KARNATAKA STATE OPEN UNIVERSITY

Mukthagangotri, Mysuru-570006

MBA

(Third Semester)

PROJECT MANAGEMENT

Department of Studies and Research in Management

Course : 15

Block - 1

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Course : 15

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DEPARTMENT OF STUDIES AND RESEARCH IN MANAGEMENT

M.B.A III Semester

COURSE - 15 : PROJECT MANAGEMENT

BLOCK

1

INTRODUCTION TO PROJECT MANAGEMENT

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BLOCK - I : INTRODUCTION TO PROJECT MANAGEMENT

In the present competitive world the success of many organizations is the product of success of efficient project manageament. Many organizations accepted the project management as a professional practice. The block-1deals with the basics of project management. This block is divided into four unit.

Unit-1 is concerned with introductry part of project management, it begins with the meaning and definitions of project management, which continues to discuss the scope and objectives of project management. Further, the unit sheds light upon evolution of project management and role of project management.

Unit- 2 deals with evolution of integrated project management; an integrated study of all the process of a successful project gives clear picture of entire project. Thus it is important to study the evoution of integrated project.The unit defines integrated project management , continues to explain evolution of integrated project management system,also this unit discusses project management process, integrated project management cycles and alining projects with organization stategy.

Unit- 3 deals focuse on project portfolio management, at the outset this unit discusses the concept of project portfolio management system, then it explains the need for project portfolio management further the unit discusses how to design project portfolio management and at the end of the unit it breifly throughs light upon project life cycle and its phases.

Unit-4 deals with feasibility of projects. All business ideas may not be practially feasible. Thus, before starting any project it is important to conduct feasibility study. This unit begins with the concept and components of feasibilities of projects, then it discusses different forms of project contacting. Further, this unit explains the role of in project management.

UNIT- 1: BASICS OF PROJECT MANAGEMENT

Structure:

1.0 OBJECTIVES

After studying this unit you should be able:

- provide an overview of Project Management
- define Project Management
- have a better understanding of Scope of Project Management
- understand the Role of Project Manager

1.1 INTRODUCTION

Project management is a professional practice that has reached wide acceptance in many industries from government to technology. Organizations that have adopted project management as a key competency have benefited from improved project outcomes to significant competitive advantage. Most of the information available to development organizations focuses on the funding and monitoring and evaluation process; but there is little information about all the management competencies, methodologies and practices required to manage a project from beginning to end.

Development organizations are facing increasing demands to do more with less, from becoming catalysts of change in the communities they serve to deliver the project on time, under budget and in the quality not only expected but demanded by donors and beneficiaries. To face these challenges development and humanitarian assistance organizations are in urgent need of the tools, practices methodologies that a well established project management methodology can provide, one that has been quite successful in other industries.

Project management processes and techniques are used to coordinate resources to achieve predictable results. It should be understood clearly from the outset that project management is not totally a science, and there is never a guarantee of success. Because projects involve people, there are always complexities and uncertainties that cannot be absolutely controlled – so it is also an art that requires flexibility and creativity. It is a science because it relies on proven and repeatable processes to achieve success and an art because it has everything to do with managing and relating to people.

Concept of Project

A project can be defined as a complex of non-routine activities that must be completed with a set amount of resources and within a set time limit. The following figure explains the basic tenets of project management.

Typical examples of projects include: construction of a house, performing a marriage, overhauling a machine, maintenance of equipment, commissioning of a factory, conducting national elections, research on developing a new technology, launching a new weapon system, conducting a war, pre-crisis planning for preventing a riot, recruitment of a project manager, etc. Each of the above cases involves investment of resources on a package of inter-related, time-bound activities, thereby constituting a project.

A project is a temporary endeavour, having a defined beginning and end (usually constrained by date, but can be by funding or deliverables), undertaken to meet unique goals and objectives, usually to bring about beneficial change or added value. The temporary nature of projects stands in contrast to business as usual (or operations), which are repetitive, permanent or semi-permanent functional work to produce products or services**-"Project Management Body of Knowledge"**

A Project is a related set of activities and milestones with a present goal and time frame that is designed as a specific event and not an ongoing process**-"Bridge field group"**

Project Characteristics

Projects come in all shapes and sizes. The following characteristics help to define a project further:

A project has a unique purpose: Every project should have a well-defined objective. For example, many people hire firms to design and build a new house, but each house, like each person, is unique.

A project is temporary: . A project has a definite beginning and a definite end. For a home construction project, owners usually have a date in mind when they'd like to move into their new home.

A project is developed using progressive elaboration or in an iterative fashion*:* Projects are often defined broadly when they begin, and as time passes, the specific details of the project become more clear. For example, there are many decisions that must be made in planning and building a new house. It works best to draft preliminary plans for owners to approve before more detailed plans are developed.

A project requires resources, often from various areas: Resources include people, hardware, software, or other assets. Many different types of people, skill sets, and resources are needed to build a home.

A project should have a primary customer or sponsor*:* Most projects have many interested parties or stakeholders, but someone must take the primary role of sponsorship. The **project sponsor** usually provides the direction and funding for the project.

A project involves uncertainty*:* Because every project is unique, it is sometimes difficult to define the project's objectives clearly, estimate exactly how long it will take to complete, or determine how much it will cost. External factors also cause uncertainty, such as a supplier going out of business or a project team member needing unplanned time off. Uncertainty is one of the main reasons project management is so challenging, because uncertainty invokes risk.

1.2 MEANING OF PROJECT MANAGEMENT

Project management is the application of knowledge, skills and techniques to execute projects Effectively and efficiently. It's a strategic competency for organizations, enabling them to tie project results to business goals and thus, better compete in their markets. It is no longer a special-need management. It is rapidly becoming a standard way of doing business. Project Management Institute's *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)* identifies its recurring elements. Project management processes fall into five groups such as *initiating, planning, executing, monitoring, controlling and closing.*

Project management *knowledge* draws on nine areas, viz., integration, scope, time, cost, quality, procurement, human resources, communications and risk management. All management is concerned with these, of course. But project management brings a unique focus shaped by the goals, resources and schedule of each project. The value of that focus is proved by the rapid, worldwide growth of project management as a separate area of study and as a mode of functioning.

Project management deals with planning, scheduling, controlling and monitoring the complex non-routine activities that must be completed to reach the predetermined objectives of the project. Network techniques are primarily used for project planning and controlling. Planning is the process of preparing for the commitment of resources in the most economical manner. Controlling is the process of making events conforms to schedules by coordinating the action of all parts of the project to achieve the objective.

1.3 DEFINITIONS OF PROJECT MANAGEMENT

Project Management is a methodical approach to planning and guiding project processes from start to finish. It is the method of planning the plan. It starts from project definitions and ends with goal achievement.

Project management is an approach to management of work within the constraints of time, cost and performance in terms of scope and quality.

Project Management is defined as the application of knowledge, skill, tool and techniques to project activities in order to meet stakeholder's needs and expectations from a project**-"PMBOK"**

Project Management is defined as the methods and disciplines used to define goals, plan and monitor tasks and resources, identify and resolve issues, and control costs and budgets for a specific project**-"Bridge group"**

Project managements can be defined as an art of managing new challenges coming frequently and breaking the whole challenge into smaller, comfortable activities to accomplish them in an effective and efficient way. So, Project management uses many tools to accomplish a project in a comfortable way.

Figure 1-3 illustrates a framework to help you understand project management. Key elements of this framework include the project stakeholders, project management process groups, knowledge areas, tools and techniques, project success, and the contribution of a portfolio of projects to the success of the entire enterprise. Each of these elements of project management is discussed in more detail in the following sections.

Project management framework

Project Stakeholders

Stakeholders are the people involved in or affected by project activities and include the project sponsor, project team, support staff, customers, users, suppliers, and even opponents to the project. These stakeholders often have very different needs and expectations. For example, there are several stakeholders involved in a home construction project.

The project sponsors would be the potential new homeowners. They would be the people paying for the house and could be on a very tight budget, so they would expect the contractor to provide accurate estimates of the costs involved in building the house. They would also need a realistic idea of when they could move in and what type of home they could afford given their Budget constraints. The new homeowners would have to make important decisions to keep the costs of the house within their budget. Can they afford to finish the basement right away? If they can afford to finish the basement, will it affect the projected move-in date? In this example, the project sponsors are also the customers and users for the product, which is the house. The project manager in this example would normally be the general contractor responsible for building the house. He or she needs to work with all the project stakeholders to meet their needs and expectations.

The project team for building the house would include several construction workers, electricians, carpenters, and so on. These stakeholders would need to know exactly what work they must do and when they need to do it. They would need to know if the required materials and equipment will be at the construction site or if they are expected to provide the materials and equipment. Their work would need to be coordinated since there are many interrelated factors involved. For example, the carpenter cannot put in kitchen cabinets until the walls are completed.

Support staff might include the employers of the homeowners, the general contractor's administrative assistant, and other people who support other stakeholders. The employers of the homeowners might expect their employees to complete their work but allow some flexibility so they can visit the building site or take phone calls related to building the house.

The contractor's administrative assistant would support the project by coordinating meetings between the buyers, the contractor, suppliers, and other stakeholders.

Building a house requires many suppliers. The suppliers would provide the wood, windows, flooring materials, appliances, and other items. Suppliers would expect exact details on what items they need to provide, where and when to deliver those items, and similar information.

Additional stakeholders would include the city council and mayor, who would be interested in increasing revenues. They might suggest certain guidelines for the minimum value of the homes for providing adequate property taxes. The city may also have regulations to ensure the safety of the public in the area of the construction site. The local housing inspector would also be a stakeholder, concerned with ensuring that everything meets specific codes and regulations.

There may or may not be opponents to a project. In this example, there might be a neighbour who opposes the project because the workers are making so much noise that she cannot concentrate on her work at home, or the noise might awaken her sleeping children. She might interrupt the workers to voice her complaints or even file a formal complaint. Alternatively, the neighbourhood might have association rules concerning new home design and construction. If the homeowners did not follow these rules, they might have to halt construction due to legal issues.

As you can see from this example, there are many different stakeholders on projects, and they all have different interests. Stakeholders' needs and expectations are important in the beginning and throughout the life of a project. Successful project managers develop good relationships with project stakeholders to understand and meet their needs and expectations.

Project Management Process Groups and Knowledge Areas

The five project management process groups include initiating, planning, executing, monitoring and controlling, and closing activities.

Project Management Tools and Techniques

Thomas Carlyle, a famous historian and author, stated, "Man is a tool-using animal. Without tools he is nothing, with tools he is all." As the world continues to become more complex, it is even more important for people to develop and use tools, especially for managing important projects. **Project management tools and techniques** assist project managers and their teams in carrying out work in all ten knowledge areas. For example, some popular time-management tools and techniques include Gantt charts, project network diagrams, and critical path analysis.

1.4 SCOPE OF PROJECT MANAGEMENT

It covers the following arenas as part of its scope. They are initialization, planning and Development, project execution, project monitoring and finally project closing. There are many different approaches and these include traditional approach, critical chain, extreme, and event chain methodology. The project manager must be able to effectively communicate requirements, handle the decision-making process with respect to project scope and goals, manage employee activities, negotiate with other members of the team, build a good team and allocate resources according to requirements.

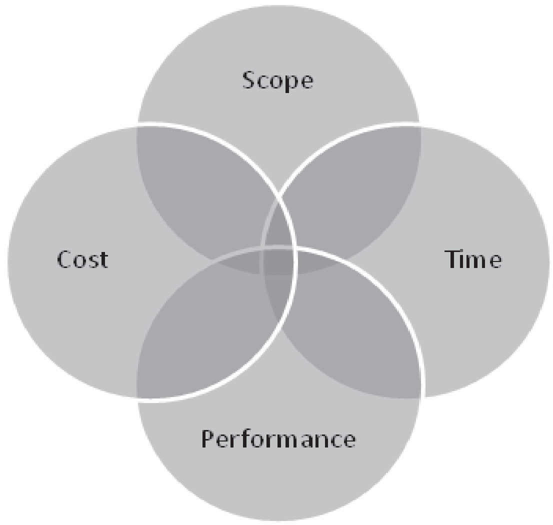
As part of the management process, it should make use of tools that help them to organize tasks, track hours, create a centralized location from where everything can be taken and collaborate with partners. In order to keep the project on the right track it is essential to have project control mechanisms in place. The appropriate level of control must be implemented because too much of control can be really time consuming, while toll less of control can make the project go out of hand. A project's success is determined if or not the project was completed. Within the stipulated time period and within the set budget and if it has met customer requirements.

1.5 OBJECTIVES OF PROJECT MANAGEMENT

There are four major objectives of project management.

1. Scope: The boundary of a project is called the scope of the project. Any project remains undefined without its scope being defined. Scope means what are the expectations from you as a project manager and your team. There may be enhanced scope being asked for during the implementation phase of any project. Shortage of skills, funds or time may lead to reduced scope of any project.

For example, a project allotted to a civil contractor always has well-defined scope, like all civil works including excavation, foundation, concreting, brickwork, plastering of walls as per the attached drawings.



2 ... ed performance level. If ... er, it is certainly an unsuccessful project.

For example, a river valley project is having performance standard defined as: to hold 10million meter cube of water and produce 500 MW of electricity. If the project does not satisfy any one of the above performance standards, it is considered an underperforming project.

3. Time: There is always a fixed tenure and end to a project. A successful project is the one which is completed within the time limits perceived during the planning. As cost is dependent on the time, time management becomes a crucial activity of project management. There are so many tools and techniques which can be used to manage time in a project.

For example, an IT solution provider company is asked to develop Systems, Applications and Products in Data Processing for a client in 3 months. If the company is not able to do so in the stipulated time, it is considered unsuccessful.

4. Cost: Cost is dependent on all the above objectives. Mathematically, we can write as Cost=f(P,T,S) Therefore, cost is a function of performance, time and scope. If any of the above increases, it is surely going to increase the cost of the project. It is generally seen that nearly all government projects have cost overruns.

Although majority of government and public sector projects have faced problem of time and cost overruns, there are some fine examples of successful projects in recent times, like Konkan Railways and Delhi Metro. Both the projects have nearly met all the objectives.

There is a similar approach in defining the objectives, its SMART approach.

We say that an objective must be smart, each letter standing for a particular aspect:

- Specific: Project should be targeting a specific aim or goal.
- Measurable: It should be quantifiable.
- Attainable : It should be attainable with resources available.
- Realistic: It should be realistic in nature. Dreaming is fine, but we certainly cannot manage the dreams we need some real things to be managed.
- Time limited: There is a fixed time limit for any project.

