

ACTIVITY

Suppose you are a project manager in a construction company. You have been given the responsibility of conducting the planning-monitoring-controlling process for a flyover construction project. What steps would you take to perform the process? Also, list the aspects that you would look for during the process.

7.3 PROJECT MONITORING

Monitoring is a systematic effort of collecting, recording, and reporting the required information regarding project activities. It is a quantitative and qualitative procedure of assessing the performance of project activities. The main objectives of monitoring project activities are to evaluate the risks pertaining to a project and identify the problems that affect the performance of the project. These problems can be failure to fulfil project scope, delay in project completion, over expenses, etc.

The monitoring function is performed throughout the lifecycle of a project. Effective monitoring leads to efficient execution where all interconnected changes are noted down and reported to the top management of the organisation. There are five indicators defined for monitoring a project. These indicators are used by denoting the level at which project activities have been completed.

The four monitoring indicators are explained as follows:

- **Input indicators:** These indicators represent the resources used for conducting a project. The inputs may be economic (money), non-economic (men), and technical (machines).
- **Output indicators:** These indicators signify the income generated after conducting a project. The output can be in the form of final products, cash, and kind.
- **Outcome indicators:** These indicators show the result of the project regarding the goals achieved and the amount of products produced. The results help in ascertaining the rate of success.

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- **Impact indicators:** These indicators reflect the effects of the project on the growth and performance of the organisation. Impact indicators assess the changes, working conditions, infrastructure of the organisation due to the result of the project.

7.3.1 DESIGNING OF MONITORING SYSTEM

A project monitoring system is a framework of activities to be performed under the monitoring process. The main aim of designing a project monitoring system is to spot the loopholes at all the levels of project management starting from project planning to project execution. The system is designed to mainly identify the project performance, cost, and time. Figure 7.2 depicts the steps involved in designing a project monitoring system:

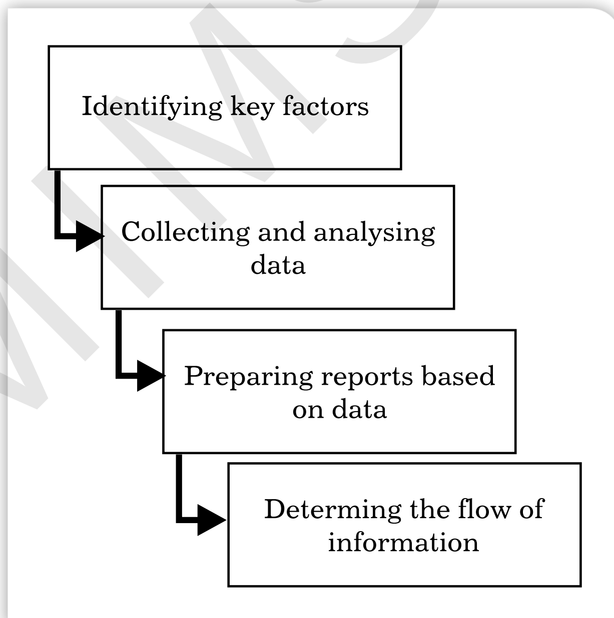

Figure 7.2: Process of Designing a Monitoring System

These steps are explained as follows:

1. **Identifying key factors:** This involves ascertaining the key factors to be monitored. There are three key factors, namely project performance, cost and time. The success and failure of a project is decided through these factors.
2. **Collecting and analysing data:** This step includes accumulating data the key factors (performance, cost, and time). The data can be collected from various sources, like discussions with project teams and project managers; previous records, project plans,

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mission and vision statements, competitors' profiles, etc. After the collection, data is analysed to extract meaningful information. A detailed explanation on data collection and analysis is given in the subsequent section.

3. **Preparing reports based on data:** This step involves creating a report on the project's performance using the information extracted in the previous step. The report mentions the project model, relative performance, statistical evaluation, and suggestions for improvement, if needed. Report preparation is explained in detail in the subsequent section.
4. **Determining the flow of information:** This step involves ascertaining information to be entered into the monitoring system. A project manager needs to be careful while selecting information as any inaccuracy at this step can lead to the failure of project performance assessment.

7.3.2 DATA COLLECTION AND EVALUATION

The monitoring process cannot be performed without accurate and timely information about the cost, budget, and time of a project. Thus, data collection requires thoughtful consideration and supervision, or else, the real problem would not be identified. In the monitoring process, the collected data can be as follows:

- **Frequency counts:** This data represents different project events and their impact on the progress of the project. These events can be the number of times error occurs within the entire project duration; the number of times the computer program is hit by a virus; and various other events. These events are recorded and expressed as time or percentage of standard.
- **Raw numbers:** This data provides details of various components like cost and time spent on performing project activities. In addition, it involves details, such as project deadlines and resources used. The numbers are expressed in ratios to measure the estimated and actual units.
- **Subjective numeric rating:** It represents the subjective nature of activities which differ from one project to the other. However, the difference between raw and subjective numbers is their nature of symbolising. The quality of product activities and the skills of individuals involved in the project are measured using subjective rating.
- **Indicators:** As discussed earlier, indicators provide information on the performance of a project. Data on indicators helps a proj-

ect manager in evaluating activities that are qualitative in nature. Project incorporation and adjustment with changes indicate the quality of a project team. Thus, indicators assist in evaluating the project performance and quality.

The data is collected in the raw form that cannot help in monitoring a project. Therefore, a thorough analysis of data should be performed in order to interpret the data and extract the relevant information.

7.3.3 REPORTING AND ITS TYPES

Reporting is a systematic presentation of information needed for monitoring. A report has information related to the progress, cost, and time of a project. It can be used by any level of management. For instance, the lower management uses a project report to obtain information regarding individual work activities; the middle level management uses it to allocate work to the lower level staff in accordance with their abilities; and the top management uses it for ascertaining the current progress of the project. The following are the benefits of reporting:

- A report creates an understanding across various departments.
- It provides information on the progress of project activities so that they can be coordinated well.
- It assists in recognising problems in the project.
- A report spots the possibility of delay in the project.
- It provides a better insight into the project performance to the top management.

There can be different reports prepared depending on the nature of the project. The following are three main types of reports:

- **Routine report:** This records the progress of a project. These reports are prepared at regular intervals and shared at all levels of management. A routine report involves information on general topics like members involved in a project, raw materials required, etc.
- **Exception report:** This report records any crucial decision of the project. The members of the team share this exception report. An exception report comprises information on the adoption of a new strategy, structural changes, etc.
- **Special analysis report:** This report is prepared for a clarification of any special challenge in the project; for example the technical or financial failure of a project. This report consists of particulars of the challenge and suggestions to deal with it.

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EXHIBIT

Project Status Report Template

The following is an example of a report prepared to show the progress of a project:

[Data]

Project Status Report

ProjectName
[Project Name]

Client Name
[Client Name]

Project Manager
[Project Manager]

Prepared By
[Name]

Snapshot of Project

Activity	% Complete	Issues	Delivery Date	Owner

Status Summary

[Start text here]

Budget Overview

Item	Owner	On track?	Notes

[Company]

Tel [Telephone] [Street Address] [Website]
Fax [Fax] [City, ST ZIP] [Email]

replace with
LOGO

Source: MS Office Guru (2013). Project Status Report Template. Retrieved from: http://www.msofficeguru.org/status-report.html

SELF ASSESSMENT QUESTIONS

3. The monitoring function is performed throughout the ________ of a project.
4. Which of the following indicators shows the result of a project regarding the goals achieved and the amount of products produced?
   a. Input indicators
   b. Output indicators
   c. Outcome indicators
   d. Impact indicators

5. Preparing reports based on data is the _________ step of designing a monitoring system.
6. The monitoring process cannot be performed without accurate and timely information regarding cost, budget, and time of a project. (True/False)
7. Which report records any crucial decision of a project?

ACTIVITY

Using various sources like the Internet, business magazines, newspapers, etc., find out reports prepared for the following projects of some renowned companies:

- Road construction projects
- Retail store set up projects
- Township development projects
- Telecommunication projects

After finding reports for the above projects, find out the type and effectiveness of reports. Also, find how these reports helped different organisations that prepared those reports.

7.4 EARNED VALUE ANALYSIS

Cost control is the final and last process of project cost management. Cost control helps in monitoring the status of the project regularly in order to update project costs. This process helps in identifying all deviations between planned and actual costs. Corrective actions can also be taken to minimise the risk.

Various methods or tools/techniques that can be used in the cost control process include Earned Value Analysis (EVA), Forecasting, To-complete performance index (TCPI), performance reviews, reserve analysis, etc. In this section, you will study about Earned Value Analysis (EVA).

Earned Value Analysis (EVA) is a technique that measures the performance of a project by comparing planned and actual expenditures and integrating the scope of the project and required resources into a set of measurements.

According to **Englert** and **Associates**, Inc., EVA is *"A method for measuring project performance. It compares the amount of work that was planned with what was actually accomplished to determine if cost and*

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schedule performance is as planned." EVA is also called performance measurement, management by objectives, budgeting cost of task performed and cost schedule and control system. This method is called earned value as it relates the anticipated performance with the estimated cost and time. Thus, it helps in examining the performance of a project early in the life cycle of a project.

The Earned Value Analysis (EVA) is a method to monitor and control the progress of a project. Using the EVA, the completion date, final costs, schedule variances and budgets are measured at any given point of time while the project is in progress. The EVA compares actual costs, time and work done with their respective planned values. It serves as an early warning system to detect discrepancies in the project progress.

The earned value refers to a value assigned to the work completed during a given time period. As the work gets completed, it is said to have been earned. The earned value can be designated in units such as hours or rupees or dollars. Therefore, the earned value provides information related to the progress of the project, which serves as valuable information about the project status.

There are three important values considered while calculating the earned value. These three values are discussed as follows:

- **Planned Value (PV):** It refers to the planned project expenditure or the approved, estimated cost that can be spent on a given activity during a given period. In other words, PV is the budget authorised for a scheduled work. It is also known as the Budgeted Cost of Work Scheduled (BCWS). To state in a different way, planned values are the project expenditures decided starting from project initiation to the current stage of the project. PV is determined by summing up all the estimates of carrying out all project tasks and the required time based on the project schedule.
- **Actual Cost (AC):** It is the actual cost of expenditure incurred on a given activity during a given period. It is also known as the Actual Cost of Work Performed (ACWP). In other words, AC represents the current expenditures of a project. AC is calculated by adding all costs incurred on project activities completed at the current moment of time.
- **Earned Value (EV):** It is the value of the work that has been accomplished till a particular point in time. It is also known as the Budgeted Cost of Work Performed (BCWP). EV represents the actual progress of the project. In other words, it is a percentage of the total financial goal achieved in reality at one fixed time. The formula for calculating EV is as follows:

  EV= Percentage of work completed × total budget

N O T E S

Using PV, AC and EV, some other values are calculated:

- **Schedule Variance (SV)**

  $SV = EV - PV$

  When $SV < 0$, the project is behind schedule or has achieved less than what was planned. When $SV = 0$, the project is on schedule. When $SV > 0$, the project is ahead of schedule or has achieved more than what was planned.

- **Cost Variance (CV)**

  $CV = EV - AC$

  When $CV < 0$, more expenses are incurred on the project than what was planned. When $CV = 0$, the expenses that were actually planned are incurred on the project. When $CV > 0$, less expenses are incurred on the project than what was planned.

- **Schedule Performance Index (SPI)**

  $$SPI = \frac{EV}{PV}$$

  When $SPI < 1$; the project is behind schedule. When $SPI = 1$; the project is on schedule. And when $SPI > 1$; the project is ahead of schedule.

- **Budget at Completion (BAC):** The total planned value for the project is called BAC.

- **Cost Performance Index (CPI)**

  $$CPI = \frac{EV}{AC}$$

  When $CPI < 1$; the project exceeds the budget. When $CPI = 1$; the project is on budget. And when $CPI > 1$; the project is under budget.

In practice, a project is affected by various factors that cannot be controlled or managed. Therefore, it is important to recognise the impact of changes on the project. For this purpose, three forecasting techniques can be used. They are Estimate at Completion (EAC), Estimate to Complete (ETC) and To Complete Performance Index (TCPI).

- **Estimate at Completion (EAC):** EAC gives a forecast value of the project after it is completed. EAC can be calculated using different formulae under different circumstances as described below:

  (i) When it is expected that the project will keep spending at the same rate at which the expenditure has been done till now, we use the following formula:

  $$EAC = \frac{BAC}{CPI}$$

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(ii) When it is expected that the project will keep spending at the original forecast rate, we use the following formula:

$$EAC = AC+(BAC\text{-}EV)$$

(iii) When it is expected that the project cost and schedule would be affected by the current cost and schedule performance of the project, we use the following formula:

$$EAC = AC+\left[\frac{(BAC\text{-}EV)}{SPI*CPI}\right]$$

(iv) When it is found that the original assumptions and conditions regarding cost and schedule were not correct or adequate, we use the following formula:

$$EAC = AC + \text{New Estimate}$$

- **Estimate to Completion (ETC):** It is the estimated amount of money required to complete the remaining work.
- **To Complete Performance Index (TCPI):** TCPI is a measure of the cost performance that is required to be achieved with the remaining resources to meet a specified management goal or to complete the project. TCPI is calculated as the ratio of the cost to finish the remaining amount of work to the remaining budget. Mathematically, TCPI is expressed as follows:

  (i) When the project is to be finished within the allocated budget, we use the following formula:

  $$TCPI = \left[\frac{(BAC\text{-}EV)}{BAC\text{-}AC}\right]$$

  (ii) When the project is to be finished within the new budget (EAC), we use the following formula:

  $$TCPI = \left[\frac{(BAC\text{-}EV)}{EAC\text{-}AC}\right]$$

- **Variance at Completion (VAC):** It is the difference between the new estimate at completion and the originally planned value. It is calculated as:

  $$VAC = BAC – EAC$$

  If a project is running over-budget, the VAC will be negative, and if the project is running under budget, the VAC will be positive.

Let us now look at an example. Project A has to be completed within two years. An amount of ₹ 30 lakhs has been allocated for it. After one year, ₹6 lakhs have been spent. Also, 30% of the work has been completed. Calculate EAC.

N O T E S

Here, BAC = ₹30 lakhs

AC = ₹6 lakhs

PV = 50% of ₹30 lakhs = ₹15 lakhs

EV = 30% of ₹30 lakhs = ₹9 lakhs

To calculate EAC, we need to calculate CPI:

CPI = EV/AC = 9/6 = 1.5

Therefore, EAC = BAC/CPI =30/1.5 = ₹20 lakhs

According to EAC estimates, the given project would be completed within the budget along with savings.

SELF ASSESSMENT QUESTIONS

8. Estimate at completion is calculated as the ratio of ______ and ______.
9. For a project EV at a point in time is ₹5 lakhs whereas PV was ₹4 lakhs. What information can you conclude from the given conditions?

ACTIVITY

The overall amount allocated for a project is ₹1.2 crore. The project has to be completed within six years. After three years, ₹80 lakhs had been spent. If at the end of three years, the EV of the project is ₹72 lakhs, calculate the percentage of work completed. Also calculate the CPI.

Hint:

BAC = ₹1.2 cr.

AC = ₹80 lakhs

PV = 50% of BAC = ₹60 lakhs

Given: EV = ₹72 lakhs

Therefore, ₹72 lakhs = Percentage work completed × ₹1.2 crore

7.5 PROJECT CONTROLLING

Project controlling is the act stage of the planning-monitoring-controlling cycle or the plan-do-check-act cycle. It is all about correcting projects gaps identified at the monitoring level. Apart from this, project controlling involves establishing standards for the performance of a project. Let us understand the concept of project controlling with

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the help of an example. For example, a manufacturing division produces 900 bulbs in a month. However, the set target was the product of 1200 bulbs.

The shortage of 300 bulbs is attributed to excess of labour and raw materials costs. Labour costs can be reduced by eliminating excess staff and raw material costs can be controlled by ensuring optimal utilisation and surplus purchasing. Such remedial measures used for managing the costs of labour and raw materials come under controlling.

Controlling helps project managers in the following ways:

- It ascertains whether the real performance complies with the set standards of performance.
- It rectifies deviations in the performance of the project.
- It allots and schedules resources to achieve the goal.
- It assists in monitoring the activities of the project and performance of the team.

7.5.1 PURPOSE OF CONTROLLING

Most project managers, while controlling projects, get engrossed in the measurement and evaluation of their current situation. They are more focused on evaluating their immediate position and the distance their projects have covered so far. However, controlling a project is not a simple task as it involves a number of complex, interconnected activities.

The foremost mission of every project is to deliver what was promised. Thus, the controlling process aims at minimising gaps between the actual performance of a project with its desired performance. Maintaining a proper control of a project requires a project manager to consider the following three parameters:

- What is the actual status of the project against the desired one?
- What lies ahead that can affect the project?
- Where is the project going to end up against what was promised?

7.5.2 TYPES OF CONTROL

As studied earlier, controlling is an important function as it helps to identify errors in a project and take corrective actions so that deviations in performance can be reduced. However, different controls are performed for different types of projects. There are three types of controls, which are explained as follows:

- **Feed forward control:** It is a beginning and precautionary control that is performed before any major change takes place in the project output. Feed forward control is generally conducted to take remedial measures against the poor performance of a project caused due to inputs, such as raw material, labour, and machines. The measures in this control can be surplus purchasing of raw materials, elimination of excess staff, defining new job skills, preventive maintenance of machines, etc.

- **Concurrent control:** It is performed when project activities are going on. It monitors on-going activities and ensures that they are performed in compliance with the established standards. The main aim of concurrent control is to ensure that project activities generate the anticipated outcome.
- **Feedback control:** This type of control is performed after a project is completed. Feedback control is performed when feed forward and concurrent control are not possible to be performed or are too expensive. However, the main disadvantage of this control is that it gives information at the end when losses are almost suffered.

7.5.3 TOOLS FOR CONTROL

To perform effective control, different tools and techniques are used by project managers. These tools provide the right information at the right time required for performing control to managers. These techniques not only enable managers to check and regulate continuing changes, but also provide feedback on devising better control tools for the future.

Some of the commonly used tools are listed in Figure 7.3:

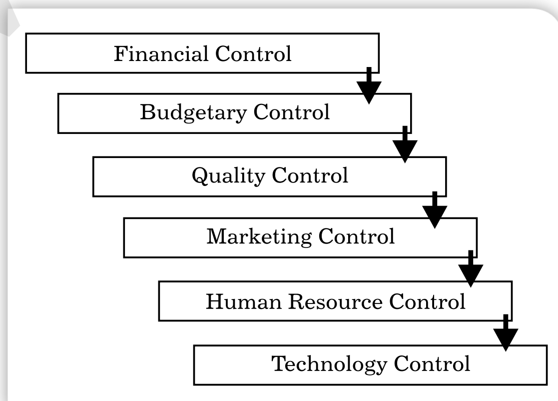

Figure 7.3: Different Control Tools

These tools are explained as follows:

- **Financial control:** This control tool is used for taking measures against the monetary performance of a project. This tool makes use of information drawn from financial statements (income statement, balance sheet, and cash flow statement); financial audits (that check compliance with accounting methods, policies, and rules); and ratio analysis (financial statement analysis performed

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for determining the financial performance of an organisation in various key aspects.)

- **Budgetary control:** This tool is used for comparing the real capital and expenditure with budgeted capital and expenditure. In this method, the budget of the previous year is used as foundation for removing excess cost. Budgetary control provides a clear view to the management on what needs to be done to lessen the depletion of resources. However, it involves high level of unpredictability as budgets are always prepared much later.
- **Quality control:** This tool allows managers to analyse the level of quality maintained in production. It is important to use this control in order to produce quality products cost effectively. This tool can also be used for quality inspection, quality assurance, and total quality management.
- **Marketing control:** It is a control method that enables managers to check the progress of marketing goals like customer satisfaction, balance between demand and supply, faster delivery process, and so on. Marketing control includes continuous research, testing, and market statistics.
- **Human resource control:** This control checks the performance of employees. Human resource control makes used of performance reviews, corrective programs, training and development, counselling and mentoring, and so on.

  The success and failure of the project relies on the performance of human resource. Thus, a project manager should strive to improve the skills and abilities of project team members.
- **Technology control:** This control enables project managers to ensure that information systems are functioning properly. As information is a crucial aspect of any project, the non-functioning of information system may lead to the failure of the project.

SELF ASSESSMENT QUESTIONS

10. Project controlling is the ________ stage of the planning-monitoring-controlling cycle or the plan-do-check-act cycle.
11. Controlling ascertains whether the desired performance complies with the set standards of performance. (True/False)
12. Which control is performed after a project is completed?
13. __________ control enables project managers to ensure that information systems are functioning properly.
14. Budgetary control is used for comparing the real capital and expenditure with budgeted capital and expenditure. (True/False)

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ACTIVITY

Find information on the controlling process of construction projects undertaken by Gammon India.

7.6 SUMMARY

- In project management, the planning-monitoring-controlling process involves making sure that the approved project is performed within its scope, time, and budget.
- The PMC cycle involves five stages, which are planning, executing, monitoring, controlling, and closing.
- Monitoring is a systematic effort of collecting, recording, and reporting the required information regarding project activities. The four monitoring indicators are input indicators, output indicators, outcome indicators, and impact indicators.
- The main aim of designing a project monitoring system is to spot the loopholes at all the levels of project management starting from project planning to project execution.
- The monitoring process cannot be performed without accurate and timely information about the cost, budget and time of a project. Thus, data collection requires thoughtful consideration and supervision.
- Reporting is a systematic presentation of information needed for monitoring. A report has information related to the progress, cost and time of a project. There can be different reports prepared depending on the nature of the project.
- A project monitoring system is a framework of activities to be performed under the monitoring process.
- Project controlling is the act stage of the planning-monitoring-controlling cycle or the plan-do-check-act cycle.
- Different controls are performed for different types of projects. There are three main types of controls, namely feed forward control, concurrent control, and feedback control.

KEY WORDS

- **Performance appraisal:** A process of assessing the performance of employees in terms of quality, quantity, cost, and time corresponding.
- **Total Quality Management (TQM):** It is a process of ensuring total quality in all organisational processes.
- **Auditing:** This refers to the process of checking records or financial accounts to determine their accuracy.

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- **Budget:** It is prepared for keeping a record of the expenditures incurred on project activities planned over a set period of time in advance.

7.7 DESCRIPTIVE QUESTIONS

1. Explain the five stages of the PMC cycle.
2. Explain different types of data collected for designing a project monitoring system.
3. What are the advantages of preparing reports?
4. Write a short note on project controlling.
5. Explain the three types of control.
6. Explain the concept of Earned Value Analysis in detail.

7.8 ANSWERS AND HINTS

ANSWERS FOR SELF ASSESSMENT QUESTIONS

Topic	Q. No.	Answers
Planning-Monitoring-Controlling Cycle	1.	Closed-loop
	2.	False
Project Monitoring	3.	Lifecycle
	4.	c. Outcome indicators
	5.	Third
	6.	True
	7.	Exception report
Earned Value Analysis (EVA)	8.	BAC, CPI.
	9.	Project is ahead of schedule.
Project Controlling	10.	Act
	11.	False
	12.	Feedback control
	13.	Technology
	14.	True

HINTS FOR DESCRIPTIVE QUESTIONS

1. The five stages of the PMC cycle are planning, executing, monitoring, controlling, and closing. Refer to Section **7.2 Planning-Monitoring-Controlling Cycle.**
2. The different types of data collected for monitoring system design are frequency counts, raw numbers, subjective numeric rating, and indicators. Refer to Section **7.3 Project Monitoring.**

N O T E S

3. A report creates an understanding across various departments, provides information on the progress of project activities so that they can be coordinated well, etc. Refer to Section **7.3 Project Monitoring.**
4. Project controlling involves correcting projects gaps identified at the monitoring level and establishing standards for the performance of a project. Refer to Section **7.5 Project Controlling.**
5. The three types of control are feed forward control, concurrent control, and feedback control. Refer to Section **7.5 Project Controlling.**
6. The Earned Value Analysis (EVA) is a method to monitor and control the progress of a project. Using the EVA, the completion date, final costs, schedule variances and budgets are measured at any given point of time while the project is in progress. Refer to Section **7.4 Earned Value Analysis (EVA)**.

7.9 SUGGESTED READING FOR REFERENCE

SUGGESTED READINGS

- Kim Heldman. (2011). PMP Project Management Professional Exam Study Guide (6^{th} ed.). New York: Wiley.
- James Taylor (2007). Project Scheduling and Cost Control: Planning, Monitoring and Controlling , J. Ross Publishing.
- Alberto De Marco. (2011). Project Management for Facility Constructions. Springer Science & Business Media.

E-REFERENCES

- Pmtips.net. *Project Management tips*. http://pmtips.net/project-control/
- Villanovau.com/. *Monitoring and Controlling Process Groups*. http://www.villanovau.com/resources/project-management/pmbok-monitoring-controlling-process-group/#.VFndm_mUfqs
- Brighthubpm.com. The *Monitoring & Controlling Process Group: A Definition*. http://www.brighthubpm.com/project-planning/1675-looking-at-project-monitor-and-control/
- Projectcontrolsonline.com/. *Project Controls: What is it and why is it important?*. http://projectcontrolsonline.com/Home/Definition-andImportanceofProjectControls.aspx
- Theprojectmanagementsteps.com. *Monitoring & Controlling*. http://www.theprojectmanagementsteps.com/project-management-steps/monitoring-controlling

8

CHAPTER

PROJECT COMMISSIONING & PROJECT CLOSURE

CONTENTS

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INTRODUCTORY CASELET

PROJECT CLOSURE AND LESSONS LEARNT

Mr. Kemal Atesmen is a US-based academician who holds B.Sc., M.Sc. and Ph.D. degrees in mechanical engineering. In his initial years, he worked as a professor of Mechanical Engineering. Later on, he moved on to work in the field of international engineering project management and engineering management for over three decades. He has overseen projects related to domains such as automotive, computer components, data communication and offshore oil industries.

Kemal has authored various books one of which is based on his experiences and lessons learnt at end of various projects that were completed by him. Recently, Kemal completed a two-year long design and manufacture project (advanced electric bus design and manufacturing). At the end of the project, Kemal submitted his project status report and it was accepted by the client. Final project metrics were also presented to the top officials of the domestic and international management of his company. The client's project manager also gave a positive evaluation report. The only tasks that were pending in this project were the conduct of a formal project closure and lessons learnt meeting with team members, client's project manager and subcontractors and with the upper management of the company.

At this point of time, Kemal was instructed by his company to manage another troubled project in South Korea. Here, he sorted out all issues which took about three weeks. Upon his arrival back to US, he prepared a summary of important lessons learnt from his last project. He tried to conduct a meeting with all the stakeholders. However, by this time, all project members were reassigned to other projects. It was very difficult for him to fix a time for project closure meeting as many team members were in different parts of the world and it appeared as if they were not interested in such a meeting because they considered it as futile. There were 10 project team members in the previously concluded project out of which two have been sent to Japan to look after new projects. Somehow, Kemal arranged a meeting with the remaining eight members at a lunch meet where he presented his lessons learnt meeting and a brainstorming session was also carried out to discuss the ways in which they can avoid difficult problems and situations.

