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Project Management and Operations Research

SEMESTER - 3

MASTER OF COMMERCE

BLOCK - 1

KRISHNA KANTA HANDIQUI STATE OPEN UNIVERSITY

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MASTER OF COMMERCE

PROJECT MANAGEMENT AND OPERATION RESEARCH

Block 1

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COURSE INTRODUCTION:

'Project Management and Operations Research' is the fourth course of the programme M.Com 3rd semester .The course is divided into two blocks.The first block consists of seven units and second block consists of eight units.

The basic principles and theory have been explained in a simple,concise and lucid manner in this course .Adequate number of illustrative examples have also been included to help the learners to grasp the course easily.

Block 1 deals with the concept of project Management.Concepts related to project analysis,selection and planning are included in this block.Topics related to project scheduling and PERT CPM are also covered in this block.Concept of project completion and Evaluation will also be discussed in this block.

Block 2 deals with the basic concept operation research. Various techniques of operation research willl be discussed in this block.

BLOCK INTRODUCTION:

This is the first block of the course 'Project Management and Operations Research'. The block consists of seven units.This block is devoted to the topics of project management.Project Management is very crucial for the timely implementation of a project within the estimated time and money.

Unit 1 deal with historical background on project management and its overall evolution.

Unit 2 describe about the organizational context.

Unit 3 discusses about project analysis and selection.

Unit 4 covers the concept of project planning..

Unit 5 introduces fundamental concepts of project scheduling and PERT CPM.

Unit 6 deals with the concept of implementation and control of a project.

In Unit 7, we will discuss about project competion and evaluation.

While going through a unit, you will notice some along-side boxes, which have been included to help you know some of the difficult, unseen terms. Again, we have included some relevant concepts in "LET US KNOW'' along with the text. And, at the end of each section, you will get "CHECK YOUR PROGRESS" questions. These have been designed to self-check your progress of study. It will be better if you solve the problems put in these boxes immediately after you go through the sections of the units and then match your answers with "ANSWERS TO CHECK YOUR PPROGRESS" given at the end of each unit.

UNIT 1 : INTRODUCTION TO PROJECT MANAGEMENT

UNIT STRUCTURE

1.1 Learning Objectives
1.2 Introduction
1.3 Meaning and Features of Project
1.4 Meaning of Project Management
1.5 Need of Project Management
1.6 Life Cycle of a Project
1.7 Life Cycle Curve
1.8 Let Us Sum Up
1.9 Further Reading
1.10 Answers To Check Your Progress
1.11 Model Questions

1.1 LEARNING OBJECTIVES

After going through this unit, you will able to-

- the meaning and features of project
- the meaning of project management
- need of project management
- life cycle of a project and life cycle curve.

1.2 INTRODUCTION

Project Management is an important and distinct area of management. It helps in handling projects. It is often associated with fields of engineering and construction, health care, information technology (IT) etc. In this unit, we will define a project, project management, and learn about the need, and life cycle of a project.

1.3 MEANING AND FEATURES OF PROJECT

By a project we mean ‘a temporary endeavour undertaken to create a unique product or service or result’. By the term ‘temporary’, we mean

that the project has a definite beginning and end. By 'unique product or service or result', we mean that the product or service or result is different in some form or the other from all products or services or results of the same kind. Thus, a project is a piece of work which has a beginning and end, and goals. Projects can be very simple or very complex. Organising a picnic is a simple project, whereas constructing a telecommunication satellite is a complex project.

There are different types of projects such as construction and engineering projects, petrochemical projects, agricultural projects, military and aerospace projects, IT and computer projects, advertising and marketing projects etc.

Some of the salient features of a project are as follows.

1. Each project is unique by itself.
2. Each project has definite objectives.
3. A project requires resources (equipment and workforce).
4. A project has a time limit.
5. A project involves risk and uncertainty.
6. A project must have cross-functional terms and interdisciplinary approach.



CHECK YOUR PROGRESS

Q 1: Give five examples of project.

.....

.....

.....

1.4 MEANING OF PROJECT MANAGEMENT

By Project Management, we mean 'the application of knowledge, skills, tools, and techniques to project activities to meet the project requirement'. It is the way a person organises and manages resources that are necessary to complete a project. People who manage projects are known as Project Managers.

Project Management has three key features. They are as follows,– a project manager, the project team, and the project management system.

1.5 NEED OF PROJECT MANAGEMENT

1. Project Management helps in handling projects. It brings leadership and direction to projects. Without Project Management, a team is like a rudderless ship.
2. Project Management ensures that there is a proper plan for executing on strategic goals.
3. Project Management helps in managing complex, risky, costly projects by providing interdisciplinary approach.
4. Project Management helps in managing assignments within a specified time limit with definite starting and completion points.
5. Project Management provides task orientation to personnel in an organisation in managing assignments.

1.6 LIFE CYCLE OF A PROJECT

A project has a finite life with a specific start and end. It passes through various phases just as a living being passes through several phases. According to A Guide to the Project Management Body of Knowledge (PMBOK) 5 ed (2012) Project Life Cycle is 'the series of phases that a project passes through from its initation to closure'.

Most projects pass through a four phases project life cycle. They are as follows.

1. Conception and Selection

The first phase of a project is conceptualisation and selection. The act of conceiving starts with the seed of an idea. It covers identification of the product/service, feasibility studies, and appraisal and approval. As soon as the idea becomes established, a proposal is prepared with definite method, estimated costs, benefits, and othe details for appraisal of the stakeholders. In other words, the first phase defines the goals, specifications, tasks, and responsibilities.

2. Planning and Scheduling

In the second phase, the project must be planned in details. A project plan is prepared covering the activities, tasks, dependencies, and time limit. The project manager coordinates the preparation of the project budget by providing information regarding costs, labour, equipment, etc. The three principal components of the planning process are identification of the work, preparation of the schedule, and estimation of the costs.

3. Implementation and Control

In this phase, plans are put into operation. Each of the activities is monitored, controlled, and coordinated to achieve the desired objectives. Some of the activities that are performed in this phase are, – communication with stakeholders, frequent review of progress, monitoring time and cost, control of quality, management of changes, etc.

4. Evaluation and Termination

This phase marks the completion of the project. Proper emphasis is given on releasing the deliverables i.e., the tangible end products to the customer. The closure of the project is communicated to all the stakeholders.

1.7 LIFE CYCLE CURVE

Life cycle of a project can be shown with the help of a curve. There are two types of curves, – S shaped, and J shaped.

In the S shaped curve, the progress is slow at the starting and the terminating phases, whereas the progress is fast in the implementation stage (Fig 1.1)

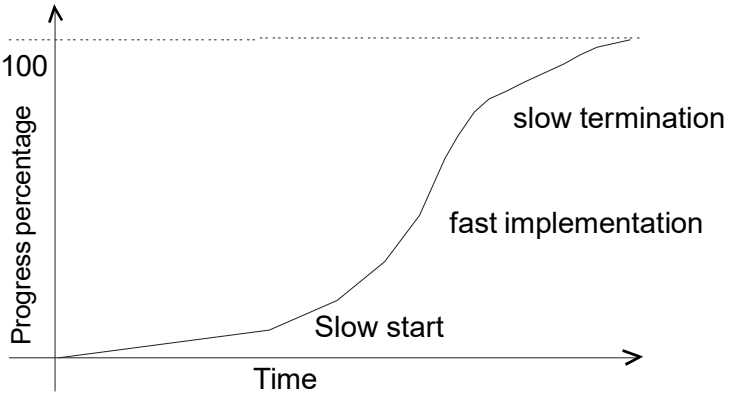


Fig 1.1

In the J shaped curve, the progress is slow at the starting phase, whereas the project improves at fast rate as the time passes (Fig 1.2)

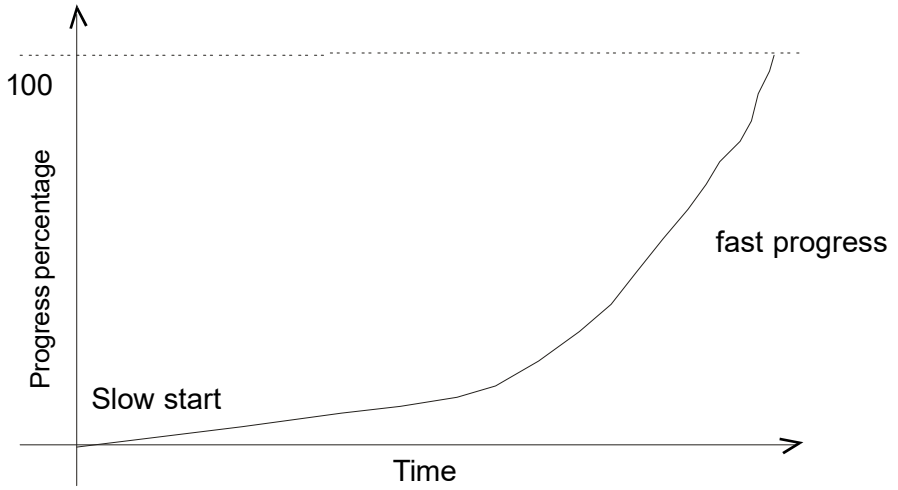


Fig 1.2



1.8 LET US SUM UP

- Project is 'a temporary endeavour undertaken to create a unique product or service or result'
- Project Management is an important and distinct area of management.
- Project Management is 'the application of knowledge, skills, tools, and techniques of project activities to meet the project requirements'.
- A project has a finite life with a specific start and end. Most projects pass through a four phase life cycle. They are as follows :
  1. conception and selection,
  2. planning and scheduling,
  3. implementation and control,
  4. evaluation and termination.



1.9 FURTHER READING

1) *Project Management :* Planning and control techniques by Rory Burke (Wiley, 2013).

2) *Project Management* (The Open University of Hong Kong).

3) *Fundamentals of Project Management* by James P. Lewis (AMACOM, 3rd edition).



1.10 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: Five examples of projects–

(a) construction and engineering project,

(b) petrochemical projects,

(c) agricultural projects,

(d) military and aerospace projects,

(e) IT and computer projects.



1.11 MODEL QUESTIONS

Q 1: Define a Project, and Project Management.

Q 2: Give three examples of complex project.

Q 3: Write the salient features of a project.

Q 4: Write the needs of Project Management.

Q 5: What is meant by life cycle of a project. Describe its various phases.

Q 6: Draw the two Life Cycle Curve giving proper explanation of each.

*** ***** ***

UNIT 2 : THE ORGANISATIONAL CONTEXT

UNIT STRUCTURE

2.1 Learning Objectives

2.2 Introduction

2.3 Project Stakeholder Management

2.4 Identifying Project Stakeholders

2.5 Managing Project Stakeholders

2.6 Project Organisational Structure

2.7 Functional Organisation

2.8 Matrix Organisation

2.9 Pure Project Organisation

2.10 Meaning of Organisational Culture

2.11 Organisational Culture and Project Management

2.12 Let Us Sum Up

2.13 Further Reading

2.14 Answers To Check Your Progress

2.15 Model Questions

2.1 LEARNING OBJECTIVES

After going through this unit, you will able to-

- know about project stakeholder management, identifying project stakeholders, managing project stakeholders
- know about different forms of project organisation structure
- know about impact of organisational structure on project management
- organisational culture and project management.

2.2 INTRODUCTION

Any project is considered to be a success if it meets its objectives and fulfills the expectations of the wide range of people who are affected by the project. Therefore, stakeholder management is crucial for success of a

project. Again project organisations structure is a project management technique. It enables the project manager to lead and manage a multi-discipline project organisation. In this unit, we will study project stakeholder management,– identifying project stakeholders, managing project stakeholders. Also, we will study project organisation structure, functional organisation, matrix organisation, pure project organisation.



LET US KNOW

A project manager is the person responsible for leading a project from its inception to execution. The project manager has the responsibility to manage and achieve the project's objectives

2.3 PROJECT STAKEHOLDER MANAGEMENT

Stakeholder, according to the PMBOK 5ed (2012), is 'an individual, group, or organization who may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project'. Therefore, the project manager must be able to identify the needs and expectations of the stakeholders.

PMBOK : Project Management Body of knowledge (USA)

Stakeholder Management, according to the APM Bok 6 ed (2012), 'is the systematic identification, analysis, planning and implementation of actions designed to engage with stakeholders'. Therefore, stakeholder management is a critical component to the successful delivery of any project.

Project stakeholder management comprises four steps. They are as follows.

1. To identify, recognize and acknowledge stakeholder.
2. To determine their interest and influence.
3. To develop communication management plan.
4. To engage and influence stakeholders.

APM Bok : Association of Project Managers body of knowledge (UK)



CHECK YOUR PROGRESS

Q 1: 'Project stakeholder Management comprises four steps'. Writer down these four steps.

.....

.....

2.4 IDENTIFYING PROJECT STAKEHOLDERS

Projects are undertaken to fulfill the requirements of stakeholders. A project is considered to be successful if all the stakeholders are satisfied. The identify stakeholders process is used to identify all people or organisations that may be impacted by or have an impact on a project.

Rory Burke, in his outstanding book **Project Management** (5th ed 2013), has identified the following stakeholders from the project manager's–

1. Client project sponser
2. Project Steering Board ('a collection of eminent experienced practitioners').
3. Project Team.
4. Functional Managers (''who 'own' the company's resources, machines and equipment'').
5. Contractors.
6. Suppliers.
7. Consultants ('to provide expert advice on technical and professional matters').
8. Uses (It should be borne in mind that users are not customers. Users are the people 'who will operate the project or facility on behalf of the owner of the facility').
9. Regulators ('government departments and other national and international statutary bodies that have the authority to impose their rules and regulations on the project').
10. Lobby Groups ('special interest groups')
11. Customers
12. Local Residents

13. Competitors ('other companies that are vying for the some market')
14. Support companies (the organisations that provide goods and services to enable the project to be built').