1.6 EVOLUTION OF PROJECT MANAGEMENT

Project management developed from several fields of application including civil construction, engineering, and heavy defence activity. Two forefathers of project management are Henry Gantt, called the father of planning and control techniques, who is famous for his use of the Gantt chart as a project management tool and Henri Fayol for his creation of the five management functions that form the foundation of the body of knowledge associated with project and program management. Both Gantt and Fayol were students of Frederick Winslow Taylor's theories of scientific management. His work is the forerunner to modern project management tools including work breakdown structure (WBS) and resource allocation.

The 1950s marked the beginning of the modern project management era where core engineering fields come together to work as one. Project management became recognized as a distinct discipline arising from the management discipline with engineering model. In the United States, prior to the 1950s, projects were managed on an ad-hoc basis, using mostly Gantt charts and informal techniques and tools. At that time, two mathematical project-scheduling models were developed. The "Critical Path Method" (CPM) was developed as a joint venture between DuPont Corporation and Remington Rand Corporation for managing plant maintenance projects. And the "Program Evaluation and Review Technique" or PERT, was developed by the United States Navy in conjunction with the Lockheed Corporation and Booz Allen Hamilton as part of the Polaris missile submarine program.

PERT and CPM are very similar in their approach but still present some differences. CPM is used for projects that assume deterministic activity times; the times at which each activity will be carried out are known. PERT, on the other hand, allows for stochastic activity times; the times at which each activity will be carried out are uncertain or varied. Because of this core difference, CPM and PERT are used in different contexts. These mathematical techniques quickly spread into many private enterprises. In 1969, the Project Management Institute (PMI) was formed in the USA.

Importance of Project Management

Project management is the art of managing the project and its deliverables with a view to produce finished products or service. There are many ways in which a project can be carried out and the way in which it is executed is project management. Project management includes: identifying requirements, establishing clear and achievable objectives, balancing the competing demands from the different stakeholders and ensuring that a commonality of purpose is achieved. It is clear that unless there is a structured and scientific approach to the practice of management, organizations would find they aimless and hence would be unable to meet the myriad challenges that the modern era throws at them. Hence, the importance of project management to organizations cannot be emphasized more and several reasons why project management is important is discussed below.

a) Squeezed Life Cycle of products

The product life cycle is one of the most significant driving forces behind the demand for project management. As the lives of the products are shortened, time to market for new products with short life cycles has become increasingly important. Innovation and invention becomes the key for success and speed to innovate or invent becomes a competitive advantage. More and more organizations are depending on cross-functional project teams to get new products and services to the market as quickly as possible.

b) Global Competition

In the globally competitive today's market, customers want cheaper products and services with better quality at cheaper prices. This had led to the emergence of the quality movement across the world in International Standards Organization certification requirements for doing business. Quality management and improvement essentially requires project management. As the basic elements of project management concentrate on time, cost and quality, project management has become style of managing business.

c) Knowledge Explosion

The knowledge explosion world over has increased the complexity of managing projects. Product complexities have increased and demanded integration of divergent technologies. To manage all this, project management is the only way.

d) Corporate Downsizing

Restructuring of organizations in the recent years has resulted into the downsizing or rightsizing. Downsizing and sticking to core competencies have become essential for survival for many organizations.

e) Customer Focus

Increased competition has increased the expectation of customers. Customers expect customized products and services instead of generic ones. The customization of products and services required better understanding of the customers' needs by project team members. The customers are more aware and their changing needs are to be taken into account to survive in the market.

f) Managing Small Projects

In today's competitive world, a situation has emerged in the organizations that many projects are run concurrently. This resulted into the multi-project environment and also plethora of new problems. Sharing and prioritizing resources across a portfolio of projects is a major challenge for top management. In the course of managing many projects, large projects are given more importance than the small projects. Small projects typically carry the same or more risk as do large projects. Small projects are perceived as having little impact on the bottom line because they do not demand large amount of scarce resources and/or money. Unfortunately, many small projects soon add up to large sums of money and their inefficiency would result into adverse impact.

g) Upsurge of Third World and Closed Economies

The gradual opening of emerging economies has created an explosion of demand for goods and services within these economies for their development. Thus, new markets emerge in the scenario. The developed markets have started introducing their products and services into these markets. Many firms are using project management techniques to establish distribution channels and foreign bases of operations.

1.7 ROLE OF PROJECT MANAGER

A project manager is the person who has the overall responsibility for the successful initiation, planning, design, execution, monitoring, controlling and closure of a project. The job title is used in construction, petrochemical, architecture, information technology and many different industries that produce products and services. The project manager must have a combination of skills including an ability to ask penetrating questions, detect unstated assumptions and resolve conflicts, as well as more general management skills.

Good project managers should have a variety of skills. Good program and portfolio managers often need additional skills and experience in managing projects and understanding organizational strategies. Project managers and their teams must develop knowledge and skills in the following areas:

- All ten project management knowledge areas
- The application area (domain, industry, market, etc.)
- The project environment (politics, culture, change management, etc.)
- General management (financial management, strategic planning, etc.)
- Human relations (leadership, motivation, negotiations, etc.)

The application area refers to the application to which project management is applied. For example, a project manager responsible for building houses or apartment buildings should Understand the construction industry, including standards and regulations important to that industry and those types of construction projects. A project manager leading a large software development project must know a lot about that application area. A project manager in education, entertainment, the government, and other fields must understand those application areas.

The project environment differs from organization to organization and project to project, but there are some skills that will help in most project environments. These skills include understanding change, and understanding how organizations work within their social, political, and physical environments. Project managers must be comfortable leading and handling change, since most projects introduce changes in organizations and involve changes within the projects themselves. Project managers need to understand the organizations they work in and how products are developed and services are provided.

For example, it takes different skills and behaviour to manage a project for a Fortune 100company in the United States than it does to manage a government project for a new business in Poland or India. It also takes different skills and behaviours to manage a project in the construction industry from one in the entertainment or pharmaceutical industry.

Project managers should also possess general management knowledge and skills. They should understand important topics related to financial management, accounting, procurement, sales, marketing, contracts, manufacturing, distribution, logistics, the supply chain, strategic planning, tactical planning, operations management, organizational structures and behavior, personnel administration, compensation, benefits, career paths, and health and safety practices. On some projects, it will be critical for project managers to have substantial experience in one or several of these general management areas. On other projects, project managers can delegate detailed responsibility for some of these areas to a team member, support staff, or even a supplier. Even so, the project managers must be intelligent and experienced enough to know which of these areas are most important and who is qualified to do the work. They must also make and/or take responsibility for all key project decisions.

Achieving high performance on projects requires human relations skills, also known as soft skills. Some of these soft skills include effective communication, influencing the organization to get things done, leadership, motivation, negotiation, conflict management, and problem solving. Project managers must lead their project teams' by providing vision, delegating work, creating an energetic and positive environment, and setting an example of appropriate and effective behaviour. Project managers must focus on teamwork skills in order to use their people effectively. They need to be able to motivate different types of people and develop *esprit de corps* within the project team and with other project stakeholders..

Organizations need to build a better understanding of the role of a project manager and understand that this role is not the same as a technical manager. The project manager role is one of integrator, communicator and facilitator; this role is of equal or more importance than the role of a technical manager.

There are three critical roles of the project manager:

- **Integrator**; ensures all the project activities, strategies and approaches are an integrated effort.
- **Communicator**; most of the work is spend here, communicating with all stakeholders and building the right support and relationships.
- **Leader**; motivating and inspiring a team to deliver the project work by providing a vision and direction.

A key responsibility of the project manager is to ensure the proper integration of the project management processes and coordinate the project phases through the project management cycle. This responsibility is to ensure that all areas of the project come together to deliver the project to a successful conclusion. This is the main role of the project manager; it is not related to the technical responsibilities of the project, which in most cases are managed by the project staff. The role of integrator involves three specific areas of responsibility:

- Develop the project management plans, which consist of the development of all project planning documents into a consistent, coherent project plan document.

- Implement the project plan, which involves the execution of the project plan and ensuring all activities are performed by all the people involved.
- Monitor and control the plan, which involves measuring the initial results against the intended objectives and coordinating all changes to the plans.

As communicator the project manager ensures that all stakeholders receive the right information at the right time. This is an important role. The project manager has a holistic view of the project and is in the best position to know the why, when, what and how the project is doing and communicate progress, changes and risks to the parties involved. Studies confirm that the project manager spends about 80% of his/her time communicating. Project managers in the role of communicators assume three functions:

- Gathering information from project staff and other people involved with the project;
- Analyzing the information and make sense of its implications; a
- Distributing the information to the internal and external environments, such as the donor, beneficiaries, and the general public to gain support for the project.

As leader, the project manager must ensure the team and project stakeholders have an understanding of the project vision. A leader inspire others to achieve the project objectives, the leader encourages full participation from the project team, promotes mutual understanding with the beneficiaries and cultivates shared responsibility among all project stakeholders.

The leadership role implies the skills to:

- Facilitate: To ease and assist the project team to do their work
- Coordinate: To organize, direct and synchronize the efforts of all involved in the project
- Motivate: To inspire, stimulate and encourage the team to achieve the project objectives

These roles are integrated and cannot be treated as separate, and they are critical to the success of any project manager.

1.8 CASE STUDY

Project Management at Global Green Books Publishing

Global Green Books Publishing was started two years ago by two friends, Jim King and Brad Mount, who met in college while studying in Philadelphia, USA. In the new business Jim focused on editing, sales and marketing while Brad Mount did the electronic assembly and publishing of books for Global Green Books. Their business was successful and profitable in the first two years, largely due to contracts from two big businesses.

In their third year they got very busy thanks to their third major customer, a local college that needed customized eBooks. They hired several part time employees to help them with their publishing business.

But by the end of third year of operation, Global Green Books started experiencing critical problems. They were:

- Unable to leverage all the new employees effectively
- Unable to deliver eBooks to their customers on schedule
- Unable to provide quality texts—time and money was being spent fixing defects in their products
- Unable to control costs—their business was not profitable in the third year.

Global Green Books saw a significant rise in issues, a lot of unpleasant “surprises” were cropping up; business was down as new resources were hired, also some of the projects were poorly estimated. The local university was unhappy as their eBook products reached campus late for use by professors and student. In some cases, the books were a week or two late. Since the courses must start on schedule and students need their books at the beginning of their courses, the new lucrative college customer was unhappy.

One of the new part-time employees hired by Jim and Brad, Samantha, had taken a project management course at college. Samantha was excited about the discipline of project management and had intentionally selected a job with Global Green Books Publishing as she saw an opportunity to polish her project management skills.

One fine day, Jim invited Samantha, for a lunch meeting. He was aware that Samantha was familiar with project management, and wanted to hear what she had to say about the problems he and Brad were facing. Over lunch he questioned why their small business which had operated and implemented projects so successfully over the first two years was being challenged significantly now. He specifically listed the problems they were facing and asked for input to solve them.

Samantha asked for more time to research all the issues but noted that Global Green Books, while being innovative, completed projects without a roadmap or a project plan and lacked a disciplined approach to project management. She noted that Jim and Brad did not use any project software for scheduling and they did not use tools or techniques to estimate, budget or to communicate with stakeholders. Finally, they had no processes in place to manage project risks and quality.

Impressed with this and other conversations, Jim King asked Samantha if she would consider joining them as a project associate or project manager on a full-time basis to help them introduce project management practices and help them tide over their current crisis. Samantha accepted the offer! She has several key skills—she is an excellent communicator with very good interpersonal skills and detail-oriented. Within the first three months in her new role as PM, she introduced formal project management processes, created a PM manual and trained the employees to get the work done well.

Within nine months Samantha had fully turned things around. Due to proactive risk analysis and risk response planning, surprises and issues reduced. Communication with stakeholders was enhanced.

Brad and Jim noted that the company was delivering projects on schedule, the quality processes worked—and customers were happy with the products!

Comment on the following aspects of the case study:

a) Why did Global Green Books Publishing struggle?

b) What were the specific PM solutions that were introduced by Samantha that worked?

c) What kind of suggestions would you give to Brad and Jim if you were the PM?

d) Are you aware of other similar start-up businesses that struggle in a similar manner? How did they overcome the challenges?

e) Global Green Books Publishing is a technology intensive business, but Samantha is not technically knowledgeable, will she continue to be a successful project .

1.9 NOTES

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1.10 SUMMARY

- Projects are a single use plan to achieve certain objective or a et of objectives/objectives of introducing something unique or a change and ensure that progress is maintained in line with the objective, generally in terms of time, cost and various technical and quality performance parameters.
- Project management is an art of managing new challenges coming frequently and breaking the whole challenge into smaller, comfortable activities to accomplish them in an effective and efficient way.
- Projects have some peculiar characteristics which differentiate them with routine operations.

- They have a fixed tenure.
- They are unique in themselves.
- They are more risky.
- They are always made to order.
- The success of any project is dependent on the attainment of the following objectives:
  - o Scope
  - o Time
  - o Cost
  - o Performance

- Project Management might have started in ancient times with the construction of huge monuments. Two forefathers of project management are Henry Gantt, called the father of planning and control techniques, who is famous for his use of the Gantt chart as a project management tool and Henri Fayol for his creation of the five management functions that form the foundation of the body of knowledge associated with project and program management.
- Project management includes: identifying requirements, establishing clear and achievable objectives, balancing the competing demands from the different stakeholders and ensuring that a commonality of purpose is achieved.
- Good project managers should have a variety of skills. Good program and portfolio managers often need additional skills and experience in managing projects and understanding organizational strategies. Project managers and their teams must develop knowledge and skills.

1.11 KEYWORDS

Project Stakeholders

Globalisation

Customer Focus

Performance

Cost

1.12 SELF ASSESSMENT QUESTIONS

1. Define the term Project Management and explain its Scope.
2. How are projects "unique" and "temporary" as defined by PMBOK?
3. Comment on the emerging role of Project Managers in India
4. Discuss in detail the objectives of project management.

1.13 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.
2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.
3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.
4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.
5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill
6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011
7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002
8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012
9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.
10. Sanjiv Marwah. *Project Management.* New Delhi: Dreamtech Press, 2011.