Similar lessons learnt exercise was conducted with the management people, remaining two team members in Japan, client's project manager and subcontractors and with his new project's team members in Germany either in person or using videoconferencing.

INTRODUCTORY CASELET

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After these meetings were over, lessons learnt list was updated with constructive output generated from meetings. After properly updating the Lessons Learnt document, Kemal released it into document control so that it can be kept safely for future reference.

The major learnings from the project were:

- The exercise of conducting project closure and lessons learnt meeting was actually a part of the project life cycle but by then the project has been closed and all books of accounts were closed. Therefore, Kemal charged a week's time (spent in the entire exercise) to company overheads accounts.
- Frames used for manufacturing buses were imported from a German Supplier and the payment had to be done in Euro as per the contract. At the time of making payment, the US dollar depreciated against Euro and as a result the project experienced a 20% hike in the costs. Therefore, it was recommended that in all future international projects, foreign exchange liabilities in different foreign currencies should be considered carefully and a sufficient amount of futures must be bought in advance.
- The project involved steel as a major input for production and the project bought the required amount of steel in three instalments. During this period, the price of steel had skyrocketed and the company had to shell out a lot more money than was planned. This substantially increased the overall cost of project. Therefore, it was recommended that all the required inputs should be bought by the project management at the start of the project or an arrangement should be made with a supplier to supply the required input at a fixed price at different times during a project.

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LEARNING OBJECTIVES

After studying this chapter, you will be able to:

- Explain the concept of project closure and termination
- Explain the concept of natural and unnatural termination of projects
- Classify the types of project termination
- Describe the concept and importance of a transition plan
- Explain the structure of a close-off report
- Examine the key post project activities
- Discuss the process of benefits realisation

8.1 INTRODUCTION

In the previous chapter, you studied the concept of monitoring and controlling a project. This chapter discussed topics such as Planning-Monitoring-Controlling Cycle; Project Monitoring; Earned value analysis (EVA) and Project Controlling.

In this chapter, you will study about project commissioning and closure which is the last phase of project life cycle. The process of project closure can be very simple or extremely complex. The project closure process involves a lot of coordination between the stakeholders of the project. All projects do not have similar closing or they do not follow the same steps for project closure. This chapter will clarify the difference between the words project closure and termination. You will come to understand why the word termination is not necessarily associated with project failure. There are two basic types of project termination viz. natural and early. A project that is closed after it has delivered the required outputs on time is said to be closed upon completion. A project that closes after achieving success or failure after exceeding its due date is said to be terminated. It can be said that a project closure is a process that entails verifying whether or not all the administrative actions have been completed before the physical closure of the project. Physical closure is considered complete when either the necessary services or supplies have been either performed or delivered to the customer and have undergone inspection and acceptance; or the vendors have been served a contract termination notice.

In this chapter, you will study about various aspects such as types of project closure and termination; transition plan, close-off report, key post project activities and benefits realisation.

8.2 PROJECT CLOSURE AND TERMINATION

People usually associate the term project termination with project failure. However, this word is not associated with the success or failure

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of a project. At times, the term termination is used interchangeably with project closure or close out. There is a subtle difference between these two terms. Project termination refers to a condition when a project has ended (either as success or as failure) before the due date of project. When a project ends at its planned time, it is referred to as project closure. Irrespective of whether a project has been terminated or closed, it is important to carry out certain activities which include:

- Securing customer feedback and approval
- Planning and carrying out smooth transition
- Capturing and sharing lessons learned
- Performing administrative closure
- Celebrating success
- Providing on-going support

A project comes closer to completion when the scope of the project has been validated by the end clients and they have accepted project deliverables. Project closure refers to the stage or phase of the project where the project (along with all the end deliverables, documents, etc.) is handed over to final end users or the client. It is at this stage that a judgement can be made regarding the success/failure or effectiveness of the project. Project closing processes are extremely important because they affect the effective finalisation/commissioning or the termination of the project and also with effective handover of the project to the concerned client. Most project teams focus on planning, execution and monitoring and control activities with no or very little focus on project close-out. Mostly, the project closeout phase is poorly planned. In order to avoid such a situation, the project team must plan the close-out phase at the beginning of the project itself.

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According to the PMBOK, for any project, there exist five process phases (groups) and ten knowledge areas. All knowledge areas include one or more processes that can be mapped to a particular phase. It means that a process occurs in a particular phase of the project life cycle. In PMBOK, closing processes (Close Project and Contract Closure) can be mapped to project integration management and project procurement management knowledge areas.

There are certain factors that must be examined continually to ensure that they realise the set goals of a planned or running project. It is required to ensure the continuity of projects else they might be terminated. These factors include:

- **Technology:** The organisation must value the technology adopted by the project so that they can measure the progress of a project.

In addition, the organisation may also have a fair idea regarding when to expect a breakthrough in the project.

- **Organisational factors:** While evaluating the feasibility of project factors such as internal competition, executive support and organisational strategy must be considered. The project must be in line with the organisational strategy. Projects that do not serve the organisation's purpose are terminated.
- **Market forces:** Market forces such as availability of alternatives and competing technological innovations can have a wide ranging impact on the viability of planned or existing projects. Communication between marketing, manufacturing and R&D departments can also ensure that any out-dated project that is not likely to generate positive results for the organisation is not continued.
- **Planning:** Most project managers agree that the most important factor in the success or failure of a project is project plan. A project always entails a certain level of risk. However, with thorough planning, majority of risks can be controlled and brought to a controllable level.
- **Project team:** Project teams and the level of experience team members have, has a lot of impact on the success or failure of the project. The role of a project manager is the most important because he/she is the one who is responsible for managing changing activities and resolving conflicts. He/she is also the one who is responsible for gaining management's buy-in. It is his/her responsibility to ensure that the project is on track.
- **Economic factors:** There are various economic factors that significantly affect the project's ability to generate the minimum required return vis-à-vis investment of the organisation. There is no one factor that decides the fate of a project or whether the project would be selected or dropped. A multitude of factors are considered for project selection but there are also cases where projects that are on schedule and within the budget get dropped off by organisations due to other financial constraints of the organisation. At any time during the project, the organisation may feel that its project is not being able to generate the required level of profitability; it may re-evaluate its projects and terminate all projects that are less profitable or are running in losses.

In various publications and expert opinions, project close-out includes various different components. However, major components of a project close-out include:

- Capturing or documenting lessons learnt
- Contract completion
- Commissioning
- Archiving documents

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- Securing stakeholder agreement to criteria for success
- Product acceptance

Closing processes that occur in practice are as follows:

- **Planning for closure:** Closure activities are associated with the end of a phase or project. However, it is important to plan them at the start of the phase or project. It is often said that a project should be started with an end in mind. When project objectives are being determined, a set of criteria must be developed in order to determine that a particular objective has been met or not. Criteria should also be developed to determine whether the planned scope has been delivered. During the entire process of determining project objectives and scope; all stakeholders must be involved so that all of them are in agreement.
- **Product acceptance:** One of the most important closing processes is to gain client's acceptance of the product or deliverable created at the end of a phase or project. It becomes easier for the client and the project team to understand the acceptance or rejection on part of the client if well-defined acceptance criterion is developed and fixed during the initial stages of the project. At most times, the project produces outputs or deliverables that are shown or provided to the client at various points in time. It is important to keep a good record of the acceptance of the staged deliverables by the client. There may be deliverables that require some kind of acceptance testing in order that these are approved and accepted by the client. For this, acceptance tests and resources required for the same must be fixed during the later stage of the project. During the life of the project and when staged deliverables are produced and given to a client, certain feedback is given from the client's end. All the customer feedback must be taken seriously and must be implemented in the project. After the final deliverable has been generated, tested and accepted by the client, it must be handed over to the client and must also be transitioned into operations.
- **Commissioning and handover:** The term commissioning is usually associated with large-scale engineering projects. However, it may be used for other projects as well. The commissioning of a project means that all deliverables of the project are checked, inspected, tested and accepted by the client. The project team has to ensure that outputs have been delivered as per specifications and they are functioning as required by the client. In other words, commissioning is a process required for ensuring that the project is operational and running. For huge projects such as hospitals, data centres, power plants, etc., commissioning is treated as a separate project and herein the project team hands over the project to the commissioning team.
- **Contractual closure:** Contractual closure means that the project team finalises all its outstanding agreements and contracts with

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the contractors and suppliers; finalise all monetary transactions and close accounting books. It also involves ensuring that all the contracted work has been completed. A contract usually includes the work that has to be completed, terms and conditions of the contract along with legal and financial consequences of not abiding by the contract terms. A contract also mentions closing processes associated with project finalisation. The contract also mentions the actions that can be taken if the project is terminated before its finalisation. Therefore, careful thought and analysis must be applied whenever a project is considered for termination as it may result in claims and disputes.

- **Administrative closure:** Administrative closure usually involves finalising and archiving project records. Usually, contractual closure takes precedence over administrative closure because non-performance in contractual closure involves penalties. Storage of project documents is a crucial step because they must be stored in a secure and confidential manner. Maintaining documents is also important because they can be referred to at a later stage in case any issue arises. At times, there may be legal requirements for maintaining project documents. In addition, project documents can also be required at the time of taking up projects similar to ones that have been completed and archived in the past. Lastly, it is also important to maintain project document archives in order to compare the performance of similar projects completed by the organisation. This is used for setting standards (benchmarking) and improving the performance of projects over time.
- **Post Implementation Review (PIR):** After 3-6 months of project completion and acceptance, a review is conducted by an independent authority in order to verify whether or not the benefits mentioned in the original business case and project contract have been realised. Actual benefits must be compared with the realised benefits as stated in the benefits realisation plan.
- **Review and learning:** At the end of a phase of a project or the overall project, review activity is carried out and reports are generated accordingly. Important events, outputs, techniques, personnel, etc. are mentioned in the reports. These reports help in corporate knowledge management and aid in organisational learning.
- **Celebrate success:** A project is a demanding and exhausting task and it involves effort of all project members to make a project a success. Therefore, it is important that after a project is completed, efforts of all members are recognised and a small celebration is carried out.

It is known beyond doubt that a project will be terminated but how and when it will be terminated and how unsuccessful projects are closed and treated by the organisation has a long and enduring impact on the future projects as well.

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An organisation may start various projects that have different levels of risks. Organisations that choose greater risks should handle their employees carefully if some projects started by them end in failure. It is necessary to be firm yet assertive with the team members because they might perceive that they are being punished or reprimanded because they were part of unsuccessful projects. Under such circumstances, such members may become reluctant to take risks and may not terminate the projects. It becomes all the more important to terminate failed projects in an organised manner because of the impact they may have on future projects as well as the future prospects of the organisation. If the organisation gains confidence of all project members during termination process, it usually increases their commitment and loyalty towards the organisation.

POST-AUDIT REVIEW

At end of a project, a post-audit or post-closure audit is conducted and a post-audit report is prepared. This document summarises the project and provides a list of recommendations for similar projects on the basis of learning of the project.

The post audit review report also enlists success factors and shortcomings of the project. This report can be referenced by the management when it takes up other similar projects. This report can be used to gain an understanding of the bright side of projects so that they can be reproduced in the upcoming projects. Similarly, this report also details the fallacies of the previous projects so that they can be avoided in the future. In other words, a post-audit review report serves as a tool to identify which strategies worked and which did not work.

A post-audit report should focus on aspects such as project performance, administrative performance, organisational structure, project and administrative teams and project management techniques.

Every section of the report should ideally draw a comparison between the actual and the planned objectives. The administrative performance section holds importance in contributing towards augmentation of a positive organisational culture. The importance of the organisation's structure is important because it can help or hinder a project. Some organisations make changes in their organisational structure depending on such reports. The abilities, skill, aptitude and personal traits of the team members highlight training needs and organisational development interventions and also help in succession planning.

SELF ASSESSMENT QUESTIONS

1. Mention any two important components of a project close-out.
2. Administrative closure takes precedence over contractual closure. (True/False)

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ACTIVITY

Prepare a case study on management of trauma of a failed and terminated project.

8.3 TYPES OF PROJECT TERMINATION

In practice, there are different types of projects having varied characteristics. The duration of different projects varies according to their nature and industry. For example, software projects may be completed within a few days whereas infrastructure projects take years to complete. It must be remembered that no project is permanent and a project must come to a conclusion at some time. Therefore, the termination of a project becomes inevitable or a certain event. The project can be terminated in a positive or negative manner.

How and when a project is terminated affects the morale of employees in addition to affecting the image of the organisation. When project teams are punished for delivering unviable or unsuccessful projects, they avoid taking risks leading to more failed projects and wastage of resources. In such circumstances, it becomes all the more important to have in place a defined termination process. The end of project may be successful completion or failure. A project can be terminated in one of the four ways as shown in Figure 8.1:

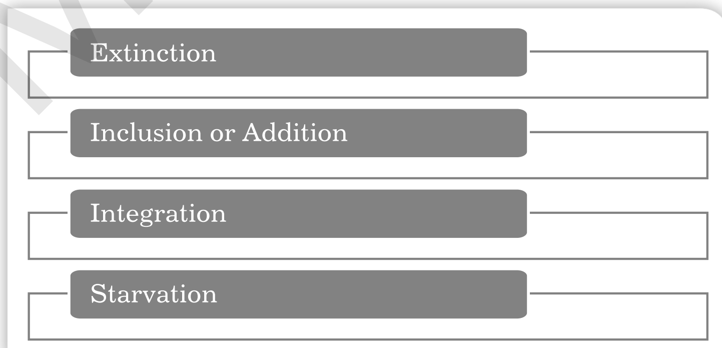

Figure 8.1: Four Ways of Project Termination

Let us now study these four ways of project termination.

- **Termination by extinction:** A project is said to be terminated by extinction after the final deliverables have been developed and handed over to the client. For example, when a builder completes the construction of a house and hand over it to the client or when software has been developed and given to the client. Projects terminated through extinction may be successful or unsuccessful. In such cases, project activities have been completed and stopped or halted or delayed indefinitely. In such cases, no further progress is possible. Another possible reason for project termination

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by extinction is that the project does not have the support of top management. An example of project termination by extinction is the cancellation of the Superconducting Supercollider (SSC). In that case, project management failed to clearly specify costs and expected benefits of the project.

- **Termination by inclusion/addition:** A project is said to be terminated by inclusion when the entire project team along with all resources are migrated or transferred to a new project or division or the parent organisation. In this type of termination, the project is institutionalised as a new and formal part of the organisation. In such projects, project managers are often made managers of these entities. In such a case, all assets of the organisation are transferred to the new entity. This type of termination exerts a lot of stress over the organisation and the project team. Therefore, the project team must remain careful and sensitive so that the organisation can adjust itself.
- **Termination by integration:** This category of project termination (integration) occurs when a project team that was initially derived from the organisation is re-integrated with the organisation after the project has been completed. This is the most common termination method for projects that have ended in success. All personnel, equipment, material, property and functions of the project are transferred to the parent organisation. The output of the project becomes a standard part of the operating systems of the parent organisation. Here, it becomes a challenge to integrate technologies and practices being used by the project team and the organisation.
- **Termination by starvation:** A project is terminated by starvation when it becomes unwise to terminate a project outright. In such a case, the budget allocated for the project is gradually slashed till the project comes to an end. This situation usually occurs when the concerned project termination has been suggested by an important client or by a senior member of the management. Some non-performing projects are terminated using starvation because such projects may be considered to be as embarrassing failure of the management.

EXHIBIT

Reasons for Project Termination

A project may be terminated before its due date because of the following reasons:

- Project has been completed and handover to the client before its due date.
- It becomes known that the project would not be able to achieve the stated goals of the project.

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- It becomes known that a competitor or rival is already engaged in a similar project.
- A key project resource such as Project Manager or a critical vendor withdraws.
- Natural disasters or circumstances may turn hostile.
- Regular audits may indicate that the project would not be able to achieve the desired results.

Whenever the management of a project is faced with a decision to whether or not to continue a project; it becomes important to consider the type of project. Mathematical models can be made use of in deciding whether to continue a project or not. Sometimes financial techniques like payback period or net present value are also used to determine the feasibility of project continuation/termination. The final decision depends on the outcome of such analysis and strategic factors like the competitive edge the project offers to the organisation.

Cybernetic control processes and Go/No-Go control processes are two commonly used techniques to monitor projects through their life cycle.

- The cybernetic control method is a tool that can be used to compare the actual performance of the project with the expected path. The project team can visualise deviations and take corrective actions. Cybernetic control processes are generally used as a tool to make the project stay on its track to avoid premature termination owing to poor planning.
- Go/No-Go controls are a type of periodic testing to identify if specific preconditions have been met (Meredith & Mantel; 1995). The project team can assign specific weightage to individual measures to give a quantitative dimension to the monitoring process.

All projects whether successful or not must be terminated. In order to ensure a smooth and uncomplicated termination and closure of a project, some projects may also decide to engage a termination manager. The roles and responsibilities of a termination manager include:

- Project completion without any delays and glitches
- Ensure delivery and acceptance of end deliverable by the client
- Presentation of a final project report to the sponsors
- Clearance of bills and invoices to clients and vendors
- Redistribution of resources
- Record keeping and maintenance
- Delegate product support responsibility wherever required
- Monitor the closure of project-related books

NOTES

At the time of terminating a project, it is of utmost importance that the project manager and project sponsors support and motivate the project team. The sponsor may, ideally, also recognise and reward the performance of the project team at this stage. This will help in developing a positive culture in the organisation.

8.3.1 NATURAL AND UNNATURAL TERMINATION OF PROJECTS

A project is usually terminated under either of two circumstances namely project success and project failure. It is the responsibility of the top management of an organisation to facilitate all circumstances that help in making projects a success and to create a positive project culture. However, the top management must also allow a project to fail if it no longer serves as a strategic fit with an organisation's objective. Project termination does not necessarily mean that a project has ended in success. Steps that must be taken at the time of termination are as follows:

- All outstanding contracts and payments with suppliers and clients must be finalised.
- Release all human and non-human resources of the project and reallocate these to other projects.
- Complete all accounting procedures and close all the books of accounts.
- Prepare the post audit review report that documents the results of the project along with lessons learnt. These lessons can be used as recommendations for future projects.
- Acceptance or rejection of project deliverables by the client according to the acceptance criteria agreed upon and mentioned in the Project Agreement.
- Installation and field testing.

Factors that affect project termination are:

- Inability to meet project's objectives and no intellectual value anticipated on continuation
- Change in the internal and external project environment
- No sustainable value for the company expected from the project even when completed
- Unexpected introduction of advanced technological version of the product in the market that makes the project obsolete
- Obsolescence of the final product earlier than expected, shortage of customer support
- Deviated schedule and unexpected cost escalation

NOTES

- Lack of technical knowhow
- High resource attrition
- Financial constraints of the organisation
- Significant change in the company's interest and strategy

Projects can be terminated in two ways. They are natural and unnatural termination. Natural termination occurs when the end objective of the project has been attained. Sometimes projects that are successful are terminated by institutionalising them as a part of the organisation. Resources such as personnel, immovable and moveable assets and equipment are transferred from the closed or terminated project to a division of the organisation. Though this method of terminating projects is the most common way of project termination, it is the most complex method.

Unnatural project termination is also called early project termination. More often than not, early termination results when the project fails to attain its objective. It may also occur as a result when the outcomes or deliverables of a project are no longer needed. In such cases, the project is said to be abandoned. The management of a project can take a decision whether or not to terminate a project on the basis of the following project indicators:

- Actual costs of the project are greater than the expected business benefits
- A project is unable to make a strategic fit with organisational objectives
- Unwarranted and uncontrolled delays
- Advanced technological requirements beyond project scope

It is usually said that no effort that we make to attain something ever goes waste. The same is true for projects as well. An organisation may carry out a project or fails to proceed. However, such projects help in creating knowledge base that is used in producing successful products at later stages. In cases of unnatural termination, the timing of termination has a huge impact on the organisation and its upcoming projects. The earlier a project is terminated, the earlier its resources can be distributed and allocated to other projects where they can be used in a better way.

EXHIBIT

Causes of Project Failure

Major causes of project failure include:

- Ignoring lessons learnt and best practices
- Unavailability of appropriate skill-set

- Sponsorship loss
- Unrealistic deadlines
- Change in business needs
- Technology obsolescence
- Poor change management
- Ill-defined scope
- Poor understanding of customer needs

The timing of decision to abandon a project holds important value as the quicker the decision is made, earlier resources can distributed among more viable projects to create value.

SELF ASSESSMENT QUESTIONS

3. _________ termination occurs when the end objective of the project has been attained.
4. In the case of termination by ____________, the output of the project becomes a standard part of operating systems of the parent organisation.

ACTIVITY

Using the Internet, prepare a list of ten projects that have been completed or terminated by different organisations in the past one year. Study these projects and summarise the type of termination that was met out to each project. For example, if an organisation reduced the budget of Project A to such an extent that it became infeasible to complete it, then you would state that Project A was terminated by starvation.

8.4 TRANSITION PLAN

At the end of a project or project termination, the project manager must create (write/document) a transition plan in order to help the client in effectively using project deliverables. A project transition plan is a kind of instruction manual that can be referred by the client for using project deliverables. At times, one group of project team members creates certain deliverables that need to be worked upon by another project group. The transition plan is required in such cases. The essence of creating a transition plan is to ensure that all completed or partially complete deliverables are passed on to the people who will now use or work on these deliverables with the help of a well-documented transition plan.

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When a deliverable is handed over to another team or individual for further processing, it is possible that one or more activities remain incomplete. In such a case, the project manager needs to itemise all pending activities and allocate these to the persons who would be carrying out these activities in the transition plan. It is important to have in place a transition plan in order to avoid quality problems and smoothly transition the project deliverables into operations. A transition plan may come in various forms. However, a sample transition plan template is shown in Figure 8.2:

Role Transition Plan Template

Instructions: How to Use This Tool

As one person exits a role and a success or takes over, a clear checklist-based plan will help ensure a smooth transition. This template should be used by HR, in conjunction with department leadership, to effectively track transition between roles.

Incumbent		Role Exit Date	
Current Role		New Role	
Current Supervisor		New Supervisor	
Current Department		New Department	

Successor		New Role Start Date	
Current Role		New Role	
Current Supervisor		New Supervisor	
Current Department		New Department	

Figure 8.2: Sample Transition Plan Template

Source: https://www.template.net/business/plan-templates/transition-plan-template/

A transition plan refers to a document that contains guidelines or a framework describing various pending tasks and activities that must be performed in order to complete a project. A transition plan lays out responsibilities of each member of the transition team. The transition plan defines various tools and techniques that should be used during the transition. For example, contingency planning and risk mitigation are two such techniques that must be used during transition.

A transition plan is created in addition to other important project documents such as project charter, business requirements, technical design, etc. The most important components of a transition plan include scope; risks and contingencies; strategies; transition schedule, tasks

N O T E S

and activities; configuration control; transition team; post implementation activities; document approval; etc.

Let us now discuss each of the components of a transition plan briefly:

In the context of a project, **scope** refers to an overview of a project that includes details such as unique identification numbers, item titles, etc. Important parts of a project scope include project title, project brief, project documentation and transition impact. Project brief provides an overview of the current project and its relation to other projects. All important project documents that are related to a project such as related diagrams, flow charts, licensing information, etc. must be included in the project scope. The scope must also contain details regarding the anticipated effects of project transition on the clients, other systems and projects and on the community as a whole.

Another component of a transition plan is **risks and contingencies**. All risks identified during the project are listed in this section. It is done in order to reduce operational risks. The risks included in the list must be classified as per an agreed upon criteria. Each item of risk must also describe its probability of occurrence, impact and time frame of occurrence of risk. All risks must be prioritised in order to allocate resources. For each risk, a project team member is assigned and he/she has to manage each risk including its drafting, mitigation plans, risk factor monitoring, mitigation plan and reporting of risk status.

A transition cannot be effected vaguely. The organisation needs to make its transition in a smooth manner by using a **transition strategy** and tools. A well-defined transition strategy helps the organisation to transit seamlessly. The list of all possible ways in which the project's production and operations can be transmitted is also made. A transition strategy can be implemented in three ways. First, the organisation can follow a phased implementation; second, transition that is executed parallel to the main operations; and last is the immediate or one-time switch. The organisation or the project's management must select one of these transition strategies keeping in mind factors such as pros and cons of each option; anticipated risks under each; and approximate time, cost and resource requirement under each option. After weighing in each option, one option must be selected and transition must be carried out per se after all the necessary documentation and approvals.

Another important aspect of project transition is related to **transition schedule, tasks and activities**. Under this section, details regarding the execution start and end dates and the processes to be followed during transition are mentioned. Project transition must be planned keeping in mind factors such as:

- Work Breakdown Structure (WBS)
- Significant milestones and dependencies

- Validation and verification activities
- Contingency management plan
- Training and other specific activities related to new or existing equipment or software
- Handling and maintenance requirements of external vendors and internal users
- Organisation must share the Transition Standard Operating Procedures (SOP) with its employees and operational staff.
- Setting apart provision to document the outcomes, deficiencies, plus points and corrective actions with respect to project transition.

Last aspect related to project transition is **resources**. For successful transition, the organisation may be required to deploy certain human resources, equipment, tools, hardware, software, facilities, etc. Resources include software, hardware, personnel and facilities. The contact details of all the project team members must be listed in an easy to reference manner.

The transition plan must enlist all the required software along with details such as name of software, unique identification number, version and configuration details, user manual details, vendor support, licenses, user rights, terms and conditions of maintenance and support, etc.

Hardware requirements such as computer systems, computer peripherals, diagnostic equipment, etc. must also be documented in the transition plan. The plan must enlist the information related to the hardware items such as the configuration requirements, versions, user manuals, spare parts required, etc.

The role and responsibility of all human resources must be enlisted for reference and compliance. Facility requirements such as requirement of building, space or location along with infrastructure such as flooring, roofing and heating, ventilation and air conditioning (HVAC) requirements etc. must be listed. Cabling, plumbing and electrical requirements must also be provided. A transition plan must document the details of the reporting structure and the communication methodology to use followed during the transition. Last aspect that should be detailed in the transition plan is the transition acceptance which refers to the criteria for acceptance of the transition by the client.

A project transition plan also details other information such as management controls and configuration controls. Management controls are those actions that are deployed in order to ascertain that all the task transitions are made smoothly in compliance with the acceptance criteria. If any changes are made in the configuration of computer systems and associated peripherals, it should be duly documented.

SELF ASSESSMENT QUESTIONS

5. It is important to have a transition plan in order to smoothly transition the project deliverables into__________.
6. Which of the following factors must be kept in mind while developing a project transition plan?
   a. Work Breakdown Structure (WBS)
   b. Milestones and dependencies
   c. Contingency management plan
   d. All of these

ACTIVITY

Assume that you are the project manager of Project A of Organisation X that recently took up a housing project. Due to certain difficulties, Project A has to be halted mid-way and transferred to Organisation Y which is a subsidiary of Organisation X. Prepare a transition plan for this case.