The project manager must identify the key project stakeholders. Some of the characteristies of key project stakeholders are as follows.

1. Thay have the decision making power to define the course of the project.
2. They have the power to define what success means for the project.
3. Their decisions affect larger groups of people.
4. Their level of satisfaction with the project affects future business.

Some of the benefits of identifying the right stakeholders are as follows.

1. The quality of the project can be improved. Stakeholders can give vital information regarding the project. Nothing important is missed.
2. Delay can be avoided by making stakeholders supporters. Stakeholders should not be regarded as obstacles.
3. Supporters can provide extra resources for the project.

If the stakeholders are not identified properly.

(1) the project may go over budget,
(2) important deadlines may be missed,
(3) time and energy of the people delivering the project may be wasted,
(4) the project may be a failure.

2.5 MANAGING PROJECT STAKEHOLDERS

Stakeholders are people. Some will be easier to manage than others. The project manager must have the skill to deal with a variety of persons.

Herman Mehling has sought the 'advice' of 'three experienced project managers' on management of stakeholders. On their 'advice', Mehling has come to the conclusion that stakeholders can be managed 'effectively' by the following eight ways.

1. Identify all the stakeholders at the beginning of the project.
2. Eusure all the stakeholders agree on the project's deliverables and what their roles are.

3. Get consensus on how to handle changes to the project.
4. Practise good communication.
5. Keep the project vision visible.
6. Engage stakeholders throughout the process.
7. Agree on what 'done' is.
8. Finally, don't forget to empathize with other stakeholders.

2.6 PROJECT ORGANISATIONAL STRUCTURE

The project organisational structure is a project management technique. It has a major impact on the execution of a project. It decides the resources, communication methods, and other aspects of project management.

According to Rory Burke, the project manager's challenge is to develop a project organisation structure that reflects.

- the needs of the client
- the needs of the project
- the needs of the project team members,
- the needs of the stakeholders.

Rory Burke has further opined that "an organization structure enables a company to group people in a controlled manner for the purpose of performing work ".

There are three main types of project organisation structure viz

- Functional organisation,
- Matrix organisation,
- Pure project organisation.



CHECK YOUR PROGRESS

Q 2: Write down the three main types of project organisation structure.

.....

.....

2.7 FUNCTIONAL ORGANISATION

Functional organisation, according to The PMBOK 5ed (2012), 'is a hierarchical organization where each employee has one clear superior, and staff are grouped by areas of specialization and managed by a person with expertise in that area'.

A typical functional organisation structure is shown in figure 1.

[Courtesy : Project Management (5th ed 2013) by Rory Burke]

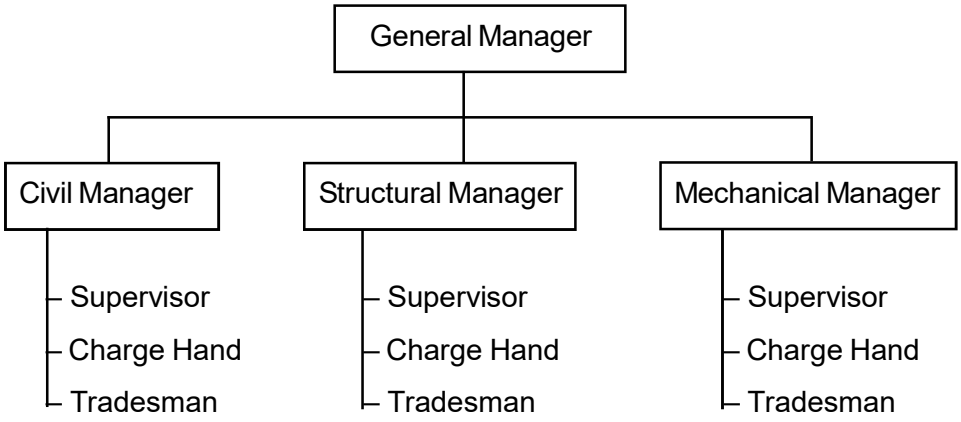


Figure 1

Functional organisation structure is optimal for small businesses or companies producing standardised goods or services.

Some of the advantages of functional organisation are as follows.

1. Functional organisation yields high level of specialisation.
2. Functional organisation can minimise the cost of operation.
3. Functional organisation can enhance the work efficiency and productivity due to specialised skills and technology.
4. In functional organisation, employees are possible to become experts.
5. In functional organisation, employees are highly motivated as they see their career path within the functional units.

Some of the disadvantages of functional organisation are as follows.

1. Wokers have to work under different bosses. It is difficult to maintain discipline among them.
2. There are several functional experts in the organisation. This may create the problem of coordination.
3. Control is divided among the various specialists. The speed of action is hampered.

4. If there is any unsatisfactory progress, it is difficult for the management to fix responsibility.
5. It is very expensive as a large number of specialists are to be appointed under this system.

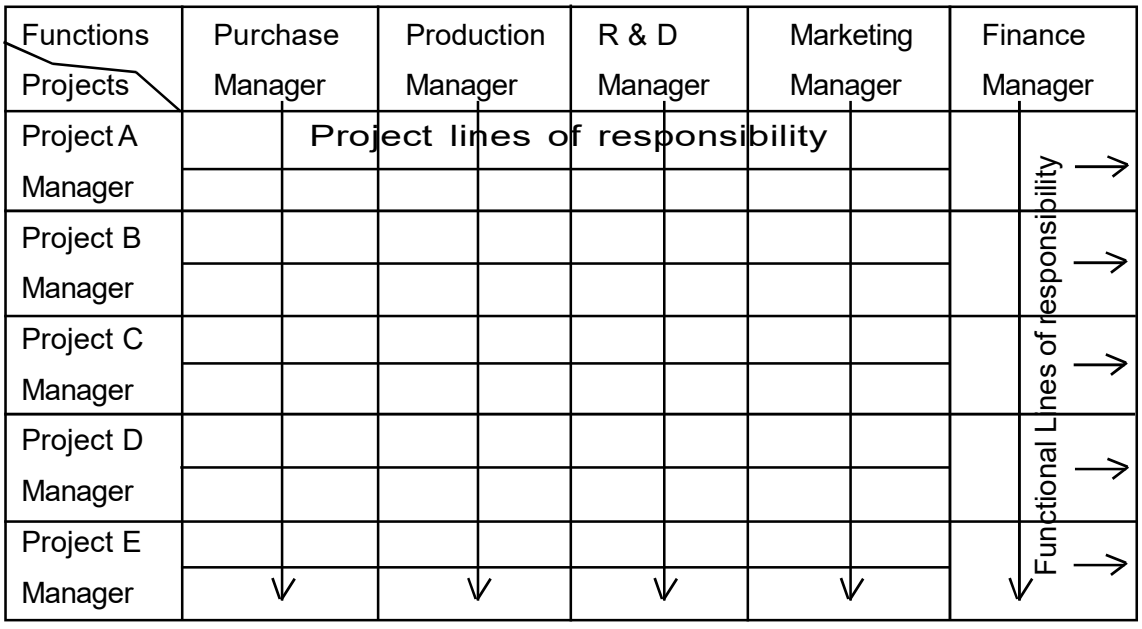
2.8 MATRIX ORGANISATION

Matrix organisation is a combination of two or more organisation structures.

The organisation is divided into different functions, for example, purchase, production, R & D, Marketing, Finance etc. Each function has a Functional Manager.

The organisation is also divided on the basis of projects, for example, Project A, Project B, Project C, Project D, Project E etc. Each project has a Project Manager.

The employer has to work under two bosses. The authority of the functional manager flows downwards (vertical). On the other hand, the authority of the Project Manager flows across (horizontal). Thus, the authority flows downwards and across. So, it is called a Matrix Organisation. An example is given below (Figure 2).



(Courtesy : Project Management DMGT521 Lovely Professional University)

The Characteristics of matrix organisation are as follows.

1. Matrix organisation is a combination of two or more organisation structures. There are two chains of command, one along functional lines, and the other along project lines. Thus, it has the merits and demerits of both these organisation structures.
2. The functional manager has authority over the technical aspects of the project.
3. The project manager has authority over the administrative aspects of the project.
4. The subordinates get orders from two bosses, viz, the Functional Manage, and the Project Manager.
5. Matrix organisation is used by large construction companies. It is suitable for multi-project organisations.

Some of the advantages of matrix organisation are as follows.

1. All decisions are taken by experts. So, the decisions are logical.
2. The employees work as a team.Therefore, they are motivated to perform better.
3. It results in higher efficiency. It gives high returns at lower costs.
4. It helps the employees to broaden their skills. Purchase people can learn about finance, and vice versa.
5. There is a specialisation in matrix organisation. The functional manager has authority over the technical aspects of the project. The project manager has authority over the administrative aspects of the project.
6. There is no wastage of resources. Many projects function simultaneously. So it makes optimum use of the human and physical resources.

Some of the disadvantages of matrix organisation are as follows.

1. Matrix organisation is complex. It is more difficult to understand than the functional organisation or pure project organisation.
2. Dysfunctional conflict may arise between functional managers and project managers. It may lead to confusion.
3. The cost of running a matrix organisation is higher than a functional organisation or pure project organisation.

4. The functional manager has authority over the technical aspects of the project. The project manager has authority over the administrative aspects of the project. This division of power and responsibility may lead to a complex situation.
5. In matrix organisation, the power would be balanced between departments. It may lead to confusion. Productivity of the project might suffer.

2.9 PURE PROJECT ORGANISATION

A pure project organisation is a model of a businggs where project managers have total control over the project they oversee. A pure project organisation may be termed as 'task force'.

A typical pure project organisation structure is shown in figure 3

[Courtesy : Project Management (5th ed 2013) by Rery Burke]

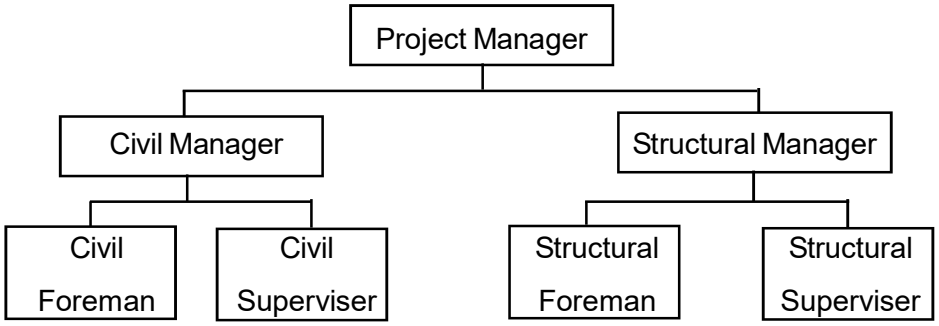


Figure 3

Some of the advantages of pure project organisation structure are as follows.

1. The project manager has complete authority over the project.
2. There is only one boss. Therefore, the lines of communication, responsibility, and authority are clear. The lines of communication are also short.
3. It is easy to understand and operate.
4. Team members are totally committed. Inspiration and motivation are high.
5. Decisions are made promptly.

Some of the disadvantages of pure project organisation structure are as follows.

1. Each project tends to be fully staffed. This can lead to a duplication of effort in every area from clerical staff to technological support.
2. The functional division is a repository of technical lore. But it is not readily accessible to team members of the pure project team.
3. In a pure project organization, the project takes on a life of its own.
4. There tends to be concern among team members about 'life after the project ends'.

(Courtesy : https://www.coursehero.com)



CHECK YOUR PROGRESS

Q 3: What is meant by 'regulators' in a project?

.....

.....

Q 4: Fill up the blanks.

(a) The project organisational structure is a project ..... technique.

(b) There are ..... main types of projection organisation structure.

(c) Functional organisation can ..... the cost of operation.

(d) The cost of running a matrix organisation is ..... than a functional organisation or pure project organisation.

(e) In a pure project organisation, there is only ..... boss.

2.10 MEANING OF ORGANISATIONAL CULTURE

Every organisation has its own unique 'personality'. The unique 'personality' of an organisation is referred to as its culture. Organisational culture is a powerful force. It influences the behaviour of the members of the organisation. Every organisation develops and maintains a unique culture.

It provides guidelines and boundaries for the behaviours of the members of the organisation.

There are various definitions of organisational culture that have been put forward by different authors.

According to Sathe (1985) organisational culture is the set of important assumptions. often unstated, that members of a community share in common. Drennan (1990) defines organisational culture as how things are done in an organisation. According to Ouchi (1981) and Pascale and Athos (1982) organisational culture is the philosophy that guides an organisation's policies towards employees and / or customers. Walid Belassi (2013) opines that 'culture both prescribes and proscribes individual behaviour in organisations'.

2.11 ORGANISATIONAL CULTURE AND PROJECT MANAGEMENT

Let there be two organisations. Let them use the same project management practices and structures. Their levels of success may not be the same. Organisational culture can influence the way projects are managed and executed.

W. Belassi, A. Z. Kondra, and O.I. Tukel in their paper titled **New Product Development Projects :** The Effects of Organizational Culture (2007) have mentioned the following dimensions of organisational culture:

Positive work environment : It includes factors such as–

- openness to new ideas,
- employees feeling valued as individuals,
- open discussions with superiors encouraged etc.

Management leadership : It includes factors such as–

- clear goals set and responsibilities delegated,
- employees have input in decision making,
- incentives offered to work on new ideas,
- high-risk high-return projects encouraged etc.

Results Orientation : It includes factors such as–

- employees are pressured to finish work,
- correct procedures more important than correct results etc.

The authors of the paper have used the following dimensions to measure project success.

Consumer-based : The customers are satisfied with the product. This can also be classed as customer satisfaction.

Commercial success : The product makes money.

Technical success : The product works as intended.