UNIT-2 : EVOLUTION OF INTEGRATED PROJECT MANAGEMENT

Structure :

2.0 Objectives

2.1 Introduction

2.2 Definition of Integrated Project Management

2.3 Evolution of Integrated Project Management system

2.4 Project Integration Management Processes

2.5 Integrated Project Management Cycles

2.6 Aligning projects with Organization strategy

2.7 Case Study

2.8 Notes

2.9 Summary

2.10 Key Words

2.11 Self Assessment Questions

2.12 References

2.0 OBJECTIVES

After studying the unit you should be able to:

- provide an overview of Integrated Project Management system
- have a better understanding of Evolution of Integrated Project Management System
- understand aligning projects with organization strategy.

2.1 INTRODUCTION

Management of project integration includes the process of synthesis and response to change. The overall project employs five basic processes: *initiating, planning, executing, controlling, and closing.* The initiating process incorporates development of the idea for the project and justification based on a feasibility study. It is at this stage that the boundaries of the project should be defined. To return to the earlier training example, the responsibility for identifying a specific training program should be determined.

Project planning addresses the specific timeframe and budget for the project. Activities are identified and assigned. Planning is considered a most important process because without excellent planning the ensuing activities are unlikely to succeed. Executing involves carrying out the assigned activities, while controlling monitors the activity for scope, time, and budget concerns.

Perhaps the most ignored process of projects in general is the closing process. Toward the end of a project, enthusiasm can wane, and it is the responsibility of the project manager to maintain active collaboration until the end of the project. Phased-out employees should be evaluated and returned to the pool/function from which they were recruited. A series of meetings should be held to review the degree to which the performance measures were met, from both the defined scope and the satisfaction of the customer. If these are not in agreement, then the reasons should be documented. Areas of success and failure are both important to note, as these can be the basis for company-wide learning. Even dissimilar projects can provide some learning opportunities, as the company understands, for instance, its tendency to underestimate costs or scheduling requirements.

While these processes, initiated through closing, appear to be linear in nature, they instead define a feedback system. The specifics of the planning process may indicate that the initiating idea was flawed. Execution may encounter problems with planning. Controlling may indicate a return to planning, or even to the earlier initiating idea process. And closing may determine that the entire project was doomed from the outset. Failure to recognize the iterative nature of these processes can be costly, as a project may be adjusted or abandoned at early stages to prevent loss.

Within the company, the project life-cycle stages of the project should be identified. Generically, these may be identified as definition, design, test, implementation, and retirement stages, or some variation on this theme. Interestingly, each of these stages employs each of the processes described above. For example, in the definition life-cycle stage, there is an initiation process, progressing to a feasibility study. As the definition stage reaches its conclusion, it "delivers" the project to the design stage, but only if the mini-project of definition has been successful. Many projects have lingered when a rational analysis would suggest that revision or abandonment would be less costly. The iterative nature of project management logic suggests a stringent review at frequent stages to ensure that both the project itself and the environment to which the project was to respond are in agreement. Management of the integration of project stages is especially important in a rapidly changing environment.

Many project managers have tried many tools, techniques and systems to manage projects. These piecemeal systems fail to integrate the overall strategies of the organizations and connect the selected projects to resources. They also fail to balance the application of project planning and control methods with appropriate adjustments in the organization's culture to support project activities. Thus, today's project management environment requires an integrated approach. Integrated project management process focuses all project efforts towards the strategic plan of the firm and reinforces mastery of both the project management tools or techniques and interpersonal skills necessary to achieve successful project completion.

Integration management is a collection of processes required to ensure that the various elements of the projects are properly coordinated. It involves making trade-offs among competing objectives and alternatives to meet or exceed stakeholder needs and expectations.

2.2 DEFINITION OF INTEGRATED PROJECT MANAGEMENT

Integrated project management, or program management as it is sometimes called, involves selecting, coordinating, and synchronizing projects in a company or agency, so that all the key factors for success are optimized. Program managers see both the big picture and the details of program and project work-all at the same time.

Integration involves analysing project business value at the high level; mobilizing team performance and dynamics; monitoring projects to assure midstream adjustment and project recovery; resolving technical, resource, and interpersonal conflicts at every level; managing program interfaces and multitasking; identifying organizational constraints and exploiting them; keeping tabs on accountability; and reporting to avoid ethical and waste problems. Integration actually defines program management, that body of knowledge and practice dealing with multi-project portfolios, project selection methods, and long-term, complex programs with multiphase.

Vertical and Horizontal Integration

There are two types of integration and they are both essential success factors, particularly in a multi-project program environment. They are vertical and horizontal integration.

Vertical integration looks *inside* and *up and down* into the business, program, project, and product service components. This kind of integration targets the program, project, and product, and builds a product or service with integrity.

It looks downstream in the project process to product performance and customer satisfaction.

Horizontal integration looks *outside and around* to the external, the environmental, and the *organizational assets that support the project.* It focuses on outside forces that create risk and opportunity, market forces that will shape the product or service. Vertical integration is program integration; it proceeds down the project, going deep into the project processes and product configuration. It focuses on performance. Vertical integration is related to horizontal integration in the sense that a project that reflects outside factors and environmental scanning information is more apt to succeed in its performance because these factors can make or break a project.

Analysis, Selection, and Scheduling: Portfolio integration

Vertical and horizontal integration factors are reflected in the analysis, selection, and scheduling of projects and portfolio integration. Programs or product lines are "chunks" of business development that will help define a portfolio of projects to improve business performance. Once these programs are identified, we can identify, say, five projects in each program as candidate projects to implement. In effect, you might be choosing three projects from a series of 15 projects for implementation.

We use a variety of program management tools in selecting the three projects that will be planned and scheduled in detail. These tools include

1. Cash flow analysis. This tool requires you to forecast the first **5+** years of cash flow for each project. Costs will come from a budget built up from a preliminary task list and schedule for the project, while revenues will come from

your assessment of how the project deliverable or product will generate income or "value." Remember that a cash flow estimate can be identified for a project that does not produce a marketable product but adds value to the program portfolio. Simply allocate a dollar value each year to the benefits of the project to a user or customer in order to estimate the cash flow equivalent to the stream of project benefits.

2. Net present value (NPV). This tool requires you to take the cash flow analysis you have prepared and calculate the net present value of each so that you can compare all the projects regardless of how many years their cash flow is projected.

3. Risk assessment and management. This tool requires you to identify the high-level risks in each project and prepare a risk matrix, including task, task risk description, impact, probability, severity, and contingency plans.

4. Weighted scoring model. This tool allows you to score each project against the various strategic objectives of your company, to place weights on each strategic objective and multiply the scores by the weights to get a "weighted" score for each project. Once you have performed this analysis for each project, you will be using the results to rank the projects in each program and to select three projects for detailed scheduling and budgeting using Microsoft Project. The selected projects may not be the ones most highly ranked in your rank ordered listing; but they will be the three projects that must be implemented first, to enable the remaining projects to be implemented to integrate the program and business strategic objectives.

Once you have performed this analysis for each project, you will be using the results to rank the projects in each program and to select three projects for detailed scheduling and budgeting. The selected projects may not be the ones most highly ranked in your rank ordered listing; but they will be the three projects that must be implemented first, to enable the remaining projects to be implemented to integrate the program and business strategic objectives.

2.3 EVOLUTION OF INTEGRATED PROJECT MANAGEMENT SYSTEM

Integrated project management has its roots in the experience of managing complex technological and system developments during World War II. During WWII, traditional management approaches proved deficient in integrating the many aspects of the development and production of complex weapon systems. After WWII, the need to manage large and complex undertakings increased the interest in project management approaches. This was fostered by successful efforts, such as the Manhattan project. In the early 1950s, project management started to evolve into a more systematic approach to completing programs. Project management became necessary as industries took on specific jobs, usually defence-related or civil engineering-related. These programs were typically for the management of major space, weapons, and construction projects through the stages of design, development, Manufacturing, testing, and production. In the 1960s, project management began to be implemented in many organizations besides defence, space, and construction industries. Project management became essential in the computer industry.

By the 1970s, project management was recognized as an established management approach for many organizations involved in government, education, and private endeavours. Today, project management has continued to progress into a management approach-essential to producing many deliverables. Further, project management software helps perform many of the project management tasks.

As it evolved from the management of complex projects, project management, usually involved the management of defined, no routine activities aimed at distinct time, financial, and performance goals for a system development project. Through the years, project management has been refined through the application of a wide range of industrial and service organizations. The most well-known use of project management is within the DoD industries to develop weapon systems. Weapon systems such as the B-2 aircraft, with its state-of-the art design, would not be possible without highly sophisticated project management techniques. Modern construction projects could not be built without using project management. Today, computer companies, the movie studios, small businesses, and even the music industry uses project management.

The basic project management techniques have remained fairly standard over the years. However, the greatest impact on project management has been with the use of technology. Technology, especially automation and telecommunications, has allowed project management techniques to expand in breadth and scope.

Integration Model

The integration model that follows Figure captures the essential factors requiring a new level of integration in program and project management.

People. People integrate, not systems, so people are trained to coordinate and interact with program and project participants, forming a true interdisciplinary team.

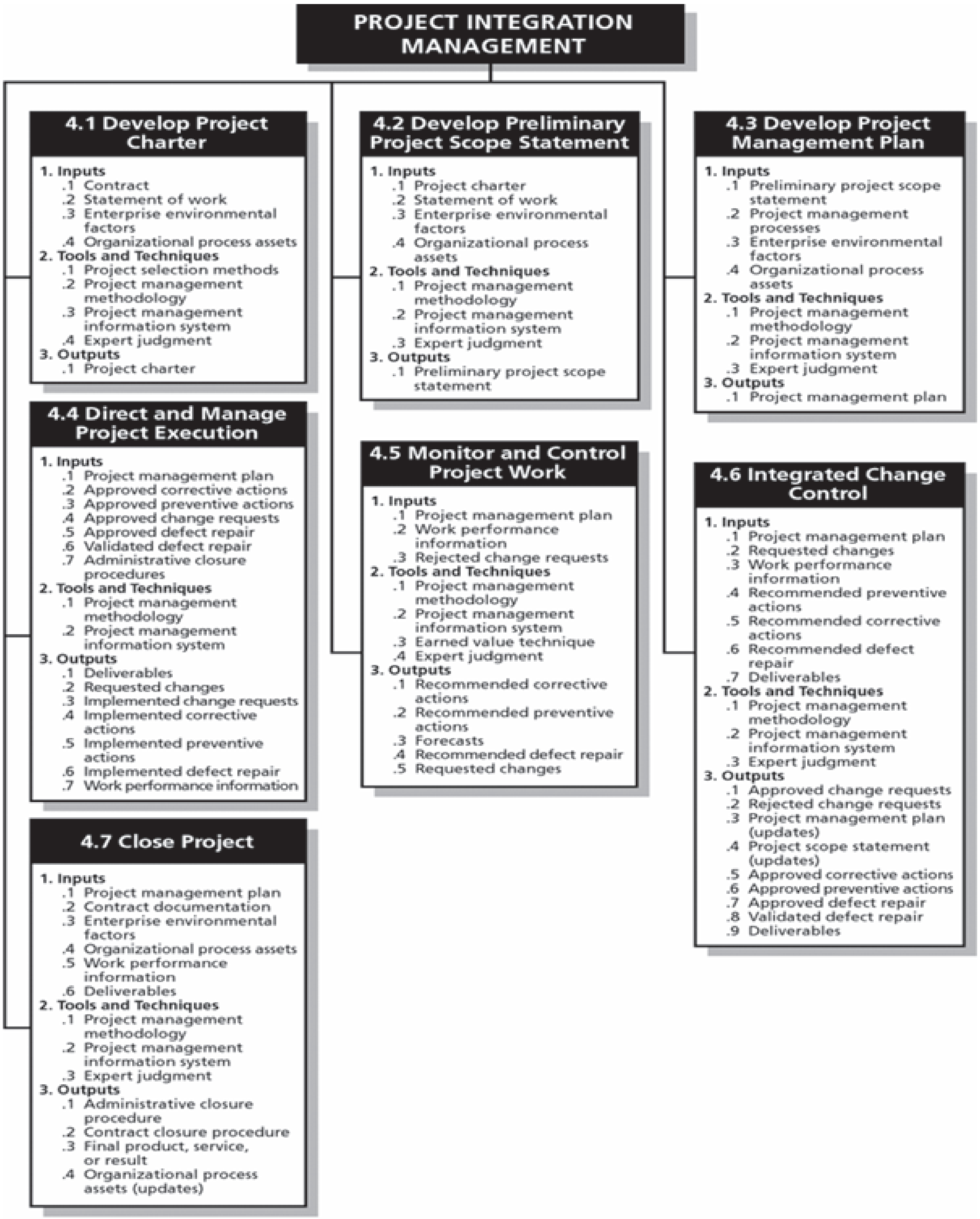
Projects. Projects become more cross-functional as project work is defined in terms of coordination and integration of work.

Technology. Complex products are managed at the interface, placing more emphasis on product and service integration.

Financial, schedule, risk, and quality combined. Through earned value and integrative tools, program and project progress is seen in terms of the combined impacts on financial, schedule, risk response, and quality issues.

Program management applications. Integration defines the program manager's role; working between top management and project managers; program managers integrate projects with company plans and strategies, and work with enterprise-wide resource management systems. Systems support integration. Organizational and information technology systems are designed to interface with each other and to encourage integration. Customer is "seen" ***by*** the program team. All program and project activity is performed with the customer in full view, integrating the work with customer's expectations. managers integrate projects with company plans and strategies, and work with enterprise-wide resource management systems. Systems support integration. Organizational and information technology systems are designed to interface with each other and to encourage integration. Customer is "seen" ***by*** the program team. All program and project activity is performed with the customer in full view, integrating the work with customer's expectations.