8.5 CREATE THE CLOSE-OUT REPORT

At the end of the project, the project manager and his team has to present a Project Closure report to the top level management of the project organisation. It is also known by alternative names such as Project Closure and Post Implementation Report (PCPIR) and Project Close-out report. A Project Closure report is used to provide an overview of the final assessment of the project. It specifically details the level of success, benefits achieved, summarised information obtained from a post implementation review meeting.

A lot of organisations follow certain formal procedures for preparing closeout reports and archiving project records. A close-out report usually includes lessons learned and a review of important things related to project such as "Did the project accomplish its intended goals?". It is important to answer this question because many changes take place during the life of a project. Changes may involve changes in timing, costs and deliverables. It is the responsibility of the project manager to ensure that the project closure report is prepared in a manner that allows various stakeholders to access required information such as lessons learned, audit details, etc. A project closure report usually includes details as shown in Table 8.1:

N O T E S

TABLE 8.1: PROJECT CLOSURE REPORT FOR PROJECT XYZ.

Company Logo

Project Title/Reference no.: ________________

Name of person completing this document: _________________

Department:

Focus Area:

Product/Process:

Prepared By

Document Owner(s)	Project/Organisation Role

Project Closure Report Version Control

Version	Date	Author	Change Description

TABLE OF CONTENTS

1. Project Closure Report Purpose
2. Project Closure Report Goals
3. Project Closure Report Summary
    - Project Background Overview
    - Project Highlights and Best Practices
    - Project Closure Synopsis
4. Project Metrics Performance
    - Goals and Objectives Performance
    - Success Criteria Performance
    - Milestone and Deliverables Performance
    - Schedule Performance
    - Budget Performance
    - Metrics Performance Recommendations
5. Project Closure Tasks
    - Resource Management
    - Issue Management
    - Risk Management
    - Quality Management
    - Communication Management
    - Customer Expectation Management

NOTES

Asset Management
Lessons Learned
Post-project Tasks
Project Closure Recommendations
6. Project Closure Report Approvals

The project closure or close-off report is the final document produced in a project. It is presented to the higher level management of organisation so that they can assess the success or failure of a project. In addition, it also helps in identifying the best practices of the project for future use. It is also used to formally close a project.

A project closure report formally describes that the objectives of the project have been fulfilled and the final deliverables have been handed over to the client. The project manager and the organisation need to obtain the consent of all the internal and external stakeholders to ensure that the project can be closed.

In essence we can say that a closure report contains the executive summary, final status of the project and recommendations for future projects. It serves as a quick reference guide and is used by future project managers in order to learn about a project's best practices.

In addition, the closure report should also describe any abnormal situations that emerge during a project and what its impact was. If, at the end of a project, some issues have not been resolved, follow-on action must be prescribed for them.

When the project manager is preparing the closure report, he/she should also analyse the root cause of problems faced in the project and what corrective actions should be taken in case such problems reoccur in the future. This document may also predict or anticipate similar problems in the future and lists out the treatment that can be undertaken to avoid these problems. It is important to prepare a closure report because of the following reasons:

- It highlights the outputs produced by the project
- It describes the level of success achieved by a project
- It lists all the outstanding issues and make recommendations against each
- It lists activities necessary for proper and formal closure of the project
- It prepares business intelligence for future projects

To list down the best practices and the lessons learnt from a project into the project closure document, the project manager and his team

N O T E S

first needs to capture information which can be done in one of the following ways:

- Analysis and study of all the records and documents of the project
- Survey of the stakeholders by using techniques such as interviews and questionnaires
- Face to face interviews with project team members
- Conducting feedback sessions
- Stakeholder perceptions

SELF ASSESSMENT QUESTIONS

7. A project closure report allows various stakeholders to access information such as lessons learned and audit details. (True/ False)
8. A project closure report usually contains the executive summary, final status of the project and _________.

ACTIVITY

Prepare a case study on the usefulness of the project closure report.

8.6 POST PROJECT ACTIVITIES

Whether a project concludes in success or in failure or is terminated mid-way, one thing that is sure is that it comes to an end. The project team should ready itself for taking up new projects with a positive frame of mind. The project team members must take lessons from their success and failures both. It is important to begin new projects with a positive attitude leaving behind any negativities of the project.

There are certain activities that must be carried out after a project has been terminated and before a new project is started. These activities include:

- **Reassigning project members:** Since project team members are human resources, they must be allocated to a new project after the existing project is over. This activity is undertaken at the time of product closure. If the organisation has contractual employees, they can be transferred to other projects or they can be released after the settlement of their dues.
- **Celebrating success and reward participants:** It is important to celebrate the success of a project to achieve the following:
  - Celebration reminds team members of their recent accomplishments and how each individual contribution helped in

NOTES

overall success. It creates a favourable environment and motivates or energises team members to perform even better in the upcoming projects.

- Celebration may also make individuals believe in them with even more conviction and boost their confidence
- Celebrations are considered as transition points where team members leave one project and move to other one. They also symbolically recognise the efforts of all the individuals or team members.
- Celebrations also help in easing the stress level of the members.

- **Providing on-going support:** After a project has been concluded, the project manager needs to ensure that the client is provided transitional and post implementation support. For this purpose, an on-going support contract may also be prepared at the start of a project. On-going support activities include:
  - **Training and re-training:** After handing over of deliverables to the client, the client may face usage issues that cannot be found in user manuals and transition reports. In extreme cases, they may also face certain defects that were inadvertently passed into deliverables. Therefore, providing training and re-training to the users is an important activity. Training is provided using various tools such as quizzes, interactive sessions, demonstrations, discussions, etc.
  - **Transfer deliverables and support staff**: In some projects, such as software projects require specific training of end users after the outputs have been delivered. Here, the client requires operational support. For this purpose, the organisation may have to send in a trainer on site. This also helps in generating feedback from the client and developing a working relationship with the customer team.
  - **Finalise documentation:** Projects may also require support for maintaining documentation of the project. Documentation requirements include initial project requirements and scope, documentation related to development phases and the transition phase.
- **Ensuring realisation of project benefits:** Project organisations usually follow up with their customers after providing them deliverables in order to judge how well customers are using the deliverables. The overall impact of project results can be measured or estimated by considering the use by direct customers and other stakeholders.

N O T E S

SELF ASSESSMENT QUESTIONS

9. List any two post-project activities.
10. ____________ creates a favourable environment and motivates or energises the team members to perform even better in the upcoming projects.

ACTIVITY

Describe briefly important post-project activities involved in the case of software development projects. For this purpose, you may use any method such as survey, case study or the Internet.

8.7 REALISATION OF PROJECT BENEFITS

A benefit can be considered as an outcome or something which is considered to be of value by at least one stakeholder that is based on the delivery of the project. According to the **Association for Project Management (APM)** *benefit management are the identification, definition, planning, tracking and realisation of business benefits.*

Some important characteristics of a benefit are:

- It holds some value in form or fashion
- It is possible to measure, observe and quantify a benefit

Some questions that help understand the characteristics and value of benefits are:

- Who will measure
- What will be measured
- Why will it be measured
- When should it be measured
- Where should it be measured
- How to present the measures

A benefit should not be confused to be a:

- Merely a business case
- Deliverable in contrast, benefits result from deliverables

The process of benefits management involves identifying, measuring, tracking and delivering the benefits of a project. It is not a one-time event, but is a continuous cyclical process that runs through the complete project life cycle. Figure 8.3 shows the benefits realisation process can be considered to be a five-phased process in alignment with the project life cycle.

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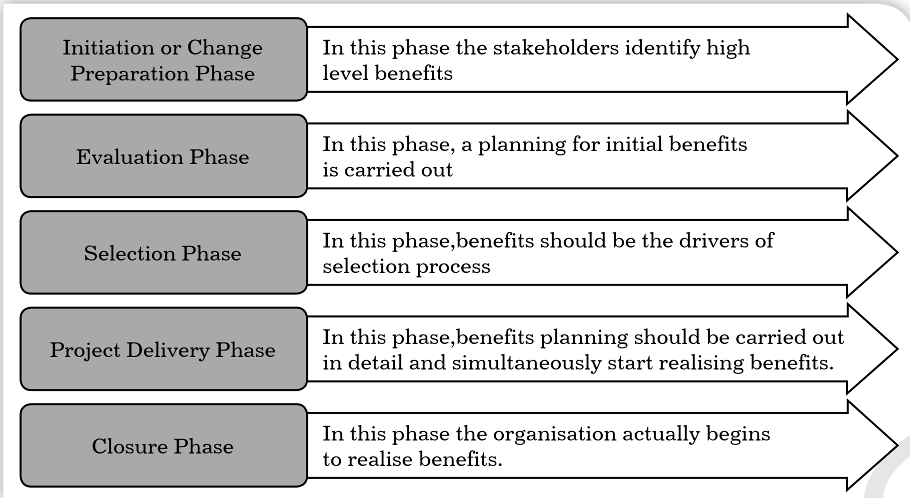

Figure 8.3: Benefit Realisation Process Phases

Common deficiencies in the process of benefit management are:

- Lack of clear understanding and definition of benefits
- Deficient commitment of key stakeholders in the process
- Deficient ownership of benefits, it is limited only to the business case
- Lack of robust processes to manage, monitor and realise benefits
- Business case not aligned with circumstantial changes in the benefits

SELF ASSESSMENT QUESTIONS

11. In this phase, benefits' planning is carried out in detail and benefits start to realise. Which phase of the benefit realisation process is being mentioned here?
    a. Evaluation
    b. Selection
    c. Project delivery
    d. Closure

ACTIVITY

Imagine a project implementation in your organisation and make a list of phase wise benefits that are expected from that project.

8.8 SUMMARY

- Project termination refers to a condition when a project has ended (either as success or as failure) before the due date of the project.

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When a project ends at its planned time, it is referred to as project closure.

- There are certain factors such as technology, organisational factors, market forces, planning, project team, etc. that must be examined continually to ensure that they realise the set goals of a planned or running project. It is required to ensure the continuity of projects else they might be terminated.
- Closing processes that occur in practice include: planning for closure, product acceptance, commissioning and handover, contractual closure, administrative closure, post implementation review (PIR), review and learning and celebrate success.
- At the end of a project, post-audit or post-closure audit is conducted and a post-audit report is prepared. This document summarises the project and provides a list of recommendations for similar projects on the basis of learning of the project. Every section of the report should ideally draw a comparison between the actual and the planned objectives.
- Termination of a project becomes inevitable or a certain event. The project can be terminated in a positive or a negative manner.
- A project can be terminated in one of the four ways: extinction, inclusion or addition, integration and starvation.
- Some projects may also decide to engage a termination manager.
- It is the responsibility of the top management of an organisation to facilitate all circumstances that help in making projects a success and creating a positive project culture. However, the top management must also allow a project to fail if it no longer serves as a strategic fit with an organisation's objective.
- An organisation may carry out a project and may also fail at it. However, such projects help in creating a wealth of knowledge that is used in producing successful products at later stages.
- The timing of decision to abandon a project holds important value as the quicker the decision is made, earlier the resources can be distributed among more viable projects to create value.
- A project transition plan is a kind of instruction manual that that can be referred by the client for using project deliverables.
- At times, one group of project team members creates certain deliverables that need to be worked upon by another project group. The transition plan is required in such cases too.
- A transition plan refers to a document that contains guidelines or a framework describing the various pending tasks and activities that must be performed in order to complete a project.
- Components of a transition plan include: scope, Risks and Contingencies, transition strategy, etc.

NOTES

- At the end of the project, the project manager and his team has to present a project closure report to the top level management of the project organisation.
- It is presented to the higher level management of organisation so that they can assess the success or failure of a project. In addition, it also helps in identifying the best practices of the project for future use.
- Whenever a project comes to an end, the project team should ready itself for taking up new projects with a positive frame of mind. The project team members must take lessons from their success and failures both.
- Some of the post-project activities include: reassign project members; celebrate success and reward the participants; provide on-going support; and ensure realisation of project benefits.
- The process of benefits management involves identifying, measuring, tracking and delivering the benefits of a project. It is not a one-time event, but is a continuous cyclical process that runs through the complete project life cycle.

KEY WORDS

- **Acceptance testing:** A type of testing where the deliverable under consideration is made to undergo tests to determine their functionality for acceptance of the deliverables by the client.
- **Archiving:** The process of segregating the data that is not used frequently by the project or organisation to a separate storage location so that the freed space can be used to store frequently used data and also to be able to use archived data whenever required.
- **Benchmarking:** A process of measuring a project or organisation's policies, products, programs, strategies, etc., with the measurements that have been recorded or standardised for other similar projects.
- **Commissioning:** An activity of bringing a newly produced deliverable or output into a working condition.
- **Market forces:** Economic factors that have a direct impact on the demand, supply and price of a good or service.
- **Strategic fit:** The situation where a particular business, organisation, product or deliverable is deemed to be appropriate w.r.t. an organisation or project's overall objectives.

8.9 DESCRIPTIVE QUESTIONS

1. Explain the concept of project closure and termination. Also explain the relevance of natural and early closure.

N O T E S

2. Describe in detail four types of project termination with examples.
3. Briefly describe major components of a transition plan.
4. Write a detailed note on the importance and use of a closure plan.
5. List and explain activities that are carried out after a project is closed formally.

8.10 ANSWERS AND HINTS

ANSWERS FOR SELF ASSESSMENT QUESTIONS

Topic	Q. No.	Answer
Project Closure and Termination	1.	Capturing or documenting lessons learnt; Product acceptance
	2.	False
Types of Project Termination	3.	Natural
	4.	Integration
Transition Plan	5.	Operations
	6.	d. All of these
Create the Close-Out Report	7.	True
	8.	Recommendations for future projects
Post Project Activities	9.	Ensure realisation of project benefits; Reassign project members
	10.	Celebration
Realisation of Project Benefits	11.	c. Project delivery

HINTS FOR DESCRIPTIVE QUESTIONS

1. Project termination refers to a condition when a project has ended (either as success or as failure) before the due date of the project. When a project ends at its planned time, it is referred to as project closure. Refer to Section **8.2 Project Closure and Termination.**
2. A project can be terminated in one of the four ways which are: termination by extinction; termination by inclusion/addition; termination by integration; and termination by starvation. Refer to Section **8.3 Types of Project Termination.**
3. At the end of a project or at the time of project termination, the project manager must create (write/document) a transition plan in order to help the client in effectively using project deliverables. The most important components of a transition plan include scope; risks and contingencies; strategies; transition schedule, tasks and activities; configuration control; transition team; post

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implementation activities; document approval; etc. Refer to Section **8.4 Transition Plan.**

4. A project closure report is used to provide an overview of the final assessment of the project. It specifically details the level of success, benefits achieved, summarised information obtained from a post implementation review meeting. Refer to Section **8.5 Create the Close-Out Report.**
5. Activities that are carried out after a project is closed formally (post-project activities) include: reassign project members; celebrate success and reward the participants; provide on-going support; and ensure realisation of project benefits. Refer to Section **8.6 Post Project Activities.**

8.11 SUGGESTED READINGS & REFERENCES

SUGGESTED READINGS

- Kloppenborg, T. (2015). *Contemporary project management* (3rd ed.). Stamford, Conn.: Cengage Learning.
- ATESMEN, M. (2017). *PROJECT MANAGEMENT CASE STUDIES AND LESSONS LEARNED.* [S.l.]: CRC PRESS.
- Mantel, S., Meredith, J., Shafer, S., & Sutton, M. (2005). *Core concepts of project management.* Hoboken (N.J.): J. Wiley.
- Richman, L. (2012). *Improving your project management skills.* New York: American Management Association.
- Dinsmore, P., & Cabanis-Brewin, J. (2009). *The AMA Handbook of Project Management.* Rio de Janeiro: Brasport.

E-REFERENCES

- (2018). Retrieved from https://www2a.cdc.gov/cdcup/library/practices_guides/cdc_up_project_close-out_practices_guide.pdf
- Project Closure Template – Key Steps to Closing a Project. (2018). Mymanagementguide.com. Retrieved 16 January 2018, from http://www.mymanagementguide.com/project-closure-template-key-steps-to-closing-a-project/

9

CHAPTER

COMPUTER APPLICATIONS IN PROJECT MANAGEMENT

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9.1 Introduction
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INTRODUCTORY CASELET

PMIS INSTALLATION AT THE PORT OF AMSTERDAM

Recently, the Port of Amsterdam was using an old PMIS system that was out dated and archaic. The old system was heavily text based and all the functions required key inputs and were not operable by mouse clicks. In the view of all these problems, the port authorities decided that they need to install a new customised PMIS that was compatible with MS Windows. It was important to customise the PMIS and purchase a standard one because the new system must be integrated with the ship registration module and lock module. Port of Amsterdam is different from other ports because of Amsterdam's canal system and large sea locks. The old PMIS had no functionality to operate the locks.

In the late 2000s, the construction of the Port of Amsterdam PMIS was awarded to Klein Systems through its parent company HITT NV, Netherlands. Hendrik-Jan Oost was appointed as the Project Manager and was responsible for implementing the new system. Klein Systems successfully implemented the KleinPort Management Information System. This system manages the deep sea and inland vessel traffic both. This port experiences about 120,000 vessel movements per year. The PMIS uses EDI data to create new vessel movements in the system. It also receives information regarding dangerous goods and cargo using the EDIFACT EDI. This PMIS also updates regulatory authorities with the information about vessel and cargo. This PMIS is also tailored to interface with the systems of various service providers. This feature helps in coordinating all the aspects involved in a safe and efficient vessel using a single application.

After initial implementation, the PMIS received a set of updates that solved all the minor issues and customised it according to the specific preferences. The new PMIS now supports all the operations and functions under one system.

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LEARNING OBJECTIVES

After studying this chapter, you will be able to:
- Discuss the role of management information systems in projects
- Explain the concept of a Project Management Information System
- Describe the importance and ways of archiving project data

9.1 INTRODUCTION

In the previous chapter, you studied about project closure and termination. You also studied about the natural and early termination of projects. The transition plan of a project is a structured manual or reference material that is used by the project team or the client when project deliverables are passed on to them. An important activity of the closure phase are preparing the closure report and carrying out post-project activities.

During the entire project, Project Management plays a crucial role. Project management is used during entire life cycle of the project i.e. during the initiation, planning, execution, control and closure phases of the project. Project management is considered to be successful if it is competed in time within the allotted budget without compromising on quality. Project execution involves a host of activities such as planning and organising resources. It is the responsibility of the project manager to keep a track of all processes in order to monitor the project closely.

Balancing the scope, cost, time and resources of a project is also an important factor and requires updated information regarding various aspects of the project. A project manager cannot make informed decisions if the information required by him/her is not available. It may also lead to wastage of time and resources. During the last few years, developments such as increased use of computers and Internet and various other technological innovations have also impacted the field and practice of project management. Now, there are various products and tools available in the markets that help the project managers and their teams immensely. For example, there are tools that help people involved in a project collaborate and communicate swiftly and effectively. Project people can also communicate for bids and procurement of materials and services. Certain project tools or software can also be used by project people in order to create schedules, plans, collection and documentation of data, analysis of data, generation of project reports, and also providing various other information services.

This chapter will familiarise you with the concept of information systems and how they are used in projects. The use of Management In-

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formation Systems for projects is also described in detail. The later section of this chapter discusses the concept of archiving historical information. After a project has been closed or terminated, all related project documents need to be stored in an easily accessible manner so that they can be retrieved and referred to by other project managers and teams whenever required. Project documents carry within themselves a lot of valuable information that can be used in other projects. This is done by creating an archive for completed projects.

9.2 MANAGEMENT INFORMATION SYSTEM FOR PROJECTS

Without the presence of accurate and relevant information, it would be difficult to manage a project. To manage the different activities of the project properly, the team must gather information regarding the various phases of the project. The process of collecting, processing and distributing information can be done with the help of a Management Information System (MIS).

MIS is a computerised system that enables managers in making rational and effective decisions by providing complete information as required. In order to manage projects effectively, organisations use Project Management Information System (PMIS) that enables the documentation and storage of the project management plan, subsidiary plans and other documents associated with the project. According to the PMBOK Guide (2000 edition), "a PMIS consists of tools and techniques used to gather, integrate, and disseminate the outputs of project management processes. It is used to support all aspects of the project from initiating through closing and can include both manual and automated systems".

PMIS plays an important role in the successful completion of a project. The system consists of information needed for initiating, planning, executing, controlling and closing a project. It also helps in making decisions efficiently at various levels by giving information such as the specific cost, schedule, technical performance, etc.

PMIS helps in accomplishing various activities of a project. Activities of the project that can be performed with the help of PMIS are as follows:

- Planning the budget.
- Describing the scope of the project.
- Developing schedule and network of the project. This includes the critical path analysis and complete task analyses.
- Planning cost management.
- Planning and scheduling resources.

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PMIS is used to assess the project plan, and to make sure that all the demands of the project can be met. The main features of PMIS are:

- **Accuracy**: PMIS provides fault free information. Wrong information can delude the team by which the project can fail.
- **Precision**: Means that the information provided should be appropriate and clear. Too much information can lead to confusion, while too little can be deceptive and without sense.
- **Reliability:** Means that all the information relating to PMIS is trustworthy.
- **Simplicity**: Means that the project team should be able to interpret and utilise information without difficulty. In PMISs, the information is provided using graphics, pictures and illustrations for better perception. Using numerical system helps in conveying the information in a better way.

Even though PMIS augments the effectiveness of project management, an organisation can face different problems during the progress and execution of PMIS. The most familiar problem is shaping of PMIS. If the process of conveying information to the system and collecting it is too complicated, it is not easy for the project team to use the system. This complexity can dissuade users from using the system which can result in the failure of the project. Also, too much information can lead to temporary or permanent problems. Hence, the users should not crowd the system with unnecessary information.

SELF ASSESSMENT QUESTIONS

1. ________________ is a computerised system that enables managers in making rational and effective decisions by providing complete information as required.
2. PMIS helps in making decisions efficiently at top level by providing information like the specific cost, schedule, technical performance, etc. (True/False)
3. Name the feature of PMIS that is related to the clarity of information.
4. A PMIS helps in critical path analysis and complete task analysis. (True/False)

ACTIVITY

Using the Internet, search two organisations that have implemented MIS to manage their projects.

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9.3 PROJECT MANAGEMENT INFORMATION SYSTEMS (PMIS)

In practice, project managers use a variety of tools and techniques for each phase of a project which includes planning and budgeting, execution, monitoring and controlling and closure of a project. It is quite difficult and time consuming to use these tools and techniques and calculate the required parameters. In order to ease this work, project managers use Project Management Information Systems (PMIS). PMIS can either be manual or automated system and multi-user or single user system. In most cases, the automated PMIS is a computer based, web-based or cloud-based system and includes components such as hardware, software, database, procedures, people and network. PMIS usually has its own database where all data is stored, processed, analysed and transformed into meaningful information.

The use of PMIS has increased manifold in the past few years due to which it has become essential that all project managers, individuals and teams understand the concept and use of PMIS. The extent of use of PMIS has become so widespread and relevant that it is almost impossible for a project manager to carry out his or her work without using one or the other information system. They must also acquire all the skills necessary for project management hardware and software. Organisations use a variety of information systems such as billing systems, payroll systems, ordering systems, accounting systems, inventory systems, etc.

With respect to PMIS, there are various types of PMIS available in the market. Major among them are Nodewave, Webster for Primaware, etc. The PM and his/her team choose and use the PMIS based on their requirements and the specific functionalities of PMIS software.

Ideally, PMIS should automate, organise and provide full control for all project management processes. It also helps the project manager to identify project problems and the project status. Project managers use PMIS for various activities such as planning, budgeting, resource allocation, variance analysis, performance and forecasting. A PMIS can be used to chalk out schedules, costs, expectations and expected results. The most useful aspect of a PMIS is that it can scan and analyse an enormous amount of data which would otherwise take days or even months if done manually. The major advantages of using automated PMIS are as follows:

- **Speed:** A large amount of data can be collected, processed and analysed in a relatively short span of time. Also, using a PMIS helps in creating and updating/modifying the plans, schedules and budgets relatively fast. Lastly, it also becomes easy to access, prioritise and summarise information.
- **Capacity and efficiency:** Large amounts of data can be stored and analysed accurately.

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- **Economy:** Purchasing PMIS may require a large sum of money initially. However, the benefits provided by the PMIS over the life of a project usually far exceed its cost.
- **Accuracy:** When a PMIS is used for a project, it usually decreases the number of mistakes that remain in the project. Therefore, the cost of fixing these mistakes is quite less than the cost of fixing a large number of errors left due to manual PMIS.
- **Ability to handle complexity:** A PMIS is essential in the case of large and complex projects that involve lots of tasks or multiple organisations, suppliers and stakeholders along with a large number of workers. Such projects can be managed efficiently with the use of PMIS.

PMIS offers a lot of features and functionalities as follows:

- **Budgeting:** In most of the PMISs, the budgeting module is integrated with other modules such as planning, scheduling and procurement modules. A PMIS has the capability of generating budget and cost summary reports by analysing fixed, variable and overhead costs.
- **Cost control and performance analysis:** The PMIS has the capability to compare the actual performance of the project against the budgeted performance. It also performs tasks such as calculating cost and schedule variances, earned values, performance indices and forecasting future performances. The PMIS can generate reports for all the levels of WBS. In addition, the PMIS may also be updated by modifying the early and latest start and finish times. The PMIS also has the capability to integrate the network, budget and resource information. This integration helps the PM to get answers under the what-if scenarios. It means that users can access, cross-reference, and generate reports from various distinct databases that are integrated by the use of Web-based technology.
- **Interface, flexibility and ease of use:** A lot of PMIS are compatible with a variety of databases and processing systems such as the payroll system, ERP system, inventory system, spreadsheet programs, etc.
- **Reporting, graphics and communication**: The PM must be careful while choosing PMIS because various PMIS differ in the number, type and the quality of the reports generated by them. Some PMIS may generate only tables and schedules, whereas some better PMIS may generate project networks, resource histograms, along with a variety of charts, graphs, etc. Some PMIS also have the capability of flagging problems or negative situations.
- **Resource management:** PMIS software also performs various functions such as resource loading, resource levelling and resource allocation. However, the level of sophistication and report generation varies. The PMIS does resource management by keeping in

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mind factors such as maximum amount of resources permitted per activity or project, type of resource scheduling techniques used, split scheduling, rate of resource usage and interchangeable usage of different resources.

- **Scheduling and network planning:** Almost all project management software have the capability of scheduling projects using network algorithms. These software can compute the early and late start and finish times, slack times and critical path. The PMIS software also have the capability to distinguish between an activity and an event-oriented procedure. In addition, the PMIS can also judge the maximum number of activities allowed and the quality and clarity of the outputs. Some PMIS may also have the capability to plan and track various projects simultaneously. Most software have the provision of inputting non-work days or periods such as weekends, holidays and leaves while preparing schedules.

SELF ASSESSMENT QUESTIONS

5. A PMIS can either be a manual or automated system and ________or _______system.
6. List any three important components of a PMIS.
7. A PMIS can scan and analyse enormous amounts of data. (True/False)
8. List two important features of a PMIS.