Lastly, the authors have correlated organisational culture to product success using correlation and regression analysis. The results indicate that

Positive work environment and management leadership are strongly correlated with each other and with the three measures of product success. That is–

- Strong management leadership and positive work environment go hand-in-hand.
- Companies with positive work environment have better commercial success with new products, enjoy better customer satisfaction and have greater technical success than those with less positive work environment.
- Results orientation is not strongly correlated with any of the other variables.

(Courtesy : Eight to Late Blog at WordPress. com)



2.12 LET US SUM UP

- 'Stakeholder is an individual, group, or organization who may affect, be affected by, or perceive itself to be affected by a decision, activity or outcome of a project.'
- 'Stakeholder Management is the systematic identification, analysis, planning and implementation of actions designed to engage with stakeholders.'
- The Identify Stakeholders process is used to identify all people or organisations that may be impacted by or have an impact on a project.

- The project organisational structure is a project management technique. It has a major impact on the execution of a project. It decides the resources, communication methods, and other aspects of project management.
- There are three main types of project organisation structure, viz,
  – Functional organisation,
  – Matrix organisation,
  – Pure project organisation.
- 'Functional organisation is a hierarchical organization where each employee has one clear supervisor, and staff are grouped by areas of specialization and managed by a person with expertise in that area.'
- Matrix organisation is a combination of two or more organisation structures. The organisation is divided into different functions, for example, purchase, production, R & D, Marketing, Finance etc. Each function has a Functional Manager.
- A pure project organisation is a model of a business where project managers have total control over the project they oversee.
- The unique 'personality' of an organisation is referred to as its culture. organisational culture influences the behaviour of the members of the organisation.
- Organisational culture can influence the way projects are managed and executed.



2.13 FURTHER READING

1) Rory Burke : *Project Management* Planning and Control Techniques (2013) Wiley.
2) *Project Management* DMGT 521 Lovely Professional University (2013)
3) Dr. B. Charumathi : *Project Management,* Pondicherry University.
4) From business 2 communites stakeholder Identification and Analysis Made Easy for Project Managers by Jamie Macdonald.



2.14 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: Four steps are as follows :

(a) To identify, recognize and acknowledge stakeholder.

(b) To determine their interest and influence.

(c) To develop communication management plan.

(d) To engage and influence stakeholders.

Ans to Q No 2: See Art 2.6

Ans to Q No 3: See Art 2.4

Ans to Q No 4: (a) management (b) three

(c) minimise (d) higher (e) one.



2.15 MODEL QUESTIONS

Q 1: What is meant by stakeholder, and Stakeholder Management?

Q 2: Write a note on Identifying Project Stakeholders.

Q 3: Write down the advantages and disadvantages of functional organisation.

Q 4: Write down the advantages and disadvantages of matrix organisation.

Q 5: Write down the advantages and disadvantages of pure project organisation.

Q 6: Write a note on organisational culture and Project Management.

*** ***** ***

UNIT 3 : PROJECT ANALYSIS AND SELECTION

UNIT STRUCTURE

3.1 Learning Objectives

3.2 Introduction

3.3 Project Identification

3.4 Projct Formulation

3.5 Market and Demand Analysis

3.6 Technical Analysis

3.7 Economic and Financial Analysis

3.8 Social Cost Benefit Analysis

3.9 Formulation of Detailed Project Report

3.10 Let Us Sum Up

3.11 Further Reading

3.12 Answers To Check Your Progress

3.13 Model Questions

3.1 LEARNING OBJECTIVES

After going through this unit, you will able to-

- know about project identification and formulation
- understand market and demand analysis
- understand technical analysis
- understand economic and financial analysis
- understand social cost benefit analysis
- know about formulation of detailed project report.

3.2 INTRODUCTION

A project should earn sufficient amount of return on investment The main intention of the investor is to earn lucrative returns on investment. If there are many alternative projects the investor should make a comparative analysis of the return on the different alternative proposals before selecting one. Projects undertaken by government may take into account social cost

benefits of the proposed project. In such cases financial return is not the only criterion.

Starting a project is a very challenging task. Hence the identification of the project to be undertaken requires an in-depth analysis of the project. In this unit we will analyse the different aspects involved in a project.

3.3 PROJECT IDENTIFICATION

Project identification is an important rung in project formulation. A project is conceived with the objective of meeting the market demand, exploiting natural resources, creating wealth etc.

Generally development projects come from the national planning. Industrial projects come from identification of commercial prospects and profit potential. Projects are introduced in order to achieve certain objectives. There may be several alternative projects that will meet these objectives. It is necessary to mention all the other alternatives considered with justification in favour of the specific project proposed for consideration.

3.4 PROJECT FORMULATION

Project formulation involves the following steps, – opportunity studies/ support studies, identification of product/service, prefeasibility study, feasibility study, project appraised, detailed project report.

An opportunity study identifies investment opportunity. A prefeasibility study is regarded as an intermediate stage between a project opportunity study and a detailed feasibility study. A feasibility study is a means to arrive at an investment decision. The feasibility studies focus on Market and Demand Analysis, Technical Analysis, Economic and Financial Analysis, Social Cost Benefit Analysis etc.



LET US KNOW

Project apprisal

'systematic and comprehensive review of the economic, environmental, financial social, technical and other such

aspects of a project to determine if it will meet its objectives.' Business Dictionary.com

3.5 MARKET AND DEMAND ANALYSIS

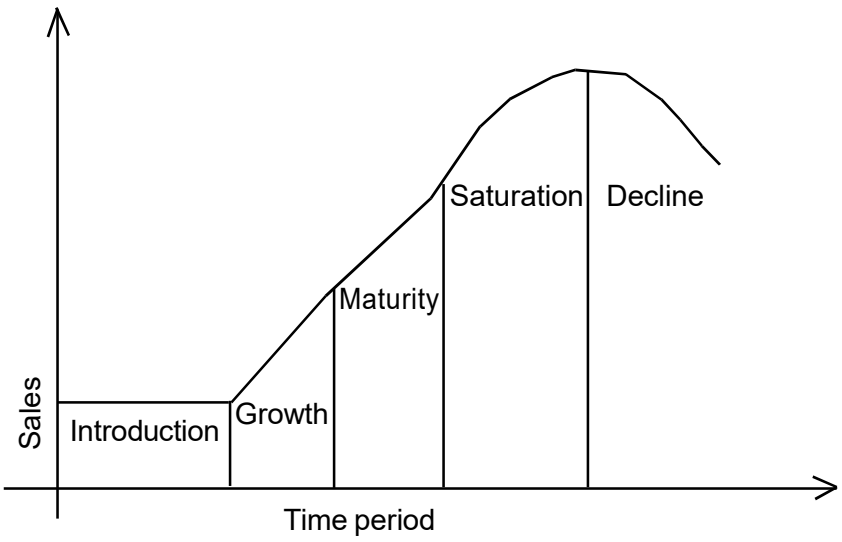
One of the foremost tasks of a project manager is the identification of the market while analysing market the project manager has to take into account the following factors, viz., product specification, price, channels of distribution, trade practices, threat of substitutes, competition etc. He must be able to anticipate the probable customers. Also he must know where his finished product is to be sold. Anticipation of the possible market for the product to be produced is essential for business.

Demand for a product may be estimated by the following methods, viz., opinion poll, life cycle segmentation analysis.

Opinion poll may be conducted with the help of complete survey of all customers or of a selected few.

A product passes through five stages of life cycle,– Introducting Growth, Maturity, Saturation, and Decline.

In the beginning sale of a product may be slow. After promotion sales begin to grow, and at one time sales reach its zenith. After sometime, the product may lose its demand and sales may decline. Sales at different stages can be shown with the help of the following figure.



Considering the above stages, sales at different stages can be anticipated.



LET US KNOW

Project manager is 'the person assigned by the performing organisation to lead the team that is responsible for achieving the project objectives'.



CHECK YOUR PROGRESS

Q 1: 'A product passes through five stages of life cycle', What are these five stages? Show them with the help of a figure.

.....

.....

3.6 TECHNICAL ANALYSIS

While initiating a project, it must be ensured that the required equipment/knowhow is available with the entrepreneur. Technical Analysis establishes whether a project is technically feasible or not. Other types of analyses are clearly connected with technical analysis.

There may be two or more alternative technologies available for manufacturing a product/service. For example, soap can be manufactured either by semi-boiled process or by the fully boild process. Similarly, cement can be made either by the dry process or by the wet process.

The choice of technology is governed by a variety of considerations. These are as follows,– plant capacity, principal inputs, investement outlay and production cost, use by other units, product mix, latest developments, case of absorption.

Methods of production which are suitable to local economic, social, and cultural conditions are referred to as appropriate technology. The propounders of appropriate technology opine that the technology should be evaluated in terms of the following question.

1. Whether the technology utilises local row materials?
2. Whether the technology utilises local man power?
3. Whether the goods and services produced cater to the basic needs?
4. Whether the technology protects ecological balance?
5. Whether the technology is harmonious with social and cultural conditions?

Satisfactory arrangements must be made to obtain the technical knowhow needed for the proposed manufacturing process.

3.7 ECONOMIC AND FINANCIAL ANALYSIS

The economic and financial analysis examines the viability of a project from the economic and financial point of view. The Financial Analysis gives the return on investment. Some of the techniques used for financial analysis are given below–

(a) Payback period
(b) Return on investment (ROI)
(c) Net present value (NAV)
(d) Profitability index (PI)/Benefit Cost Ratio
(e) Internal Rate of Return (IRR)

(a) Payback period

The payback period, according to Rory Burke, is the time taken to gain a financial return equal to the original investment. Let us take an example.

A man has invested Rs. 1,00,000/- as initial investment for establishing a poultry firm. The annual cash flow is as follows.

Period	Annual Income	Annual Expenditure	Annual Return	Cumulative Return
First year	55,000/-	25,000/-	30,000/-	30,000/-
Second year	75,000/-	35,000/-	40,000/-	70,000/-
Third year	80,000/-	20,000/-	60,000/-	1,30,000/-

From the above table we see that the payback period is 2 years 6 months.



LET US KNOW

Cash Flow

'Cash Flow is the net amount of cash and cash-equivalents being transferred into and out of a business.'

Rory Burke, in his outstanding book **Project Management Planning and Control Techniques** (2013), has enumerated the advantages and disadvantages of payback period as follows.

Advantages

1. Payback period is simple and easy to use.
2. It uses readily available accounting data to determine cash flows.
3. It reduces the project's exposure to risk by selecting the shortest payback period.
4. It reduces the uncertainty of future cash flow.
5. It is an appropriate technique to evaluate high technology projects where the technology is changing quickly.

Disadvantages

1. It does not consider the time value of money. The payback period is indifferent to the timing of the cash flow. The project with a high, early income (cash-inflow) would be ranked equally with a project that had a late income if the payback periods were the same.
2. It is not a suitable technique to evaluate long term projects where the impacts of differential inflation and interest rates could significantly change the results.
3. The figures are based on project cash flow only.
4. Although the payback period would reduce the duration of the risk, it does not quantify the risk exposure.
5. The payback period calculation does not look at the total project– what happens to the cash flow after the payback period is not considered. A project built up slowly to give excellent returns would be rejected in favour of a shorter payback period.

(b) Return on investment (ROI)

Return on Investment (ROI) is also a propular investment appraisal

technique. It is calculated as follows.

$$\text{ROI} = \frac{\text{Average annual return}}{\text{Original investment}} \times \frac{100}{1}$$

Let us consider the example of poultry firm as given in 'Payback Period.'

Original investment = Rs. 1,00,000/-

Total return = Rs. 1,30,000/-

Average annual return = Rs. $\frac{1,30,000}{3}$

= Rs. 43333.33

$$\therefore \text{ROI} = \frac{43333.33}{1,00,000} \times 100$$

$$= \frac{4333333}{1,00,000}$$

= 43.3

Thus, ROI = 43.3%

Advantages

1. ROI is simple and easy to use.
2. It considers cash flow over the whole project.
3. The total outcome of the investment is expressed as a profit and percentage return on investment.

Disadvantages

1. It does not differentiate between two projects one giving immediate return and another where return is received after some gestation period.

Discounted Cash Flow

Payback period and Return on Investment (ROI) are simple, and easy to use. They are more suited for quick analysis of a project. But sometimes they provide inadequate measures of project viability. In such circumstances it is desirable to use these methods with other discounted cash flow methods, viz, Net Present Value, Profitability Index/Benefit Cost Ratio, Internal Rate of Return.

Discunted cash flow method takes into account the time value of money. For example, a Rs. 100 today will not have the same worth or buying power as a Rs. 100 this time next year.

The principle of discounting is the reverse of compounding. It takes into account the value of money over time let us take an example. Let us assume a return of 20% After one year, Rs. 100 will grow to Rs. 120 and to Rs. 144 in the second year. Now, let us look at the reverse of it. In a reverse statement, the present worth of next year's return at a discount rate of 20% is Rs. 83.3 $\left(\frac{100 \times 100}{120}\right)$. Similarly the present value of the return after two years is Rs. 80.6. These values Rs. 83.3 and Rs. 80.6. These values Rs. 83.3m and Rs. 80.6 are known as present values of future annual return of Rs. 100 in first and second year respectively.

The formula for calculating present value (PV) is given by

$$PV = \frac{C_n}{(1+i)^n}$$

Where C_n is the cash flow in the n^{th} year at discount rate of i per unit [r of the rate of r% = i]

The present value is calculated for both investment and returns. The results are presented in three different measures, viz., Net Present Value, Profitability Index/Benefit Cost Ratio, Internal Rate of Return.

(c) Net Present Value (NAV)

The sum of discounted values of the stream of investments in different years of project implementation gives present value of the cost. Let it be denoted by Y. Again, the sum of discounted returns gives the present value of benefits. Let it be denoted by X. Then X–Y gives the NPV. The project manager expects higher value of NPV.