Program Element		Integration Mode
People	⇒	Integration mindset
Projects	⇒	Cross-functional tasking
Technology	⇒	Component Interface and performance
Financial, Schedule, Risk and Quality combined	⇒	Earned value seen as an integrating tool
Program Management	⇒	Program management is an integrated multi-project system
System Support Integration	⇒	Organizational systems designed to encourage integration
Customer is "seldom seen" by the program team	⇒	Instead of "seldom seen," customer requirements are integrated at every level


PROJECT INTEGRATION MANAGEMENT
4.1 Develop Project Charter
1. Inputs
.1 Contract
.2 Statement of work
.3 Enterprise environmental factors
.4 Organizational process assets
2. Tools and Techniques
.1 Project selection methods
.2 Project management methodology
.3 Project management information system
.4 Expert judgment
3. Outputs
.1 Project charter
4.2 Develop Preliminary Project Scope Statement
1. Inputs
.1 Project charter
.2 Statement of work
.3 Enterprise environmental factors
.4 Organizational process assets
2. Tools and Techniques
.1 Project management methodology
.2 Project management information system
.3 Expert judgment
3. Outputs
.1 Preliminary project scope statement
4.3 Develop Project Management Plan
1. Inputs
.1 Preliminary project scope statement
.2 Project management processes
.3 Enterprise environmental factors
.4 Organizational process assets
2. Tools and Techniques
.1 Project management methodology
.2 Project management information system
.3 Expert judgment
3. Outputs
.1 Project management plan
4.4 Direct and Manage Project Execution
1. Inputs
.1 Project management plan
.2 Approved corrective actions
.3 Approved preventive actions
.4 Approved change requests
.5 Approved defect repair
.6 Validated defect repair
.7 Administrative closure procedures
2. Tools and Techniques
.1 Project management methodology
.2 Project management information system
3. Outputs
.1 Deliverables
.2 Requested changes
.3 Implemented change requests
.4 Implemented corrective actions
.5 Implemented preventive actions
.6 Implemented defect repair
.7 Work performance information
4.5 Monitor and Control Project Work
1. Inputs
.1 Project management plan
.2 Work performance information
.3 Rejected change requests
2. Tools and Techniques
.1 Project management methodology
.2 Project management information system
.3 Earned value technique
.4 Expert judgment
3. Outputs
.1 Recommended corrective actions
.2 Recommended preventive actions
.3 Forecasts
.4 Recommended defect repair
.5 Requested changes
4.6 Integrated Change Control
1. Inputs
.1 Project management plan
.2 Requested changes
.3 Work performance information
.4 Recommended preventive actions
.5 Recommended corrective actions
.6 Recommended defect repair
.7 Deliverables
2. Tools and Techniques
.1 Project management methodology
.2 Project management information system
.3 Expert judgment
3. Outputs
.1 Approved change requests
.2 Rejected change requests
.3 Project management plan (updates)
.4 Project scope statement (updates)
.5 Approved corrective actions
.6 Approved preventive actions
.7 Approved defect repair
.8 Validated defect repair
.9 Deliverables
4.7 Close Project
1. Inputs
.1 Project management plan
.2 Contract documentation
.3 Enterprise environmental factors
.4 Organizational process assets
.5 Work performance information
.6 Deliverables
2. Tools and Techniques
.1 Project management methodology
.2 Project management information system
.3 Expert judgment
3. Outputs
.1 Administrative closure procedure
.2 Contract closure procedure
.3 Final product, service, or result
.4 Organizational process assets (updates)

The following are the steps involved in Project Integration Management Processes

Develop the project charter: Work with stakeholders to create the document that formally authorizes a project—the charter. Project Charter, includes:

- Project purpose or justification
- Measurable project objectives and related success criteria,
- High-level requirements,
- High-level project description,
- High-level risks,
- Summary milestone schedule,
- Summary budget,
- Project approval requirements
- Assigned project manager, responsibility, and authority level
- Name and authority of the sponsor or other person(s) authorizing the project charter.

♦ **Develop the preliminary project scope statement**: Work with stakeholders, especially users of the project's products, services, or results, to develop the high-level scope requirements and create a preliminary project scope statement.

♦ **Develop the project management plan**: Coordinate all planning efforts to create a consistent, coherent document—the project management plan. It includes

♦ Documenting the actions necessary to define, prepare, integrate and coordinate all subsidiary plans

♦ How to execute monitor control close the How to execute, monitor, control, close the project progressively elaborated by updates and controlled and approved through Integrated controlled and approved through Integrated Change Control process

♦ **Direct and manage project execution**: Carry out the project management plan by performing the activities included in it. The process of performing the work defined in PM Plan includes

  - Performing activities
  - Creating deliverables
  - Staff/train/manage the team members

- Obtain/manage/use resources
- Implement methods/standards
- Establish/manage communication channels

♦ **Monitor and control the project work**: Oversee project work to meet the performance objectives of the project.

- Tracking, reviewing, regulating t he progress
- Collecting , measuring g, distributing performance info., assessing measurements & trends to effect process improvements
- Comparing actual project performance vs. planned one planned one
- Assessing performance
- Identifying new risks, their status, risk response plans

♦ **Perform integrated change control**: Coordinate changes that affect the project's deliverables and organizational process assets.

- The process of reviewing change requests, approving changes, managing changes which Includes Influencing factors so that only approved changes are implemented
- Reviewing, analyzing, approving change requests
- Managing approved changes
- Reviewing, approving, denying recommend corrective/preventive actions

♦ **Close the project**: Finalize all project activities to formally close the project.

Actions/activities necessary to satisfy completion or exit criteria for phase/project.

- Actions/activities necessary to transfer the project s' product service result to next product, service, result to next phase/production/operation
- Actions/activities necessary to collect records, audit success/failure, lesson learned audit success/failure, and lesson learned.

Benefits of IPM

- Knowledge is transferred from project level to the organization
- Improved planning through better understanding of process performance
- Lower cost of process planning in projects as reuse is promoted
- Improved coordination among people involved in a project

- Commitment to the organization is improved as communication & sharing between teams is facilitated
- Institutionalizing key management practices
  - Reuse of knowledge
  - Integration of plans
  - Tracking dependencies & collaboration issues
  - "Post mortem" analysis

2.5 INTEGRATED PROJECT MANAGEMENT CYCLES

Project management involves a cycle of processes. These cycles for defining, designing, developing, and delivering a deliverable vary according to organization. The classical project management approach and DoD cycles provide two examples of most widely used project management cycles. The classic project management cycle has been described by many authors. For instance, David I. Cleland (2002) in *Project Management, Strategic Design, and Implementation* discusses a generic project management life cycle including conceptual, definition, production, operation, and divestment. This approach is also detailed by Harold Kerzner (2003) in *Project Management.* The five phases generally involve the following functions:

1. Conceptual. This is the phase in which objectives and goals are set and specifications determined. It is in this phase that projects are outlined and modelled to assure that the project deliverable is understood. Often the assumption is that the customer-the sponsoring agency or firm has already determined the priority and need for the project deliverable, and that the basic role of the project team is to deliver it within schedule and budget. Traditional project management does not make much room for involvement of the project team with the customer in selecting the project, much less assuring that it results from a quality improvement process performance within the customer's organization and environment.

2. ***Definition***. This is the process of defining the project deliverable in terms of a work breakdown structure (WBS), a budget and schedule, and a critical path network. This is where the WBS provides an organizational and hierarchical look at the project, showing basic interdependencies and interrelationships with the project task structure. **A** scope of work, budget, and schedule is drawn up in this phase, and the project team is developed around the tasks.

3. *Production*. It is in this phase that the project deliverable is actually produced or "prototyped," so that testing and measuring can proceed. Production involves lining up all the required resources and integrating them according to their interdependencies as shown in the WBS.

4. Operations. Here the project deliverable is installed, tested, and measured in operation, with the customer or user. Operations assure that the project deliverable, whether a system, product, or a new service, conforms with the original specifications.

5. Divestment. Divestment involves documenting the project and closing it down. Here the team members are typically selected for other project teams and the project books are closed. Within the DoD, the project management cycle is described as the seven phase acquisition cycle. The seven phase acquisition cycle as described in James V. Jones's Integrated Logistics Support Handbook (2004) includes:

- Pre-concept
- Concept
- Demonstration and validation
- Quality and Project Integration
- Full-scale development
- Production
- Deployment and operations
- Disposal

The pre-concept phase begins the acquisition cycle. In this phase the need is identified through an analysis of missions and/or systems. This triggers the identification of operational deficiencies, operational needs, system or equipment development, modifications, and improvements.

The concept phase involves developing alternative approaches to satisfying the need identified during the pre- concept phase. During the concept phase, all possible alternatives are analyzed to determine the alternative or alternatives best capable of satisfying the need.

During the demonstration and validation phase, the alternative or alternatives developed during the concept phase are evaluated to determine feasibility to actually accomplish the requirement. The demonstration and validation phase has two purposes: (1) demonstrate that the concept can actually work, and (2) validate that the alternative can meet the need defined earlier.

Once an alternative passes the demonstration and validation phase, full-scale development begins. During full-scale development the deliverable is designed.

The production phase involves the actual development and/or manufacturing of the deliverable. The deployment and operation phase begins after the item is delivered to the customer. During this phase the customer assumes ownership with the support of the supplier. Eventually the item may need to be replaced. This is when the disposal phase begins for the old item. The disposal phase involves removing the item from inventory.

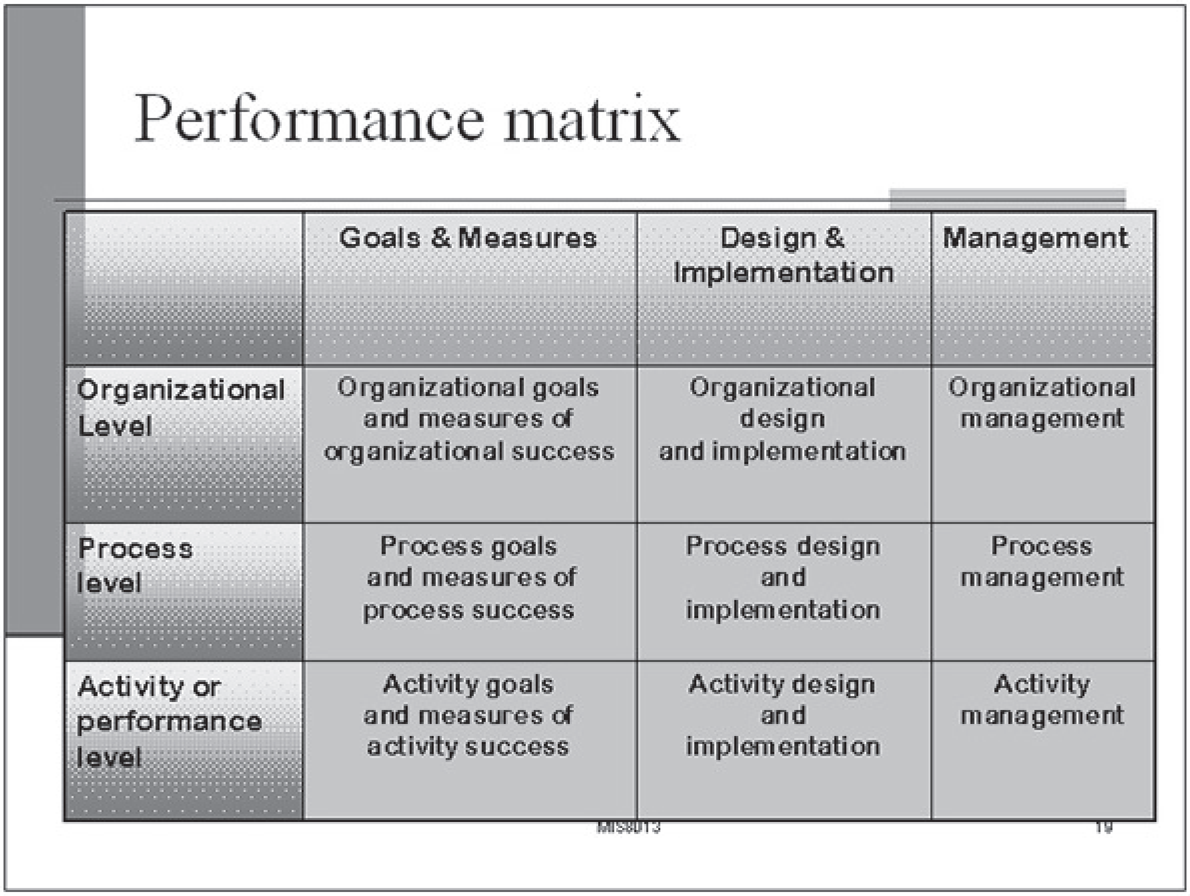
Whichever traditional project management cycle is used, the thrust is the same, producing a deliverable. The deliverable is essentially already identified by the sponsor or customer. This project management approach is based on traditional quality control. Its innovation was the matrix team that integrated internal functions to complete a project.

2.6 ALIGNING PROJECTS WITH ORGANIZATION STRATEGY

Aligning the company's portfolio of projects to maximize their contributions to strategic objectives takes a highly coordinated effort. It requires more than the old "grenade over the wall" approach, in which the business planning staff identifies and characterizes the project and then tosses it to an uninformed and uninvolved project management group that is supposed to complete the project. As any primer on modern management says, folks have to "buy in"everyone must be engaged with the project before charging ahead.

"Strategic planning for a business environment is the process of formulating and implementing decisions about an organization's future direction. This process is vital to every organization's survival because it is the process which an organization adapts to its ever-changing environment and is applicable to all levels and types of organization."There are many steps that an organization can follow to conduct strategic planning. A strategic planning process is only as good as its implementation. According to Dr. Harold Kerzner, "Implementation translates a formulated plan into policies and procedures for achieving a grand decision and involves all levels of management in moving the organization toward its mission. The process seeks to create a fit between the organization's formulated goals and its ongoing activities."

One method that can be used to achieve this fit is to create a performance matrix (Figure 1). "This analysis causes us to take a holistic view using a systems approach to the organization and its processes. "Using this approach we formulate performance variables within a performance framework" - refer Rummler-Brache (1990)



Performance matrix

	Goals & Measures	Design & Implementation	Management
Organizational Level	Organizational goals and measures of organizational success	Organizational design and implementation	Organizational management
Process level	Process goals and measures of process success	Process design and implementation	Process management
Activity or performance level	Activity goals and measures of activity success	Activity design and implementation	Activity management

Figure 1 – Rummeler-Brache's Performance Matrix

By developing the performance matrix, the organization is able to address the strategic, objectives and the goals at mutable levels. What is suggested here is that the strategic planning, and goals. Strategies are conducted and developed at the organizational level and the process levels. It is at the activity or performance level where we create a project plan to support the strategy. All goals, strategies and objectives are developed to support the higher levels. Some companies do strategic planning once and never update those plans. Companies who do strategic planning on a regular basis will outperform those that do not plan at all. Often the strategies of organizations are determined with no clear direction on how to implement the objectives. In addition to this, a high level estimate of the cost is usually developed to carry out the strategy. However, after the high level estimates are generated and agreed upon by executive management the financial process begins to develop budgets to support the strategy and objectives. The team involved in this process will provide their best top down estimate of what it will take to accomplish the objectives of the process. A careful budgeting process must then proceed with the department experts, middle management and the finance department.