ACTIVITY

List the names of few Project Management Information Systems (PMISs) that are available freely. Also list the major functionalities of each of the PMIS.

9.4 ARCHIVING HISTORICAL INFORMATION

In the previous chapter, you studied that conducting post-project meetings is an important part of project closure. You also studied that if an organisation wants to improve its chances of success, it must endeavour to learn from its past projects as well as from other similar projects undertaken by its competitors. Irrespective of whether a project was closed or terminated as a success or a failure, the documents that are created during the entire length of a project contain valuable information about projects. This information can be used by project managers to determine what and what not to do in similar projects in the future. In practice, most project managers wind up the activity of project closure documentation and forget about it as soon as they move to the next project. One important reason for this attitude is that project closure meetings and documentation of lessons learnt are considered as futile exercises. Therefore, organisations must develop

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a norm of conducting closure meets and documenting important lessons learnt and recommendations for the future.

Archiving refers to an activity of placing or storing something (in our case, data and information) in an archive (a medium of storing the collections of historical records that are related to an individual, place, organisation, or any other entity). Archived information may be stored in a long-term storage device or on a disk or magnetic tape, or a computer directory or folder that contains copies of files for backup or future reference. Files can be compressed to store them effectively. All the required data can also be stored over the Internet.

Whenever project closure reports containing lessons learnt and recommendations are prepared by the project team; they are sent into an archive where it is saved so that future project managers can refer them.

Nowadays, organisations want to complete more number of projects in less time. Due to this reason, project managers do not usually get enough time to plan a project and study it after it has finished. In such situations, project managers usually refer to the project notebook that is prepared during the life of a project. This project notebook contains a lot of information such as project plans and actual performance.

The information that should be stored in a project notebook depends majorly on the project type, the size of the project and the maturity of project management practices. However, all project notebooks usually contain information regarding:

- As-delivered plan
- Change request log and documents
- Correspondence
- Deliverable acceptance log and forms
- Detail design specifications
- Issues log
- Lessons learned
- Meeting minutes
- Original project plan including the project schedule
- Project close-out reports
- Project contact list
- Project overview
- Project performance and variance reports
- Requirements
- Risk management plan and documents

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- Status reports
- Testing
- Training

At the end of a project and after the project closure report has been prepared, these are added to the project notebook and archived thereafter. In an electronic or automated project environment, archiving may simply be a matter of moving or backing up the required project documents to a new location. In case of manual environment, physical notebooks, files and records are required to be stored in a safe area such as archive bookshelves.

Assume that a project manager has been assigned a new project and has to work on it after a few days. He considers going through project archives. In such a situation, he reaches out to the hard copy archives and sees that there are three voluminous files that contain the information he requires. It is a challenging task to study such files. Now, assume that the archives have been stored electronically. In this case, moving from one folder/file to another and deciding whether the given information would be useful or not is quite time consuming and strenuous activity. In such a condition, it is advisable to maintain a file or database that contains basic information related to all the completed projects present in the organisation's archive. This can help in finding similar projects conveniently. Such a database can be maintained in the spread sheet format as shown in Figure 9.1:

Project Code	Project Name	Client	Project Duration	Project Manager	Actual Cost/ Budgeted Cost	Project Synopsis (Business Objective, Technology, Key Results)
ABC P00001	Unified Court Information System Replacement (UCIS Replacement)	ND Courts	2/09-7/11	Fredrick Judah	$8,310,000/ $1,433,260	Unified Court Information System (UCIS) is a system originally developed in Minnesota in the 1980's and was brought to Burleigh County in North Dakota in the early 1990's. From Burleigh County, the system has gradually evolved to become the single case management system used in all 53 of North Dakota's counties. With continual modifications, enhancements and maintenance provided to the system by the State Court Administrator's office, the UCIS of today is much different from the version brought to North Dakota some 18 years ago. This project will include the implementation of the Odyssey Case Management environment from Tyler Technologies to replace all case management functionality in the current UCIS system.
ABC P00002	Statewide Automated Victim Information Notification System (SAVIN)	Criminal Justice Information Sharing	10/08-07/10	John Philips	$1,410,160/ $362,996	North Dakota Century Code ch.12.1-34 outlines the responsibilities of the entities responsible for providing victim information and notification. Since a variety of events can trigger notification, it is important to create an electronic system that allows these events to be transmitted and shared among state and local agencies, courts, and victims in a consistent, accurate and timely manner.
ABC P00003	Electronic Medical Records System (EMRS)	Dept of Corrections and Rehabilitation	09/08-5/09	Steve Wallace	$858,537/$365,436	Currently, the DOCR uses a correctional offender management system called "Itag". The Itag system does not provide for electronic medical records management. Paper records are kept on each inmate in the system and follow that inmate throughout the system. Scheduling, treatment, lab work and prescriptions are all managed with paper, or in a non-integrated fashion. The EMRS Project has gone through Phase 1, which included planning, issuing an RFP and selecting a vendor. This project covers Phase 2 which is the implementation of the chosen vendor's Commercial Off the Shelf (COTS) product
ABC P00004	Disease Surveillance and Management System	Dept of Health	07/08 - 08/09 (Rev. 1Q09 Orig. End:	Samuel Law	$555,000/$371,000	The project will consist of implementing a COTS electronic disease surveillance and outbreak management system that meets both the NDDoH's ongoing and evolving business needs and works within federal standards. The COTS solution will replace the existing software.

Figure 9.1: List of Projects in Archive Database

9.4.1 WAYS TO BUILD A PROJECT ARCHIVE

While carrying out a new project, different stakeholders such as customers, managers, team members and project managers require different types of project information. Therefore, it is recommended that all previous project's information must be organised, documented and stored in an easily accessible manner where it can be accessed and retrieved by everyone at appropriate times.

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An organisation that follows project management procedures and has a centralised Project Management Office (PMO) that manages all projects in organisation's portfolio, project archival activity is most likely carried out by the PMO itself. Here, the organisation does not have to worry about developing a project archive. The only thing the project and his team have to do is to submit completed project files to the PMO for archiving.

At times, there are organisations (especially the small and medium sized ones) that undertake one or a few small projects at a time and do not have formal archiving processes. Such organisations should start a project archive in their organisation at a small level. They should firstly determine the most important aspects of a project that they think should be stored. The organisation's needs and sophistication level grows gradually and at this stage the organisation can start using tools such as Microsoft Project Server.

In organisations, it is best to develop a project archive that supports the size and quality of projects undertaken by the organisation. It must also be ensured that the archive works within the limitation of the organisation's staff and budget.

Two of the most common methods of archiving or storing project information are as follows:

- **Shared folders:** In an organisation, project documents can be stored in a shared network drives. Shared drive can be accessed using the network of the organisation or the internet. In the drive, folder structure can be developed and all those systems (individuals) that are granted access to the drive can access all the folders and files contained in it. Project team members can access the drive such as Google Drive and work on documents required by them. This is a cost-effective and easy way of sharing project archives. However, there is one disadvantage associated with it. When the folders and files are being uploaded at the shared network, the IT staff needs to place appropriate restrictions and permissions for each system that is connected to the network. It is necessary because if all the information and files are available to everyone, they may copy, modify, delete or corrupt the project document. Therefore, document access control becomes a big issue in network sharing.
- **Shared workspace:** Project teams can use Microsoft SharePoint to store project documents. While the project is being executed, the SharePoint website is used for storing project documents and communicating with team members. After the project has been completed, the SharePoint website can be kept as an archive. Anyone who has a Web browser and has been granted required permissions can access this website.

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NOTE

Organisations that handle multiple projects simultaneously may use Microsoft's Enterprise Project Management software. This software can be used as a tool to manage their project portfolios along with the previous and current projects. In this software, project schedule and resource information is stored in the project database. In addition, SharePoint is used for documents storage, risk tracking and issue management.

SELF ASSESSMENT QUESTIONS

9. Mention any three types of information that are recorded in a project notebook.
10. _______ and ________ are two most common methods of archiving project information.

ACTIVITY

Prepare a real-life case study regarding project documentation archiving processes followed in software projects.

9.5 SUMMARY

- MIS is a computerised system that enables managers in making rational and effective decisions by providing complete information as required.
- Project Management Information System (PMIS) that enables the documentation and storage of the project management plan, subsidiary plans and other documents associated with the project.
- Activities of the project that can be performed with the help of PMIS include planning the budget; describing the scope of the project; etc.
- The main features of PMIS are: Accuracy; Precision; Reliability; and Simplicity.
- PMIS can either be a manual or automated system and multi-user or single user system. In most cases, the automated PMIS is a computer based, web based or cloud-based system and includes components such as hardware, software, database, procedures, people and network.
- The extent of use of PMIS has become so widespread and relevant that it is almost impossible for a project manager to carry out his or her work without using one or the other information system. They must also acquire all the skills necessary for project management hardware and software.

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- Ideally, a PMIS should automate, organise and provide full control for all project management processes. It should also help the project manager to identify project problems and the project status.
- The most useful aspect of a PMIS is that it can scan and analyse an enormous amount of data which would otherwise take days or even months if done manually.
- The major advantages of using automated PMIS are speed; capacity and efficiency; economy; accuracy and ability to handle complexity.
- PMIS offers a lot of features and functionalities such as: budgeting, cost control and performance analysis; interface, flexibility and ease of use; reporting, graphics and communication; scheduling and network planning; and resource management.
- Irrespective of whether a project was closed or terminated as a success or a failure, the documents that are created during the entire length of a project contain valuable information about the projects.
- Archiving refers to an activity of placing or storing something (in our case, data and information) in an archive. Archive refers to a medium over which the collections of historical records that are related to an individual, place, organisation, or any other entity are stored.
- Project managers usually refer to the project notebook that is prepared during the life of a project. This project notebook contains a lot of information such as project plans and actual performance.
- The information that should be stored in a project notebook depends majorly on the project type, the size of the project and maturity of project management practices.
- All project notebooks usually contain information regarding change request log and documents; correspondence; deliverable acceptance log and forms; detail design specifications; issues log; etc.
- At the end of a project and after the project closure report has been prepared, these are added to the project notebook and archived thereafter.
- In projects, it is advisable to maintain a file or database that contains the basic information related to all the completed projects present in the organisation's archive.
- In organisations, it is best to develop a project archive that supports the size and quality of projects undertaken by the organisation.
- Two of the most common methods of archiving or storing project information are: shared folders and shared workspace.

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KEY WORDS

- **Archive:** A place where or in which public or private records, historical documents or files are preserved.
- **Automated system:** A self-regulating system that operates and controls processes by electronic means which reduces human intervention. An automated system does not require regular inputs from an operator.
- **Critical path analysis:** A project management technique and it helps in planning tasks that must be completed to successfully complete a project. CPA involves identifying the list of tasks, identifying the time necessary to complete each activity, relationship and dependencies among different activities.
- **Information system:** A software solution that helps in collecting, storing and analysing the data in order to retrieve meaningful information.
- **Procurement:** A process wherein an organisation or project acquires or purchases the required goods and services from external vendors or suppliers.
- **Work Breakdown Structure (WBS):** A project management tool that is used to define and group together the project work pieces in a top-down manner.

9.6 DESCRIPTIVE QUESTIONS

1. Discuss the concept of Management Information Systems.
2. Explain in detail the importance and use of a PMIS.
3. Describe the relevance of archiving historical information for a project.
4. Write a short note on the ways to build a project archive.

9.7 ANSWERS AND HINTS

ANSWERS FOR SELF ASSESSMENT QUESTIONS

Topic	Q. No.	Answer
Management Information System for Projects	1.	MIS
	2.	False
	3.	Precision
	4.	True
Project Management Information Systems (PMIS)	5.	Multi-user; Single user

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Topic	Q. No.	Answer
	6.	Hardware; Software; Database
	7.	True
	8.	Budgeting; Reporting
Archiving Historical Information	9.	Issues log; Lessons learned; Risk management plan
	10.	Shared folders; Shared workspace

HINTS FOR DESCRIPTIVE QUESTIONS

1. The process of collecting, processing and distributing information can be done with the help of a Management Information System (MIS). MIS is a computerised system that enables managers in making rational and effective decisions by providing complete information as required. Refer to Section **9.2 Management Information System for Projects.**
2. Project managers use PMIS for various activities such as planning, budgeting, resource allocation, variance analysis, performance and forecasting. A PMIS can be used to chalk out schedules, costs, expectations and expected results. Refer to Section **9.3 Project Management Information Systems (PMIS).**
3. Irrespective of whether a project was closed or terminated as a success or a failure, the documents that are created during the entire length of a project contain valuable information about projects. This information can be used by project managers to determine what and what not to do in similar projects in the future. Refer to Section **9.4 Archiving Historical Information.**
4. There are two ways to build a project archive. They are use of shared folders and shared workplaces. Refer to Section **9.4 Archiving Historical Information.**

9.8 SUGGESTED READINGS & REFERENCES

SUGGESTED READINGS

- Kerzner, H. (2001). *Project management.* New York: John Wiley.
- Lock, D. (2007). *Project management.* Aldershot, England: Gower.
- Maylor, H. (1996). *Project management.* London: Pitman.
- Meredith, J., & Mantel, S. (1995). *Project management.* New York: Wiley.
- Biafore, B. (2011). *Successful project management.* Redmond, Wash.: Microsoft.

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E-REFERENCES

- (2018). Retrieved from https://www2a.cdc.gov/cdcup/library/practices_guides/cdc_up_project_close-out_practices_guide.pdf
- *PMIS installation case study: Port of Amsterdam. (2018). Porttechnology.org.* Retrieved 19 January 2018, from https://www.porttechnology.org/technical_papers/pmis_installation_case_study_port_of_amsterdam

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CHAPTER

USE OF PROJECT MANAGEMENT SOFTWARE

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IMPLEMENTATION OF MICROSOFT PROJECT AT LAIKA ANIMATION

Laika Entertainment LLC is an American stop-motion animation company. Laika is located in the Oregon state. It creates feature films, commercial content for all media, music videos and short films. It specialises in computer generated animation, stop-motion animation and cell animation. Some of the most renowned productions of the company include: Coraline, ParaNorman, The Boxtrolls and Kubo and the Two Strings. Nike's co-founder and chairman Phil Knight is the owner of Laika. Travis Knight, son of Phil Knight, is the President and CEO of the company.

Since its establishment in 2005, Laika has attracted many talented people of the animation industry. Major achievements of Laika include an Academy Award-winning director, 11 prime time Emmy Awards and over 100 international accolades.

There are two major divisions of Laika: Laika/House and Laika/Entertainment. Laika/House produces commercial videos and Laika/Entertainment produces entertainment and feature films.

The problems that were faced by Laika relating to its projects are listed as follows:

- **Project planning**
  - Limited forecasting ability
  - Limited visibility of resource demand
  - No structured method to assess productivity of creative resources
  - Absence of mapping and linking of project deliverables interdependencies.
  - Absence of enterprise-level view of inter-project impacts
  - Project planning not integrated with budget planning, tracking and visibility of project performance
  - Absence of reliable current and historical project performance data (that are useful in decision making).

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- **Project execution**
  - Lack of monitoring and control of project activities leading to an inefficient use of resources.
  - Lack of project risk assessment provisions which lead to problems in the execution of project. In such cases, the organisation is left with only reactionary measures and they cannot plan for risks in advance.
  - When project execution is not carried out systematically, it usually leads to schedule overruns.
- **Project reporting**
  - Absence of a project review mechanism.
  - Absence of planned versus actual comparisons related to time, work or cost estimates.
  - Absence of consolidated views of schedules, resource tasks or availability.
  - Lack of accuracy in data capturing
  - Lack of data integration
  - Absence of clearly defined management processes

In order to solve all the above-mentioned problems, Laika partnered with an Enterprise Performance Management (EPM) company Advisicon. They decided to deploy an integrated EPM solution to support Laika's ever-growing Project Management needs. They customised an EPM system built on Microsoft Project and Microsoft Project Server which resulted in immediate improvements in planning, scheduling, reporting and project cost control. The key elements of the customised solution were as follows:

- Automated and centralised system having functionalities like project communications, tracking and reporting.
- Acts as a strong platform to support organisation's project planning, scheduling and management methodology.
- All current and previous projects and their data on tools such as FastTrack were seamlessly migrated to Microsoft Office Project 2007. In addition, this data was also published to Microsoft Office Project Server 2007.
- Advisicon helped in developing project templates, custom fields and other business specific reporting tools.
- An enterprise-wide shared resource pool

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During this time, Advisicon also helped Laika develop and deliver a project using Microsoft Office Project Server. This also served as a pilot test for Advisicon's customised solution for Laika. The benefits realised by the new EPM system are:

- Development of accurate and realistic production schedules.
- Laika's unique WBS structure and processes could be represented effectively as a result of customised project templates.
- Consistent planning, communications, and reporting across the organisation.
- Provisions to assess and predict the productivity of creative resources.
- New EPM software provides enterprise-level views of project along with the overview of inter-project impact.
- New EPM software allows integrated planning for project budget, resource and schedule.

Source: https://www.advisicon.com/case-studies/laika/

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LEARNING OBJECTIVES

After studying this chapter, you will be able to:

- Explain the concept and use of project management software
- Describe the widely used Microsoft Project Software
- Discuss the applications of Microsoft Project Software

10.1 INTRODUCTION

In the previous chapter, you studied about the functions of Project Management Information Systems (PMIS) and the process of archiving historical project information. You also studied how technological innovation in project management in recent years has significantly changed the entire scenario. Computers and the Internet have started playing a significant role in various aspects of project management. Organisations use various software tools and products in order to enhance collaboration among professionals and to increase the effectiveness of project management activities. Apart from PMIS, Project Management software is also used extensively by project managers.

In this chapter, you will study about the importance of using project management software in executing projects. Today, organisations perform a number of tasks during a project, which at times may prove to be difficult in terms of organisation and management of activities. Project management software provides a solution to these organisations by helping them in being organised.

In market, there are a number of project management software available that may help organisations in various activities such as:

- Collaborating on projects by sharing documents, timelines and status updates.
- Delegating tasks to appropriate employees by assigning roles and responsibilities and providing access to necessary information.
- Staying on schedule by alerting employees of upcoming deadlines, allowing the employees to manage their time appropriately and complete the assigned tasks on time.
- Tracking project progress that helps in identifying the tasks, which have been completed as well as what still needs to be done.
- Providing a snapshot of the project to new staff members to let them understand the basics of the project from start and how it will move forward.

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- Communicating with clients and vendors by giving them access to project files. This may allow clients and vendors to give feedback, make edits and review the project progress.

Thus, you can say that project management software helps organisations in accomplishing their goals efficiently through the effective management of time, resources and activities.

This chapter begins by explaining the concept of project management software. Next, the chapter would describe the concept of Microsoft Project Software. At the end, the chapter will describe different applications of the MS Project software such as managing work breakdown structure, resource allocation, deciding project budgets, monitoring and controlling projects, etc.

10.2 INTRODUCTION TO PROJECT MANAGEMENT SOFTWARE

As discussed, there are a number of project management software applications available in the market. Among them, one of the most popular project management software is Microsoft Project that is developed and sold by Microsoft Corporation. The software is designed to assist a project manager in activities such as developing a plan, assigning resources for performing various tasks, tracking progress, managing the budget and analysing workloads. Project management software is an important instrument through which a project manager is able to manage and complete the project within the stipulated time and budget, specially the huge and complicated projects.

According to the Project Management Body of Knowledge (PMBOK), *"Project management software is widely used to assist with schedule development. These products automate the calculation of mathematical analysis and resource levelling, and thus allow for rapid consideration of many schedule alternatives. They are also widely used to print or display the outputs of schedule development."*

The main characteristics of project management software are as follows:

- To spot problems early, so that they can be corrected without difficulty
- To allow the optimal use of the resources to finish the work faster
- To modify plans as per changes required
- To allow modifications in the role of team members

The project management software has been present in the market for almost three decades. Initially, there was limited use of the software, but now, it is used for different programs, such as resource allotment, scheduling, collaboration, quality control, and cost control. Also, some

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help to draw a plan by making use of different methods such as Gantt chart, which represents all the work through graph. Other than this, some software are used to assess the activities of the project and ascertain the series of activities for the completion of the project using various methods such as Project Evaluation and Review Technique (PERT) and Work Breakdown Structure (WBS).

The main goal of project management software is to manage the complications that usually arise in big projects and to reduce the costs linked to different activities of the project. It helps the managers in prioritising the project activities. It also helps in handling uncertainties in calculating the duration of tasks and setting a time limit for the project.

There are many factors that must be considered by a manager while selecting project management software as each software has its own characteristics. Nevertheless, there is no need to use all components of the software. A project must be such that its features can fulfil the needs of the project. Therefore, before choosing particular software, the manager needs to have full knowledge regarding the needs of the project. Following are some of the features which need to be considered while selecting Project Management software are as follows:

- **Collaboration:** The software should contain features that help team members collaborate among themselves. The stockholders should be given required access permissions for updating and retrieving the documents of the project.
- **Scheduling:** The Scheduling feature should be present in the software. It should be able to make representation of data easy by using the Gantt charts. Along with preparation, the software should provide basic features. If there is any change needed, then the manager should be able to differentiate between the fresh plans with initial plan and should be able to know the scope and cost differences.
- **Issue tracking:** Some matters need to be checked regularly during the life span of the project. For instance, the organisation needs to keep a check on any possible faults in the software. The software must be able to detect problems.
- **Project portfolio management:** When an organisation is involved in more than one project, it should be able to measure and monitor the progress of each individual project. This is called as project portfolio management. The software should support project portfolio management.
- **Document management:** Many documents are used in a project. For the smooth progress of a project, the stakeholders should be able to access the documents easily. Hence, the project management software must include the document management facility. An accurate access control system should be set up in order to

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control access to these documents. The software should have a functionality to assign a new document version number each time a document is changed and uploaded again on the software.

- **Resource management:** It is an important component of project management software. The software should be capable of showing the use of different resources at various levels of a project.

Project management software can be mainly classified into four types, as shown in Figure 10.1:

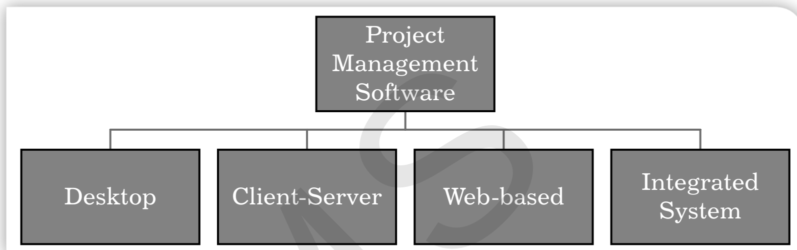

Figure 10.1: Types of Project Management Software

Let us now discuss the different types of project management software:

- **Desktop:** This relates to the software which is installed on desktop computers. Data is saved by this software in a central database which acts as a source of other users. Project team members share their plans with one another via the common network.
- **Client server:** This relates to the server based project management software applications. Server based project management software can support multiple users working in various departments of the project. It records data at a central location. It also combines collaboration tools that enable all users to collaborate and share their knowledge and proficiency.
- **Web based:** This refers to software that can be used as a Web application. It operates by using the Web browser and internet, intranet or extranet. This application can be used from any kind of computer, internet connection without having to install the software. It is multi-user in nature and is updated and controlled by the service provider. This software can be availed by paying some monthly charges which is much more economical than purchasing and handling the software application. The major drawback of this software is that it is not accessible when the user is offline. Also, web-based project management software is usually slower than desktop applications.
- **Integrated system:** An integrated project management system refers to software that includes certain other process functionalities in addition to project management. For example, an integrated

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system may be used for receiving raw materials, sale and purchase of assets, etc. in addition to project planning and management.

Many Project Management Software applications are available in the market. However, some popular applications and their features are explained as follows:

- **Microsoft Project:** It is an extensively used PC-based project management software. It is developed and sold by Microsoft Corporation. This software is used by the project manager and his team in order to plan, schedule, assign resources, track progress, manage budget and analyse workloads, track progress, manage budget, etc. It is Windows-based software that provides interface with the Web, Outlook and SharePoint.
- **Trello:** Trello is Project Management Software that is available freely. It is an easy, flexible and visual way to manage your projects and organise anything. This software is based on the concept of boards and cards where boards represent projects and cards represent tasks. The cards contain the list of tasks that is used to track the progress of the project and to categorise the tasks. Trello allows real-time collaboration among project team members. It also generates task assignments, activity logs and e-mail notifications. Different members can be added to different boards and each member can vote on ideas that are contained in the cards.
- **Basecamp:** This refers to the low-cost Web-based software, which has been lately introduced and is getting quite popular.
- **JIRA**: JIRA is project management software that helps users capture work tasks, assign and set priorities to different work tasks. It contains a simplified and intuitive interface that enables collaboration among project team members. Companies such as Cisco, LinkedIn, eBay use JIRA. It is mostly used by IT and software companies. It is used for planning, tracking and release of effective software. Certain important features of JIRA include: creating user stories and issues, planning sprint development, assigning tasks to team members, prioritising tasks and generating real-time visual data reports.
- **Matchware Mind View:** This refers to the mind mapping software which has a user-friendly, spread sheet plan. The project manager is able to present his views quickly and simply to the members. This software allows each project team member to fully understand the project, contribute in planning, follow project timeline and visualise tasks in an organised manner. All the important information can be stored in 'on-the-fly' notes and such notes can be attached to each task in the Mind Map. In addition, task information such as resources available, duration and priorities can also be attached to the Mind Map. Mind View is also used in project planning by integrating the Mind Map with Gantt Charts. The project plan can be created in the Mind Map view and then the same can be trans-

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mitted for fine tuning. This software application can be integrated with the MS Project as well.

- **Project Kick Start:** This is Project Management Software that helps in increasing the project team's efficiency by generating ideas and solving project problems. It is user-friendly software and can be interfaced with other applications such as MS PowerPoint, MS Outlook, MS Excel, MS Word and MS Project. Project Kick-Start provides a streamlined and organised framework that helps in reviewing the entire project plan and schedule using the Gantt chart. Gantt chart displays the project schedule visually and the software also allows changing task parameters. In addition, this software allows automatic generation of PowerPoint Presentation of the projects.
- **RationalPlan:** This Project Management Software follows the PMBOK guidelines and is used for providing portfolio management, resource management and team collaboration solutions. It is used by the project managers and their teams for creating project plans, allocating resources, analysing work, tracking project progress, estimating project cost, scheduling tasks and managing the project budgets for several projects. This software is usually used by organisations that work on multiple projects with shared resources. This software helps manage the shared resources, keeps finances under control, highlights critical project issues and tracks project w.r.t. terms of completion, time and costs.

The above mentioned list of project management software includes only the most frequently used software. However, the complete list of Project Management Software can very well run into thousands or even lakhs. A few more Project Management Software may include Zoho Office Suite; Smartsheet; Podio; Freedcamp; Taskworld; Redmine; Sciforma; Taiga and ProjectLibre.

SELECTING APPROPRIATE PROJECT MANAGEMENT SOFTWARE

A Project Management Software helps the project managers make important decisions. Therefore, it is necessary that an organisation select appropriate project management software that would enable the project manager to compete the project within the stipulated time in a cost effective manner.