(d) Profitability Index (PI)/Benefit Cost Ratio

PI is also known as BC ratio. The ratio $\frac{X}{Y}$ is called the BC ratio. The project manager expects higher BC ratio.

(e) Internal Rate of Return (IRR)

The IRR is the discount rate when the NPV is zero. It is calculated by either a trial and ever method or plotting NPV against IRR. The project manager expects projects with higher IRR.

Apart from the financial benefits (in terms of return on investment),

economic benefits are also taken into consideration in the feasibility study. By economic benefits, we mean employment generation, economic development of the area where the project is located, foreign exchange savings in case of imports, earning of foreign exchange in case of experts.



CHECK YOUR PROGRESS

Q 2: What is payback period?

A man has invested Rs. 80,000 in an agricultural farm and gets Rs. 16,000 as annual net return. What is the payback period? (Net return : Income-Expenditure)

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3.8 SOCIAL COST BENEFIT ANALYSIS

Social cost Benefit Analysis (SCBA) is a systematic and cohesive economic method to survey all the impacts caused by an urban development project. It comprises not just the financial effects (investment costs, direct benefits like tax and fees etc), but all the social effects, like pollution, safety, indirect (labour) market, legal aspects etc. The main aim of SCBA is to attach a price to as many effects as possible in order to uniformly weigh the above heterogeneous effects.

Two principal approaches for SCBA emerged towards the end of the sixties and in the early seventies of the last century,– one is UNIDO approach, and the other is L–M approach.

UNIDO approach involves five stages, viz.,

1. Calculation of financial profitability of the project measured at market prices.
2. Obtaining the net benefit of project measured in terms of economic (efficiency) prices.
3. Adjustment for the impact of the project on savings and investment.
4. Adjustment for the impact of the project on income distribution.
5. Adjustment for the impact of project on merit goods and demerit goods whose social values different from their economic values.

Each stage of appraisal measures the desirability of the project from a different angle.

Ian Kalcolm David Little (1915 - 2012), and James Alexander Mirrlees (1936 - 2018) have developed an approach, popularly known as L-M approach, to SCBA. The L-M approach assumes that a country can buy and sell any quantity of a particular good at a given world price Hence, all traded inputs and outputs are valued at their international prices (CIF for imports and FOB for experts) which is the opportunity cost/value of the particular good to the country.

Though there are similarities between the two approaches, there are centain differences between the two.

1. The UNIDO approach measures costs and benefits in terms of domestic rupees.

   The L-M approach measures costs and benefits in terms of international prices.

2. The UNIDO approach measures costs and benefits in terms of consumption.

   The L-M approach measures costs and benefits in terms of uncommitted social income.

3. The stage-by-stage analysis recommended by the UNIDO approach focuses on efficiency, savings, and redistribution considerations in different stages.

   The L-M approach tends to view these considerations together.



LET US KNOW

1. 'Cost, Insurance, and Freight (CIF), and Free on Board (FIB) are international shipping agreements used in the transportation of goods between a buyer and a seller.'

2. 'The social Income consists of a collection of goods and services values in terms of money. Its precise definition thus involves two problems : one of the correct enumeration of the real goods and services to be included, and one of the money values by which this heterogeneous collection is to be reduced to a common denominator'.– J. R. Hicks

3.9 FORMULATION OF DETAILED PROJECT REPORT

Detailed project report (DPR) contains the complete details of the project. It is required to submit DPR to banks and other financial institutions to obtain financial assistance. It is an essential building block for the project. It is to be prepared carefully and with sufficient detaits. The DPR should contain, – examination of technological parameters, description of the technology to be used, broad technical specification, evaluation of the existing resources, schedule plan, general layout, valume of work.



3.10 LET US SUM UP

- Project manager is 'the person assigned by the performing organization to lead the team that is responsible for achieving the project objectives'.
- One of the foremost tasks of a project manager is the identification of the market. He must be able to anticipate the probable customers. Also he must know where his finished product is to be sold. Anticipation of the possible market for the product to be produced is essential for business.
- Technical analysis establishes whether a project is technically feasible or not.
- The economic and financial analysis examines the viability of a project from the economic and financial point of view. The financial analysis gives the return on investment.
- Social Cost Benefit Analysis (SCBA) is a systematic and cohesive economic method to survey all the impacts caused by an urban development project.
- Two principal approaches for SCBA emerged towards the end of the sixties and in the early seventies of the last century, – one is UNIDO approach, and the other is L-M approach.
- Detailed Project Report (DPR) contains the complete details of the project. It is required to submit DPR to banks and other financial institutions to obtain financial assistance.



3.11 FURTHER READING

1) Rory Burke : *Project Management* Planning and Control Techniques (2013) Wiley.

2) *A Guide to the Project Management Body of Knowledge* (2000 edition), Project Management Institute, Newton Square, Pennsylvania USA.

3) *Project Management* DMGT 521 Lovely Professional University (2013)

4) Dr. B. Charumathi : *Project Management,* Pondicherry University.

5) Dr. Prasauna Chandra, *Projects* (2016), Mc Graw Hill Education (india) Provate Limited, New Delhi.

6) *Introduction to Project Management* (www.edo.ca).



3.12 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: See Art 3.5

Ans to Q No 2: Payback period is the time taken to gain a financial return equal to the original investment.

$$\text{Payback period} = \frac{80{,}000}{16{,}000} \text{ years}$$

$$= 5 \text{ years}$$



3.13 MODEL QUESTIONS

Q 1: Discuss about market and demand analysis in project management.

Q 2: Discuss about technical analysis in project management.

Q 3: What is payback period? Write down its advantages and disadvantages.

Q 4: What is return on investment? What are its advantages and disadvantages?

Q 5: Write notes on-

(a) Principle of discounting

(b) Net Present value

(c) Benefit cost ratio

(d) Internal rate of return.

Q 6: Discuss about social cost benefit analysis in project management.

*** ***** ***

UNIT 4 : PROJECT PLANNING

UNIT STRUCTURE

4.1 Learning Objectives

4.2 Introduction

4.3 Project Planning

4.4 Planning of Physical Resources

4.5 Planning of Human Resources

4.6 Planning of Financial Resources

4.7 Let Us Sum Up

4.8 Further Reading

4.9 Answers To Check Your Progress

4.10 Model Questions

4.1 LEARNING OBJECTIVES

After going through this unit, you will able to-

- project planning
- planning of physical resources
- planning of human resources
- planning of financial resources
- project organising.

4.2 INTRODUCTION

Project planning is an important phase during which the plans and strategies of project execution are set. Estimation of the required resources is an important aspect of project planning. Resources may be physical, human or financial. In this unit we will discuss planning of physical resources, planning of human resources, and planning of financial resources. Also, we will discuss project organising.

4.3 PROJECT PLANNING

Project planning is an important phase during which the plans and strategies of project execution are set. The policies, the procedures, the rules of the organisation are kept in mind. Project planning has two important aspects, viz.

(1) identification of the activities to be performed,

(2) estimation of the required resources.

Resources may be classified as physical resources, human resources, financial resources. Physical resources include tangible items that are necessary for a business to function. Some of the most common physical resources include raw materials, buildings and facilities, machimery, energy, etc. Human resources, according to Wikipedia, are the people who make up the workforce of an organisation, business sector, or economy. Financial resources is the set of liquid assets of an organisation, including cash, bank deposits and liquid financial investments. In this unit, we will discuss physical resources, human resources, and financial resources. Also we will discuss project organising.



LET US KNOW

Liquid asset : A liquid asset is cash in hand, or an asset that can be readily converted to cash.

Work Breakdown Structure : A project is a combination of interrelated activities which must be performed in a certain order for its completion. The process of dividing the project into these activities is called Work Breakdown Structure (WBS). The PMBOK (2012 edition) defines WBS as 'the process of subdividing project deliverables and project work into smaller, more manageable components.'



CHECK YOUR PROGRESS

Q 1: What is meant by physical resources?

.....

.....

Q 2: What is meant by human resources?

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Q 3: What is meant by financial resources?

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Q 4: What is meant by liquid asset?

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Q 5: What is meant by Work Breakdown Structure?

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4.4 PLANNING OF PHYSICAL RESOURCES

Physical resources include tangible items that are necessary for a business to function. Some of the most common physical resources include raw materials, buildings and facilities, machinery, fuel etc.

Physical resources are required for all types of business. Product-based businesses use physical resources for providing the goods for sale and for the operation of the business. Service-based businesses use physical resources to facilitate the delivery of the service.

According to PM Education, management of physical resources consists of four processes. These are as follows–

1. Plan Physical Resource Management.
2. Estimate Activity Physical Resources.
3. Acquire Physical Resources.
4. Control Physical Resources.

Examples of Physical Resources

Equipments, Materials, Supplies, Facilities, and Infrastructure that are utilised by a project.

1. **Plan Physical Resource Management :** A Resource Management Plan (RMP) is to be written for larger and complex projects. The RMP will contain.
   (i) how the resources will be acquired,
   (ii) how they will be managed,
   (iii) how they will be used.
   The RMP will also contain the method that will be used to ensure sufficient resources are available as and when they are needed.
2. **Estimate Activity Physical Resources :** The time and the cost of physical resources for the project must be estimated if not done earlier. Equipment rental companies may change by the number of hours a machine is used. The number of hours of intended use must be estimated for this type of rental equipment. The time requirement for the physical resources must be estimated.
3. **Acquire the physical resource :** Physical resources must be acquired at the appropriate time and must be assigned to the respective activities.. Too early acquisition adds unnecessary cost. Too late acquistion impacts project schedule. The acquired physical resources should be relased at the appropriate time.
   A purchasing process is required for acquiring external physical resources. The acquisition must be done in time.
   Some physical resources may be unique. They may be very essential to the success of the project. So, extra attention must be given to the procurement of these resources.
4. **Control Physical Resources :** This process involves ensuring that the physical resources assigned and allotted to the project are available as planned. Also it involves monitering the planned versus actual utilisation of these resources corrective action should be taken as and when necessary. (Source : Physical Resource Management)



CHECK YOUR PROGRESS

Q 6: Give some examples of physical resources.

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Q 7: What are the four processes of managing physical resources?

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4.5 PLANNING OF HUMAN RESOURCES

Human resources, according to Wikipedia, are the people who make up the workforce of an organisation, business sector, or economy.

Human resource planning, according to Wikipedia, is a process that identifies current and future human resources needs for an organisation to achieve its goals. There should be right number of people in the right jobs at the right time.

The most valuable asset of an organisation is its human resources. The success of an organisation depends on its human resources. Their skills and knowledge as well as their relationships with the customers contribute to the success of the project so, necessary attention must be given to human resource planning.

The human resource planning analyses–

(1) Current human resources,

(2) forecasts future requirements,

(3) identifies areas where there are gaps, and

(4) implements a plan to tighten up these gaps.

Thus, planning of human resources consists of four steps.

1. **Assessment of current human resource capacity :** Firstly, the current human resource capacity should be analysed. Analysis should be made with respect to the following points, number of employees, their skills, qualifications, experience, age, contract, performance ratings, etc. Areas where changes are necessary should be identified.

2. **Forecasting future human resource requirements :** Secondly, the project managers should look at the market trends. Some new technologies may come up. There may be vacancies, retirements, promotions, and end of contract terms of the employees. COnsidering all these aspects, the project manager has to gange future requirements. Definitely it is a complex task.
3. **Identifying human resource gaps :** Thirdly, human resource gaps between the current human resource capacity, and future human resource requirements must be identified. Existing employees may also be upskilled.
4. **Integrating the plan with organisation's overall strategy :** Current human resource capacity has been assessed. Future human resource requirements have been assessed. Gaps between the two have been identified. Now, human resource plan is to be integrated with the organisational strategy.

Importance of Human Resource Planning :

1. It gives the company the right number of people in the right jobs at the right time.
2. In a balance between demand for, and supply-of resources, human resource planning helps in the optimum usage of resources. It also reduces the labour cost.
3. Forecasting the future requirements helps to supervise manpower in a better way. Problems can be avoided.
4. It helps the organisation to develop a succession plan for all its employees. Thus, it creates a way for internal promotions.
5. It helps the organisation to evaluate the weaknesses and strengths of the personnel. It helps to make remedial measures.
6. The organisation is benefitted when it comes to increase in productivity, profit, skills etc. Thus, the organisation has the edge on its competitors.



CHECK YOUR PROGRESS

Q 8: Write the importance of human resource planning.

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4.6 PLANNING OF FINANCIAL RESOURCES

Financial resources is the set of liquid assets of an organisation, including cash bank deposits and liquid financial investments. Financial planning is an essential part of financial management. It is required for estimating the fund requirements of a business. It is also required for determing the sources of the fund.

Objectives of Financial Planning :

1. Financial planning is required to ensure availability of funds.It is required for generating funds as well as making them available whenever they are required. Estimation of the funds required for different purposes is also included in the Financial Planning.
2. Financial planning is required to estimate the time and source of funds. It is required to deliver the funds at the right time at the right place. It is as importanct as the generation of the funds.
3. Financial planning is required to generate capital structure. A company's capital structure refers to how it finances its operation and growth with different sources of funds, such as bond issues, long-term notes payable, common stock, preferred stock, or retained earnings.
4. Financial Planning is required to meake sure that the firm does not raise unnecessary resources. Unnecessary funds should be avoided.

Importance of Financial Planning :

1. Financial planning guarantees sufficient funds.
2. Financial planning helps in guaranteeing a harmony between outgoing and incoming of assets.
3. Financial planning supports development and expansion programmes.

4. Financial planning diminishes vulnerabilities with respect to changing business sector patterns.
5. Financial planning helps in guaranteeing security and benefits of the organisation.