The other problem is that some projects are generated that are not tied or aligned with any strategic objectives. On the other hand, the organization has many projects that are competing for the same resources. What some companies end up with at the end of a strategic planning cycle is a list of strategic objectives that must be communicated throughout the organization. Executive management and middle managers are tasked with defining the specific tactics to meet the strategic plan. Companies can have several projects and perhaps even hundreds of projects that have no direct linkage to the strategies of the organization. Herein lies the problem and what we will address in this article. The question becomes how can we align our projects to meet the organizational strategic objectives and how can we utilize project management to make sure that we develop projects that move the organization toward the goal of accomplishing their strategic objectives.

Project Management

The classical definition of projects is they are one time, unique efforts that have fixed start and end dates. The goal of project management is to complete the project work and deliver a product or service on time, within budget and at the appropriate scope for the customer. Project management is a profession that has been around since the early days of the DOD. The best practices of PM were established in the late 80's by PMI and have seen the number of certified project management professional grow from a few hundred to over 250,000 today. Project managers have been and are still called on to manage projects in Automotive, Real Estate, Construction, Banking, Research and Development and Sales, just to name a few.

Strategic planning

The strategic planning process addresses what the organization wants to do and how they want to do it. The strategic plans often include the vision, mission and the high level objectives. Once these are established the next step would be to describe a plan that will take the firm to the successful completion of those objectives. It is at this point that the project management methodology pays off during the strategic planning process. Many of the tools and techniques of project management are geared to developing a realistic plan. The value of the process for strategic development and implementation is where project management fits. Project Management will assist the strategic team in planning and defining the supporting tasks and identifying the critical resources needed to accomplish the objective from the strategic plan. So how does the organization go from where they are now and how they will reach the goals established in the early planning process?

A typical set of deliverables for a strategic planning process is a reasonable set of strategic objectives that an organization wishes to support and implement. Here is a list of strategic objectives that a company can pursue. This list is compiled from stated strategic objectives taken from large U.S. companies. The objectives are as follows:

- A bigger market share
- A higher, more secure industry rank
- Higher product quality
- Lower costs relative to key competitors
- Broader or more attractive product line
- A stronger reputation with customers
- Superior customer service
- Recognition as a leader in technology and/or product innovation
- Increased ability to compete in international markets
- Expanded growth opportunities

These objectives define a high level direction for the firm. They provide the overview, motivation and summary of where the firm is going. To accomplish these objectives it may require the firm to engage in one or several projects to support the objectives. A number of projects may be adopted to meet the strategic objectives. As an example the table below shows two strategic objectives and a set of projects that support each of these objectives.

Strategic Objective: A bigger market share	***Strategic Objective: Superior customer service***
Project A: Introduce New Product	Project E: Install new CRM Software
Project B: Sale products online	Project F: Implement Supply Change Management
Project C: Open Office in Asia	Project G: Implement 24/7 Call Center
Project D: Increase advertising	Project H: Train Support Staff

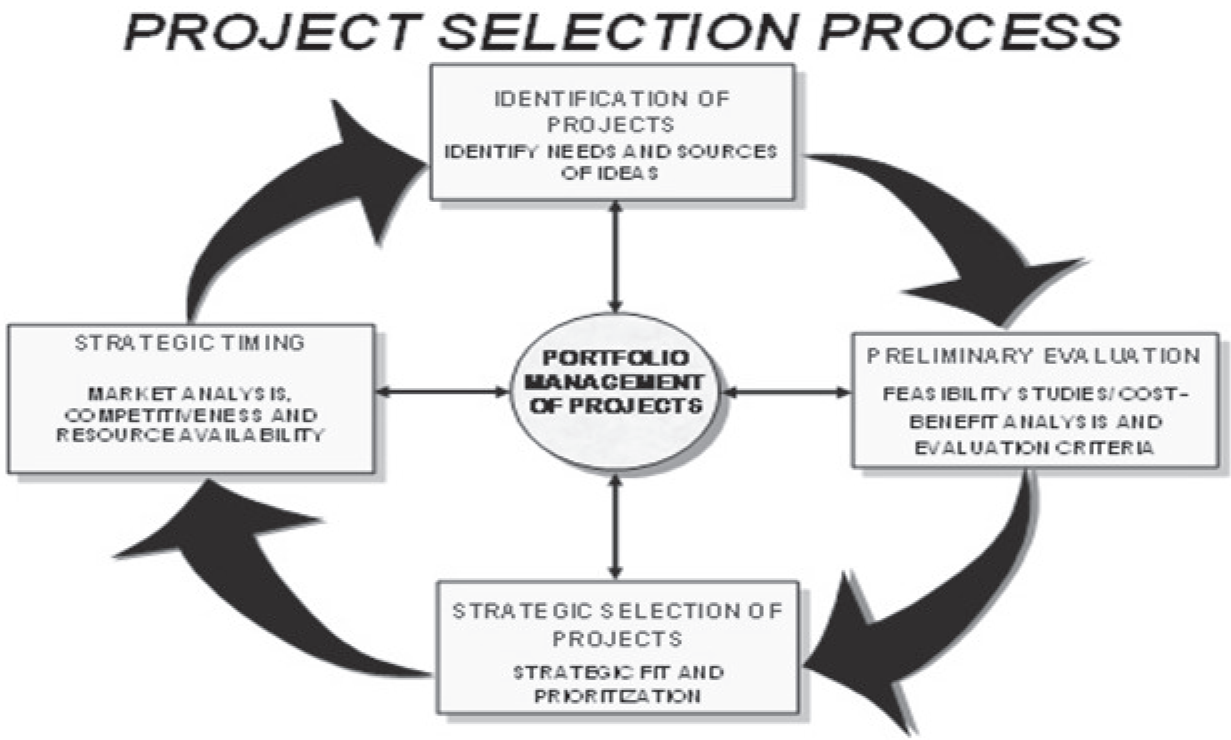
Assuming each of the projects have been approved through some form of project portfolio management process, these projects will go through the corporate project management methodology that will provide for successful implementation of each project. Each project listed above should support and be aligned with the strategic objectives. This alignment alone is still not complete in evaluating potential projects and the overall value of the project to the organization. Much of the value of each project has to be realized through the planning phase.The goal of successful project management is to have our projects come in on time, within budget and at the intended scope. These three objectives are expected to be met and also include that we deliver our project to meet the customer's expectations. Business planning provides a systematic way to accomplish the objectives of the organization. Business planning involves determining our deliverables and providing a roadmap to take us from our current position to a desired level of success. Here are some parallels between the two: There are many areas where project management can assist in the strategic planning, let's look at two of them: Identifying strategic resources and strategic selection of projects.

Identifying strategic resources:

"All businesses have corporate competencies and resources that distinguish them from their competitors. These competencies and resources are usually identified in terms of a company's strengths and/or weaknesses. Deciding upon what a company "should do" can only be achieved after assessing the strength and weaknesses to determine what the company "can do". Strengths and weaknesses can be identified at all levels of management"

Strategic selection of projects:

"What a company wants to do is not always what it can do. The critical constraint is normally the availability and quality of the critical resources. Companies normally have an abundance of projects they would like to work on but, because of resource limitations, have to develop a prioritization system for the selection of project." A company needs to develop a process to select the best projects. Many organizations will use a type of portfolio selection process. See example:



Let's look at an eight step strategic management process that was taken from the book called Management, by Stephen P. Robbins and Mary Coutler, Sixth Edition, 1999.

1. Identify the organization's current mission, objectives, and strategies
2. Analyze the environment
3. Identity the opportunities and threats
4. Analyze the organization's resources
5. Identify strength and weaknesses
6. Formulate strategies
7. Implement strategies
8. Evaluate results

Many of the above steps will and can utilize the best practices of project management to accomplish them. Of the nine knowledge areas within the PMBOK, the area of risk management addresses the issues of step 3 and 5. We evaluate the risk of the organization to determine the opportunities, threats, strengths and weakness of the organization. A risk management technique of SWOT analysis (Strengths Weakness Opportunities and Threats) can assist the planners in these phases of the strategic planning process.

Clearly the PMBOK® knowledge area of Human Resource Management and Scope Management will be used in evaluating the company resources. Lastly, all the knowledge areas of the PMBOK® will be an asset to us in planning and implementing the strategies of the organization. The areas where project management can be a factor are in steps 4, 5, 7, 8. Using PM we can analyze the resource for step 4. Using PM skills we can identify SWOT in our scope analysis to support steps 3 and 5. And finally the project scheduling would support the implementation of the strategies in step 7.

2.7 CASE STUDY

Anusha garments, a manufacturing company in apparels is exporting to European countries. Quality of the finished product and meeting the time schedule is the competitive strength of the Company. Even though new orders were lining up the company is not showing interest because of the overload already committed. Recently the company is facing problems due to scarcity of electrical power, manpower and government regulations.

As the project manager identify the risk factors in the project and do a suitable analysis of the same.

2.8 NOTES

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2.9 SUMMARY

Management of project integration includes the process of synthesis and response to change. The overall project employs five basic processes: *initiating, planning, executing, controlling, and closing.* The initiating process incorporates development of the idea for the project and justification based on a feasibility study.

Integrated project management, or program management as it is sometimes called, involves selecting, coordinating, and synchronizing projects in a company or agency, so that all the key factors for success are optimized. Program managers see both the big picture and the details of program and project work-all at the same time.

Modern construction projects could not be built without using project management. Today, computer companies, the movie studios, small businesses, and even the music industry uses project management.

Project Integration Management Processes:

- Develop the project charter
- Develop the preliminary project scope statement
- Develop the project management plan
- Direct and manage project execution
- Monitor and control the project work
- Perform integrated change control
- Close the project

Project management involves a cycle of processes. These cycles for defining, designing, developing, and delivering a deliverable vary according to organization.

The strategic and project management planning efforts are subsets of overall good planning. As stated earlier the strategic plan defines what needs to be done and why. The project management process defines how the objectives will be accomplished and what resources will be needed to accomplish the objectives.

The strategic planning process addresses what the organization wants to do and how they want to do it. The strategic plans often include the vision, mission and the high level objectives. Once these are established the next step would be to describe a plan that will take the firm to the successful completion of those objectives. It is at this point that the project management methodology pays off during the strategic planning process. Many of the tools and techniques of project management are geared to developing a realistic plan. The value of the process for strategic development and implementation is where project management fits. Project Management will assist the strategic team in planning and defining the supporting tasks and identifying the critical resources needed to accomplish the objective from the strategic plan.

2.10 KEYWORDS

Project planning

Integrated Project Management Cycles

Performance Matrix

Project Selection Process

Strategic Planning

2.11 SELF ASSESSMENT QUESTIONS

1. Define Integrated Project Management. Explain the Concept and nature of Integrated Project Management.
2. Explain the evolution of Integrated Project Management
3. Explain Project Integration Management Processes and its benefits in detail.
4. Explain Integrated Project Management Cycles.
5. Discuss the alignment of projects with organizational strategy.

2.12 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.
2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.
3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.
4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.
5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill
6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011
7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002
8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012
9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.
10. Sanjiv Marwah. *Project Management*. New Delhi: Dreamtech Press, 2011.

UNIT-3 : PROJECT PORTFOLIO MANAGEMENT SYSTEM

Structure:

3.0 Objectives

3.1 Concept of Project Portfolio Management System

3.2 Need for Project Portfolio Management System

3.3 Design of the Project Portfolio Management

3.4 Project Life Cycle and its phases

3.5 Case Study

3.6 Notes

3.7 Summary

3.8 Key Words

3.9 Self Assessment Questions

3.10 References

3.0 OBJECTIVES

After studying this unit you should be able to:

- provide an overview of Project Portfolio Management System
- define the concept of Project Portfolio Management System.
- appreciate the need for Project Portfolio Management System
- describe the design of the Project Portfolio Management System.

3.1 CONCEPT OF PROJECT PORTFOLIO MANAGEMENT SYSTEM

Project Portfolio Management System (PPM) is a term used by project managers and project management (PM) organizations, (or PMO's), to describe methods for analyzing and collectively managing a group of current or proposed projects based on numerous key characteristics. The fundamental objective of PPM is to determine the optimal mix and sequencing of proposed projects to best achieve the organization's overall goals - typically expressed in terms of hard economic measures, business strategy goals, or technical strategy goals - while honouring constraints imposed by management or external real-world factors. Typical attributes of projects being analyzed in a PPM process include each project's total expected cost, consumption of scarce resources (human or otherwise) expected timeline and schedule of investment, expected nature, magnitude and timing of benefits to be realized, and relationship or inter-dependencies with other projects in the portfolio.

Project Portfolio Management is about more than running multiple projects. Each portfolio of projects needs to be assessed by its business value and adherence to strategy. The portfolio should be designed to achieve a defined business objective or benefit. Project management guru Bob Buttrick summarized it when he said; "Directing the individual project correctly will ensure it is done right. Directing 'all the projects' successfully will ensure we are doing the right projects." Project portfolio management organizes a series of projects into a single portfolio of reports that capture project objectives and other critical factors. While at individual project level it is important to know how each project is performing, the impact of each project on the portfolio is also important.

Working at portfolio level is about working with summary or key data. It is important to avoid information overload. The detail of each project should be kept at the project team level, managed by the individual project managers. Key information should be rolled up and presented at each level within the organization as appropriate. Within most project portfolio management systems there is a project evaluation process. This process is used to evaluate the projects at various points during their life cycle. At the beginning of each stage (often called a "gate") the responsible party evaluates the business case, asking whether it is still relevant and able to deliver the organizations' objectives. If the answer is no, then the project should be stopped. This way the organization can ensure they stay focused on delivering a strategy, goal or other benefit, and that resources are used where they will offer the best return.

3.2 NEED FOR PROJECT PORTFOLIO MANAGEMENT SYSTEM

There are three problems or reasons why we need project portfolio management system. They are

a) Implementation Gap

In many organizations, top management formulates strategy and functional management implements. For implementation, the functional managers develop objectives based on the strategies. As the strategies and objectives are developed at different levels by top management and executive management respectively, implementation gap arises. It may lead to frequent conflict among functional managers, conduct of frequent meetings to establish or renegotiate priorities, people frequently shifting from one project to another, depending on current priority and employees getting confusion about which projects are important. As clear linkages do not exist, the organizational environment becomes dysfunctional, confused and ripe for ineffective implementation of organization strategy and hence, projects. The implementation gap refers to the lack of understanding and consensus of organization strategy among top and middle level managers. Hence, project portfolio management system will help the organization to minimize the implementation gap.

b) Organizational Politics

When criteria and processes for selecting projects are ill-defined and non-aligned with the mission of the firm, projects suffer from not getting priority and resources. The term 'sacred cow' is used to refer to the worthless projects which are advocated by higher officials. Similarly, project sponsor can play a significant role in the selection and successful implementation of projects. Politics can play a role not only in project selection but also in the aspirations behind the projects. Individuals can enhance their powers within the organization by managing extraordinary and critical projects. Thus, project portfolio management system will help in reducing the organizational politics.

c) Resource conflicts and multitasking

When more projects are carried out, it leads to resource conflicts and multitasking. Resource sharing also leads to multitasking. People working on several projects concurrently are found to be inefficient. Multitasking adds to delay and costs, i.e., both time and cost overruns. Thus, project portfolio management system will help in optimum allocation of scarce resources.