Few measures that can be taken in order to choose appropriate project management software out all of the prospective software are as follows:

- Project Management software under consideration for being adopted must be such that all the software applications can be interfaced with the software and it must also fit strategically with the goals of the organisation and project.

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- Project Management Software to be adopted must have functionalities that allow making amendments to the existing projects. Amendments may include changes in the resources, changes in costs, changes in schedule and dependencies, etc.
- Streamline all business operations so that expenses incurred on the project are reduced and all the activities are performed effectively.

ADVANTAGES AND DISADVANTAGES OF PROJECT MANAGEMENT SOFTWARE

In the initial days when the use of Project Management Software had started, the organisations were quite hesitant and indecisive whether or not to adopt such software and what kind of use and benefits it entails. With time, the companies have realised the benefits associated with use of Project Management Software. It has gained so much popularity that its use has now become indispensable. Organisations can use Project Management Software to optimise the processes and ensuring efficiency and effectiveness during the conduct of the projects. Today, the Project Management Software is used in almost all the major industries. Some noteworthy advantages of the project management software include:

- **Effective communication and collaboration among project team members:** All the project management software contain functionalities that enable team members to communicate in real-time. Due to this, all the team members are kept up to date with project progress and issues. The issues can be resolved as and when they arise. The software enables interaction between the manager and customer since the information can be obtained side by side by them. Reviews can be shared with each other regarding the project.
- **Document sharing:** Document sharing and editing are critical functions of a Project Management Software. The team members can use this functionality in order to allow team members to upload, edit, view, and download the important documents and reports. Document sharing can be effectively regulated by placing access control restrictions. In this manner, the project members can be kept up to date with the project progress and reporting. In addition, it also aids in maintaining transparency w.r.t. project documentation.
- **Managing project costs:** Keeping project costs under control is important for all the projects. Project management software provides various tools that help in managing project costs.
- **Managing risks, forecasting and budgeting:** Project management software helps in listing various project risks, creating forecasts and tracking project budget. Future risks concerning the project can be predicted through this software and can be rectified.

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- **Reporting capabilities:** The project management software includes project reporting capabilities due to which the management can access the required data. The reports can be used to keep the project schedule and budget on track.
- **Ease of use:** Most of the project management software are accessed using a dashboard which is quite easy to use and implement. It is also very easy to install and use.
- **Fast calculation:** The project management software allows the user to make accurate and faster calculations. For instance, the Excel worksheet enables the handling of huge amount of data, which is difficult of done manually.
- **Editing and modification of data:** The software helps in recording all the changes taking place in the work development by making modifications in data whenever needed.
- **Quick updating of project progress:** This refers to the mechanised updating of project development in a fast and accurate manner. Due to quick updation, the status of the project can be ascertained regarding its success or failure on time.
- **Effective training and education of project team:** This shows that the software assists in giving training to the employees. The software is used to impart education to employees on using new machinery in the project, which helps in developing competence.
- **Better coordination of project activities:** Various activities can be coordinated. For instance, the manager can use the software to give importance to different activities.
- **Quality project reporting:** Produces mechanised reports, which the stockholders use to collect information.
- **Smooth designing of work breakdown structure (WBS):** The software assists in shaping the WBS of the project. Complex activities can be divided into smaller ones through WBS.
- **Easy processing of bulk data:** Handling and preserving a large amount of data is done with the help of this software. This helps in saving time and energy to preserve the records.

In spite of these advantages, the all project management software have some limitations. The common disadvantages related to any project management software are:

- **Extra cost:** This relates to the added cost included in installing and maintaining the software.
- **Limited availability of technical skills:** This refers to exclusive technical knowledge and skills which the project team must have for maintaining and operating the software. These requirements come as obstacles in software application.

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- **Data safety related issues:** This refers to virus threats to data, which can obliterate important records. Any external component can act as a threat to the competitive status of the project.
- **Fault in software:** This relates to the fault in the software due to which the software may provide incorrect analysis of information. It can hinder project activities and can lead to project failure.
- **Resistance from employees:** This refers to the hesitation on the part of workers to use this software. Usually, workers do not adapt to this new technology readily. Adequate training is required by the employees. This leads to delay in completing the project and augments total expense of the project.

EXHIBIT

Primavera

An example of Project Management Software is Primavera. Along with Microsoft Project, Primavera is the important solution for the management of the project. An important Primavera product is Primavera P6, developed by Primavera systems, an American organisation. Oracle obtained Primavera P6 in 2008. The software has been designed to assist managers dealing with different types of projects. It assists in making effectual decisions such as managing project portfolio management, analysing project risk and evaluating resources.

Some of the software application tools of Primavera include:

- Primavera Inspire for SAP
- Primavera Earned Value Management
- Primavera P3 and SureTrak Project Planner
- Primavera P6 Professional Project Management
- Primavera Portfolio Management
- Primavera Contract Management
- Primavera Risk Analysis
- Primavera P6 Enterprise Project Portfolio Management
- Primavera P6 Analytics

SELF ASSESSMENT QUESTIONS

1. The main goal of ____________ is to manage the complications of big projects and to reduce the costs linked with different activities.

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2. Which one of the following is not a feature of to be considered while selecting the software?
   a. Collaboration
   b. Planning
   c. Scheduling
   d. Resource management
3. Project management software allows the user to make correct calculations within no time. (True/False)

ACTIVITY

Using the Internet, search for three applications of project management software.

10.3 INTRODUCTION TO MICROSOFT PROJECT

Selection of a project software according to the budget and need of the project is important for the successful completion of the project. Therefore, the manager needs to take utmost care while making the selection. A number of software are available in the market. One of the most extensively used software is the Microsoft Project software. MS Project was first introduced as a DOS based software in 1984. Over a period of time, it has developed into Web-based application. It is a window-based tool that assists in efficient implementation of administrative activities.

Microsoft Project is designed to help project managers of the project in carrying out various project activities such as developing project plans, allocating resources to activities, monitoring project progress, keeping track of project budget and evaluating workload. Resources such as people, equipment and material can be shared among different projects using a shared resource pool. A calendar is maintained for each resource that defines what days and shifts it will be available. The rates are used to calculate the cost of resources which are totalled and summed up at a resource level. Each resource can be allocated to numerous activities in different projects and each activity can be assigned multiple resources. Microsoft Project schedules activities based on resources as defined in the resource calendar. All resources are described in the enterprise resource pool.

NOTE

In the MS Project software, resource calendars define the standard working and non-working times for projects and resources. Working time refers to all the days and hours defined in a calendar during which work can occur. Non-working time refers to all the days and hours in a calendar where no work has been scheduled. Non-working time includes weekends, holidays and non-working hours.

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Next, the MS Project creates budgets based on resources assigned to different activities and the cost of resources that are used. MS Project calculates the cost as the product of resource used for a certain time period and the cost of resource per unit of time. This is done at the sub-activity level which is summed up for activity level and finally for the project level.

MS Project is perhaps the most popular project management software because it can be integrated with various other popular Microsoft applications and software. For example, MS Project has been extended as it can be used with Microsoft Project Server, Microsoft SharePoint Server, Microsoft SQL Server and Microsoft Project Web Access. Under MS Project, all project data is stored in the central database.

Project team can use MS Project Web Access to view and update the project data over the Internet. However, only authorised users can access the MS Project Server database across the Internet using MS Web access. Web Access includes timesheets, graphical analysis of resource workload and certain other managerial tools.

There are various applications of MS Project software. You will study about them in the following sections.

SELF ASSESSMENT QUESTIONS

4. Microsoft Project helps project managers in activities such as ________ and _______.
5. Project team can use ___________ to view and update project data over the Internet.

ACTIVITY

Using the Internet, make a list of at least five well-known Indian organisations that use MS Project software for carrying out their projects.

10.4 APPLICATIONS OF MICROSOFT PROJECT SOFTWARE

Certain important features of the Microsoft Project software are as follows:

- **Project planning:** MS Project software assists the project team in the project planning activity and developing the project plan by allocating activities to the team and relating inter-project dependencies.

N O T E S

- **Efficient project scheduling:** MS Project software helps in developing a plan for achieving project goals and objectives by providing project calendars. Project calendars can be used to alter the schedule of assigned activities. In addition, it also provides automated scheduling tools that help in reducing inefficiencies. The software also allows developing multiple timelines which makes it easier to visualize complex projects schedules.
- **Resource management:** MS Project software assists the project team in allocating the available resources among different project activities. In addition, it also organises project resources for resource loading activities.
- **Project review:** MS Project software assists the project team in carrying out the project review process by using techniques such as Gantt charts, Critical Path Management (CPM) and PERT techniques. These graphical representations of project progress help in evaluating the project progress. This software also helps in preparing the Gantt and PERT charts through which activities of the project are handled.
- **Tracking project progress:** MS Project software helps in monitoring whether the activities of the project are being carried out in accordance with the initial plan. If project monitoring reveals that the performance of a project is not as planned, corrective actions are implemented to improve performance.
- **Generating automatic reports:** MS Project software helps the project team, executives and higher level management by preparing various reports that are used to track the progress of the project. The software also has predictive analysis tools using which it can predict the future of the project and generate reports.

Apart from the above mentioned features, MS Project also assists the project team in aspects such as project controlling, resource ramp-up and resource down operations, workload analysis, capacity utilisation operations, change in the type of the project execution methodology, Gantt chart preparations, critical path determination, etc.

In an earlier section of this chapter, we have mentioned that MS Project can be integrated with various other MS software and applications. It means that the data created and stored in an MS Word Application can be used in the Microsoft Project also. Similarly, if the MS Project software is integrated with the attendance software or application, the project manager does not require monitoring team members' attendance separately. It can be stated that MS Project is a platform where all the relevant data from various sources is consolidated and is displayed and provided to the project team and project client from time to time.

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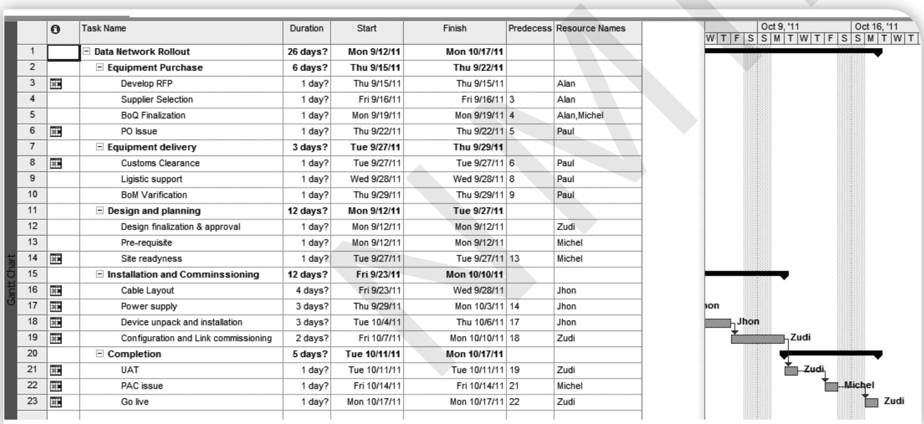
The Microsoft Project software includes features such as developing the project plan and the Work Breakdown Structure (WBS); project costing; scheduling of project resources and activities in accordance with contractual requirements; etc.

> NOTE
>
> In Microsoft Projects, project files are saved using extension.mpp. We can say that an MPP file is a project created by Microsoft Project.

Let us now discuss the important applications of MS Project software.

10.4.1 WORK BREAKDOWN STRUCTURE (WBS)

Before we understand how MS Project software helps in the development of the Work Breakdown Structure (WBS), let us first define what a WBS is. A WBS is a top-down and hierarchical representation of various activities of a project. A WBS lists all activities that are included in a project. Figure 10.2 depicts the WBS structure as created in Microsoft Project Software:



	Task Name	Duration	Start	Finish	Predecess	Resource Names
1	**Data Network Rollout**	**26 days?**	**Mon 9/12/11**	**Mon 10/17/11**		
2	**Equipment Purchase**	**6 days?**	**Thu 9/15/11**	**Thu 9/22/11**		
3	Develop RFP	1 day?	Thu 9/15/11	Thu 9/15/11		Alan
4	Supplier Selection	1 day?	Fri 9/16/11	Fri 9/16/11	3	Alan
5	BoQ Finalization	1 day?	Mon 9/19/11	Mon 9/19/11	4	Alan,Michel
6	PO Issue	1 day?	Thu 9/22/11	Thu 9/22/11	5	Paul
7	**Equipment delivery**	**3 days?**	**Tue 9/27/11**	**Thu 9/29/11**		
8	Customs Clearance	1 day?	Tue 9/27/11	Tue 9/27/11	6	Paul
9	Ligistic support	1 day?	Wed 9/28/11	Wed 9/28/11	8	Paul
10	BoM Varification	1 day?	Thu 9/29/11	Thu 9/29/11	9	Paul
11	**Design and planning**	**12 days?**	**Mon 9/12/11**	**Tue 9/27/11**		
12	Design finalization & approval	1 day?	Mon 9/12/11	Mon 9/12/11		Zudi
13	Pre-requisite	1 day?	Mon 9/12/11	Mon 9/12/11		Michel
14	Site readyness	1 day?	Tue 9/27/11	Tue 9/27/11	13	Michel
15	**Installation and Comminssioning**	**12 days?**	**Fri 9/23/11**	**Mon 10/10/11**		
16	Cable Layout	4 days?	Fri 9/23/11	Wed 9/28/11		Jhon
17	Power supply	3 days?	Thu 9/29/11	Mon 10/3/11	14	Jhon
18	Device unpack and installation	3 days?	Tue 10/4/11	Thu 10/6/11	17	Jhon
19	Configuration and Link commissioning	2 days?	Fri 10/7/11	Mon 10/10/11	18	Zudi
20	**Completion**	**5 days?**	**Tue 10/11/11**	**Mon 10/17/11**		
21	UAT	1 day?	Tue 10/11/11	Tue 10/11/11	19	Zudi
22	PAC issue	1 day?	Fri 10/14/11	Fri 10/14/11	21	Michel
23	Go live	1 day?	Mon 10/17/11	Mon 10/17/11	22	Zudi

Figure 10.2: Representation of Work Breakdown Structure created using Microsoft Project Software

Source: https://somudrodev.wordpress.com/2011/09/12/work-break-down-structure-wbs-using-ms-project-and-chart-pro/

From Figure 10.2, it is seen that WBS is a hierarchal structure comprising activities and deliverables which are required to be used in the project. Along with activities and sub-activities in the project, it also depicts the duration, start and finish dates of each of the activities. Further, it also displays the sequencing of activities which are required while executing the project. It means that the MS Project also recognises the parallel activities and activities which take input from the output of another activity.

N O T E S

Following points must be taken into consideration while developing a WBS for the project:

- For developing a project, the type of the project and its scope must be clearly identified because a WBS depends on the type of the project. For example, the WBS for Greenfield project would be created in a different manner than a WBS for a turnkey project.
- Project objectives must be defined clearly.
- Start and end dates of the project must be known.
- All working and non-working days and hours decided for a project must be known in advance and MS Project software must be fed with this information. It is important because the MS Project software contains default working and non-working values which if not altered may lead to errors in project scheduling and resource allocation.
- All deliverables must be identified and listed in a hierarchy.
- Resources required for activities and their costs must be identified and evaluated.
- Information such as a sequence of activities, activity duration, start and end dates, whether the activity is sequential or parallel, must be known.

In MS Project software, the WBS can be constructed by following the below-mentioned steps:

1. Open Microsoft Project Software
2. Select new project and give the file name.
3. Clearly define the tasks/activities which are to be included in the WBS.
4. Enter tasks/activities which have been identified in the project base work. The activities are required to be entered in the 'Task Name' column (refer Figure 10.2) along with the duration.
5. Enter the duration for the lowest level tasks. The duration can be in terms of the number of days as well in terms of the duration of the dates i.e. the starting date and the ending date.
6. Once the lowest level tasks have been identified, then the next tasks in the hierarchy are entered.
7. After the hierarchical tasks are entered, the task indenting control icon is selected which automatically links these tasks to level 0 tasks.
8. Now, enter the dates of hierarchical tasks.

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Figure 10.3 depicts the layout of the format when Microsoft Project Software is used:

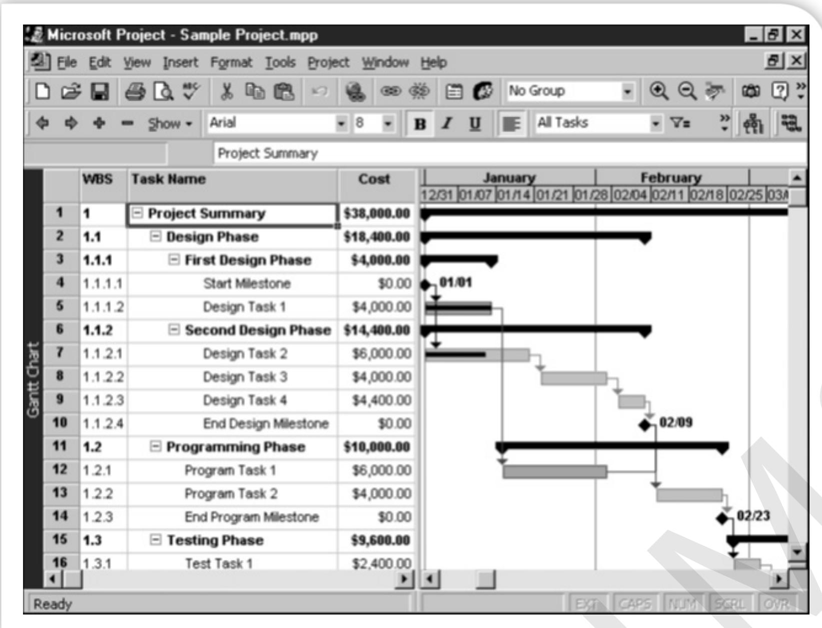

Figure 10.3: Work Breakdown Structure in Microsoft Project

Source: www.criticaltools.com

From Figure 10.3, it can be seen that the 'WBS' column refers to the level of the work breakdown structure. Level 1, for instance, refers to the overall deliverable or the task which are required to be given in the project. The column 'task summary' refers to the task name field. Thus, number 1.1 in the WBS column refers to the task 1 of the WBS field Project summary which is the design phase. The cost field is used to allocate the cost of various WBS elements. The WBS element 1.1.1 refers to the subsequent element of the design elements and the cost component of the overall cost of the design phase.

The right hand side in the Figure is depicts the Gantt Chart of the WBS structure. From the figure, it can be observed that 3 colours are used in the Gantt Chart. The black colour bar depicts the overall cost of the entire component while the dark grey and light grey colour depicts the order of commencement of the linked tasks in the manner as they are required to be executed in the project. For example, the output of design task 2 forms an input to the design task 3. This is indicated by the down arrow key from the design task 2 to the beginning of design task 3.

The black colour bar within the design task 2 indicates the status of the design task 2 at the end of the week 01/07. This means that the amount or cost of task which is consumed from the total of the cost of $6000 allocated to this task. Thus, we can see that a WBS can be easily generated in the Microsoft Project Software.

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Let us look at another example to demonstrate the use of MS Project in construction of a WBS as shown in Figure 10.4:

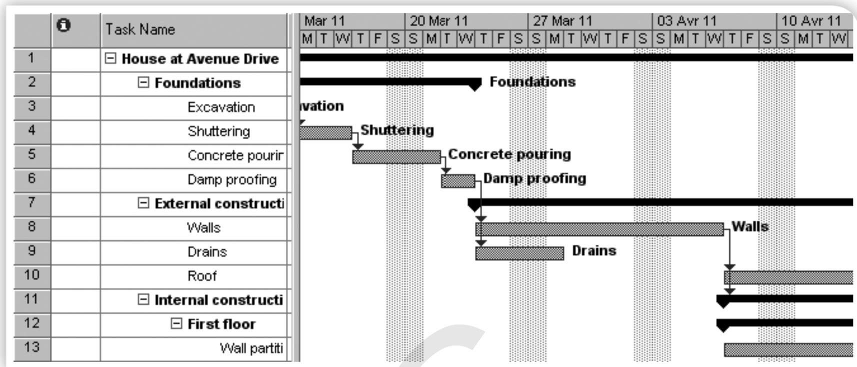

Figure 10.4: Using Tasks Pertaining to Walls and Drains
Source: http://www.matchware.com/en/images/om/wbs_proj.gif

From Figure 10.4, it is seen that in this case particularly, tasks pertaining to the walls and the drains are parallel tasks. This means that depending on the type of the components of WBS, the tasks are designated as parallel tasks, input tasks, output tasks or overlay tasks. Parallel tasks are those tasks which can be executed simultaneously as they do not require the output of one task as an input to begin the task. In other words, there is no dependency on the tasks. We have covered one aspect of the WBS structure. However, we can have the WBS as depicted in Figure 10.5. From Figure 10.5, we can use Microsoft Project to depict the names of resources who would be working on the tasks including the predecessor of the tasks, the start date and the end date of the task.

WBS	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1	**⊟ Better WBS**	**15 days**	**Wed 9/22/04**	**Tue 10/12/04**		
1.1	**⊟ System Integration**	**15 days**	**Wed 9/22/04**	**Tue 10/12/04**		
1.1.1	**⊟ Canada Payroll**	**15 days**	**Wed 9/22/04**	**Tue 10/12/04**		
1.1.1.1	Extract Program	1 wk	Wed 9/22/04	Tue 9/28/04		Scott
1.1.1.2	Validation	3 days	Wed 9/29/04	Fri 10/1/04	4	Connor
1.1.1.3	Conversion	2 days	Mon 10/4/04	Tue 10/5/04	5	Connor
1.1.1.4	Import	1 wk	Wed 10/6/04	Tue 10/12/04	6	Kaleigh
1.1.2	**⊟ US Payroll**	**15 days**	**Wed 9/22/04**	**Tue 10/12/04**		
1.1.2.1	Extract Program	2 days	Wed 9/22/04	Thu 9/23/04		Frank
1.1.2.2	Validation	3 days	Fri 9/24/04	Tue 9/28/04	9	Laurie
1.1.2.3	Conversion	1 wk	Wed 9/29/04	Tue 10/5/04	10	Laurie
1.1.2.4	Import	1 wk	Wed 10/6/04	Tue 10/12/04	11	Grace
1.1.3	**⊟ Mexico Payroll**	**15 days**	**Wed 9/22/04**	**Tue 10/12/04**		
1.1.3.1	Extract Program	1 wk	Wed 9/22/04	Tue 9/28/04		Dawn
1.1.3.2	Validation	2 days	Wed 9/29/04	Thu 9/30/04	14	Chance
1.1.3.3	Conversion	3 days	Fri 10/1/04	Tue 10/5/04	15	Chance
1.1.3.4	Import	1 wk	Wed 10/6/04	Tue 10/12/04	16	Ayden

Figure 10.5: A MS Project WBS Depicting the Resources Names, Duration, Start and Finish Dates the Predecessor
Source: http://www.tacticalprojectmanagement.com/wpcontent/uploads/2013/01/msprojectwbs2.jpg

Alternatively, we can use Microsoft Project to depict the percentage completion of the tasks in the WBS. Figure 10.6 depicts the completion of the tasks and the duration taken to complete the task by taking into consideration the non-working days in the project:

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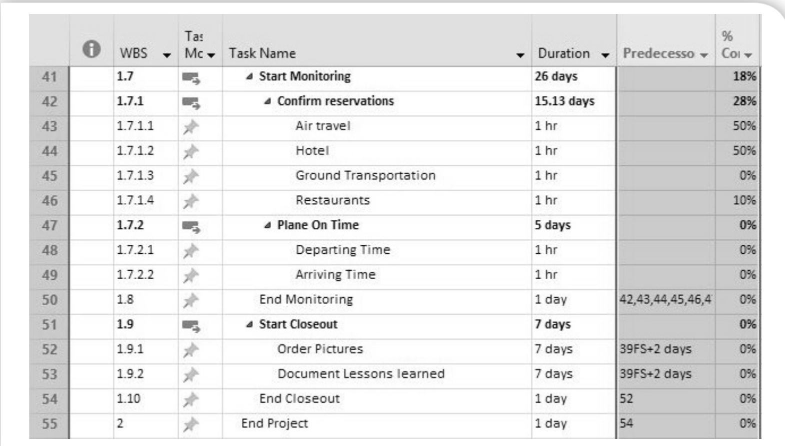

		WBS	Task Mode	Task Name	Duration	Predecessors	% Complete
41		1.7		Start Monitoring	26 days		18%
42		1.7.1		Confirm reservations	15.13 days		28%
43		1.7.1.1		Air travel	1 hr		50%
44		1.7.1.2		Hotel	1 hr		50%
45		1.7.1.3		Ground Transportation	1 hr		0%
46		1.7.1.4		Restaurants	1 hr		10%
47		1.7.2		Plane On Time	5 days		0%
48		1.7.2.1		Departing Time	1 hr		0%
49		1.7.2.2		Arriving Time	1 hr		0%
50		1.8		End Monitoring	1 day	42,43,44,45,46,4	0%
51		1.9		Start Closeout	7 days		0%
52		1.9.1		Order Pictures	7 days	39FS+2 days	0%
53		1.9.2		Document Lessons learned	7 days	39FS+2 days	0%
54		1.10		End Closeout	1 day	52	0%
55		2		End Project	1 day	54	0%

Figure 10.6: Completion of Tasks in Terms of Percentage

Source: http://www.themainstreetmouse.com/wp-content/uploads/2014/07/32.jpg

Thus, from the above, it is concluded that the Microsoft Project Management Software provides the following features related to the WBS functionality of the project:

- Addition of tasks
- Deletion of tasks
- Showing the sequence of tasks in which they are required to be constructed
- Showing the moving up or moving down tasks
- Allocation of tasks to the WBS components
- De-allocation of tasks to the WBS components
- Percentage of completion of each of the tasks
- Scheduling of tasks i.e. parallel tasks or non-parallel tasks

For invoking these tasks, the manager is required to make entries in the Microsoft Project Software in terms of duration which can in a number of days, allocate the cost of resources to the WBS, mark the number of days and holidays. The project manager is required to choose appropriate options from the various tabs and work accordingly.

10.4.2 NETWORK PLANNING

Executing a project is a complex and complicated activity. It is complex due to the fact that there are several interfaces in the project and each of the interfaces have their own assumptions, dependencies and constraints. These traits, impact several inter-related activities which in turn affect the project schedule. All these lead to the process of what is known as the construction of a network diagram and the determination of the critical path and schedule. The network diagram of the project in MS Project shows the dependencies and constraints of the components that are identified during the WBS construction phase.