LET US KNOW

Common stock : 'Shares entitling their holder to dividends that vary in amount and may even be missed, depending on the fortunes of the company.' The term common stock is used promarily used in the united states. It is known as equity shares or ordinary shares in the UK.

Preferred stock : 'Stock that entitles the holder to a fixed dividend, whose payment takes priority over that of ordinary share dividends.'

The main difference between preferred stock and common stock is that preferred stock gives no voting rights to shareholders while common stock does.

Preferred shareholders have a priority over a company's income. They are paid dividends before common shareholders.



CHECK YOUR PROGRESS

Q 9: What is meant by capital structure?

.....

.....

Q 10: What is the main difference between preferred stock and common stock?

.....

.....



4.7 LET US SUM UP

- Project planning is an important phase during which the plans and strategies of project execution are set.
- Physical resources include tangible items that are necessary for a business to function.
- Human resources are the people who make up the workforce of an organisation, business sector, or economy.
- Financial resources is the set of liquid assets of an organisation, including cash, bank deposits and liquid financial investments.
- A liquid asset is cash on hand, or an asset that can be readily to converted to cash.
- A project is a combination of interrelated activities which must be performed in a certain order for its completion. The process of dividing the project into these activities is called Work Breakdown Structure (WBS). The PMBOK (2012 edition) defines WBS as 'the process of subdividing project deliverables and project work into smaller, more manageable components'.



4.8 FURTHER READING

1) Rory Burke : *Project Management* (2013), Wiley.
2) Prem Kumar Gipta, D. S. Hira : *Operations Research* (2007), S Chand and Company Limited, New Delhi 110055.



4.9 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: For Question Nos. 1, 2, 3, 4, 5; see Art 4.3

Ans to Q No 6: Some examples of physical resources : Equipments, Materials, Supplies, Facilities, and Infrastructure that are utilised by a project.

Ans to Q No 7: Four processes of managing physical resources are as follows physical resources are as follows :

(1) plannine physical resource management,

(2) estimating activity physical resources,

(3) acquiring physical resources,

(4) controlling physical resources.

Ans to Q No 8: See ast 4.5.

Ans to Q No 9: A company's capital structure refers to how it finances its operation and growth with different sources of funds, such as bond issues, long-term notes payable, common stock, preferred stock or retained earnings.

Ans to Q No 10: The main difference between preferred stock and common stock is that preferred stock gives no voting rights to shareholders while common stock does.



4.10 MODEL QUESTIONS

Q 1: Deseribe the planning of physical resources.

Q 2: Describe the planning of human resources.

Q 3: Describe the planning of financial resources.

*** ***** ***

UNIT 5 : PROJECT SCHEDULING AND PERT-CPM

UNIT STRUCTURE

5.1 Learning Objectives

5.2 Introduction

5.3 Basic Components of Network and Precedence Relationship

5.4 CPM (Critical Path Method)

5.5 PERT

5.6 Basic Difference Between PERT and CPM

5.7 Let Us Sum Up

5.8 Further Reading

5.9 Answers To Check Your Progress

5.10 Model Questions

5.1 LEARNING OBJECTIVES

After going through this unit, you will able to learn

- network and its basic components
- CPM
- PERT
- basic difference between CPM and PERT.

5.2 INTRODUCTION

A project consists of interconnected activities. These activities are to be executed before the completion of the entire task. A project is represented in the form of a network in order to get solution for scheduling and controlling its activities. CPM and PERT are two network-based project management techniques. They exhibit the flow and sequence of the activities and events.

CPM is an abbreviation for critical Path Method. It was developed in the late 1950s by EI du pont de Nemoms and company (founded by French-American chemist and industrialist EI du Pont (1771-1834) as an application to construction projects. It was later extended by Mauchly Associates

(founded by John William Mauchly (1907-1980)

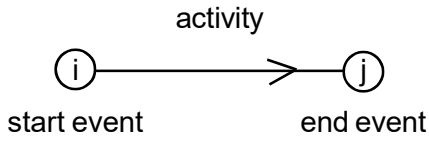
PERT is an acronym for programme (project) evaluation and Review Technique. It was developed in the late 1950s for scheduling the research and development activities for the Polaris Missile Program of US Navy.

5.3 NETWORK COMPONENTS AND PRECEDENCE RELATIONSHIP

A network is a graphical representation of project's operations. It consists of activities and events.

An activity is a task to be done. It requires time, money, and other resources. It is physically identifiable part of a project. An activity is represented by an arrow. The tail represents the start, and the head represents he end. The length and direction of the arrow has nothing to do with the size of the activity.

An event (or node) represents the start or the end of an activity. It requires no time. Moreover it does not consume any resource. An event is represented by a circle.



Events (or nodes) are numbered to identify an activity. Tail node must be smaller than the head node ($i < j$).

A project is considered to be a series of activities which may begin only after another activity (or activities) is completed. The activities are interrelated in a logical sequence. It is known as precedence relationship. Thus, a project network is a collection of precedence relationships among various activities of a project.

An activity which determines the dependency of one activity over the other, but does not consume any time and resource is called a dummy activity. It is a hypothetical activity. Dummy activity is generally denoted by dotted arrow.

Note : 1. The objective of network analysis is to minimise total project duration.

2. Network problems have advantage in terms of project scheduling, planning, controlling.
3. An activity in the network represents a task which has a definite beginning and a definite end, and it cannot start unless all its immediate predecessors are completed.

Example 1 : Activities A, B, C, D, E, F, G, H, I constitute a project. The precedence relationships are

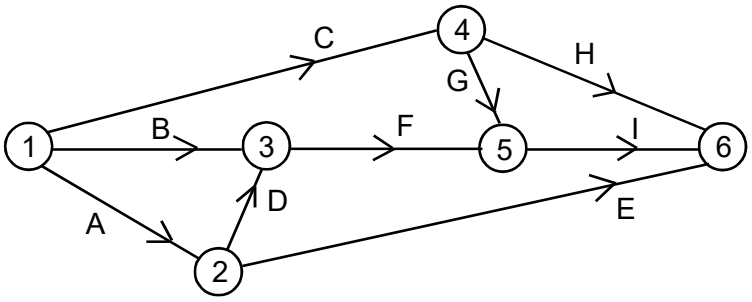
A<D, A<E, B<F, D<F, C<G, C<H, F<I, G<I.

[A<D means D cannot start until A is completed].

Draw a network to represent the project.

Solution : We have seen that there are no predecessors to activities A, B, C. Therefore, they start from the same initial node. Again, there are no successors to activities E, H, I. Therefore, they merge into the end node of the project.

The network of the project is given below.





CHECK YOUR PROGRESS

Q 1: Activities A, B, C, D, E, F, G, H, I, J Constitute a project Activities, and their immediate predecessors are given below.

Activities	A	B	C	D	E	F	G	H	I	J
Immediate predecessors	–	–	A, B	A, B	B	C	D	F, G	F, G	E, H

Draw a network to represent the project.

Q 2: A project schedule has the following characteristics.

Predecessor events	1	2	3	4	5	6	7	8	9
Successor events	2, 3	4	4, 5	9	6, 7	8	8	10	10

Draw a network to represent the project.

Q 3: A project schedule has the following characteristics.

Predecessor events	1	2	3	4
Successor events	2, 3	3, 4	4	5

Draw a network to represent the project.

Q 4: Construct a network in the project whose activities and their precedence relationships are given below :

Activities	A	B	C	D	E	F	G	H	I
Immediate predecessors	–	A	A	–	D	B,C,E	F	D	G, H

Q 5: Construct a network in the following project :

A<C, D, I; B<G, F; D,G, F; F<H, K; G, H<J; I, J, K<E

5.4 CPM (CRITICAL PATH METHOD)

The CPM (Critical Path Method), also called CPA (Critical Path Analysis), is one of the special project management techniques. The critical path for any network is the longest path throughout the entire network. We know that all activities must be completed to complete the entire project. The length of the critical path is also the shortest time allowable for completion of the project. Thus, if a project is to be completed in the shortest time, all activities on the critical path must be started as soon as possible. Activities (including dummy activities) on critical path are known as critical activities. Any delay in the completion of the activities lying on this path would cause a delay in the completion of the whole project.

The CPM is generally used for simple, repetitive types of projects such as construction of road, bridge, building; yearly closing of accounts by a company etc. Activity time and cost are precisely known. CPM is deterministic in nature.

One of the methods for determining a critical path is as follows.

We enumerate all possible paths from start point to end point of a network. We determine total duration for each path by adding the duration of all the activities lying on any path. The path with maximum duration is the critical path.

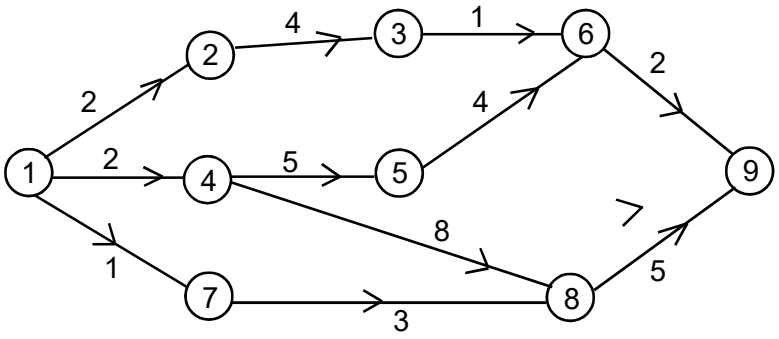
Example 2: A project schedule has the following characteristics.

Activity	Duration	Activity	Duration
1 – 2	2	4 – 8	8
1 – 4	2	5 – 6	4
1 – 7	1	6 – 9	3
2 – 3	4	7 – 8	3
3 – 6	1	7 – 8	3
4 – 5	5	8 – 9	5

Draw the network, and find the critical path.

Solution : Here, the initial node is 1 and the end node is 9.

The network of the project is given below.



Path	Duration (units of time)
1 – 2 – 3 – 6 – 9	2 + 4 + 1 + 3 = 10
1 – 4 – 5 – 6 – 9	2 + 5 + 4 + 3 = 14
1 – 4 – 8 – 9	2 + 8 + 5 = 15
1 – 7 – 8 – 9	1 + 3 + 5 = 9

The path with maximum duration is 1 – 4 – 8 – 9. So, the critical path is 1 – 4 – 8 – 9. The critical activities are 1 – 4, 4 – 8, 8 – 9.



CHECK YOUR PROGRESS

Q 1: A project schedule has the following characteristics.

Activity	Duration
1 – 2	8
1 – 3	8
1 – 4	10
2 – 4	10
2 – 6	16

Activity	Duration
3 – 5	18
3 – 6	14
4 – 5	17
5 – 6	9

Draw the network, and find the critical path.

Q 2: A project schedule has the following characteristics.

Activity	Duration (in weeks)
1 – 2	4
1 – 3	1
2 – 4	1
3 – 4	1
3 – 5	6
4 – 9	5

Activity	Duration (in weeks)
5 – 6	4
5 – 7	8
6 – 8	1
7 – 8	2
8 – 10	5
9 – 10	7

Draw the network, and find the critical path.

Q 3: A project schedule has the following characteristics.

Predecessor events	1	1	2	3	3	4	4	4	6	5	7
Successor events	2	3	4	4	5	5	6	7	7	8	8
Time estimate (weeks)	3	5	5	6	3	7	3	5	0	4	2

Construct the network, and find the critical path.

5.5 PERT

The critical path analysis takes into considerations deterministic estimates for time durations of various activities in a project.

The PERT is based on probabilistic considerations. It takes into consideration three time estimates of the performance time of an activity, optimistic time, pessimestic time, and most likely time.

Optimistic time : It is the shortest time required for the completion of an activity if the execution goes 'extremely good'. We will denote it by a or t_0.

Pessimistic time : It is the maximum possible time the activity will take if the execution goes 'very badly'. We will denote it by b or t_p.

Most likely time : It is the time an activity will take if executed under normal conditions. We will denote it by m or t_m.

The probabilistic data for project activities generally follow Beta (β) distribution. The formula for mean μ, and variance α^2 are as follows.

$$\mu = \frac{a + 4m + b}{6}, \qquad \alpha^2 = \left(\frac{b - a}{5}\right)^2$$

The expected project completion time is $\Sigma\mu_i$, where μ_i is the expected duration of the i th critical activity.

The variance of the project completion time is $\Sigma\alpha_i^2$, where α_i^2 is the variance of the i th critical activity.

Note : In PERT network, a Beta distribution is assumed because it

(i) is unimodal,

(ii) has non-negative end points, and

(iii) is approximately symmetric.

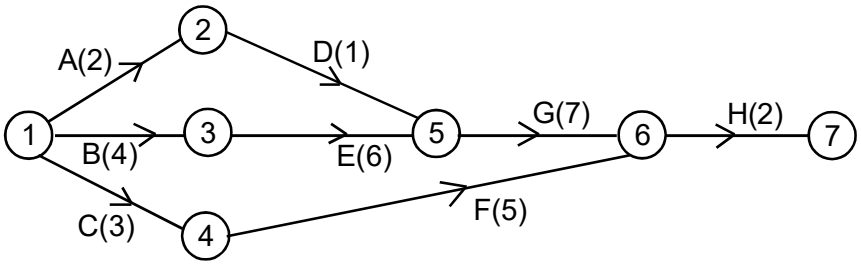
Example 3: A project consists of eight activities with the following relevant information.

Activity	Immediate	Estimated duration (day)		
		optimistic	most likely	pessimistic
A	–	1	1	7
B	–	1	4	7
C	–	2	2	8
D	A	1	1	1
E	B	2	5	14
F	C	2	5	8
G	D, E	3	6	15
H	F, G	1	2	3

Draw the PERT network and find out the expected project completion time.

Solution : We have seen that there are no predecessors to activities A, B, C. Therefore, they start from the same initial node. Again, there is no successor to activity H.