3.3 DESIGN OF THE PROJECT PORTFOLIO MANAGEMENT SYSTEM

Design of project portfolio management system should include the following:

a) Classification of Project

Most of the organizations may have three kinds of projects in their portfolio, viz., compliance and emergency projects, operations projects and strategic projects. Compliance and emergency projects are compulsory in nature to meet the regulatory conditions. Operational projects are those that are needed to support operations and are designed to improve efficiency of delivery system, reduce product costs, and improve performance. Strategic projects are those that are directly support the organizations' long run mission. The strategic value of a project should be determined before it is placed in the project portfolio. However, compliance projects may also be undertaken to avoid regulatory problems.

b) Selection Criteria

Selection criteria for projects may be divided into financial and nonfinancial. Financial criteria are the most preferred method to evaluate projects. Common financial methods include payback method and net present value method. Payback method is a method in which the projects which pays back the original investment in a shorter period are given priority.

In case of net present value method, the project which gives positive NPV is selected. NPV is the excess of present value of cash inflows over present value of cash outflows. Non-financial criteria may include the following: a) restoring corporate image or b) enhancing brand image. Many organizations are committed to corporate citizenship and support community development projects. Thus, the social desirability of the projects is also equally important as financial viability

c) Sources of Project Proposals

Projects should originate from anyone who believes their project will add value to the organization. Many organizations restrict proposals from specific levels or groups within the organization. This could be an opportunity lost. Thus, project ideas should be solicited from all internal and external sponsors.

d) Evaluation and Selection of Project Proposals

Evaluating many project proposals and selecting the projects which add value to an organization is important. Data and information are collected to assess the value of the project to the organization. Given the selection criteria and current portfolio of projects, the priority team rejects or accepts the project. If the project is accepted the priority team set implementation in motion.

e) Managing the Project Portfolio System

Managing portfolio takes the selection system one step higher in that the merits of a particular project are assessed within the context of existing projects. At the same time, it involves monitoring and adjusting selection criteria to reflect the strategic focus of the organization. The priority system can be managed by a small group of key employees in a small organization or in a large organizations, it can be managed by the project office or enterprise management group. Management of a portfolio system requires two major inputs from senior management, viz. senior management must provide guidance in establishing selection criteria that strongly align with the current organizational strategies; and senior management must annual decide how they wish to balance the available organizational resources among the different types of projects. Given these inputs, the priority team or project office can carry out its many responsibilities, which include supporting project sponsors and representing the interest of the total organization.

f) Balancing the portfolio for risks and types of projects

A major responsibility of the priority team is to balance projects by type, risk and resource demand. This requires a total organization perspective. Hence, a proposed project that ranks high on most criteria may not be selected because the organizational portfolio already includes too many projects with the same characteristics. Balancing the portfolio is as important as project selection.

3.4 PROJECT LIFE CYCLE AND ITS PHASES

Project life cycle is a complex process consisting of different steps arranged in a sequential order. Different authors have described these steps in different sequential manner but the concept of the cycle is almost similar in each case. According to United Nations Guidelines for Rural Centre Planning, there are 7 steps in the project life cycle such as project identification and appraisal, pre-feasibility study, feasibility study, detailed design project implementation, operation maintenance, monitoring and evaluation.

Rondineli, Dennis & Apsy Palia in their book—Project Planning and implementation in Developing countries—identified the following 12 steps in the project life cycle. Project identification and definition, project formation, preparation and feasibility analysis, project design, project analysis, project selection, project activation and organization, project implementation and operation, project supervision (monitoring and control) project completion or termination, output diffusion and transition to normal administration, project evaluation, follow-up and action. World Bank Guidelines reveals the following six major steps in the project life cycle. Conception (identification), Formation (preparation), Analysis (appraisal), Implementation (Supervision), operation and evaluation.

The project life cycle serves to define the beginning and the end of a project. For example, when an organization identifies an opportunity to which it would like to respond, it will often authorize a needs assessment and/or a feasibility study to decide if it should undertake the project. The project life-cycle definition will determine whether the feasibility study is treated as the first project phase or as a separate, standalone project.

The project life-cycle definition will also determine which transitional actions at the beginning and the end of the project are included and which are not. In this manner, the project life-cycle definition can be used to link the project to the ongoing operations of the performing organization.

The phase sequence defined by most project life cycles generally involves some form of technology transfer or handoff such as requirements to design, construction to operations, or design to manufacturing. Deliverables from the preceding phase are usually approved before work starts on the next phase. However, a subsequent phase is sometimes begun prior to approval of the previous phase deliverables when the risks involved are deemed acceptable. This practice of overlapping phases is often called *fast tracking*.

Project life cycles generally define:

- What technical work should be done in each phase (e.g., is the work of the analyst part of the definition phase or part of the execution phase)?
- Who should be involved in each phase (e.g., resources that need to be involved with requirements and design)?

Project life-cycle descriptions may be very general or very detailed. Highly detailed descriptions may have numerous forms, charts, and checklists to provide structure and consistency. Such detailed approaches are often called project management methodologies.

Most project life-cycle descriptions share a number of common characteristics:

- Cost and staffing levels are low at the start, higher toward the end, and drop rapidly as the project draws to a conclusion.
- The probability of successfully completing the project is lowest, and hence risk and uncertainty are highest, at the start of the project. The probability of successful completion generally gets progressively higher as the project continues.
- The ability of the stakeholders to influence the final characteristics of the project's product and the final cost of the project is highest at the start and gets progressively lower as the project continues. A major contributor to this phenomenon is that the cost of changes and error correction generally increases as the project continues.
- Project life cycle defines phases that connect beginning and end of the project. After each phase deliverables are reviewed for the completeness in time, accuracy according to defined objectives and their final approval (approval for acceptance) before moving to the next phase.
- In the beginning, phases can be overlapped to save time and to have fast tracking on the life cycle. This technique is used to compress the whole schedule (if required resources are available or manageable).
- There is no way to define Project Life Cycle ideally. Because of this every project management team can define its own way to work on the project. They can use best common practices and can learn new ways of dealing projects by their experiences in detail or in general. Only three phases are always certain to be performed; conceptualization, intermediate phase(s), and closure.
- Cost and staffing level is defined for every single phase.
- Project may have sub-project(s) and sub-projects may have their own project life cycle.
- The typical project life cycle – initiating, implementing and clos-ing – has critical decision points where the project may continue, be changed, or be abandoned.

Phases of Project Life Cycle

The phases of project life cycle are detailed below:

a) Project Initiation

The first of a project is the initiation phase. During this phase a business problem or opportunity is identified and a business case providing various solution options is defined. Next, a feasibility study is conducted to investigate whether each option addresses the business problem and a final recommended solution is then put forward. Once the recommended solution is approved, a project is initiated to deliver the approved solution. Terms of reference are completed outlining the objectives, scope and structure of the new project, and a project manager is appointed.

The project manager begins recruiting a project team and establishes a project office environment. Approval is then sought to move into the detailed planning phase."Within the initiation phase, the business problem or opportunity is identified, a solution is defined, a project is formed and a project team is appointed to build and deliver the solution to the customer.

The Project Initiation activities

Develop a business case: The trigger to initiating a project is identifying a business problem or opportunity to be addressed. A business case is created to define the problem or opportunity in detail and identify a preferred solution for implementation. The business case includes a detailed description of the problem or opportunity, the Project Management Life Cycle ,a list of the alternative solutions available, an analysis of the business benefits, costs, risks and issues, a description of the preferred solution ,a summarized plan for implementation.

"An identified project sponsor then approves the business case and the required funding is allocated to proceed with a feasibility study. Undertake a feasibility study: At any stage during or after the creation of a business case, a formal feasibility study may be commissioned. The purpose of a feasibility study is to assess the likelihood of each alternative solution option achieving the benefits outlined in the business case. The feasibility study will also investigate whether the forecast costs are reasonable, the solution is achievable, the risks are acceptable and the identified issues are avoidable.

Establish the terms of reference: After the business case and feasibility study have been approved, a new project is formed. At this point, terms of reference are created. The terms of reference define the vision, objectives, scope and deliverables for the new project. They also describe the organization structure and activities, resources and funding required for undertaking the project. Any risks, issues, planning assumptions and constraints are also identified.

***Appoint the project team*:** The project teams are now ready to be appointed. Although a project manager may be appointed at any stage during the life of the project, the manager will ideally be appointed prior to recruiting the project team. The project manager creates a detailed job description for each role in the project team, and recruits people into each role based on their relevant skills and experience

Set up a project office: The project office is the physical environment within which the team is based. Although it is usual to have one central project office, it is possible to have a virtual project office with project team members located around the world. A project office environment should include:

Equipment, such as office furniture, computer equipment, station-ery and materials;

Communications infrastructure, such as telephones, computer network, e mail, Internet access, file storage, database storage and backup facilities; such as a project methodology, standards, pro-cesses, forms and registers;

Tools, such as accounting, project planning and risk modelling software.

b) Project Planning

Once the scope of the project has been defined in the terms of reference, the project enters the planning phase. This involves creating a:

Project plan outlining the activities, tasks, dependencies and timeframes;

Resource plan listing the labor, equipment and materials required;

Financial plan identifying the labor, equipment and materials costs;

Quality plan providing quality targets, assurance and control measures;

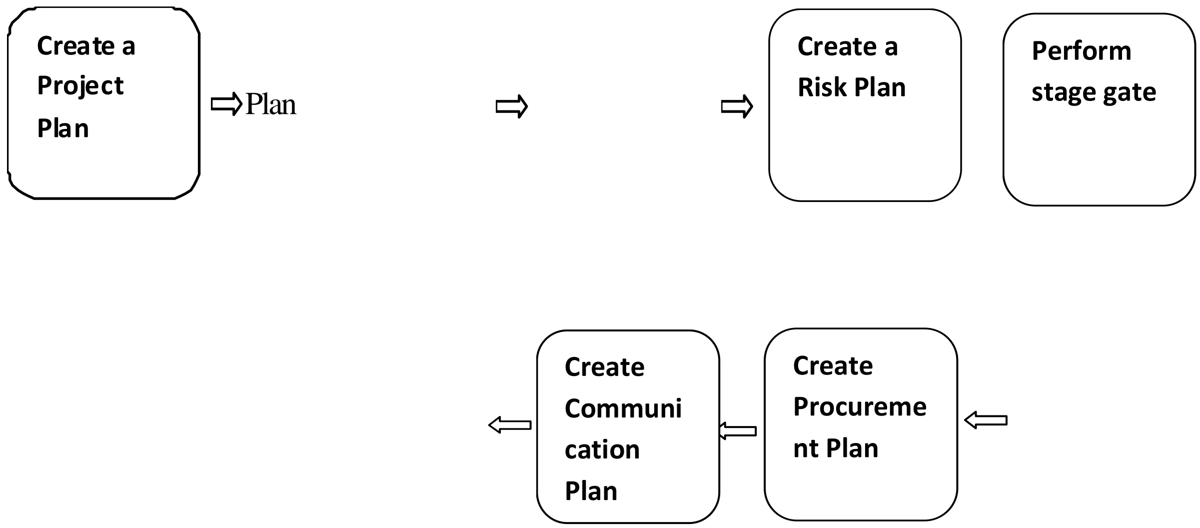
Risk plan highlighting potential risks and actions to be taken to mitigate those risks;

Acceptance plan listing the criteria to be met to gain customer acceptance;

Communications plan describing the information needed to inform stakeholders;

Procurement plan identifying products to be sourced from external suppliers.

Project costs and benefits have been documented, the objectives and scope have been defined, the project team has been appointed and a formal project office environment established. It is now time to undertake detailed planning to ensure that the activities performed during the execution phase of the project are properly sequenced, resourced, executed and controlled. The activities shown in the following figure are undertaken.



Project Planning Activities

***Create a project plan*:** The first step in the project planning phase is to document the project plan. A 'work breakdown structure' (WBS) is identified which includes a hierarchical set of phases, activities and tasks to be undertaken to complete the project. After the WBS has been agreed, an assessment of the level of effort required to undertake each activity and task is made. The activities and tasks are then sequenced, resources are allocated and a detailed project schedule is formed. This project plan is the key tool used by the project manager to assess the progress of the project throughout the project life cycle. Create a resource plan: Immediately after the project plan is formed, the level of resource required to undertake each of the activities and tasks listed within the project plan will need to be allocated. Although generic resource may have already been allocated in the project plan, a detailed resource plan is required to identify the:

- Type of resource required, such as labor, equipment and materials;
- Quantity of each type of resource required;
- Roles, responsibilities and skill sets of all human resource required;
- Specifications of all equipment resource required;
- Items and quantities of material resource required.

A schedule is assembled for each type of resource so that the project manager can review the resource allocation at each stage in the project.

Create a financial plan: A financial plan is created to identify the total quantity of money required to undertake each phase in the project (in other words, the budget). The total cost of labor, equipment and materials is calculated and an expense schedule is defined which enables the project manager to measure the forecast spend versus the actual spend throughout the project. Detailed financial planning is an extremely important activity within the project, as the customer will expect the final solution to have been delivered within the allocated budget.

Create a quality plan: Meeting the quality expectations of the customer can be a challenging task. To ensure that the quality expectations are clearly defined and can reasonably be achieved, a quality plan is documented. The quality plan:

- Defines the term 'quality' for the project.
- Lists clear and unambiguous quality targets for each deliverable. Each quality target provides a set of criteria and standards to be achieved to meet the expectations of the customer.
- Provides a plan of activities to assure the customer that the quality targets will be met (in other words, a quality assurance plan).
- Identifies the techniques used to control the actual quality level of each deliverable as it is built (in other words, a quality control plan).

Not only is it important to review the quality of the deliverables produced by the project, it is also important to review the quality of the management processes that produced them. A quality plan will summarize each of the management processes undertaken during the project, including time, cost, quality, change, risk, issue, procurement, acceptance and communications management.