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MS project contains a number of tools and adds-on such as Chart Pro for presenting the project network. Navigate to the path: Microsoft Project → View → Other Views. You can view your project network in various different views as shown in Figure 10.7:

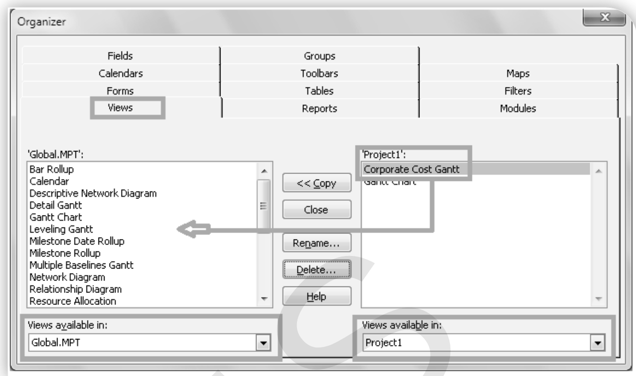

Figure 10.7: Different Views Available under MS Project

Source: https://support.office.com/en-us/article/show-slack-in-your-project-5e3e8b07-4a7a-4b14-a453-9c4c9e4d48da

Figure 10.8 depicts one out of various different views of a network diagram as follows:

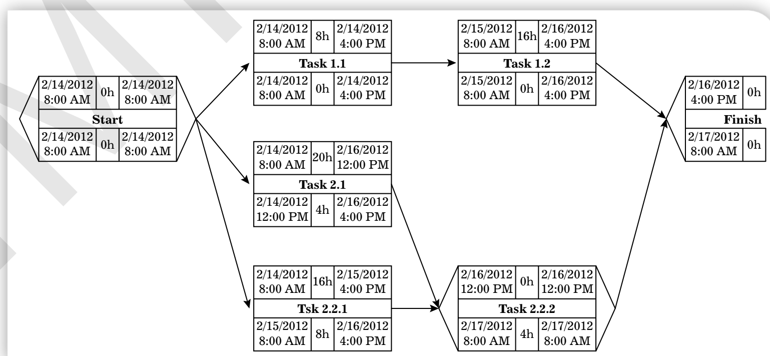

Figure 10.8: Depiction of Network Diagram by Means of Microsoft Project Management Software

Source: http://dlhsoft.com/ProjectManagementLibrary/Documentation/Screenshots/Network-DiagramView.x-small.png

From Figure 10.8, it can be observed that the network diagram shows the combination of the activities as identified in the WBS. Activities are depicted as parallel activities and the output-input activities. Parallel activities are usually depicted by blue colour boxes while red colour boxes depict the output of activities from an input to the next activity.

Thus, through this diagram the project manager determines the time as to when the activity is likely to be finished and when another activity is likely to begin. This is required by the manager so as to ensure the proper utilisation of resources such as man power, hardware, vendor, etc. Further, this diagram depicts the slack data. Slack data

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defines how much delay has cascaded down and when the late finish would take place.

Figure 10.9 depicts another view of a network diagram as follows:

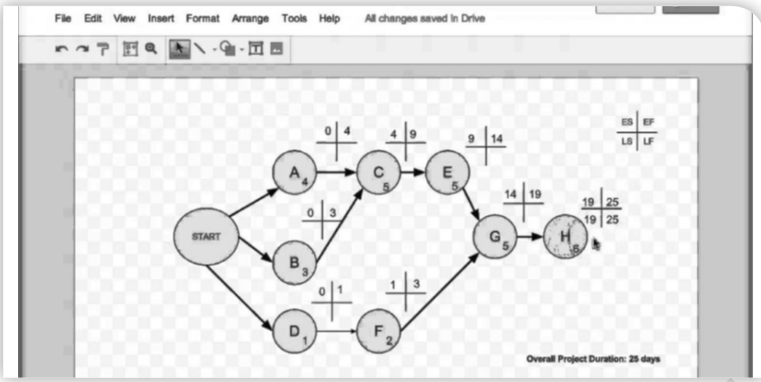

Figure 10.9: Depiction of Network Diagram by Means of Microsoft Project Management Software

Source: https://i.ytimg.com/vi/URdxhl_8qIE/maxresdefault.jpg

Figure 10.9 shows another version of the network diagram which is not as comprehensive as the earlier version of the network diagram. This network diagram depicts the activities and their dependencies in relation to other activities. For example, activity C cannot commence unless and until activity A and activity B have finished. Activity C can commence as early as 4 hours as the maximum time for completion of activity A is 4 hours while that of activity B is 3 hours. But if any (or both the activities) is delayed beyond 4 hours then C can commence only after taking into consideration the greater time. Let us now see another network diagram with the help of Figure 10.10:

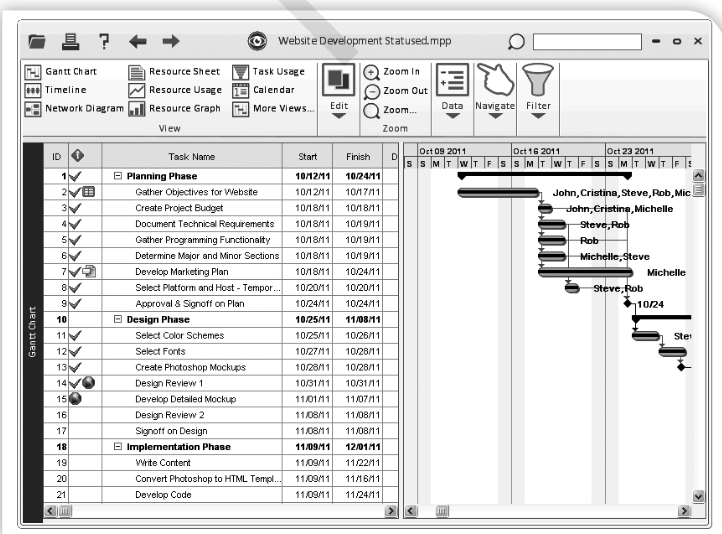

Figure 10.10: Depiction of Network Diagram by Means of Microsoft Project Management Software

Source: https://www.steelray.com/images/Viewer%20Help/More/gantt.gif

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Figure 10.10 again depicts the network diagram in more detail as it depicts some additional information such as resource involved in the activities, the date and the time period along with the parallel or the output-input activities. Thus, the project manager can use any of the network diagrams or he can use all of the above or any other type of the network diagram during the course of executing the project.

During the project execution phase, delays are bound to occur. This is due to the fact that estimations are carried out on the basis of the experience, current situation and on the basis of the similar projects done in the past. However, the fundamental fact is that every project is different even though it appears to be the same as the earlier project. Hence, the concept of critical path comes into picture. The critical path is the path which the project undertakes to complete the project within the stipulated time frame by doing away with unimportant tasks. In other words, high priority tasks are done first and lower priority tasks are done away with. Critical path or the schedule is dependent on several factors such as holidays in the project which should be made as working days, changing the priorities of the project activities, etc. The following steps depict the Microsoft Project Management Software to carry out these tasks:

1. On the project, select tools and then click change working time
2. In our calendar box, enter standard project
3. Click on the day to change
4. Click the exceptions tab and enter the description
5. Repeat the steps to make working days
6. Click ok

Figures 10.11 and 10.12 show examples of critical tasks and change in project activities:

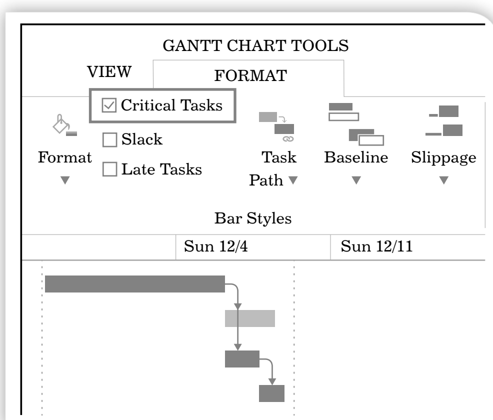

Figure 10.11: Depiction of Critical Tasks

Source: https://support.content.office.net/en-us/media/9d2daf0f-759f-4310-a831-e631829feece.jpg

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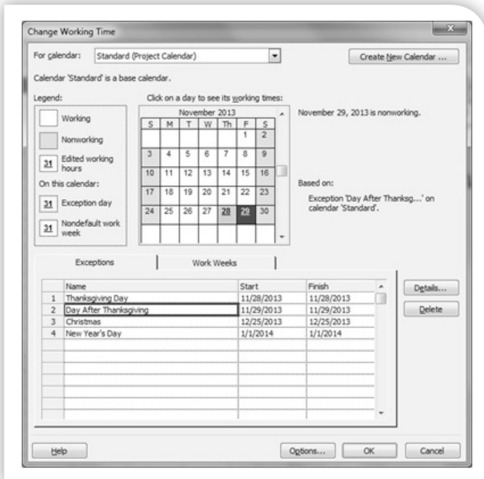

Figure 10.12: Depiction of Change of Holiday for the Critical Task
Source: http://blog.practicingitpm.com/wp-content/uploads/2013/10/Change-Working-Time.png

10.4.3 RESOURCE ALLOCATION

As mentioned above, the Microsoft Project Management Software can be used to assign resource to the project. For assigning resources to a project, the following steps are performed:

1. Identify and define resources to be used in the project. Resources include human resources, hardware and software. For this, go to the View menu, select resource sheet, select table entry. A screen appears where you can enter resource names, types and various other related parameters.
2. Assign the resource to the respective WBS components/tasks. For this, go to the View menu, select the Gantt chart. Select assign resources from the Tools menu. For each task, the resources can be added, removed or replaced.
3. You can view the final allocation by selecting More Views and Task Usage from the View menu.

Figure 10.13 depicts the resource tab of MS Project:

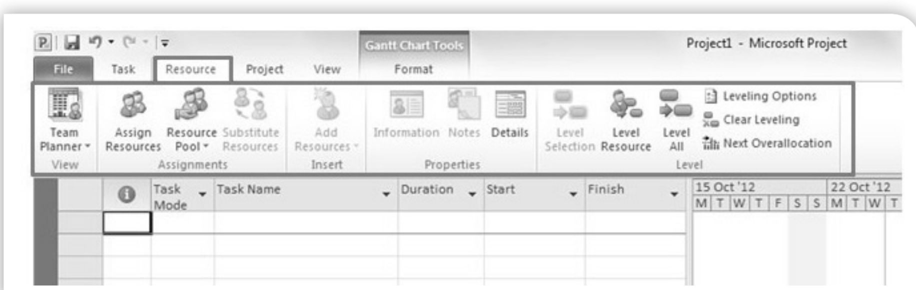

Figure 10.13: Resource Tab of MS Project
Source: http://www.project-management-srbija.com/wp-content/uploads/2013/05/2-resource-tab.jpg

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Under the Resource tab, various options such as resource allocation, resource pool, levelling of resources, etc. are present. All these options are used by the project manager to manage the project. Figure 10.14 depicts various options which can be used in the resource tab:

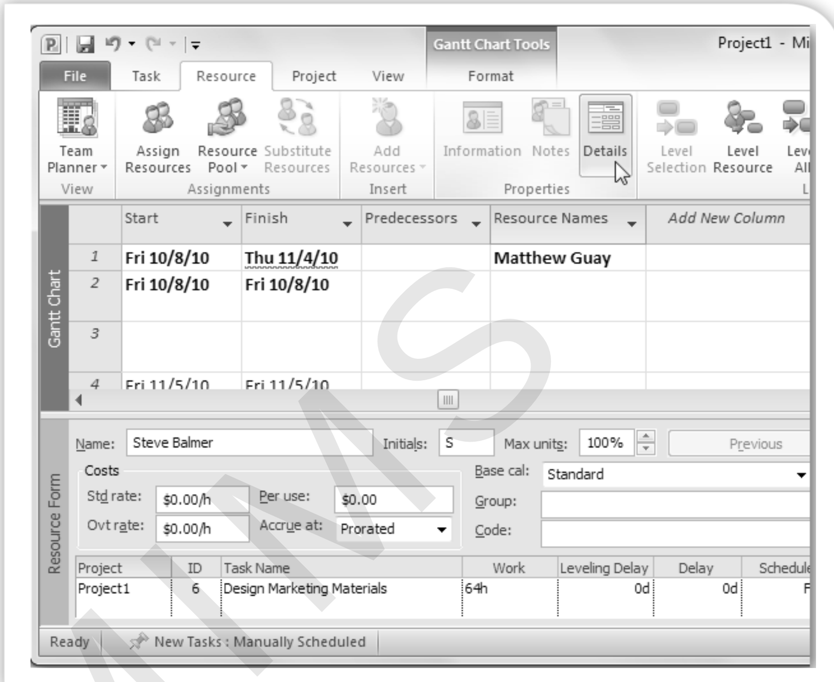

Figure 10.14: Resource Tab in Microsoft Project

Source: https://www.howtogeek.com/wp-content/uploads/2010/10/image109.png

From Figure 10.14, it can be seen that the resource tab takes into consideration aspects such as resource name column, additional column to add new resources, etc. Max units field is used to present the amount of time that the resource spends on the project. For example, a resource may spend 100% of the time or 20% of the time. The Resource tab is also used to enter the cost of the resource.

10.4.4 PROJECT BUDGET

When it comes to the process of managing a project, a project manager must keep in mind various aspects of a project such as cost, time, quality and scope. Without exercising adequate control over these core areas, project management is bound to fail. For example, if project management fails to exercise the cost component, then even if other components such as time, quality and scope are met, the project would still be considered as a failure because the project ran into losses instead of generating profit. Following points must be considered in relation to project budget:

- If a project is not delivered on time (schedule overrun), it will incur additional costs which defeat the real purpose of the project.

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- If a project is delivered on time but it has several defects (quality issue), then fixing the defects incurs additional costs.
- If the scope of a project gets expanded (scope creep), it will incur additional costs which is indicative of project management failure.

Since project execution is a commercial activity, it is required to actively monitor the costs of the project; which is a difficult task. There are various types of costs associated with a project. Also, there is a stipulated budget for every project and the project manager is required to ensure that the project is executed within the allocated budget. It can be done by monitoring different costs of project. Various costs in the project include: fixed costs, variable costs, recurring costs, non-recurring costs and regular costs.

It is a project manager's duty to estimate the costs and prepare the project budget. Once the project budget is approved and the contract for the execution of the project is validated; the next crucial part of the project manager's duty is to ensure that these costs are managed and controlled so that there are no budget overruns. Control is necessary because budget overruns may lead to losses and projects done within or under budgets may lead to profit generation.

Microsoft Project Software assists a project manager in handling issues related to project budgeting and costing. For this, go to view tab and select resource usage drop down menu. This is depicted in Figure 10.15:

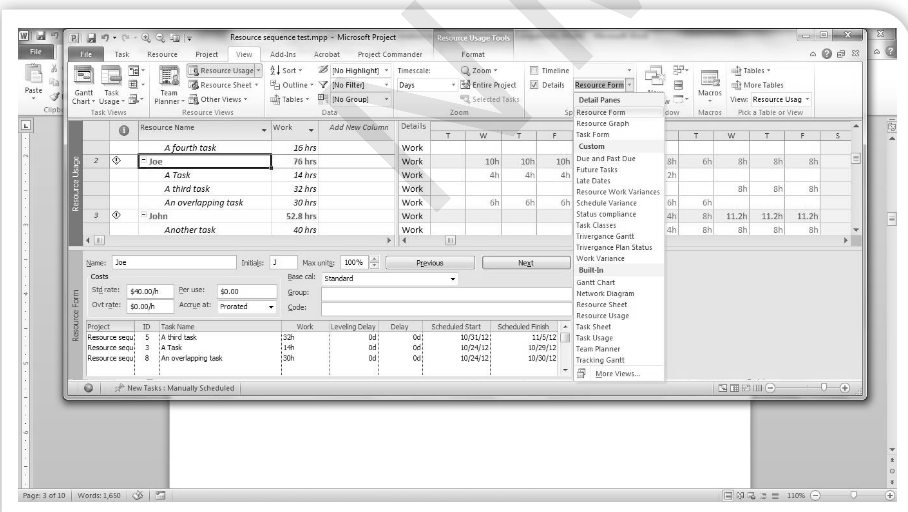

Figure 10.15: Depicting the Resource Usage View of Various Tasks as Determined in the WBS

Source: https://46ev833n9u2l3zs8zp44sst3tpr-wpengine.netdna-ssl.com/wp-content/uploads/2013/04/Cicala0413_4.jpg

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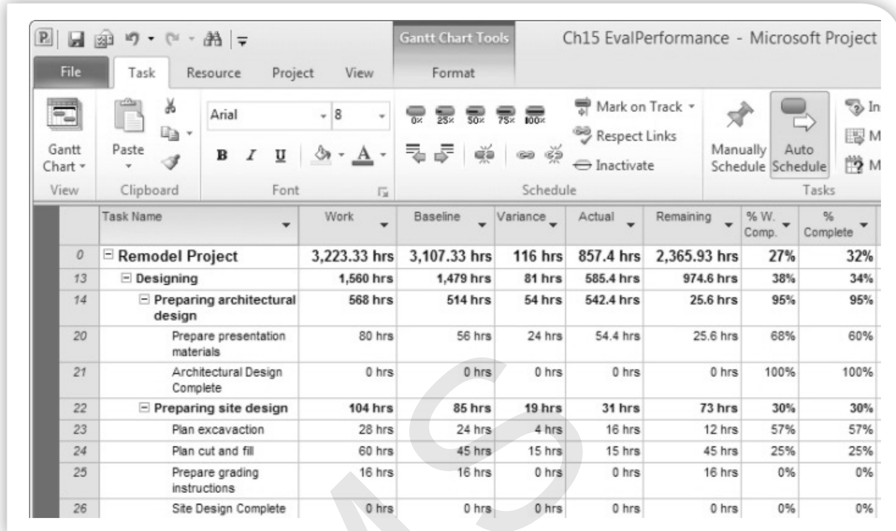
Figure 10.16 represents various aspects of costs and budget:



	Task Name	Work	Baseline	Variance	Actual	Remaining	% W. Comp.	% Complete
0	Remodel Project	3,223.33 hrs	3,107.33 hrs	116 hrs	857.4 hrs	2,365.93 hrs	27%	32%
13	Designing	1,560 hrs	1,479 hrs	81 hrs	585.4 hrs	974.6 hrs	38%	34%
14	Preparing architectural design	568 hrs	514 hrs	54 hrs	542.4 hrs	25.6 hrs	95%	95%
20	Prepare presentation materials	80 hrs	56 hrs	24 hrs	54.4 hrs	25.6 hrs	68%	60%
21	Architectural Design Complete	0 hrs	0 hrs	0 hrs	0 hrs	0 hrs	100%	100%
22	Preparing site design	104 hrs	85 hrs	19 hrs	31 hrs	73 hrs	30%	30%
23	Plan excavaction	28 hrs	24 hrs	4 hrs	16 hrs	12 hrs	57%	57%
24	Plan cut and fill	60 hrs	45 hrs	15 hrs	15 hrs	45 hrs	25%	25%
25	Prepare grading instructions	16 hrs	16 hrs	0 hrs	0 hrs	16 hrs	0%	0%
26	Site Design Complete	0 hrs	0 hrs	0 hrs	0 hrs	0 hrs	0%	0%

Figure 10.16: A View of Microsoft Project depicting certain Aspects of Costs

Source: https://www.mpug.com/wp-content/uploads/2011/07/110720_Biafore_Figure_1.jpg

In Figure 10.16, observe that project costs and budgets are measured in terms of baseline costs and variance associated with baselines. All resources being used in a project incur costs and any variance in the budgeted cost from baseline gives rise to additional costs. In the figure, you can observe that there is a variance in the number of hours which affects the costs of the project.

10.4.5 MONITORING AND CONTROLLING

As discussed earlier, unless project monitoring and controlling activity is in place, the whole project is bound to fail. Monitoring and controlling of the project is carried out at various stages of a project to determine whether the activity is ahead of the schedule or behind the schedule; whether the activity requires the amount of resources as planned, whether the activity provides the planned output, and so on.

In MS Project, the monitoring and control activity is carried out by maintaining and tracking project milestones. A milestone refers to the start or completion of a significant event(s) in a project. In other words, we can say that milestones indicate the major segments of the project and their completion dates. It is also important to note that milestones are events (and not activities) and they take zero time. In a project, the project team generally designates two types of milestones namely mandatory and non-mandatory milestones. Mandatory milestones are those events whose listing must be generated at different stages of the project.

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Milestone may be mandatory if it is required for purpose of regulatory compliance or becomes necessary owing to the nature of a project's life cycle. Other optional milestones may be required by the project team or the client to track and trace the important events occurring in the project. The project manager, his team, other stakeholders and the client decide whether a milestone is mandatory or not. The project manager may have to include certain milestones and designate them as mandatory as per the requirements stated by the client.

Different types of milestones include work completed and events occurred. For example, milestones that are generated at time of completion of work include completion of project baseline, completion of the technical design, completion of coding in case of IT projects, completion of system testing, completion of different versions or modules of the software, etc. Milestones relating to the completion of events include approval of the preliminary project documents such as business case, selecting a software solution, approval of the proof of concept, installation of the software, acceptance of the prototype by the client, when the IT project/module/version is completed and is rolled out to the client (Go Live), project closure, etc.

It is necessary to monitor and manage the milestones of a project because it gives the project manager, his team and the client a fair idea of the progress of the project and also helps in comparing it to the project baseline.

The MS Project software package offers various features that help in establishing, monitoring and managing the project milestones. Let us discuss some of these features:

1. **Highlight the key junctures in a project:** While the project team is preparing the project plan using MS Project, they need to identify important milestones and insert them into the project schedule. A milestone may highlight achieving compliance with the requirements, completion of certain work or events, or connection of a project work with an external dependency. The project team usually compares the planned and actual work completed (in terms of time, effort, cost and scope). Milestones must be spread across the project duration after each lapse of 10-20% of the duration. In MS Project, a milestone is inserted into the plan by inserting a task having duration of zero hours/days. It is represented as a filled diamond (♦) in the Gantt Chart. The MS Project software also provides various other functions that are available. For example, the user may highlight the milestones in a different colour than other tasks or activities represented on the Gantt Chart. In addition, there are various filters and views in the MS Project that can be used to effectively communicate the project milestones.
2. **Understand the dependencies:** In MS Project, a milestone may be linked to certain predecessors and a milestone is considered

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as completed or achieved when all the predecessor activities have been completed. Therefore, the project team can use dependencies to define when a milestone is said to be completed. When the MS Project flags out that a particular milestone has been achieved, it is indicative that the next activities (or successor activities) can now be initiated. Therefore, the project team can transit or switch to the next phase or stage of the project in a smooth manner.

3. **Measure progress in relation to milestones:** The project teams are aware that the project milestones are related to the project performance. After a milestone has been achieved, the finish variance is calculated and it is used to monitor the performance of milestone as against the baseline plan. In case, the variance is not allowable, the dependent tasks and the deliverables are reviewed to identify the source of variation. In addition, the project team works out the appropriate corrective actions that can be taken to resolve the problems or source of variation.
4. **Assessment of the change based on the impact on milestones:** Whenever any change request is generated in the project, the project team needs to assess the impact of that change on the project milestones, schedules and on project completion dates. The project team usually manages the impact of the changes at the milestone level. This ensures that all the stakeholder commitments are understood well before the change requests are implemented. This takes care of the external project dependencies and the scheduled events. All the project changes can be simulated to view the impact of changes on the project milestones.
5. **Celebrating success and capturing lessons learned:** Whenever the project team achieves any milestone, it celebrates its success. In addition, a milestone provides an opportunity to the project team to capture the important lessons learnt from the project while the lessons are still fresh in the minds of project team members. Capturing the lessons learnt enables the project team to build project delivery capabilities which helps project team in dealing appropriately with such problems in the future.

In addition to the above, monitoring and controlling is also carried out for various other tasks, activities and entities such as:

- Vendor management
- Sub contractual management
- Client management
- Stakeholder management
- Communication management
- Scope management

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- Receipt of deliverables from the client
- Project team management

All these can be accomplished by means of Microsoft Project Management Software. Figure 10.17 depicts monitoring and controlling in MS Project:

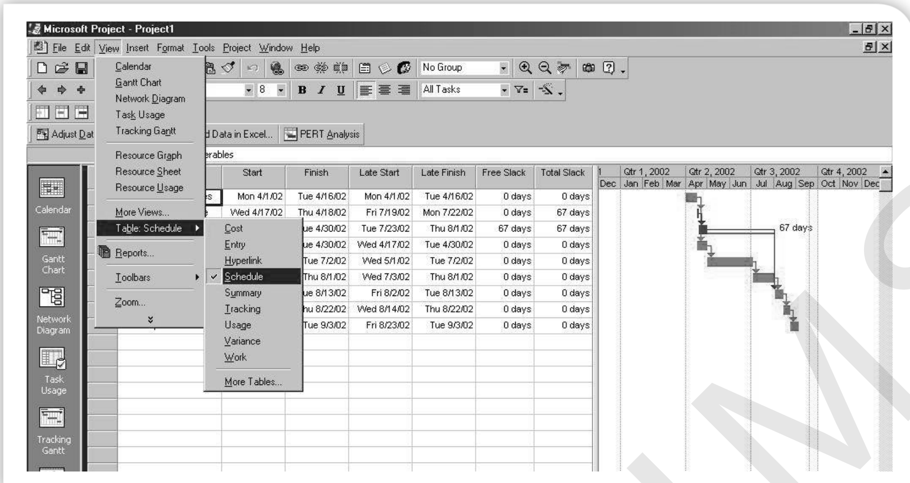

Figure 10.17: Monitoring and Controlling in Microsoft Project Management Software

Source: https://web.njit.edu/~dm279/slack.jpg

10.4.6 PROJECT CLOSURE

Once project deliverables are delivered to the customer and the customer has given the project sign off, the project is required to be formally closed. Project closure is the most important stage of the project management cycle as it involves feedback sharing, and knowledge sharing. All these information provides the requisite input for the new or upcoming projects.

Thus, the project closure phase deals with all these issues. Microsoft Project Management Software can be used during the project closure phase as covered in the following stages:

- The baselines of the project plan can be successfully archived for future reference
- Variances pertaining to cost overruns, resource utilisation and the like can be taken as experience for future projects
- The impact and the amount of the impact in terms of cost, resource utilisation and the like can be used for future purposes
- Various versions of the project plan can be archived
- Preparation of project closure report with the status to all the stakeholders

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Thus, Microsoft Project Management Software though itself does not directly takes part in the project closure process but it provides various inputs to the closure process which itself culminates in the form of the project closure report and the knowledge sharing session report and finally hosting them to the central repository.

SELF ASSESSMENT QUESTIONS

6. Network diagrams show the ____________ amongst the tasks or activities in WBS.
7. Microsoft Project Management Software assists in project closure. (True/False)

ACTIVITY

Using the Internet, find some functions (which are not mentioned in the chapter) that can be performed with the help of Microsoft Project Management Software. Prepare a report on it.

10.5 SUMMARY

- Project management software is an important instrument through which a project manager is able to manage and complete the project within the stipulated time and budget, specially the huge and complicated projects.
- The features which need to be considered where selecting the software: Collaboration, Scheduling, Issue tracking, Project portfolio management, Document management and Resource management.
- Project management software can be mainly classified into four major type's namely desktop, client server, web-based, and integrated system.
- Some noteworthy advantages of the project management software include: effective communication and collaboration among project team members, document sharing and managing project costs.
- The common disadvantages related to any project management software are: Extra cost, limited availability of technical skills, data safety related issues, fault in software and resistance from employees.
- Prominent Project Management Software available in market include Trello, Basecamp, JIRA, Matchware Mind View, etc. However, Microsoft Project is one of the most extensively used software.
- MS Project was first introduced as a DOS based software in 1984. Over a period of time, it has developed into Web-based application. It is a window-based tool that assists in efficient implementation of administrative activities.