The network of the project is given below.



Let the optimistic time be a, most likely time be m, and the pessimistic time be b. Thus,

Activity	a	m	b	$\frac{a+4m+b}{6}$
A	1	1	7	2
B	1	4	7	4
C	2	2	8	3
D	1	1	1	1
E	2	5	14	6
F	2	5	8	5
G	3	6	15	7
H	1	2	3	2

$\left[\frac{1+4+7}{6}=2, \quad \frac{1+16+7}{6}=\frac{24}{6}=4, \quad \frac{2+8+8}{6}=3 \right.$

$\frac{1+4+1}{6}=1, \quad \frac{2+20+14}{6}=6, \quad \frac{2+20+8}{6}=5$

$\left. \frac{3+24+15}{6}=7, \quad \frac{1+8+3}{6}=2 \right]$

Path	Expected duration of time
1 – 2 – 5 – 6 – 7	2 + 1 + 7 + 2 = 12
1 – 3 – 5 – 6 – 7	4 + 6 + 7 + 2 = 19
1 – 4 – 6 –7	3 + 5 + 2 = 10

$\therefore$ expected duration of time = 19



CHECK YOUR PROGRESS

Q 1: The time estimates (in weeks) for the activities of a PERT network are given below.

Activity	t_0	t_m	t_p
1–2	1	1	7
1–3	1	4	7
1–4	2	2	8
2–5	1	1	1
3–5	2	5	14
4–6	2	5	8
5–6	3	6	15

Where t_0, t_m t_p denote optimistic time, most likely time, pessimistic time respectively.

(a) Draw the project network and identify all the paths through it.

(b) Determine the expected project length.

(c) Calculate the standard deviation and variance of the project length.

Q 2: A project has the following activities and other characteristies.

Activity	Preceding activity	Time (in weeks)		
		t_o	t_m	t_p
A	–	4	7	16
B	–	1	5	15
C	A	6	12	30
D	A	2	5	8
E	C	5	11	17
F	D	3	6	15
G	B	3	9	27
H	E, F	1	4	7
I	G	4	19	28

Where t_o, t_m, t_p denote optimistic time, most likely time, pessimistic time respectively.

(a) Draw the PERT network.

(b) Identify the critical path.

(c) Find the mean project completion time.

5.6 BASIC DIFFERENCE BETWEEN PERT AND CPM

PERT and CPM are two 'analytic' techniques for planning, scheduling, and controlling of projects. However there are some basic differences between the two techniques.

PERT	CPM
1. PERT is used for non-repetitive jobs.	1. CPM is used for repetitive jobs.
2. PERT is event-oriented.	2. CPM is activity oriented.
3. PERT is a probablistic model used to manage uncertain activities of a project.	3. CPM is a deterministic model that manages well-defined activities of a project.
4. PERT is a technique of planning and control of time.	4. CPM is a method to control cost and time.
5. PERT is evolved as research and development project.	5. CPM is evolved as construction project.
6. PERT manages unpredictable activities.	6. CPM manages predictable activities.
7. PERT is appropriate for high precision time estimate.	7. CPM is appropriate for reasonable time estimate.



5.7 LET US SUM UP

- PERT is an acronym for programme (project) Evaluation and Review Technique. It was developed for rescheduling the research and development activities.
- CPM is an abbreviation for critical Path Method. It was developed as an application to construction projects.

- A network is a graphical representation of project's operations.
- A project is considered to be a series of activities which may begin only after another activity (or activities) is completed. The activities are interrelated in a logical sequence. It is known as precedence relationship.
- The critical path for any network is the longest path throughout the entire network. The length of the critical path is also the shortest time allowable for completion of the project.
- PERT is based on probabilistic considerations. It takes into consideration three time estimates of the performance time of an activity, – optimistic time (a or t_0), pessimistic time (b or t_p), most likely time (m or t_m)



5.8 FURTHER READING

1) R. Panneerselvam : Operations Research (2006), Prentice Hall of India Private Limited, New Delhi-110001.
2) Prem Kumar Gupta, D. S. Hira : Operations Research (2007), S Chand and Company Limited, New Delhi-110055.
3) Kanti Swarup, P. K. Gupta, Man Mohan : Operations Research (2017), Sultan Chand and Sons, New Delhi.



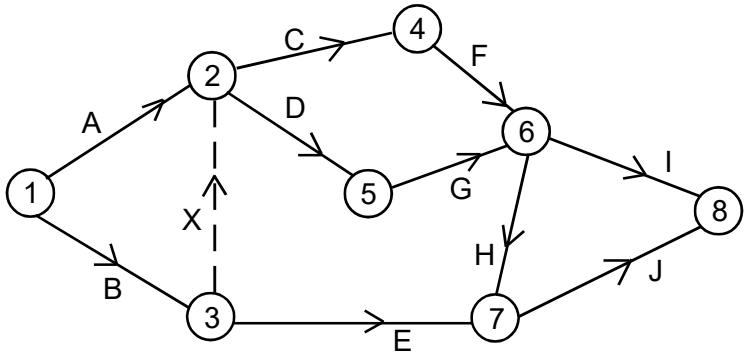
5.9 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1:

Activities	A	B	C	D	E	F	G	H	I	J
Immediate predecessors	–	–	A, B	A, B	B	C	D	F, G	F, G	E, H

We have seen that there are no predecessors to activities A, B. Therefore, they start from the same initial node. Again, there are no successors to activities I, J. Therefore, they merge into the end node of the project.

The network of the project is given below.



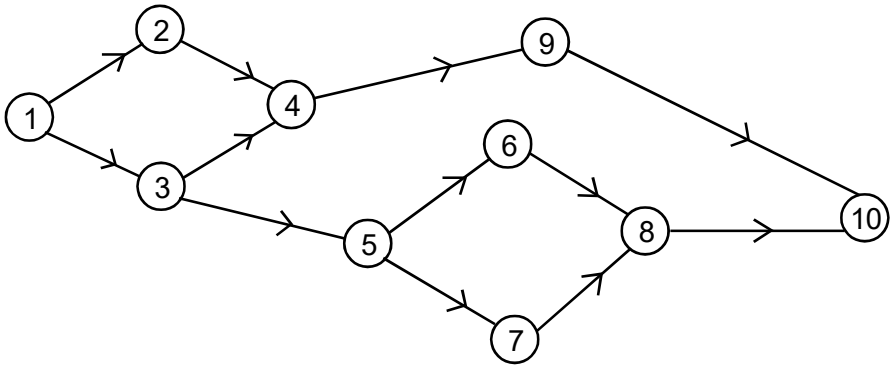
We note that X is a dummy activity.

Ans to Q No 2:

Predecessor events	1	2	3	4	5	6	7	8	9
Successor events	2, 3	4	4, 5	9	6, 7	8	8	10	10

Here, the initial node is 1, and the end node is 10.

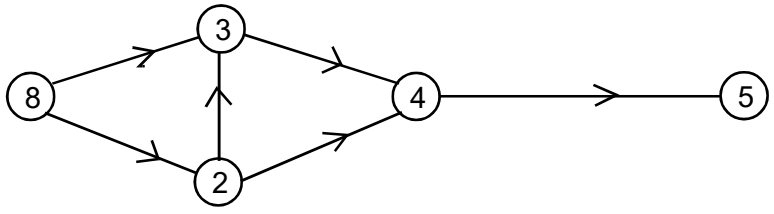
The network of the project is given below.



Ans to Q No 3:

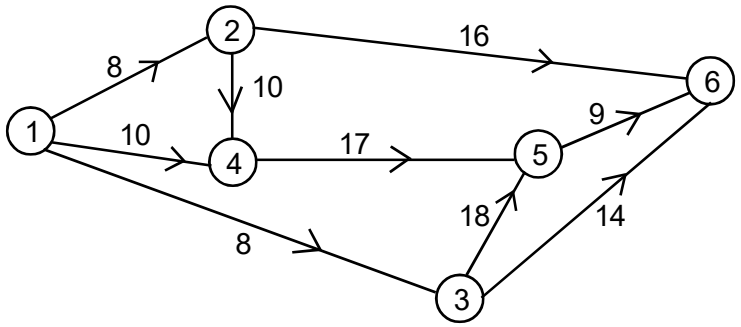
Predecessor events	1	2	3	4
Successor events	2, 3	3, 4	4	5

Here, the initial node is 1, and the end node is 5.



Ans to Q No 1: Here, the initial node is 1, and the end node is 6.

The network of the project is given below.

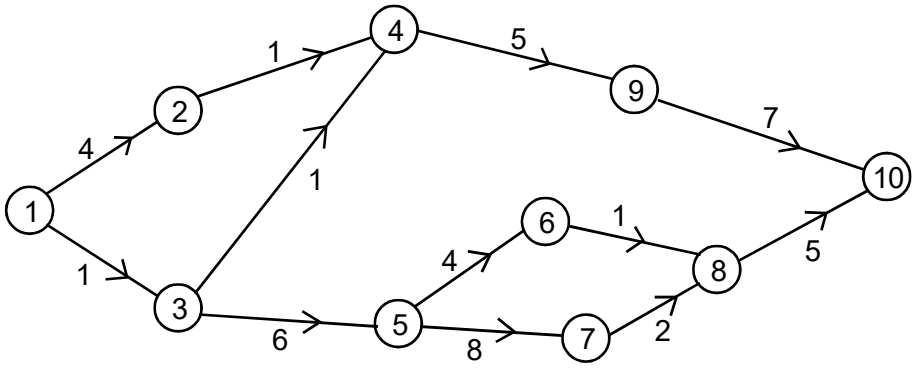


Path	Duration (in days)
1 – 2 – 6	8 + 16 = 24
1 – 2 – 4 – 5 – 6	8 + 10 + 17 + 9 = 44
1 – 4 – 5 – 6	10 + 17 + 9 = 36
1 – 3 – 5 – 6	8 + 18 + 9 = 35
1 – 3 – 6	8 + 14 = 22

The path with maximum duration is 1 – 2 – 4 – 5 – 6. So, the critical path is 1 – 2 – 4 – 5 – 6. The critical activities are 1 – 2, 2 – 4, 4 – 5, 5 – 6.

Ans to Q No 2: Here the initial node is 1, and the end node is 10.

The network of the project is given below.



Path	Duration (in days)
1 – 2 – 4 – 9 – 10	4 + 1 + 5 + 7 = 17
1 – 3 – 4 – 9 – 10	1 + 1 + 5 + 7 = 14
1 – 3 – 5 – 6 – 8 – 10	1 + 6 + 4 + 1 + 5 = 17
1 – 3 – 5 – 7 – 8 – 10	1 + 6 + 8 + 2 + 5 = 22

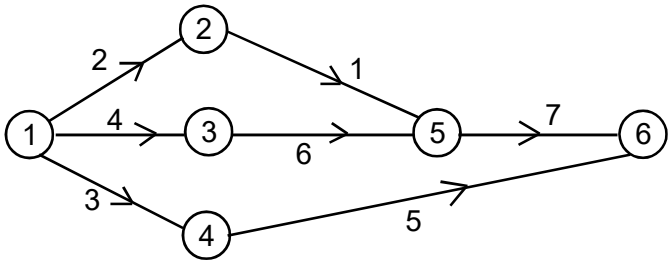
The path with maximum duration is 1 – 3 – 5 – 7 – 8 – 10. So, the critical path is 1 – 3 – 5 – 7 – 8 – 10. The critical activities are 1 – 3, 3 – 5, 5 – 7, 7 – 8, 8 – 10.

Ans to Q No 1:

Activity	t_0	t_m	t_p
1–2	1	1	7
1–3	1	4	7
1–4	2	2	8
2–5	1	1	1
3–5	2	5	14
4–6	2	5	8
5–6	3	6	15

Here, the initial node is 1, and the end node is 6.

(a) The network of the project is as follows.



The paths are as follows

1 – 2 – 5 – 6,

1 – 3 – 5 – 6,

1 – 4 – 6.

(b)

Activity	t_o	t_m	t_p	$\frac{t_0 + 4t_{tm} + t_p}{6}$	$\alpha^2\left(\frac{t_p - t_0}{6}\right)^2$
1 – 2	1	1	7	2	1
1 – 3	1	4	7	4	1
1 – 4	2	2	8	3	1
2 – 5	1	1	1	1	0
3 – 5	2	5	14	6	4
4 – 6	2	5	8	5	1
5 – 6	3	6	15	7	4

$$\left[\frac{1+4+7}{6}=2, \quad \frac{1+16+7}{6}=\frac{24}{6}=4, \quad \frac{2+8+8}{6}=3 \right.$$

$$\frac{1+4+1}{6}=1, \quad \frac{2+20+14}{6}=6, \quad \frac{2+20+8}{6}=5$$

$$\left. \frac{3+24+15}{6}=7 \right]$$

$$\left[\left(\frac{7-1}{6}\right)^2=1, \quad \left(\frac{7-1}{6}\right)^2=1, \quad \left(\frac{8-2}{6}\right)^2=1 \right.$$

$$\left(\frac{1-1}{6}\right)^2=0, \quad \left(\frac{14-2}{6}\right)^2=4, \quad \left(\frac{8-2}{6}\right)^2=1$$

$$\left. \left(\frac{15-3}{6}\right)^2=4 \right]$$

Path	Expected duration of time
1 – 2 – 5 – 6	2 + 1 + 7 = 10
1 – 3 – 5 – 6	4 + 6 + 7 = 17
1 – 4 – 6	3 + 5 = 8

critical path 1 – 3 – 5 – 6

expected duration of time = 17 weeks.

(c) Variance of the project length

= sum of the variances on the critical path

= 1 + 4 + 4 = 9

Standard deviation = 3

Ans to Q No 2: Do yourself.