Create a risk plan: The next step is to document all foreseeable project risks within a risk plan. This plan also identifies the actions required to prevent each risk from occurring, as well as reduce the impact of the risk should it eventuate. Developing a clear risk plan is an important activity within the planning phase, as it is necessary to mitigate all critical project risks prior to entering the execution phase of the project.

Create an acceptance plan: To deliver the project successfully, you will need to gain full acceptance from the customer that the deliverables produced by the project meet or exceed requirements. An acceptance plan is created to help achieve this, by clarifying the completion criteria for each deliverable and providing a schedule of acceptance reviews. These reviews provide the customer with the opportunity to assess each deliverable and provide formal acceptance that it meets the requirements as originally stated.

Create a communications plan: Prior to the execution phase, it is also necessary to identify how each of the stakeholders will be kept informed of the progress of the project. The communications plan identifies the types of information to be distributed to stakeholders, the methods of distributing the information, the frequency of distribution, and responsibilities of each person in the project team for distributing the information.

Create a procurement plan: The last planning activity within the planning phase is to identify the elements of the project to be acquired from external suppliers. The procurement plan provides a detailed description of the products (that is, goods and services) to be acquired from suppliers, the justification for acquiring each product externally as opposed to from within the business, and the schedule for product delivery. It also describes the process for the selection of a preferred supplier (the tender process), and the ordering and delivery of the products (the procurement process).

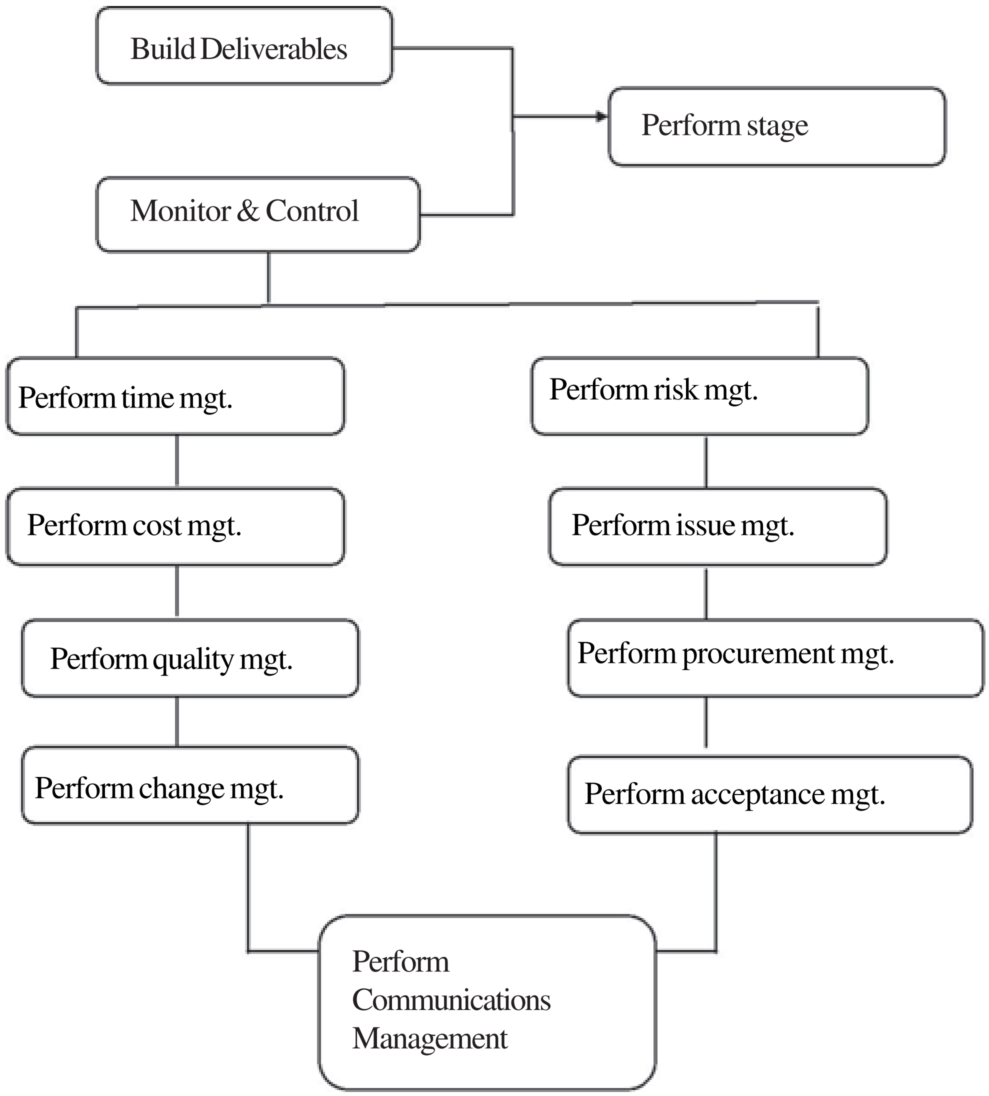
Contract the suppliers: Although external suppliers may be appointed at any stage of the project, it is usual to appoint suppliers after the project plans have been documented but prior to the execution phase of the project. Only at this point will the project manager have a clear idea of the role of suppliers and the expectations for their delivery. A formal tender process is undertaken to identify a short list of capable suppliers and select a preferred supplier to initiate contractual discussions with. The tender process involves creating a statement of work, a request for information and request for proposal document to obtain sufficient information from each potential supplier and select the preferred supplier. Once a preferred supplier has been chosen, a contract is agreed between the project team and the supplier for the delivery of the requisite products.

Perform a phase review: At the end of the planning phase, a phase review is performed. This is a checkpoint to ensure that the project has achieved its objectives as planned.

c) Project Execution

This phase involves implementing the plans created during the project planning phase. While each plan is being executed, a series of management processes are undertaken to monitor and control the deliverables being output by the project. This includes identifying change, risks and issues, reviewing deliverable quality and measuring each deliverable produced against the acceptance criteria. Once all of the deliverables have been produced and the customer has accepted the final solution, the project is ready for closure.

The activities of this phase are shown in the following figure.



Project Execution activities

The execution phase is typically the longest phase of the project in terms of duration. it is the phase within which the deliverables are physically constructed and presented to the customer for acceptance.

To ensure that the customer's requirements are met, the project manager monitors and controls the activities, resources and expenditure required to build each deliverable. A number of management processes as shown are undertaken to ensure that the project proceeds as planned.

Build the deliverables: This phase involves physically constructing each deliverable for acceptance by the customer. The activities undertaken-en to construct each deliverable will vary depending on the type of project being undertaken.

Activities may be undertaken in a 'waterfall' fashion, where each activity is completed in sequence until the final deliverable is produced, or in an 'iterative' fashion, where iterations of each deliverable are constructed until the deliverable meets the requirements of the customer. Regard-less of the method used to construct each deliverable, careful monitoring and control processes should be employed to ensure that the quality of the final deliverable meets the acceptance criteria set by the customer.

Monitor and control: While the project team is physically producing each deliverable, the project manager implements a series of management processes to monitor and control the activities being undertaken by the project team. An overview of each management process follows.

Time Management: Time management is the process of recording and controlling time spent by staff on the project. As time is a scarce resource within projects, each team member should record time spent undertaking project activities on a timesheet form. This will enable the project manager to control the amount of time spent undertaking each activity within the project. A timesheet register is also completed, providing a summary of the time spent on the project in total so that the project plan can always be kept fully up to date.

Cost management: Cost management is the process by which costs/expenses incurred on the project are formally identified, approved and paid. Expense forms are completed for each set of related project expenses such as labor, equipment and materials costs. Expense forms are approved by the project manager and recorded within an expense register for auditing purposes.

Quality management: Quality is defined as the extent to which the final deliverable conforms to the customer requirements. Quality management is the process by which quality is assured and controlled for the project, using quality assurance and quality control techniques. Quality reviews are undertaken frequently and the results recorded on a quality review form.

Change management: Change management is the process by which changes to the project scope, deliverables, timescales or resources are formally requested, evaluated and approved prior to implementation. A core aspect of the project manager's role is to manage change within the project. This is achieved by understanding the business and system drivers requiring the change, identifying the costs and benefits of adopting the change, and formulating a structured plan for implementing the change. To formally request a change to the project, a change form is completed. The status of all active change forms should he recorded within a change register.

Risk management: Risk management is the process by which risks to the project are formally identified, quantified and managed. A project risk may be identified at any stage of the project by completing a risk form and recording the relevant risk details within the risk register.

Issue management: Issue management is the method by which issues currently affecting the ability of the project to produce the required deliverable are formally managed. After an issue form has been completed and the details logged in the issue register, each issue is evaluated by the project manager and a set of actions undertaken to resolve the issue identified.

Procurement management: Procurement management is the process of sourcing products from an external supplier. Purchase orders are used to purchase products from suppliers, and a procurement register is maintained to track each purchase request through to its completion.

Acceptance management: Acceptance management is the process of gaining customer acceptance for deliverables produced by the project. Acceptance forms are used to enable project staff to request acceptance for a deliverable, once complete. Each acceptance form identifies the acceptance criteria, review methods and results of the acceptance reviews undertaken.

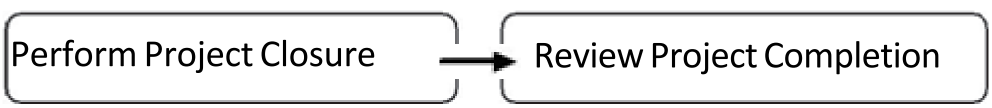
Communications management: Communications management is the process by which formal communications messages are identified, created, reviewed and communicated within a project. The most common method of communicating the status of the project is via a project status report. Each communications message released is captured in a communications register.

Perform a phase review: At the end of the execution phase, a phase review is performed. This is a checkpoint to ensure that the project has achieved its objectives as planned."

d) Project Closure

Project closure involves releasing the final deliverables to the customer, handing over project documentation to the business, terminating supplier contracts, releasing project resources and communicating the closure of the project to all stakeholders. The last remaining step is to undertake a post implementation review to quantify the level of project success and identify any lessons learnt for future projects. Following the acceptance of all project deliverables by the customer, the project will have met its objectives and be ready for closure. Project closure is the last phase in the project life cycle, and must be conducted formally so that the business benefits delivered by the project are fully realized by the customer.

The activities outlined in the following figure are undertaken.



The project closure activities

Perform project closure: Project closure, or 'close out', essentially involves winding up the project. This includes:

- Determining whether all of the project completion criteria have been met;
- Identifying any outstanding project activities, risks or issues;
- Handing over all project deliverables and documentation to the customer;
- Cancelling supplier contracts and releasing project resources to the business
- Communicating the closure of the project to all stakeholders and interested parties.

A project closure report is documented and submitted to the customer and/or project sponsor for approval. The project manager is responsible for undertaking each of the activities identified in the project closure report, and the project is closed only when all the activities listed in the project closure report have been completed.

Review project completion: The final activity within a project is the review of its success by an independent party. Success is determined by how well it performed against the defined objectives and conformed to the management processes outlined in the planning phase. To determine how well it performed, the following types of questions are answered:

- Did it result in the benefits defined in the business case?
- Did it achieve the objectives outlined in the terms of reference?
- Did it operate within the scope of the terms of reference? 0 Did the deliverables meet the criteria defined in the quality plan?
- Was it delivered within the schedule outlined in the project plan?
- Was it delivered within the budget outlined in the financial plan?

To determine how well the project conformed, an assessment is made of the level of conformity to the management processes outlined in the quality plan. These results, as well as a list of the key achievements and lessons learnt, are documented within a post-implementation review and presented to the customer and/or project sponsor for approval.

3.5 CASE STUDY

In recent years, Vietnam Rubber Company (VRC) has invested big capital for expanding rubber plantations and upgrading rubber processing facilities both domestic and outside the country. For VRC, the concept and practice of owner's project life cycle have been used in rubber plantation projects. Nevertheless, VRC has not built a type of project life cycle appropriating with its specific characteristics; therefore, some projects meet with serious difficulties during performance.

According to internal audit and situation report, VRC's overseas rubber projects show many problems especially in cost and schedule on the project management in construction during 2007-2010 such as:

- Cost overrunning or over budget;
- Projects are prone to delay;
- Project quality uncontrolled;
- Project scope creep.

Also according to this report, VRC recognize the bad results in Cambodia are created by many reasons; however, poor management of the project life cycle is one of the reasons bring about serious consequences including the followings:

- Not establishing a framework of project life cycle;
- Project proposals and business cases and project selecting process in the first phase were carried out incautiously have impacted to all remain phases of the project life cycle;
- Some projects do not have a strong project management team;
- Inadequate delegation from VRC's head quarter and the project organization is not properly;
- Lack of managerial skills and competencies as well as the internal capacities of the owner

VRC considered that poor management of the project life cycle caused negative impact to the projects. They are the critical problems which VRC and other related parties to Cambodia projects need to consider cautiously.

Mr. Do Huu Phuoc made a research to study Vietnam Rubber Company's project life cycle approach, analyze situation and develop a framework of project life cycle of a rubber plantation project and guideline to possibly ensure the projects deliver on time, on budget and to the level of quality expected.

Give your Conclusion and also recommendations for VRC's project life cycle approach.

3.6 NOTES

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3.7 SUMMARY

Project Portfolio Management System (PPM) is a term used by project managers and project management (PM) organizations, (or PMO's), to describe methods for analyzing and collectively managing a group of current or proposed projects based on numerous key characteristics.

There are three problems or reasons why we need project portfolio management system. They are a) Implementation Gap, b) Organizational Politics c) Resource conflicts and multitasking.

Design of project portfolio management system should include the following

a) Classification of Project

b) Selection Criteria

c) Sources of Project Proposals

d) Evaluation and Selection of Project Proposals

e) Managing the Project Portfolio System

f) Balancing the portfolio for risks and types of projects

The project life cycle serves to define the beginning and the end of a project. The phase sequence defined by most project life cycles generally involves some form of technology transfer or handoff such as requirements to design, construction to operations, or design to manufacturing. Deliverables from the preceding phase are usually approved before work starts on the next phase. However, a subsequent phase is sometimes begun prior to approval of the previous phase deliverables when the risks involved are deemed acceptable.

The stages of project life cycle are detailed below:

Project Initiation

Project Planning

Project Execution

Project Closure

3.8 KEYWORDS

Project Portfolio Management

Project life cycle

Project plan

Project Management Organizations

3.9 SELF ASSESSMENT QUESTIONS

1. What is project portfolio management system?
2. Explain the need for project portfolio management system.
3. Explain the design of project portfolio management system
4. Explain the various stages in Project Life Cycle

3.10 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.
2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.
3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.
4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.
5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill
6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011
7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002
8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012
9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.
10. Sanjiv Marwah. *Project Management.* New Delhi: Dreamtech Press, 2011.