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- Microsoft Project is designed to help project managers of the project in carrying out various project activities such as developing project plans, allocating resources to activities, monitoring project progress, keeping track of project budget and evaluating workload.
- MS Project is perhaps the most popular project management software because it can be integrated with various other popular Microsoft applications and software. Under MS Project, all the project data is stored in the central database.
- Certain important features of the Microsoft Project software are: project planning, efficient project scheduling, resource management, project review, tracking project progress and generating automatic reports.
- Important applications of MS Project software include:
  - WBS structure as created in Microsoft Project Software. In the screen generated for WBS, the left hand side lists various WBS elements whereas the right hand side depicts the Gantt Chart of the WBS structure.
  - The network diagram of the project in MS Project shows the dependencies and constraints of the components that are identified during the WBS construction phase.
  - Microsoft Project Management Software can be used to assign resource to the project.
  - If project management fails to exercise the cost component, then even if the other components such as time, quality and scope are met, the project would still be considered as a failure because the project ran into losses instead of generating profit. Microsoft Project Software assists a project manager in handling issues related to project budgeting and costing.
  - In MS Project, the monitoring and control activity is carried out by maintaining and tracking the project milestones.
  - Thus, Microsoft Project Management Software though itself does not directly takes part in the project closure process but it provides various inputs to the closure process which itself culminates in the form of the project closure report.

KEY WORDS

- **Database**: A structured set of data stored in a manner such that it can be retrieved and manipulated.
- **Project Evaluation and Review Technique (PERT)**: A statistical tool used to analyse and represent various tasks involved in the completion of a project.

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- **Project scheduling**: A process of listing a project's milestones, activities and deliverables, along with start and completion dates.
- **Software**: A collection of written programs, procedures or rules and associated documentation pertaining to the operation of a computer system.
- **Work Breakdown Structure (WBS)**: A top-down and hierarchical representation of the various activities of a project.

10.6 DESCRIPTIVE QUESTIONS

1. List and explain major characteristics of project management software.
2. Describe the importance and use of project management software 'Microsoft Project'.
3. What are major applications of Microsoft Project software? Explain in detail at least three such applications.

10.7 ANSWERS AND HINTS

ANSWERS FOR SELF ASSESSMENT QUESTIONS

Topic	Q. No.	Answers
Introduction to Project Management Software	1.	Project Management Software
	2.	Planning
	3.	True
Introduction to MS Project	4.	Developing project plans; Monitoring project progress
	5.	MS Project Web Access
Application of MS Project Software	6.	Dependency
	7.	True

HINTS FOR DESCRIPTIVE QUESTIONS

1. Major characteristics of project management software include: collaboration, scheduling, issue tracking, project portfolio management, document management and resource management. Refer to Section **10.2 Introduction to Project Management Software.**
2. Microsoft Project is one of the most extensively used software is the Microsoft Project software. Microsoft Project is designed to help the project managers of a project in carrying out various project activities such as developing project plans, allocating

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resources to activities, monitoring project progress, keeping track of project budget and evaluating workload. Refer to Section **10.3 Introduction to Microsoft Project.**

3. Important applications of MS Project software include generating WBS, generating project network such as PERT or CPM, assigning resources to a project, handling project budgeting and costing, monitoring and controlling for activities and project closure. Refer to Section **10.4 Applications of Microsoft Project Software.**

10.8 SUGGESTED READINGS & REFERENCES

SUGGESTED READINGS

- Kerzner, H. (2017). *Project management metrics, KPIs, and dashboards*. Hoboken, New Jersey: John Wiley & Sons, Inc.
- Lock, D. (2007). *Project management, ninth edition*. Aldershot, England: Gower Pub.
- Maylor, H. (2018). *Project Management*. [S.l.]: Pearson Education Limited.
- Meredith, J., Shafer, S., & Mantel, S. (2016). *Project management*. Hoboken: Wiley.

E-REFERENCES

- (2018). *Theseus.fi*. Retrieved 5 February 2018, from https://www.theseus.fi/bitstream/handle/10024/83521/Hoang_Nhat_Minh_Shrestha_Swostik.pdf?sequence=2
- (2018). *Wuecampus2.uni-wuerzburg.de*. Retrieved 5 February 2018, from https://wuecampus2.uni-wuerzburg.de/moodle/pluginfile.php/726065/mod_resource/content/1/Introduction_to_MS%20Project.pdf
- Disadvantages, P. (2018). *Project Management Software Advantages and Disadvantages*. *Small Business*. Retrieved 5 February 2018, from https://smallbusiness.yahoo.com/advisor/project-management-software-advantages-disadvantages-144914106.html
- Shaheed, M., & →, V. (2018). *Work Break down Structure (WBS) using MS project and chart pro*. *Mamun Shaheed*. Retrieved 5 February 2018, from https://somudrodev.wordpress.com/2011/09/12/work-break-down-structure-wbs-using-ms-project-and-chart-pro/
- *Using Project Execution Management*. (2018). *Oracle Help Center*. Retrieved 5 February 2018, from https://docs.oracle.com/en/cloud/saas/project-portfolio-management/r13-update17d/oapem/define-project-plan-tasks-and-schedule.html#OAPEM906596

10
CHAPTER

CASE STUDIES

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CASE STUDY 1

PROJECT LIFE CYCLE FRAMEWORK OF VIETNAM RUBBER COMPANY (VRC)

This Case Study discusses the need and importance of designing a framework for project lifecycle in 'Vietnam Rubber Company'. It is with respect to Chapter 1 of the book.

Vietnam Rubber Company is a state owned company and is one of the largest rubber manufacturers in Vietnam. Recently, the management of VRC has invested a large amount of capital for expanding its plantations business domestically and internationally in order to enhance their manufacturing capacity and market share.

VRC has used the concept of project life cycle in some rubber plantation projects. However, VRC has not built a specific project life cycle for different projects framework to ensure a proper execution and successful completion of the project. As a result, the project encountered various difficulties during its execution.

The company appointed an internal audit team to identify the reasons for the ongoing losses in the project. After a few weeks, the internal audit team submitted its report. The report stated that most of the problems were related to the cost and schedule of the project. Major observations of the report were as follows:

- Budget overruns
- Delay in project activities
- Uncontrolled project quality
- Weak project management team
- Scope creep

One specific project of VRC in Cambodia was incurring very negative results. The main reason for this was poor project life cycle management in addition to the following reasons:

- Absence of a project life cycle framework.
- Major activities such as development of project proposals, business cases and project selection process in the first phase were carried out indiscriminately and this impacted all remaining phases of the project life cycle.
- Absence of a strong project management team.Inadequate delegation of project teams from VRC's head quarter.
- Absence of project organisation.
- Lack of managerial skills and competencies

CASE STUDY 1

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Mr. Do Huu Phuoc, a project specialist conducted a research to study Vietnam Rubber Company's project life cycle approach, analysed the current project situation, developed a framework of project life cycle of a rubber plantation project and provided guidelines to possibly ensure that the projects were delivered on time and within adequate budget while assuring the expected level of quality.

According to the study, the project life cycle of VRC's projects may progress through four phases:

- Initiation phase
- Planning phase
- Implementation phase
- Completing and closing phase

Research also revealed that there is no single approach for organising the project life cycle management. Different life cycle approaches have their own advantages and disadvantages, depending on the knowledge of the owner in project management, type, size and location of the project.

VRC must be aware of the approach that is most suitable and beneficial for their plantation project. The company should be concerned about the life cycle costs of a rubber tree plantation and constructed facilities rather than focusing only on the initial cost. Saving small amount of money may not be effective during the entire project lifecycle if the functional requirements of the new facility are not met or if the objectives are not aligned with the project scope. A rubber plantation project must be focused on the entire project lifecycle to ensure the successful completion of the project.

VRC handles various projects at the same time due to which it may become difficult to get adequate support and attention of the top management. Usual problems faced by VRC while managing multiple projects are:

- Previous project's experiences are not summarised which may lead to repetition of mistakes.
- All projects may be using common technology and resources and due to this delay in one project, it may lead to delays in all other projects.
- There is unhealthy competition among the project teams to get support and attention of the top management.

It was recommended that VRC must stop all project activities on a temporary basis to review all the issues with the projects. A report

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CASE STUDY 1

must be prepared regarding the lessons learned from this project so that these mistakes cannot be repeated in the future. The owner approach to the project also needs to be reshaped because there are many important aspects related to the project management. Hence, further studies must be carried out to ensure proper management of this agriculture project.

Hence, the general framework of project lifecycle can be utilised in multiple projects over a time and there is no need to reinvent everything for a new project. The best approach is to reuse a standardised project lifecycle framework.

QUESTIONS

1. Explain various difficulties faced by the VRC's rubber plantation project.

   (**Hint:** Refer to the observations given by the audit committee report.)

2. Briefly explain the four phases of the project life cycle at VRC.

   (**Hint:** Refer to the research study conducted by Mr. Do Huu Phuoc.)

CASE STUDY 2

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PROJECT ORGANISATION STRUCTURE FOR HARDTECH INC.

This Case Study discusses the need of new project organisational structure for HardTech Inc. It is with respect to Chapter 2 of the book.

'HardTech Inc.' is an electronics start-up Company that was incorporated a few years back. It was founded by three electronics engineer friends namely, Jake Tyler, Caroline Ryan and Mike Preston. These three had also worked together as a fortune 500 company. Initially, 'HardTech Inc.' launched a high speed processing chip that was designed specifically for handheld scanning devices. This was the first product launched by the company. With this product launch, the company also got a major contract from a large software manufacturer. This software company wanted to develop an advanced version of a handheld scanner (an inventory management tool) by installing a chip into it. It was the first and an important milestone achieved by the HardTech Inc.

After this event, all three founding members decided to build an organisation structure for their firm. Finally, they all agreed to adopt a traditional organisation structure for their firm and this structure was quite similar to the firm in which they were working as colleagues. Since then, the company hired many people including development engineers, managers, designers, design department managers, sales and marketing associates and HR and administration executives.

All three founders of 'HardTech Inc.' decided to initiate three new projects as follows:

- To build a chip for grocery store scanners
- To enter into the hospital point-of-care scanner market
- To upgrade the current inventory management chip

The company's founders felt that the traditional organisational structure is not able to support the current requirements while the company is willing to initiate many new projects of new product development. Hence, there is a need for restructuring the current organisational structure. It was decided that each new product development initiative will be handled by a separate and dedicated project team. In this manner, Ryan recommended setting-up three project teams to complete these three initiatives wherein all the project teams will report directly to the top three executives.

Source: http://www.chegg.com/homework-help/questions-and-answers/read-hard-tech-inc-incident-discussion-page-70-textbook-answer-question-organizational-stru-q10643973

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CASE STUDY 2

QUESTIONS

1. What type of organisation structure would you recommend to be adopted by HardTech Inc.?

   (**Hint:** Keeping in view the recommendation given by Ryan, the company must adopt a matrix organisation structure under which each initiative of new project development will be handled by a separate dedicated team.)

2. Give at least five reasons to support your recommendation regarding the organisational structure for HardTech Inc.?

   (**Hint:** There could be various reasons for adopting matrix organisation structure in the company. One major reason is that the matrix structure facilitates efficient information exchange and comprises minimum level of hierarchy.)

CASE STUDY 3

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PROJECT MANAGEMENT OFFICE (PMO) IMPLEMENTATION

This Case Study discusses the results of Project Management Office (PMO) implementation for a large transportation company. It is with respect to Chapter 2 of the book.

'IntelliCo Solutions' is a global information technology (IT) consulting firm established in 2004. The company provides IT solutions to its clients. The company is focussed on delivering and managing diverse IT needs of its clients but it specialises in logistics solutions. The service portfolio of the company involves strategic IT project management, business intelligence, Project Management Office and IT strategy definition.

INTELLICO SOLUTIONS

Source: https://intellico-solutions.com/featured-case-study-pmo/

This case is about the need of Project Management Office (PMO) by one of the clients of 'IntelliCo Solutions'. This client was a large transportation company which has 50+ global subsidiaries. The case also discusses the concept of PMO. In simple words, PMO can be defined as the central unit which integrates various activities of a particular project to enhance efficient resource usage. PMO of any organisation serves many important needs such as project management, project supervision, project management assurance, project guidance, methodology, etc. There is need to set-up project management office as per the client requirement along with three main basic features as follows:

- The PMO must process a consistent IT cost chart of accounts for all 50+ subsidiaries in order to ensure the IT cost and IT headcount transparency.
- The PMO must be able to ensure setting-up of a control system for initiation and status reporting of the project.
- Common tasks of various projects such as, investment documentation, board presentation and project audits must be taken by the PMO.

'IntelliCo Solutions' started developing the PMO as per the client requirement. The above-mentioned features were included in the PMO. As a result, the cost structure became more transparent which led to significant reduction in the overall IT cost. The overall quality assurance improved which enabled better knowledge

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CASE STUDY 3

transfer among individuals and departments. The IT headcount has also been reduced at various sites which brings the efficiency in the entire system.

As a result, the client has decided to establish new team for their ongoing operations in India and IntelliCo Solutions is also contributing towards the development of new PMO for their upcoming operations.

Source: https://intellico-solutions.com/featured-case-study-pmo/

QUESTIONS

1. What are the main features of the PMO required by the client of 'IntelliCo Solutions'?

   (**Hint:** The PMO required by the client must be able to ensure status reporting of the project.)

2. Explain how 'IntelliCo Solutions' helped its client.

   (**Hint:** Reduction in the overall IT cost.)

CASE STUDY 4

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ENVIRONMENTAL FEASIBILITY OF LAVASA PROJECT

This Case Study discusses the impact of lack of effective environmental feasibility analysis for the Lavasa city project. It is with respect to Chapter 3 of the book.

Assessing the feasibility of a project is one of the preliminary activities of the project initiation phase. Some important activities carried out under feasibility study of a project is to conduct analysis of project w.r.t. operational feasibility, market feasibility, technical feasibility, economic & financial feasibility, legal and regulatory feasibility, environmental feasibility and social feasibility. Environmental feasibility is extremely important especially for large scale projects in order to ensure successful completion. During environmental feasibility study, the impact of the project on the environment and surrounding areas is assessed. If the study suggests high impact that may lead to issues in getting environmental clearances; the project team speculates and generates ideas to minimise the impact on environment.

An organisation has to consider various environment-related issues before final project selection. In India, large projects may need to obtain environmental clearance certificate from various authorities or boards such as the Ministry of Environment and Forest, National Green Tribunal, Central Pollution Control Board, State Pollution Control Board, etc. at the very initial level.

Lavasa is a private planned hill city being developed near Pune in the Indian state of Maharashtra by Lavasa Corporation Ltd. The project was started in the year 2004 but has not completed till now. Lavasa city is designed to be developed on the lines of Italian town of Portofino. Lavasa Corporation is a subsidiary of Hindustan Construction Company (HCC). Lavasa is a ₹50000 crore township project which achieved the status of special planning authority from the Government of Maharashtra. The project covers a total area of 5000 hectares and it was divided into two phases. As per the master plan, Phase I involved work over 2000 hectares and Phase II involved work over the remaining 3000 hectares. The first phase of the project was scheduled to be completed by 2010-11 while phase two was scheduled to get over by 2020-21.

In 2010, the Lavasa project become largely controversial because it was found that HCC had violated many environmental norms under the Environment Protection Act, 1986 and Environment Impact Assessment notification (1994). A little later the Ministry of

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Environment and Forests (MoEF) also notified that the clearances given by the Government of Maharashtra were illegal. The MoEF submitted its report regarding this issue to the Mumbai High Court in 2011. The report noted that the environmental clearance was awarded by the Maharashtra state environment department to Lavasa in 2004 which was only a day after the launch of a new hill station policy issued by the Government of Maharashtra. The MoEF hinted that the new policy was launched specially in favour of the project. Then in May 2017, Government of Maharashtra revoked Lavasa's status of Special Planning Authority (SPA). The charges filed by the MoEF and the Lavasa Corporation's response are as follows:

TABLE: CHARGES FILED BY MOEF AND COUNTER ARGUMENTS GIVEN BY LAVASA

Charges filed by MoEF	Counter arguments by Lavasa Corporation
No clearance was given to Lavasa regarding the Environment Impact Assessment notification (1994).	As per the Schedule 1 of Environment Impact Assessment notification (1994), the project was exempted from clearance.
The state government issued clearance without the statuary approval from the MoEF.	Lavasa is a state tourism project which does not need any approval from the Union Government.
The maximum limit of altitude for construction in the tourism project is 1000 meters.	No construction has been done in areas at altitude more than 1000 meters.
Forceful land acquisition and forceful relocation of tribal communities and villagers.	The company does not own any tribal land.

In February 2011, after receiving a show cause notice, the Lavasa project sought post facto approval from the MoEF to complete its first phase of the project. In June 2011, MoEF provided clearance to the Lavasa project with certain preconditions. By May 2017, Lavasa project had come under the ownership of State Government and it has to submit proposals with Pune Metropolitan Regional Development Authority (PMRDA). It was also decided that all decisions regarding the planning and execution of the Lavasa project will be taken by PMRDA.

N O T E S

QUESTIONS

1. Explain major issues reported in the MoEF report regarding the Lavasa project.

   (**Hint:** Not taking environmental clearance from the MoEF, non-assessment of environmental impact.)

2. What is the current status of the Lavasa project (as on January 2018)?

   (**Hint:** As of October 2017, it was announced that the Pune Metropolitan Region Development Authority (PMRDA) would prepare a revised master plan for Lavasa Project. For more information, research and study news related to the Lavasa project.)

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CASE STUDY 5

PROJECT SELECTION FOR HYPOTHETICAL INC.

This case study discusses how Hypothetical Inc. conducts the activity of project selection by applying the NPV method. It is with respect to Chapter 3 of the book.

Hypothetical Inc. is an electronics solution provider that was incorporated almost 15 years back. The company wanted to expand its production operations. Therefore, it started contemplating buying machinery for it. The company is having two options, machinery 1 and machinery 2. It was estimated that the company will be able to reduce its overall cost of production leading to increase in profits in either case. The company had fixed its required rate of return at 10 per cent in any case.

For machinery 1, after tax cash flows of the project are shown in the following table:

TABLE: PURCHASE PROJECT OF NEW MACHINERY

YEARS	EXPECTED CASH FLOWS (Amount in $)
0	($38,000)
1	15000
2	14000
3	13000
4	12000
5	11000

For machinery 2, after tax cash flows of the project are shown in the following table:

TABLE: PURCHASE PROJECT OF NEW MACHINERY

YEARS	EXPECTED CASH FLOWS (Amount in $)
0	($48,000)
1	15000
2	14000
3	13000
4	12000
5	11000

CASE STUDY 5

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QUESTIONS

1. Calculate the NPV for the purchase project of Hypothetical Inc.

   (**Hint:** Calculate NPV for 5 years by considering PV factors as 0.893, 0.797, 0.712, 0.636 and 0.587. The sum of present values of all cash inflows comes out to be $ 47678. Subtract the initial investment (price of machinery) from this amount. Do this activity for both the machineries.)

2. Determine which machinery should be accepted.

   (**Hint:** Machinery yielding a positive NPV should be selected.)

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CASE STUDY 6

WRONG COST ESTIMATION IN BANDRA WORLI SEA LINK PROJECT

This Case Study discusses the problem of wrong cost estimation in the Bandra-Worli Sea Link project. It is with respect to Chapter 4 of the book.

The Bandra-Worli Sea Link project is considered to be an engineering marvel. It is one of the most complex projects carried out in India. The total length of sea-link is 5.6 km; out of which 3.8 km has been constructed over the sea. After its inauguration, this eight lane sea link project has the reduced travel time (during peak hours) between Bandra and Worli by almost an hour from 50-70 minutes to 20-30 minutes. The Bandra-Worli sea link has an average daily traffic of around 37000 vehicles. This project was a part of Phase I of Western Freeway that was proposed to reduce traffic congestion in Mumbai by constructing a freeway on the entire western coastline. It also has a 16 lane toll plaza with an electronic toll collection system at Bandra. The electronic toll payment system allows commuters to pass without stopping.

Source: https://media-cdn.tripadvisor.com/media/photo-s/0d/11/0a/92/bandra-worli-sea-link.jpg

The Bandra-Worli sea link project was managed by Maharashtra State Road Transport Corporation (MSRTC) and executed by Hindustan Construction Company (HCC) along with its foreign partner China Harbour Engineering Corporation. HCC also had a damage liability of the project for a period of 5 years.

Initially, this project was conceived in the late 1990s and project construction was started in the year 2000. The initial cost of the project was estimated at around ₹350 crore and it was estimated that the project would be completed by 2004. However, the project missed several deadlines and it was opened up for commuters in June 2009. During the project, there were constant changes in the

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master plan of bridge design that led to delays in completing the project deadline. It also led to a huge gap in estimated and actual costs. The initial planned outlay of the project was around ₹350 crore which was revised to ₹1306 crore in August 2004. The overall project construction was finished in March 2010 with a delay of almost 6 years. By this time, the actual cost had crossed ₹1600 crore. It was estimated that the project was built with a total cost of ₹1684 crore.

During the project, there were irregularities found in the transfer of grants from the government to the construction company due to which HCC became more dependent on external sources of finance. There were also many other important reasons for this wrong cost estimation that led to an increase in project cost. Some of these reasons were wrong estimation of cash flows, changes in plans, changes in bridge design, changes in cable used, wrong selection of design consultant, non-achievement of milestone due to poor project progress, etc.

QUESTIONS

1. Discuss main problems of the Bandra-Worli Sea Link project.

   (**Hint:** Drastic increase in project costs and project delays.)

2. Explain various reasons for cost increase in the Bandra-Worli Sea Link project.

   (**Hint:** Wrong estimation of cash flows, selection of wrong design consultant, etc.)

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CASE STUDY 7

PROJECT PLANNING AND DECISION IN ISRO'S MARS ORBITER MISSION

This Case Study discusses project planning in ISRO's Mars Orbiter Mission (MOM),. It is with respect to Chapter 5 of the book.

'Indian Space Research Organisation (ISRO)' is the Indian space agency under the Department of Space, Government of India. ISRO was established on August 15, 1969 and it is currently headquartered in Bengaluru, Karnataka. ISRO is the world's first space agency which successfully completed Mars mission in the first attempt. The accomplishment of 'first time right' to the ISRO will not be overstated. ISRO's Mars Orbiter Mission (MOM), also called Mangalyaan was launched on November 05, 2013 and it entered into Mars orbit on September 24, 2014. After this event, India became the world's fourth and Asia's first country that has successfully completed the Mars Mission. The MOM project of ISRO proved to be cost effective and it was acknowledged as a successful project completed with the least cost. The total cost of MOM project was approximately $73 million . It was just a fraction of $650 million spent by NASA on its Mars probe, Maven. The cost effectiveness of the project can be attributed to the following reasons:

- Simple and light-weight design
- Domestic technology
- Long working hours
- Low manpower costs
- Effective time management

MOM is a suitable example of successful project management because every small detail of the project was perfectly planned. All over the world, 51 mars missions have been conducted so far and only 21 out of these ended successfullywith success. The uniqueness of ISRO's mission can be gauged by the fact that ISRO took only 15 months to complete this project whereas NASA took over 5 years to complete Maven.

The success of this project can be attributed to effective project planning and decision making. ISRO was able to achieve success by fulfilling small goals during the entire project lifecycle of MOM.

ISRO was quite aware that a fair and responsible feasibility study is the first and foremost requirement for the success of any project. ISRO also knew that most of the Mars mission projects had failed in orbits. Therefore, ISRO spent about $ 21 million (28.76%

CASE STUDY 7

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of the total project cost) only on the study of orbiters. During the feasibility study, ISRO also found that the Geosynchronous Satellite Launch Vehicle (GSLV) had failed twice in 2010 and hence, it was not advisable to use GSLV. The only viable alternate available was Polar Satellite Launch Vehicle (PSLV) which was considered as less powerful. In this situation, if ISRO had decided to wait for the new batch of Launch Vehicles (LVs) then, the MOM project would have been delayed for at least three years. Therefore, ISRO decided that it would launch 'Mangalyaan' on the advanced version of PSLV so that, there would be no delay in the project. ISRO scientists also ensured that PSLV used for the launch of Mars Orbiter had the capacity to carry 'Mangalyaan'. After conducting the feasibility study, ISRO constructed a Work Breakdown Structure for MOM project. As per the WBS framework of MOM project, the whole project was divided into various activities and all these activities were further divided into sub-activities. The WBS structure of MOM project is shown in the Table 5.1:

TABLE 5.1: WORK BREAKDOWN STRUCTURE OF MOM

Project Mgmt. (01)	Project System Engg. (02)	Mission Assurance (03)	Science (04)	Payload and Flight System (05)	Mission Operations System (06)	Launch System
Project mgmt. (01:01)	Project system engg. (02:01)	Mission assurance mgmt. (03:01)	Science mgmt. (04:01)	Payload mgmt. (05:01)	Mission operations mgmt. (06:01)	Launch services (07:01)
Business mgmt. (01: 02)	Mission design (02:02)	System safety (03:02)	Science team (04:02)	Payload system engg. (05:02)	Ground data systems (06:02)	
Risk mgmt. (01:03)	Information systems (02:03)	Environments (03:03)	Science data support (04:03)	Instrument mgmt. (05:03)	Other operations (06:03)	
Project plans and support (01:04)	Configuration mgmt. (02:04)	Reliability (03:04)	Educational outreach (04:04)	Common payload systems (05:04)		
Review support (01:05)	Launch system engg. (02:05)	Electrical and electronic parts engg. (03:05)		Payload information technology (05:05)		
Facilities (01:06)		Pollution control (03:06)		Spacecraft contract (05:06)		

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Project Mgmt. (01)	Project System Engg. (02)	Mission Assurance (03)	Science (04)	Payload and Flight System (05)	Mission Operations System (06)	Launch System
Foreign travel –ITAR (01:07)				Telecom subsystem (05:07)		
				Thermal subsystem (05:08)		
				Spacecraft assembly test and verification (05:09)		

The next task of MOM mission was the estimation of the overall cost of the project. ISRO estimated the overall cost of MOM by classifying all the costs in three broad categories which were:

- Project definition tasks
- Cost methodology tasksCosts estimate tasksThe task wise cost estimation of MOM is shown in Figure as follows:

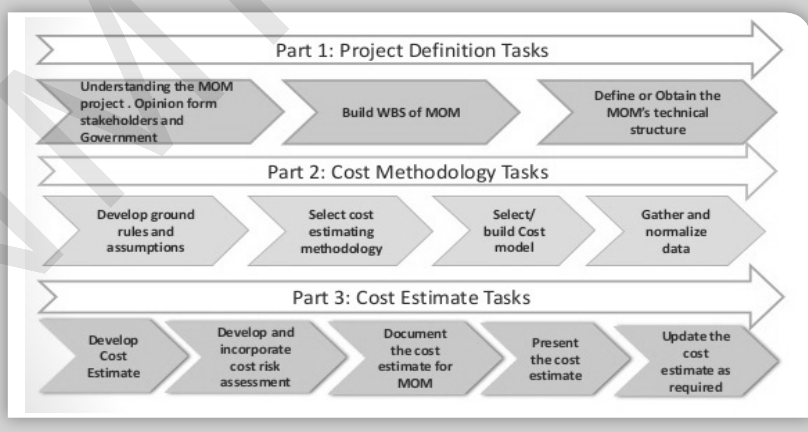

Figure: MOM Cost Estimation

From all the information presented in the text above, it can be concluded that the success of MOM was the result of effective projective planning and decision making.