5.10 MODEL QUESTIONS

Q 1: What is meant by activity? Why dummy activity is used in network analysis?

Q 2: What is meant by criitical path? Where CPM is generally used?

Q 3: Explain the following terms used in PERT :

(a) Optimistic time,

(b) Pessimistic time,

(c) Most likely time.

Q 4: What are the basic differences between PERT and CPM?

Q 5: A project schedule has the following characteristics.

Activity	Immediate predecessors	Normal time (days)
A	–	16
B	–	20
C	A	8
D	A	10
E	B, C	6
F	D, E	12

Find the critical path and the expected time of the project.

Q 6: The following table shows the jobs of a project with their duration in days. Draw the network and determine the critical path.

Jobs	1–2	1–3	1–4	2–5	3–7	4–6	5–7	5–8	6–7	6–9	7–10
Duration	10	8	9	8	16	7	7	7	8	5	12
Jobs	8–10	9–10	10–11	11–12							
Duration	10	15	8	5							

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UNIT 6 : IMPLEMENTATION AND CONTROL

UNIT STRUCTURE

6.1 Learning Objectives

6.2 Introduction

6.3 Project Management Information System

6.4 Project Monitoring and Reporting

6.4.1 Project Monitoring

6.4.2 Project Reporting

6.5 Cost Control

6.6 Let Us Sum Up

6.7 Further Reading

6.8 Answers To Check Your Progress

6.9 Model Questions

6.1 LEARNING OBJECTIVES

After going through this unit, you will able to know

- project Management Information System
- project Monitoring and Reporting
- cost control.

6.2 INTRODUCTION

A project Management Information system (PMIS), according to Bernie Roseke, is one or more software tools used for project's information storage and distribution. In this unit, we will discuss PMIS, and components of PMIS. Furthermore, we will discuss project Monitoring and Reporting, Cost Control.

6.3 PROJECT MANAGEMENT INFORMATION SYSTEM

A Project Management Information System (PMIS), according to

Bernie Roseke, is one or more software tools used for a project's information storage and distribution.

The PMBOK-5th edition defines PMIS as follows :

'An information system consisting of the tools and techniques used to gather, integrate, and disseminate the outputs of project management processes.'

PMIS is used to support all aspects of the project from initiating through closing and can include both manual and autmated systems.

There are different types of PMIS. There are diverse ways of applying these types of systems for optimal benefit to the organisation.

According to Bernie Roseke, there are eight compenents of a PMIS. They are as follows,– (1) Scheduling, (2) Estimating, (3) Resources, (4) Project documents and data, (5) Portals and dashboards, (6) Collaborative work management tools, (7) Social media, (8) Project control.

1. **Scheduling :** Schedules are core components of project management. Almost all PMIS's contains scheduling tools. The project schedule is communicated to stakeholders and it forms the baseline for project control.

   Software scheduling tools are a critical component of project management information systems. They allow the scheduling function to be performed quickly and efficiently.

   Moreover, an important function of a project management information system is the ability to track actual versus planned completion dates. It can be analysed to determine the likelihood of futune project dealys using earned value analysis indicators.

   Let us now give a brief description of earned value analysis.

- **Planned Value (PV) =** The budgeted amount through the current reporting period.
- **Actual Cost (AC) =** Actual costs to date.
- **Earned Valus (EV) =** Total project budget multiplied by the % of project completion.
- **Schedule Performance Index (SPI) =** $\frac{EV}{PV}$. SPI < 1 indicates less

work was completed than was planned (Bad).

SPI > 1 indicates more work was completed than was planned (Good)

- **Cost Performance Index (CPI) =** $\frac{EV}{AC}$. CPI < 1 indicates costs were higher than the budgeted (Bad)

  CPT > 1 indicates costs were less than budgeted (Good)
- **Schedule Variance (SV) =** EV – PV
- **Cost Variance (CV) =** EV – AC

  > 0 is good, < 0 is bad.
- **Estimate at Completion (EAC) =** $\frac{Total\ \text{Pr}oject\ at\ Budget}{CPI}$

  EAC is a forecast of how much the total project will cost.
- **Variance at Completion (VAC) =** Total Project Budget – EAC

  VAC < 0 indicates 'spent more than planned'

  VAC > 0 indicates 'completed the project within the planned budget'.
- **To Complete Performance Index (TCPI) =** $\frac{\text{Re}mainng\ Work}{\text{Re}maining\ Funds}$

  If under budget, TCPI = $\frac{\text{Total Pr oject Budget} - EV}{\text{Total Pr oject Budget} - AC}$

  If over budget, TCPI = $\frac{\text{Total Pr oject Budget} - EV}{EAC - AC}$

Earned value analysis makes the project managers aware of how they are progressing. It helps them to take corrective action if anything goes wrong.

Let us take an example. Let there be a year-long project with a total budget of Rs. 100,000. Let the amount budgeted through the first six- month make be Rs. 55,000. Let the actual cost through this six-month mark be Rs. 45,000.

Planned value (PV) = Rs. 55,000

Earned value (EV) = 50% of Rs 100,000

Actual cost (AC) = Rs. 45,000

$$SPI = \frac{EV}{PV} = \frac{50{,}000}{55{,}000} = 0.91 < 1$$

It indicates less work was completed than was planned (Bad).

$$CPI = \frac{EV}{AC} = \frac{50,000}{45,000} = 1.11 > 1$$

It indicates costs were less than budgeted (Good)

SV = EV – PV = Rs. 50,000 – Rs. 55,000

= - Rs. 5000 < 0, bad

CV = EV – AC = Rs. 50,000 – Rs. 45,000

= Rs. 5000 < 0, Good

$$EAC = \frac{\text{Total Project Budget}}{CPI} = Rs.\frac{100,000}{1.11} = Rs.90,000$$

VAC = Total Project Budget – EAC

= Rs. 100,000 – Rs. 90,000 = Rs. 10,000 > 0

It indicates that the project was completed within the planned budget.

2. **Estimating :** A price is assigned to each of the project tasks. Each task is then rolled up into all overall project estimate. A good PMIS will track the estimated cost of each task as well as the justification of the estimate.
3. **Resources :** Almost all tasks require resources for their completion. A simple task may have only a project team member. That is also a resource. It needs to be available in order to complete the task. A good PMIS allows the assignment of resources to tasks.
4. **Project Documents and Data :** Almost all projects produce documents as part of their scope. Most projects also import documents and data for use in project work. Every document tracked by the project is catalogued and the requirements are defined.
5. **Portals and Dashboards :** There are many web based project management software tools. They provide a centralised dashboard for the project. Moreover, project stakeholders often require information dissemination tools such as websites and project portals.
6. **Collaborative Work Management Tools :** Many projects utilise internal communication tools like project chat rooms, messaging apps, etc. It helps project team members to record critical project communications with other members of the team quickly.

7. **Social Media :** Many projects use social media to communicate with stakeholders. It is very simple to set up, and use. Almost all stakeholders know how to navigate the software.
8. **Project Control :** Project control refers to the tasks undertaken by the project management team to measure the project's progress. It involves the following components, – Schedule, cost, Scope, Quality, Resources, Procurement, Risks, Communications. A good PMIS provides a place for the project manager to track these items.



CHECK YOUR PROGRESS

Q 1: What is Project Management Information System?

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Q 2: Let there be a year-long project with a total budget of Rs. 250,000. Let the amount budgeted through the first three-month mark be Rs. 70,000. Let the actual cost through this three-month mark be Rs. 60,000. Find SPI, CPI, SV, CV, EAC,and interpret the results.

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6.4 PROJECT MONITORING AND REPORTING

6.4.1 Project Monitoring

Project Monitoring plays an important role in Project Management. It helps the project manager in decision making processes.

Project Monitoring refers to the process of–

(1) Keeping track of all project related metrics including team performance and task duration.

(2) Identifying potential problems and

(3) Taking corrective actions necessary to ensure that the project is within scope, on budget and meets the specified deadlines.

Thus, project monitoring is

(1) Overseeing all tasks, and

(2) Keeping an eye on project activities to make sure that the project is being implemented according to the plan

(**Source :** How Important is Project Monitoring and How do we implement it through AI ?)

Types of Project Monitering

Project Monitoring can be performed with the help of the following.

1. Staff Meetings (can be conducted on a weekly, fortrightly, monthly, or an annual basis)
2. Partners' Meeting, Learning Forums (Focus Group Discussion, Surveys) or retreats
3. Participatory Reviews by Stakeholder.
4. Monitoring and Supervision Missions.
5. Statistics or Progress Reports.

(**Source :** Knowledgehut blog)



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'A Focus Group Discussion (FGD) is a good way to gather together people from similar backgrounds or experiences to discuss a specific topic of interest.'

Tracking five variables during project monitoring

Project Monitoring involves tracking five variables. These are as follows.

1. Schedule, the estimated effort and duration versus the actual effort and duration.
2. Costs, the estimated costs versus the actual costs.
3. Deliverables, what products or components have been delivered and plan to be delivered.

4. Quality, how well are the deliverables being completed, and
5. Benefits, the processes in place to achieve and to measure the lead indicators for benefits realisation.

(**Source :** Project Monitoring and Reporting)

Why is Project Monitoring Required?

1. Project Monitoring finds out the problems which arise or might arise during the implementation of the project. These problems must be solved for the progress of the project.
2. Monitoring helps in knowing if the desired results are achieved as planned.
3. Monitoring helps in knowing how the objectives are being met, and how the desired changes are being met.
4. Monitoring helps in adapting to better contextual and risk factors.
5. Monitoring helps in learning how various approaches to partcipation influences the outcomes.
6. Monitoring helps in understanding stakeholder's perspectives.
7. Monitoring helps in assessing if the project has been effectively, appropriately, and efficiently executed. Monitoring helps in ensuring accountability.

6.4.2 Project Reporting

A document which provides details on the overall picture of the proposed business is known as project report.

A project report should contain the following topics – (1) General information, (2) Executive summary, (3) Organisation summary, (4) Project description, (5) Marketing plan, (6) Capital structure and operating cost, (7) Management plan, (8) Financial aspects, (9) Technical aspects, (10) Project implementation, (11) Social responsibility.

There are a number of benefits of regular status reporting. Some of the benefits are listed below.

1. It gives an opportunity to raise issues or variances from the plan. It helps to take corrective action if something goes wrong.

2. It makes the work more visible to all of the project stakeholders, viz. project team members, project manager, project sponser, etc.
3. It helps to create accountability for the work being done.
4. It creates a visible record of the progress of the project. The Project Manager or Senior Management can review the report from time to time.



CHECK YOUR PROGRESS

Q 3: What is meant by Project Monitoring?

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Q 4: What is meant by Project Report?

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6.5 COST CONTROL

Cost control, according to Investopedia, is the practice of identifying and reducing business expenses to increase profits, and it starts with the budgeting process. A firm compares actual results with the budgeted expectations. Actual costs may be higher than planned. In that case management takes action.

Investopedia has opined that cost control is an important factor in maintaining and growing profitability.

Outsourcing is a common method to control costs because many businesses find it cheaper to pay a third party to perform a task than to take on the work within the company.



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Outsource : obtain goods or service by contract from an outside supplier.

Advantages of Cost Control :

1. Cost control helps the firm to improve its profitability and competitiveness.
2. Despite a large and increasing sales volume, profits may be reduced if there is no cost control.
3. Cost control is necessary for achieving greater productivity.
4. If there is cost control, costs may be reduced and thus, prices may be reduced.
5. If the price of the product is stable and reasonable, it can maintain higher sales, Furthermore, it can maintain employment of work force.

Tools and Techniques for Cost Control

According to PMBOK 2000 edition, tools and techniques for cost control are as follows.

1. **Cost change control system :** A cost change control system defines the procedure by which the cost baseline may be changed. it contains the paperwork, tracking systems, and approval levels necessary for authorising changes.



LET US KNOW

Cost baseline : 'Costbaseline if the authorised time-phased spending plan for the project on which the project cost performance is to be measured against.'– Edward chung cost baselive = project cost estimates + contingency reserves.

2. **Performance measurement :** Performance measurement techniques help to determine the magnitude of any variations that occur. Let us give a brief description of performance measurement techniques. Soure of the ways to measure and evaluate employee performance data are as follows.
   - **(i) Graphic rating scales :** In this system a typical graphic scale is used with sequential order, such as 1 to 5, or 1 to 10 to rate an employee's relative performance in specific areas.

(ii) **360 degree feedback :** In this system, the feedback, opinions, and assessments of an employee's performance are taken from the people of the firm where he/she works.

(iii) **Self-evaluation :** Employees may be asked to evaluate their own performance. A farm that requires multiple-choice answers, essay-type answers, or a combination of the two may be used. It can be very effective.

(iv) **Management by objectives :** In this system, managers and employees determine individual objectives, how they align with the goals, and how performance will be measured and evaluated.

(v) **Checklists :** A simple way to identify employees that have deficiencies invarious performance areas is usage of 'yes-no' checklist.

3. **Earned Value Management :** All earned value management account plaus must continuously measure project performance by relating three independent variables, viz. Planned Value (PV), Earned Value (EV), Actual Cost (AC).

4. **Additional Planning :** The number of projects running exactly to plan is very few. Prospective changes may require new or revised cost estimates, or analysis of alternative approaches.

5. **Computerised tools :** Computerised tools (e.g. project management software) are also used to track planned costs versus actual costs. It will also forecost the effects of cost changes.



CHECK YOUR PROGRESS

Q 5: What is meant by 'outsource'?

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Q 6: What is meant by cost baseline?

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6.6 LET US SUM UP

- A Project Management Information System (PMIS), according to Bernie Roseke, is one or more software tools used for a project's information storage and distribution.
- According to Bernie Roseka, there are eight components of PMIS. They are as follows, – (1) Scheduling, (2) Estimating, (3) Resources, (4) Project documents and data, (5) Portals and dashboards, (6) Collaborative work management tools, (7) Social media, (8) Project control.
- Project monitoring plays an important role in Project Management. It helps the project manager in decision making processes.
- A document which provides details on the overall picture of the proposed business is known as Project Report.
- Cost control, according to investopedia, is the practice of identifying and reducing business expenses to increase profits, and it starts with the budgeting process. A firm compares actual results with the budgeted expectations. Actual costs may be higher than planned. In that case management takes action.



6.7 FURTHER READING

1) Rory Burke: *Project Management* (2013), Wiley.

2) Prasanna Chandra : *Projects* (2016), McGraw Hill Education (India) Private Limited, New Delhi.



6.8 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: A Project Management Information System (PMIS) is one or more software tools used for a project's information storage and distribution.

Ans to Q No 2: Planned Value (PV) = Rs. 70,000

Earned Value (EV) = 25% of Rs. 250,000

= Rs. 62,500

Actual cost (AC) = Rs. 60,000

$$SPI = \frac{EV}{PV} = \frac{62,500}{70,000} = 0.89 < 1$$

It indicates less work was completed than was planned (Bad)

$$CPI = \frac{EV}{AC} = \frac{62,500}{60,000} = 1.04 > 1$$

It indicates costs were less than budgeted (Good).

SV = EV – PV = Rs. (62,500 – 70,000)

= – Rs 7500 < 0, Bad

CV = EV – AC = Rs. (62,500 – 60,000)

= Rs. 2500 > 0, Good.

$$EAC = \frac{\text{Total Project Budget}}{CPI} = Rs.\frac{250,000}{1.04}$$

= Rs. 240,385

$\therefore$ Total project will cost Rs. 240,385.

Ans to Q No 3: Project monitoring is

(i) Overseeing all tasks, and

(ii) keeping an eye on project activities to make sure that the project is being implemented according to the plan.

Ans to Q No 4: A document which provides details on the overall picture of the proposed business is known as project report.

Ans to Q No 5: Outsource means 'to obtain goods or service by contract from an outside supplier'.

Ans to Q No 6: Cost baseline : Cost baseline is the authorised time-phased spending plan for the project on which the project cost performance is to be measured against.



6.9 MODEL QUESTIONS

Q 1: What is meant by Project Management Information system? Describe the eight components of a Project Management Information System.

Q 2: What is Project Monitoring? Why Project Monitoring is required?

Q 3: What is Project Reporting? Describe some of the benefits of Project Reporting.

Q 4: What is cost control? What are the advantages of cost control? What are the tools and techniques for cost control?

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UNIT 7: PROJECT COMPLETION AND EVALUATION

UNIT STRUCTURE

7.1 Learning Objectives

7.2 Introduction

7.3 Integrated Power Management Control System

7.4 Project Management Transition

7.5 Project Completion and Evaluation

7.6 Project Review

7.7 Project Termination

7.8 Let Us Sum Up

7.9 Further Reading

7.10 Answers To Check Your Progress

7.11 Model Questions

7.1 LEARNING OBJECTIVES

After going through this unit, you will able to know about

- integrated power management
- project management transition
- project completion and evaluation
- project review
- project termination.

7.2 INTRODUCTION

Integrated project management (IPM), according to David Arnold, is the collection of processes that ensures proper coordination various elements of projects. In this chapter, We will discuss the key components of IPM, importance of IPM, etc. Also, we will discuss Project Management Transition, Project Completion and Evaluation, Project Review, Project Termination.

7.3 INTEGRATED POWER MANAGEMENT CONTROL SYSTEM

Integrated project management (IPM), according to David Arnold, is the collection of processes which ensures that various elements of projects are properly coordinated.

IPM describes a way to understand, collect, share, and implement Project management knowledge and best practices across the organization. David Arnold has stated the following six key components of IPM.

1. **Project Charter :** The project charter is the first step in IPM. It provides the scope, objectives, roles and responsibilities of different resources, and participants in a project. It identifies the key stakeholders also. The authority and responsibilities of the project manager are also defined in the project charter.
2. **Project Scope :** The goals and objectives of the project are specified in the project scope. It must be borne in mind that goals are long-term aims of the project, whereas objectives define exact milestones.
3. **Project Management plan :** It provides all other plans and processes associated with the project. In this plan, all activities to be defined, prepared, integrated, and coordinated are documented.
4. **Project Execution :** It defines the processes for executing individual components in the project plan. It is activity- centric. Performance is measured during the execution period.
5. **Project Monitoring :** In this stage, the project performance is compared against the baseline on a continuing the basis. If there is a severe negative deviation from the baseline, the project can be modified accordingly. It must be noted that the acceptable deviation is defined in the project plan.



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A baseline in project management is a clearly defined starting point for a project plan. It is a fixed reference point to measure and compare project‘s progress.

6. **Change control :** There may be changes during the progress of the project. Some resources may become scarce. Some stakeholders may opt for additional changes. These problems are to be dealt with. It is defined in the change control document. There are multiple stakeholders in complex projects. In such projects resistance and conflicting interests are inevitable. These can be dealt with the change control document. The document also defines the criteria for evaluating change requests. If these requests are not considered favourable for the project, these may be discarded.

Importance of IPM:

Projects are complex. There are different parts in a project that are to be managed. For example, a project manager has to supervise the following,– schedule, cost, scope, quality, resources, risks, changes, stakeholders, keeping track of all these is a challenging task. For example, a change in scope will affect schedule, cost, and resource requirements. Without IPM, it is difficult to identify conflicts in advance, and know how to resolve them. How to succeed with IPM:

In order to succeed with IPM, David Arnold has suggested the following.

- To tailor organisational processes
- To get buy-in from stakeholders
- To differentiate between projects and processes
- To prepare a plan and integrate it into the project
- To establish project teams
- To manage the involvement of stakeholders
- To use project portfolio management where possible.



LET US KNOW

1. **Buy-in :** support: agreement; the acceptance of and commitment to a specific concept or course of action.
2. **Project portfolio management** is the centralized management of the processes, methods, and technologies used by project managers and project management offices to analyze and

collectively manage current or proposed projects based on numerous key characteristics''.- Wikipedia

Difference between project and process

Project	**Process**
1. A project describes a multi-step activity with a definite end.	1. A process is an ongoing, changing activity.
2. A project is client-specific. It is not repeatable or scalable.	2. Processes are usually repeatable and scalable.



CHECK YOUR PROGRESS

Q 1: What is integrated project management ?

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Q 2: Write down the differences between project and process.

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7.4 PROJECT MANAGEMENT TRANSITION

A project management transition (PMT) plan is a document that gives a brief description about the processes to be followed during the implementation stage of any project. Whenever a defined task in completed, the project team not only submits the findings and deliverables to the project Board, but also provides a detailed plan for the implementation of these ideas into the processes that already exist. The project will pass through a period of change while the plans are put into motion. This is known as transition plan.

Some of the aspects that are to be covered in a transition plan are given below.

1. **Identification of Key Transition Staff :** Key staff members must be identified who will play a pivotal role in the changing process that is about to occur.
2. **Logistics Consideration :** Before attempting to start the change, due considerations must be given in terms of new hardware, software,

hiring of additional staff, contractual amendments, etc.

3. **The Transfer of Knowledge :** The issue of knowledge transfer is another important part of transition plan. All the members of the staff who will use the new system must be properly trained. If the change affects the customers directly, they are to be informed beforehand. The transfer of knowledge has the power to affect the success or failure of the process. Therefore, any communication plan must be handled carefully.
4. **Detailed Schedules for Implementation :** It may not be possible to implement all the changes at a time. If the entire organization is to be affected, it can introduced on a phased-in basis. This schedule for the use of a new system must be coordinated properly.
5. **Identification of Risk Factors :** There may be possibility of new risk factors wherever a change is introduced. The transition team must consider it carefully. All process flows must be scrutinised properly.

7.5 PROJECT COMPLETION AND EVALUATION

Project completion and evaluation is in the last phase of the project life-cycle. The purpose of this phase is to fix a date at which acceptance for the project product is confirmed. The purpose is to recognize if the project objectives have been achieved and end user acceptance has taken place. If the end product of the project is to maintained or operated by a group/ individual, it must be handed over to them after the project has been completed. They would like to inspect or test whether the goals have been met or not. This inspection/testing has already been agreed upon at the time of project initiation.



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End user: The end user is the individual (or group) who uses the product after it has been fully developed and marketed.

End Product: 1. Final output of an activity, arrangement, or process.

2. Articles materials, and supplies delivered (or are to be delivered) under a contract. – Business Dictionary

Project Completion and Evaluation phase includes the following form stages.

1. **To hand over the project products :** This stage includes both the formal handover and follow on actions. End products must be handed over to end users. Follow on action recommendations are the activities relating to any unfinished work, ongoing issues and risks or any other activities needed to take a product to the next phase of its life.
   Follow-on actions will be a part of the project closure report.
2. **To evaluate the project :** This stage seeks to assess the effectiveness of the project. It is required to ascertain whether the project was successful or unsuccessful. The project closure Report (PCR) is to be prepared. The PCR should contain the "Executive summary'' where the performance of the project in terms of cost, time, benefits, and quality have been summarized. The PCR should assess if purpose of the project is fulfilled or not. The PCR should also conduct a review of the business case, project objectives, team performance, products, lessons learnt.



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Business case : "The business case process develop a solution to address the problems, needs and opportunities outlined in the statement of requirements. The business case then seeks justification and permission to use company resources for undertaking a project. If there is more than one requirement and more than one business case, then each business case seeks justification to be selected in preference to the other business cases''.

– Rory Burke in Project Management

3. **To recommend closure :** In this stage, the project manager will recommend closure through a PCR placed before the Project Board.

A meeting of the Project Board is held in order to close the project. A closure notification is issued to all stakeholders as and when the project board gives approval to the closure of the project.

4. **To authorize project closure :** The last activity of the Project Board is authorising project closure. The project board gives approval to the project closure report.



CHECK YOUR PROGRESS

Q 3: What are the four stages in project completion and Evaluation phase?

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7.6 PROJECT REVIEW

A post project review is an exercise undertaken at the end of each project phase. A post project review

- Identifies the current status of the project,
- Identifies the deliverables that have been produced to date,
- determines whether the project has met the objectives or not,
- Identifies areas for improvements and ways to improve them. The purpose of a post project review is to determine.
- Whether the project was completed on time,
- Whether budgetary requirements were adhered to,
- Whether project management procedures were used effectively,
- Whether communication was effective,
- How did the project team perform,
- Whether the overall outcome was acceptable,
- What changes could be made for future project,

A project may succeed or it may not be able to fulfill the expectations of the stakeholders. The project review should contain the pros and cons of the entire project so that future projects can benefit from the lessons learnt from the review. The review should contain the final status of the project, and recommendations for improvement. Before planning a post project

review, primary goals must be identified. The reviewer must –

- Identify items that were done well,
- Identify items that could improve,
- Identify items that are broken,
- decide action plans.

Lessons can be learnt from successful aspects of the project as well as from the mistakes. Thus, mistakes can be avoided in future project, and good practice can be implemented.



CHECK YOUR PROGRESS

Q 4: What is meant by a post project review? What is its purpose?

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7.7 PROJECT TERMINATION

Project termination, also known as project close-out or project finalization is the last stage of managing the project. It takes place after the implementation phase has ended. During this phase

- Acceptance testing has been carried out,
- The project deliverables have been handed over to the client,
- The project team has been disbanded,
- Unused resources have been disposed of as appropriate,
- All outstanding bills have been passed for payment,
- The final invoices for work conied out have been issued.



LET US KNOW

Acceptance testing: Formal testing with respect to user needs, requirements, and business processes conducted to determine whether or not a system satisfies the acceptance criteria and to enable the user, customers or other authorized entity to determine whether or not to accept the system.— ISIQB (International software testing qualifications board)

Deliverable : A deliverable is a tangible or intangible good or service produced as a result of a project that is intended to be delivered to a customa. – Wikipedia

The main purpose of the the termination stage is to evaluate whether the project is a success, and to learn lessons for the future.

A project is considered to be a success if

- Its goals and objectives are met on time and under budget,
- Deliverables are produced as desired by stakeholders,
- The final product is accepted by and handed over to the customer.

A project is considered to be a failure if–

- Its goals and objectives are not met,
- Its requirements are not met,
- The customer refuses to accept the product,
- There are some technical problems that cannot be solved by using existing tools and technologies,
- There is loss of human, financial and other resources.



7.8 LET US SUM UP

- Integrated Project Management, according to David Arnold, is the collection of processes that ensures various elements of projects are properly coordinated.
- Goals are long-term aims of the project, whereas objectives define exact milestones.
- A project describes a multi-step activity with a definite end. On the other hand a process is an ongoing, changing activity.
- A Project Management Transition plan is a document that gives a brief description about the processes to be followed during the implementation stage of any project.
- Project completion and evaluation is in the last phase of the project life-cycle.

- A post project review is an exercise undertaken at the end of each project phase.
- Project termination, also known as project close-out or project finalisation is the last stage of managing the project. It takes place after the implementation phase has ended.



7.9 FURTHER READING

1) Adrienne Watt; *Project Management,* The open University of Hong Kong.
2) Olaf Passenheim : *Project Mangement.*



7.10 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: See Art 7.3
Ans to Q No 2: See Art 7.3
Ans to Q No 3: See Art 7.5
Ans to Q No 4: See Art 7.6



7.11 MODEL QUESTIONS

Q 1: What is integrated project management. Describe the key components of integrated project.
Q 2: Write a note on the importance of integrated project management.
Q 3: Write a note on project management transition.

Q 4: Describe the four stages in project completion and evaluation phase.

Q 5: What is post project review ? What are its purposes?

Q 6: Write a note on project termination.

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