QUESTIONS

1. What were the reasons behind the cost effectiveness of ISRO's Mars mission?

   (**Hint:** Simple and light-weight design; Domestic technology; etc.)

CASE STUDY 7

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2. Describe how feasibility study helped ISRO in its MOM mission.

   (**Hint:** In ISRO's Mangalyaan project, feasibility study was quite important because after conducting feasibility study it was found out that GSLV is not a good option for Mangalyaan project.)

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CASE STUDY 8

PROJECT SCHEDULING AT SUDHA AUTOMOBILES LIMITED

This Case Study discusses the process of scheduling for the construction of a new manufacturing plant at Sudha Automobiles Limited. It is with respect to Chapter 6 of the book.

Sudha Automobile Limited is a mid-size manufacturing company based in Dharuhera Industrial Area in Rewari district of Haryana. The company manufactures handle bars for various reputed two wheeler manufacturers in Delhi-NCR. The demand for their products is quite high because of company's quality assurance practices.

Sudha Automobile was facing a tough time as such a high demand cannot be fulfilled by their existing plant because it was already working with its full capacity. Therefore, the top management of the company decided to invite tenders for the construction of its new plant. In the auction, Radhe Construction Company won the bid of ₹ 6 crores for constructing the project. Consequently, a construction agreement was signed between Sudha Automobile Limited and Radhe Construction Company. The construction agreement included the following two provisions:

- There will be a penalty of ₹ 300000 if the construction project is not finished within 47 weeks.
- There will be a bonus of ₹ 150000 if the construction project is finished before 40 weeks.

Various activities and their estimated duration under the project are listed in the following table:

TABLE: TYPE OF ACTIVITIES AND THEIR DURATION

Activity	Description of Activity	Predecessor Activity	Activity Wise Estimated Duration (In Weeks)
A	Evocation of the site (Site clearing and digging)	-	2
B	Lay the foundation	A	4
C	Rough construction of walls	B	10
D	Roof construction	C	6
E	Exterior plumbing installation	C	4

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Activity	Description of Activity	Predecessor Activity	Activity Wise Estimated Duration (In Weeks)
F	Interior plumbing installation	E	5
G	Putting up of exterior siding tiles	D	7
H	Exterior painting	E, G	9
I	Electrical work	C	7
J	Putting up of interior wallboards	F, I	8
K	Flooring	J	4
L	Interior painting	J	5
M	Exterior fixtures installation	H	2
N	Interior fixtures installation	K, L	6

QUESTIONS

1. Using information on activities and their duration given in the case, prepare a PERT chart for this project.

   (**Hint:** While creating the PERT chart, remember that an activity can be initiated only if its preceding activity (or activities) has been finished and all activities have been completed by the following precedence relationships. For instance, activity E and G must be finished before starting activity H.)

2. Consider the PERT chart developed in the above question and calculate the time required for project completion.

   (**Hint:** The sum of duration of all activities of a PERT chart can be referred as the total time required for completion of the project. However, you may also have to consider the average duration if two or more activities are completed at the same time.)

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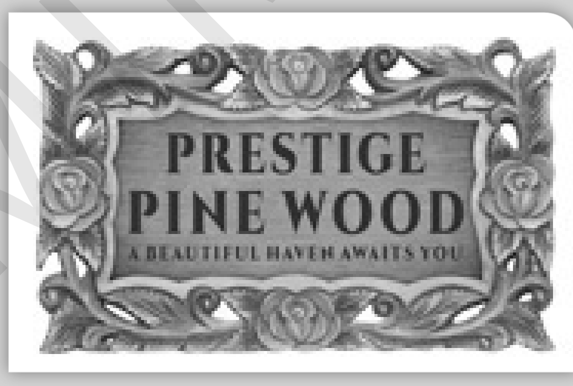
CASE STUDY 9

EARNED VALUE ANALYSIS OF PRESTIGE PINEWOOD

This Case Study discusses the process of tracking and forecasting project progress for the Prestige Pinewood Project by using Earned Value Analysis (EVA). It is with respect to Chapter 7 of the book.

Earned Value Analysis (EVA) is a benchmark method for tracking and forecasting any industrial project. It is used to measure the progress of ongoing project at a given point of time. Prestige Pinewood Koramangala, based in Karnataka, is a housing project developed by the Prestige Group. The Prestige Group was founded in 1986 and is one of the largest real estate developer companies. By 2015, the company had completed more than 200 realty projects and has an annual turnover of more than ₹ 3500 crore. This project had to be developed in the area of 2.5 acres with a total of 256 apartments. The residential apartments of the project were to be built in three towers with an area of 618827 square feet. The first two floors of each tower are dedicated for providing a parking facility to the residents.



Source: https://www.prestigeconstructions.com/wp-content/uploads/2017/01/pine-wood-3.jpg

The project detail and description of Prestige Pinewood are depicted in the following table:

TABLE: PRESTIGE PINEWOOD PROJECT DETAILS

Description	Detail
Client name	Prestige Group
Contractor name	JMC India Private Limited
Project duration (in days)	528 days
Contract value of the project (in INR)	` 290233600

CASE STUDY 9

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Project cost estimation and project schedule preparation activities are shown in the following table:

TABLE: PROJECT COST DETAILS	
DESCRIPTION OF WORK	**COST (AMOUNT IN `)**
Preliminary work	14897000
Structural work	152076000
Masonry and finishing	20866000
Plastering work	29236000
Electrical	37318500
Plumbing and sanitary	16335100
Miscellaneous work	19505000
Total	**290233600**

The month and year wise Earned Value (EV), Planned Value (PV) and Actual Cost (AC) of the Prestige Pinewood project are given in the following table:

TABLE: EV, PV AND AC OF PRESTIGE PINEWOOD PROJECT			
Months'year	**Ev (Amount In `)**	**Pv (Amount In `)**	**Ac (Amount In `)**
May'16	3724250	4469100	4469956
June'16	7448500	9686050	9687565
July'16	18890400	26185950	26000778
August'16	34916740	42108540	42158702
September'16	51845940	60835690	62378427
October'16	81502380	80774280	93046134
November'16	91565640	93257640	105693306
December'16	107273560	111548560	123754251
January'17	123234940	128904530	140887962
February'17	140704640	146231020	157866829
March'17	148718720	156712360	168111943
April'17	166258450	172919560	184616698

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CASE STUDY 9

QUESTIONS

1. Calculate month-wise Schedule Variance (SV) and Cost Variance (CV) for 2016-17. Also comment on results.

   (**Hint:** Calculate SV and CV by using formulas SV = EV – PV and CV = EV – AC, respectively. Comment by considering the values of SV and CV. For instance, SV < 0 indicates that project is behind the schedule and CV > 0 indicates that actual expenses are less than planned expenses.)

2. Calculate month-wise Schedule Performance Index (SPI) and Cost Performance Index (CPI) for 2016-17. Also comment on results.

   (**Hint:** Calculate SPI and CPI by using formulas SPI = and CPI = respectively. Comment by considering the values of SPI and CPI. For instance, SPI < 1 indicates that the project is behind the schedule.)

CASE STUDY 10

NOTES

POSITIVE AND NEGATIVE PROJECT TERMINATION

This Case Study elaborates that project termination doesn't always mean that a project has failed. It is with respect to Chapter 8 of the book.

Usually, the phrase 'project termination' has a negative connotation and is considered to be project failure. However, it is not always true because a successful termination of a project is also possible. Projects may be terminated as a result of poor project management; but a project may also be terminated in case the project had been managed successfully and gets terminated earlier than planned.

Barry W. Boehm, Software Engineering Professor at the University of Southern California, had conducted a research study related to project termination and he concluded that project termination does not always equal project failure. Prof. Boehm explains that it is incorrect to consider project termination as project failure and sometimes a successful project may also require termination. He explains that a well-managed project can be terminated because of change in original assumptions. In his study, Prof. Boehm observed that a project is usually terminated as a result of 10 major sources, which are explained as follows:

- **Incomplete requirements:** Incomplete requirements are the reason for 13.1 per cent failed projects reported in the study. A project terminates as a result of incomplete requirements when it is not managed properly or when there is no clear idea about the requirements and priorities of stakeholders. It may also occur when stakeholders disagree with the statement of requirements.
- **Lack of user involvement:** Lack of user involvement is a reason for 12.4 per cent failures reported in the study. Project termination also occurs because of miscommunication between project team members, clients and vendors. In this scenario, it is wise to terminate such a project because it may not be able to satisfy users.
- **Lack of resources:** Lack of resources is one of the most significant sources of project termination and accounts for 10.6 per cent failures reported in the study. Budget cuts or downsizing is a common practice to deal with the problem of lack of resources. At times, lack of resource availability affects the business value of the project that leads to project termination.
- **Unrealistic expectations:** Unrealistic expectations with the project account for 9.9 per cent failures reported in the study. Poorly managed projects fail to validate the feasibility of user

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expectation(s) which lead to project termination. On the other hand, when a project manager tries to validate feasibility of unrealistic expectations by using immature technology, then a well-managed project also leads to termination.

- **Lack of executive support:** Lack of executive support accounts for the 9.3 per cent project failures reported in the study. Unrealistic assumptions regarding the executive support in the project leads to mismanagement of the whole project which ultimately results in project termination. For instance, a project manager relies on the executive support pertaining to the project needs. However, there might be a situation where an individual with different ideology replaces an earlier project executive. Then in such situation, an on-going project can also be terminated because the new executive may have a different opinion or different agenda regarding the project.
- **Changing requirements:** Change in project requirements generally results when the project manager is unskilled and it accounts for 8.7 per cent failures reported in the study. A project may also be terminated when the project requirements related to the scope statement changes while project budget and schedule remains unchanged. Change in project requirement also occurs when there is change in market climate and in this case, a well-managed project may also need to be terminated.
- **Lack of planning:** Lack of planning is the reason for 8.1 per cent failures reported in the study. Lack of project planning implies improper project management which may lead to project termination.
- **Absence of need:** Absence of need accounts for 7.5 per cent failures reported in the study. Absence of need may occur in well-managed and poorly-managed projects.
- **Lack of IT management:** Lack of IT management occurs in the case of poorly managed projects and it is responsible for 6.2 per cent failures reported in the study.
- **Technology illiteracy:** Technology illiteracy of project manager or other project members is a sign of project mismanagement and it may ultimately result in project termination. It is the reason for 4.3 percent failures reported in the study.

In his study, Prof. Boehm also observed that there are certain steps that help in ensuring project success along with healthy and cost effective termination of the project. These steps are presented in the following figure:

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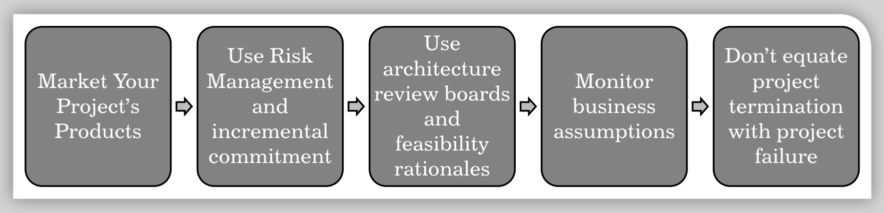

Figure: Steps to Ensure Successful Project Termination

QUESTIONS

1. Explain various sources of project termination observed by Prof. Boehm that are only found in poorly managed projects.

   (**Hint:** Technology illiteracy, lack of planning, etc.)

2. In the study conducted by Prof. Boehm, what is the major source of maximum failures of projects?

   (**Hint:** Incomplete requirements)

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CASE STUDY 11

HIVE: SOFTWARE SOLUTION IN PROJECT MANAGEMENT

This Case Study discusses the usefulness of Hive as a project management software solution and explains the implementation of Hive for its client Barefoot Proximity. It is with respect to Chapter 9 of the book.

The use of Project Management software has now become an essential element of projects to ensure successful completion. Due to this, it is now used by almost all project managers across the globe. In markets, various Project Management software applications are available. Organisations may choose Project Management software according to their project requirements.

Hive is cloud-based Project Management software. Hive combines various external systems into a common dashboard. This enables project participants to concentrate more on their productivity and quality. Hive has a sufficient capacity to combine around hundred external tools into its dashboard. Following are some important features of Hive:

- **Transparency in project management:** Hive ensures transparency in project management by keeping all data related to a particular project in a simple and organised form. This is shown in Figure 1:

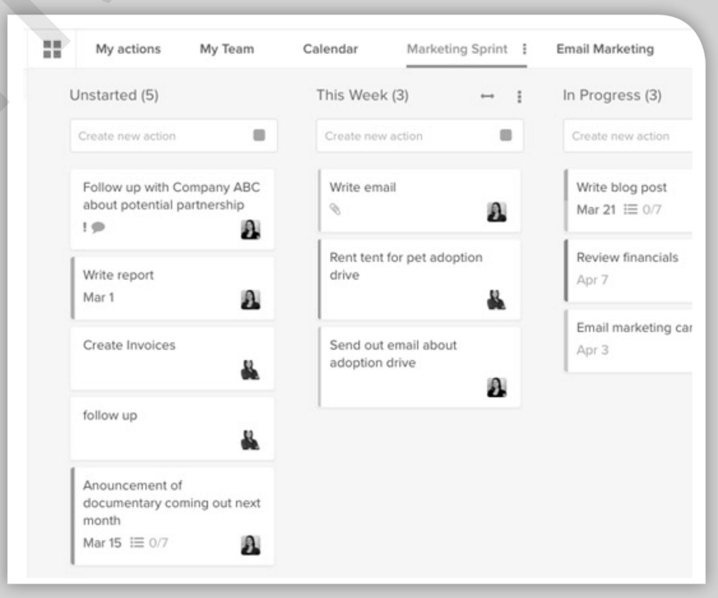

Figure 1: Project Organisation in Hive

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Figure 2 displays the Gantt Chart for a Website project in the Hive dashboard:

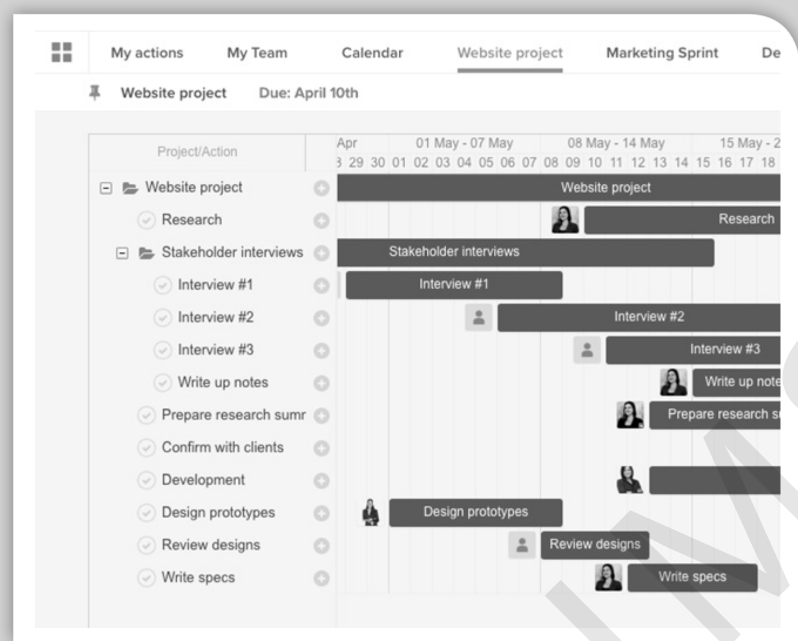

Figure 2: Gantt Chart for Website Project

- **Better communication and team collaboration:** Hive enables project teams to communicate in a better way and all team members can communicate directly through messages. Automated messages from various other tools can also be accessed via Hive dashboard. The example of the Hive communication process is shown in Figure 3:

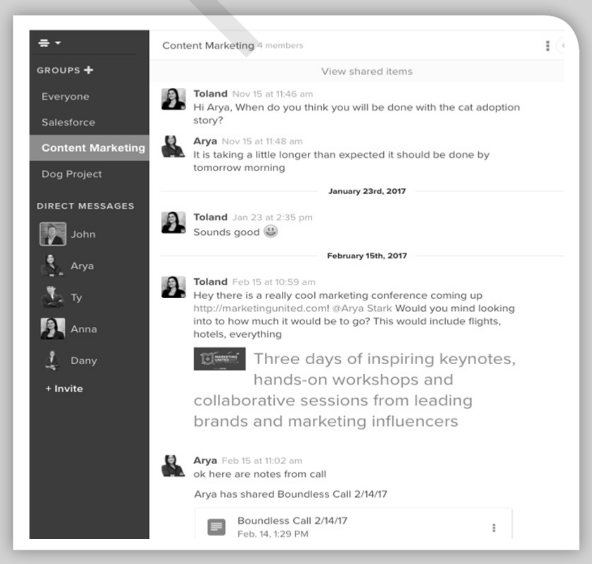

Figure 3: Better Communication by Using Hive

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CASE STUDY 11

This helps in better team collaboration and project teams working at remote areas can also be easily instructed.

- **Handling multiple projects:** A Hive user can create a large number of projects at one time and this is shown in Figure 4:

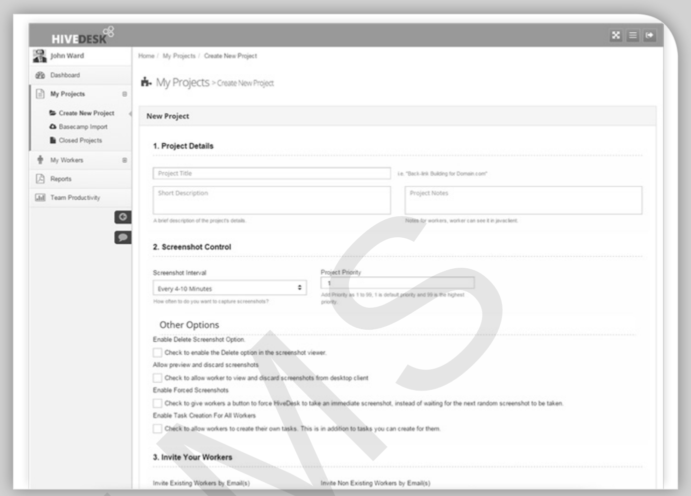

Figure 4: Creating Projects on Hive

- **Inviting team members:** A project manager using Hive can invite his/her team members to join the project. It also allows an organisation's PMO or senior management which handles multiple projects to assign project managers for various projects, schedule project tasks, change user permissions, etc. This is shown in Figure 5:

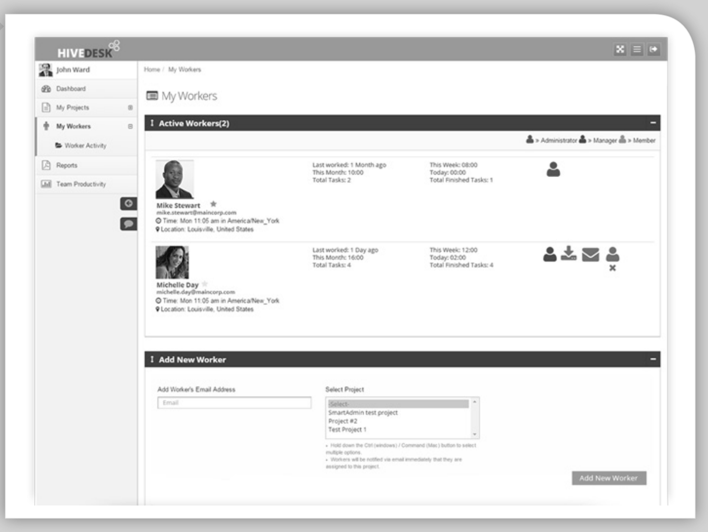

Figure 5: Inviting Team Members on Hive

- **Tracking time of team members:** Time tracking of project team especially for those teams that work in remote places is

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an important measure to ensure the successful completion of a project. Hive allows project managers to view and monitor the time taken by various members of project team. A project manager can view and generate reports regarding the team activity. He/she can also review and edit the time allocated to a particular team member. This is shown in Figure 6:

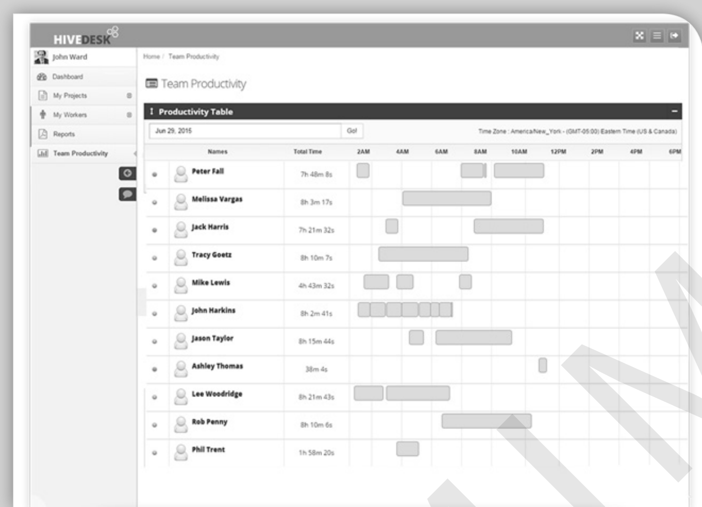

Figure 6: Team Productivity and Time Tracking in Hive

- **Easy workflow process:** One of the most significant features of Hive is that it processes complex projects in a simple manner. Hive provides various templates that ensure the automatic assignment of many project tasks. A user can choose each task separately and then allocate them to various members of project teams.

Hive has also helped one of its clients Barefoot Proximity, a marketing agency based in Cincinnati, Ohio, United States. The company offers customised and creative solutions to derive brand vision of their clients. Its main clients deal in consumer goods and lifestyle products.

However, this process of value creation was quite complex because every project required a large number of e-mail exchanges with clients. The company was using online spreadsheets to track various projects and manual spreadsheet needed to be updated for each project and a lot of time has been consumed in this process. At the time of weekly status meetings, the project manager or other team members were asked for updates regarding any particular project. Therefore, they needed to go through from all the projects by accessing manually updated spreadsheets.

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Mr. Stu Spalding, Project Manager at Barefoot Proximity became so frustrated with all this that he decided to subscribe to Hive cloud based project management software. After couple of weeks Mr. Spalding observes that various projects have been carried out more efficiently after the implementation of Hive. Now, whenever a new project comes then it is immediately assigned with the proper resources with all the required files attached. The company still conducts status meetings but now they use Hive under which all project status reports are easily accessible with just one click. There is also a significant reduction in the number of steps required to finish any project. In addition, the number of e-mails has also been reduced. Now, all projects require not more than two e-mails; one to start the project and one to deliver results.

QUESTIONS

1. Discuss the main features of Hive.

   (**Hint:** Transparency in project management; etc.)

2. Explain various problems faced by Barefoot Proximity. Also, discuss various positive outcomes achieved after the implementation of Hive.

   (**Hint:** Requirement of a large number of e-mails, manually updated spreadsheets, etc.)

CASE STUDY 12

NOTES

PROJECT EFFICIENCY ACHIEVED BY IMPLEMENTING MICROSOFT PROJECT SOFTWARE AT ALFMEIER

This Case Study discusses the efficiency in project planning achieved by Alfmeier with the help of Microsoft Project Server. It is with respect to Chapter 10 of the book.

Alfmeier is a global precision engineering company that manufactures precision system solutions and is headquartered in Treuchtlingen, Germany. The company has around 2000 employees at 13 global locations in 6 countries. Alfmeier is a leading player in the global automotive industry and its major products are valves, actuators, pumps and controllers. The company also produces modular systems in manufacturing facilities of Treuchtlingen, Pilsen, Shanghai and Monterrey. The core competencies of the company include plastic technology, electronics, mechatronics, fluid technology and various other industrial solutions.

ALFMEIER

Source: http://www.alfmeier.de/index.php?id=107&L=1

A few years prior to 2017, project managers at Alfmeier were using a mix of different project management solutions that included SAP PS and other tools for project planning. There were many projects and many project managers. Each project manager had his/her own project management tool preferences. Hence, if a top management executive needed to track the progress of all projects and combined project costs; they had to communicate with each project manager separately.

Alfmeier had operations in various countries due to which different project managers requested to create projects in SAP PS. However, documents produced by their teams while carrying out the project were usually in formats such as Word and Excel. These documents usually contained data regarding cost estimates, proposal approvals and change requests.

Generally, project team members entered the timesheet information in SAP. However, project managers processed reports using various tools such as Excel, PowerPoint, Access, Word, APIS and

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QlikView. Due to this, it became quite difficult for Alfmeier to consolidate and report all the available information. And this leads to problems in project planning, decision making, project scheduling, cost and resource planning, and reporting.

Due to all prevailing problems, Alfmeier decided that they need to centralise and streamline the project planning activity. After reflecting upon current problems and their possible solutions, the company decided to adopt on the Microsoft Project Server. The company meanwhile had hired a consultant as well. The consultant customised more than 100 user-defined fields in the Microsoft Project Server for the company. In addition, the consultant also implemented a tailor-made software solution in order to synchronise information between the project management and ERP systems of the company. This solution enabled multi-level scheduling for large projects having multiple sub-projects.

Alfmeier adopted the Project Management Server in May 2016 and since then the whole production system is working smoothly. It also provides support to all new and existing projects. Microsoft Project Server makes various aspects of project planning (i.e. scheduling, resource planning, reporting of actual and planned costs, etc.) significantly less time consuming. As a result, a lot of time and money has been saved that facilitates the successful and on time completion of all projects within the budget. It helps to standardise the entire project planning procedure which allows the access of each and every project with just one click.

Various benefits realised by Alfmeier are listed as follows:

- Savings in time and money
- Increased project visibility
- Accelerated reporting
- Increased ability to complete even complex projects on time and on budget
- Bi-directional synchronisation between Microsoft Project Server and SAP
- Project information such as WBS elements, planned costs, actual costs, profitability information and resource updates from Project Server are sent to SAP
- Enables cross-project linkages

CASE STUDY 12

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QUESTIONS

1. What was the major issue faced by project managers at Alfmeier?

   (**Hint:** Alfmeier had global operations and each project manager had his/her own project management tool preferences. The documents produced by their teams while carrying out the project were in varied formats.)

2. Explain how the consultant helped Alfmeier in its Microsoft Project Server implementation.

   (**Hint:** Here you need to list and discuss the benefits received by Alfmeier as a result of Microsoft Project Server implementation.)