UNIT-4 : FEASIBILITIES OF PROJECTS

Structure :

4.0 OBJECTIVES

After studying this unit you should be able to:

- provide an overview of Feasibilities of Projects
- explain different forms of project contracting
- analyze the role of consultants in Project Management

4.1 CONCEPT OF FEASIBILITIES OF PROJECTS

Feasibility study is an analysis of the viability of an idea. It ensures that a project is legally and technically feasible and economically justifiable.

Moreover this study can be used in various ways with focus on the proposed business. It tells us whether a project is worth doable or not? Feasibility study is a must because:

- Every Project is not doable.
- Not every project should be done.
- Not every project makes use of effective resources of company.

In its simplest terms, the two criteria to judge feasibility are cost required and value to be attained. A well-designed study should provide a historical background of the business or project, a description of the product or service, accounting statements, details of the operations and management, marketing research and policies, financial data, legal requirements and tax obligations. Generally, such studies precede technical development and project implementation.

A feasibility study evaluates the project's potential for success; therefore, perceived objectivity is an important factor in the credibility of the study for potential investors and lending institutions.

Five different areas of Project Feasibility:

- Technical Feasibility assessment is focused on the present technical resource available in the organization. It studies if the technical resources including the technical team are capable of converting the ideas into working system. It also evaluates the hardware and the software requirement of the proposed system.
- Economical Feasibility studies enable organizations to assess the viability, cost and benefits of projects before financial resources are allocated. They also provide independent project assessment and enhance project credibility. It also helps to

determine the positive economic benefits to the organization that the proposed system will provide. It includes quantification and identification of all the benefits expected. This assessment typically involves a cost/ benefits analysis of the project.

- Legally Feasibility of the project determines whether the proposed system conflicts with legal requirements like any data protection act or any social media law.
- Operational Feasibility, under which we conduct a study to analyze and determine whether your business need can be fulfilled by using a proposed solution. It also measures how well a proposed system solves the problems, and takes advantage of the opportunities identified during scope definition and how it satisfies the requirements identified in the requirements analysis phase of system development. To ensure success, desired operational outcomes must be imparted during design and development. These include such design-dependent parameters such as reliability, maintainability, supportability, usability, disposability, sustainability, affordability and others.
- Scheduling Feasibility is the most important in terms of project success. A project will fail if not completed on time. In scheduling feasibility we estimate how much time the system will take to complete and with our technical skill we need to estimate the period to complete the project using some methods.

The various stages in the project feasibility studies include

Opportunity studies

Pre-feasibility studies

Techno-economic feasibility studies

Let us know the details of opportunity studies and pre-feasibility studies in this lesson.

Opportunity Studies

Identifying suitable opportunities for investment is an intricate and involved exercise in developing countries. A variety of constraints, complexities, risks and uncertainties have to be reckoned with, and their implications on the project implementation and its subsequent success in the operational phase have to be carefully and thoroughly examined before the resources are committed. Efforts in identifying these opportunities pursued at different levels. The enterprise management is expected to take all initiative to convince itself about the prospects of the project that it wishes to launch.

The opportunity studies help in spotting investment opportunities or project ideas, which can be subjected to further detailed scrutiny, if initially found viable.

The opportunity studies can be general or specific in nature.

a) General Opportunity Studies

The government and development institutions carry out these general studies for the benefit of potential investors. These general studies could be:

Area Studies

Identifying locations that require development and investment initiatives, such as backward areas, export zones, etc.

Sub-Sectoral Studies

The focus of attention being sub sectoral areas, such as consumer durables, construction materials, etc.

Resource-Based Studies

These involve a survey of the availability of natural resources that can be processed for making immediate or final products.

b) Specific Project Opportunity Studies

After identification of general investment opportunities, whereby products that have potential for domestic manufacture get noted, the next step is to prepare an investment profile for the chosen line. Industrial promotion and development agencies often provide this information for prospective investors.

The specific opportunity study enables the project idea to graduate into an investment proposition. Government policies, incentives and other supports are aspects on which information would be needed as they have a bearing on the profitable functioning of the project. A broad investment profile should be an output of the study, in order to elicit investor response. Since the study confines itself to aggregates and summary data for a quick understanding of the investment prospects, it should not be very expensive. At a moderate cost it should be possible to get the salient facts.

Pre-Feasibility Studies

The project idea requires to be expanded with the help of a more detailed examination of all relevant information, as also by gathering additional essential information. A thorough techno-economic feasibility study is very expensive and there is need to be convinced about the worth of launching such an elaborate and costly exercise. The pre-feasibility study is thus an intermediate effort, following the identification of a project idea, to determine whether the proposal deserves to be pursued further for project formulation and implementation. The outcome of the pre-feasibility study might also be the realization that the project idea is not with pursuing further.

The conversion of the project idea into a commercial reality could possibly be achieved through a variety of choices in terms of plant size, location, technology, product mix, marketing approaches, etc.

Components of Project Feasibility Studies

Introduction

The United Nations Industrial Development Organization (UNIDO) has published in the ***Manual for the Preparation of Industrial Feasibility Studies*** to help the standardization of industrial feasibility studies, which have often found to be incomplete and inadequately prepared. It will be useful to trace the components, or contents, of the feasibility studies through the framework provided by UNIDO.

Components of Techno-Economic Feasibility Studies

Following are the contents of techno-economic feasibility studies:

a Project background and history

b Demand and market study

c Demand projections

d Forecasting techniques

e Export projections

f Market penetration

g Sensitivity analysis

h Sales forecast and marketing

i Production programme

j Plant capacity

k Materials and inputs

l Supply programme

m Project location

n Plant site, within the location

o Local conditions

p Layout and physical coverage of project

q Technology and equipment

r Civil engineering

s Plant organization

t Overhead costs

u Labour

v Staff

w Implementation scheduling

x Financial evaluation

y Economic evaluation

a) Project Background and History

The success of any project is dependent, among other things, on its consonance with the country's economic setting and its state of industrial development. The economic, industrial, financial and other relevant policies should be briefly described. There should also be information on the project promoters or sponsors and the reasons for their specific interest in the project. The nature of preliminary and subsequent studies that have proceeded from the feasibility study should be mentioned, giving the highlights and the costs incurred.

b) Demand and Market Study

After identifying the data requirements of the demand and market study, an appropriate method of data collection and evaluation will have to be chosen from among the alternative approaches available. Then the demand and market size for the products, and by-products, if any, will have to be determined and projected for the life time of the project. Estimations about the extent of market penetration by products should also be given. The proposed sales programme has to be spelt out, indicating the progress expected during the project life. The marketing strategy that has been chosen should be elaborated, presenting its rationale. Information on product pricing, promotional efforts planned the proposed pattern of organization structure for distribution and sales, and decisions on the discounts and commissions on sales, and the extent and nature of after sales services intended to be provided should be given.

(c)Demand Projections

Demand projections should take note of domestic potential as also export possibilities. These projections should cover the aspects like the estimate of the potential demand for the product or products, the estimates of the potential supplies, the degree of market penetration that the project is expected to achieve.

d) Forecasting Techniques

There are different forecasting techniques that can be adopted and an appropriate choice has to be made depending on the nature of the products and markets. The demand forecasting techniques that are normally used are the trend method, also referred to as extrapolation method, the consumption level method the end-use method, also known as the consumption coefficient method ,the leading indicator method, Regression models, Market survey.

e) Exports Projections

The information requirements for assessing export market potential are the present volume of export of the product or products, the unit export prices for these products, Countries to which these products have been, or are being, exported, special aspects concerning these products, such as quality stipulations, special selling arrangements, etc. Other countries with export assistance or export incentive provided by the home country, and the prospects of their being continued or improved. Risk of violent shifts in demand due to rapid technological changes, or changes in political situations.

f)Market Penetration

The market penetration that the proposed product can achieve is assessed with reference to the following factors like the degree of domestic and/or foreign competition, the consumer preferences or responses and the scope for substitution that exists, or might develop. There are also strategic levers that can be employed for achieving market penetration which include Product quality, Packaging, Marketing and distribution methods, and the after-sales services provided.

g)Sensitivity Analysis

There are bound to be a large number of assumptions on a variety of aspects relating to the project. These assumptions can get vitiated by unpredictable events or there could be inadequacies or inherent errors in the project data inputs. The common deviations that occur are Errors in the base data, an analysis based on inadequate data, unforeseen economic and socio-political developments, Certain essential parameters being overlooked or some relevant factors and relationships being unknown or being suppressed, Unrealistic assumptions being made with no proper justifications, Rapid technical and technological changes.

The projections also have to reckon with a number of uncertainties. Among them are Unpredictable shifts in the rates of increase of national and per capita incomes, Emergence or disappearance of a dominant competitor, Changes in transportation costs, Trade agreements within trade blocks, Introduction of new sources of raw materials or substitutes, Changes in tariff policies, New application possibilities for the product. To reduce the uncertainties from these diverse possibilities to a minimum, statistical sensitivity analysis provides a systematic approach. This technique can be used to assess the impact on costs and revenue, when the factors influencing demand turn out to be less or more favourable to demand than was assumed. Where the sensitivity analysis has to take note of a combination of changes of different factors, computer facilities can be employed with advantage to provide a range of forecasts in the categories, pessimistic and realistic.

h) Sales Forecast and Marketing

The demand analysis gets transformed into sales forecasts. Simultaneously, decisions are taken on the modes of distribution, market promotion strategy, pricing strategy etc. Analysis of sales and sales income is thus a follow-up of market study and demand analysis. The specific sales volumes, product by product, for the periods of the operating phase has to be projected and the corresponding sales income estimated.

Volume of production and sales have a critical bearing on the production and selling costs and, therefore, these estimates have to be carefully prepared, after considering possible interruptions, delays, etc. that affects production volume.

i) Production Programme

Having arrived at the sales projections for the different stages of production in the operating phase of the project, the feasibility study should spell out the detailed production programme. The levels of output and capacity utilization during the specified periods should be clearly indicated. Within the available plant capacity, the levels of output can vary substantially, from time to time, for a variety of reasons, and prepare the materials flow diagram to show the materials and utilities balances at various stages of production. The costs on inputs have to be worked out in detail for the different categories. The production programme provides the basis on which the cash flow projections for the production periods can be drawn up.

j) Plant Capacity

For determination of costs and revenues, the assumptions on plant capacity are very critical. The UNIDO manual defines two capacity terms, as below:

Feasible Normal Capacity

This represents the capacity that is achievable under normal working conditions taking into account not only the installed equipment and technical conditions of the plant, such as normal stoppages, downtime, holidays, maintenance, tool changes, desired shift patterns and indivisibilities of major machines to be combines, but also the management system applied. Thus, the feasible normal capacity is the number of units produced during one year under the above conditions. This capacity figure should correspond to the demand figure derived from the market study.

Nominal Maximum Capacity

This is technically feasible capacity and frequently corresponds to the installed capacity as guaranteed by the supplier of the plant. To reach maximum output figure, overtime as well as excessive consumption of factory supplies, utilities, spare parts, and wear and tear, will inflate the normal level of production costs. With reference to the nature of operations, technology and also the resource and input constraints, the feasible normal plant capacity has to be determined and the production costs computed on that basis.

Matching Projected Sales and Plant Capacity

In the case of products that have rapid growth potential, the initial production capacity should be higher than the initial demand and sales so as to be able to cover subsequent demand growth. Where expansion can be taken up fast to meet the demand growth, the initial production should match the demand and creation of idle capacity should be avoided. In keeping with the feasible normal capacity selected, the input requirements of materials, manpower, services, etc. should be worked out in detail.

k) Materials and Inputs

As for the requirements of material and other inputs, detailed information has to be provided about their nature, quantities, sources of procurement, and their costs. The major items of materials have to be described, mentioning possible alternatives, and justifying the selection. Information should also be provided on their qualitative aspects and quantities available, sources of supplies, and the prevailing and projected costs.

l) Supply Programme

The procurement plan should be linked to the anticipated production and inventory levels and the annual costs of consumption determined for the classified groups of materials and inputs. The utilities required have to be assessed in detail, taking note of the location, technology, and plant capacity. Their availability and proximity of sources of supply are critical for the success of the project. Supply programmes for these should also be drawn up. The general tendency is to take utilities or off-site facilities for granted, and underestimate their significance, time frame for installation and costs. Electricity, water, steam, compressed air, fuel and effluent disposal are project components that require planned and detailed attention o avert project cost and time overruns and to avoid capacity constraints during the operating phase for want of support services.

m) Location

Specific requirements that the locations have to fulfil for smooth plant operations have to be spelt out. Alternatives locations that are likely to be suitable should be identified. The reasons for the choice of the optimal location from among considered alternatives should be substantiated.

n) Plant Site

Choice of site, in a given location, for erecting the plant involves selection from available alternatives, with due consideration for the terrain, transport facilities, water supply, power supply, manpower availability, etc. Site preparation and development, in some instances, can be a very expensive proposition and this aspect has to be assessed carefully. The cost estimates should take note of the magnitude of work involved in preparing the site for plant erection.

o) Local Conditions

A good understanding of the local conditions in terms of infra- structure and socio-economic environment is very essential and the relevant information has to be gathered for the feasibility study. Infrastructural investment is a very essential precondition for the operation of any project. The socio-economic environment is another factor that has to be considered. Waste disposal, if not properly organized, will pose an environmental hazard and it is essential that the location study determines the extent of effluents and the possible manner of disposal in the locational alternatives under consideration.

p) Layout and Physical Coverage of the Project

Just as it is important to determine the composition and cost of equipment, materials, services, land, etc., in great detail, it is also necessary to consider the requirements or structures and civil works for the considerable construction and erection work that has to be undertaken during project implantation. Such constructions/erections have to be defined and their costs estimates prepared.

Alternative project layouts should be considered and the optimal layout chosen. To highlight the scope of the project and project components, the physical layout drawings have to be drawn up.

q) Technology and Equipment

The feasibility study should also describe the technologies considered and the rationale for the ultimate choice of technology. The costs of technology in terms of investments, or lump sum payment of technology fees, or royalty or annualized payments have to be determined and detailed. Equipment have to be categorized as belonging to the production, infrastructure or other categories, the basis of their choice elaborated and their costs estimated, with appropriate details of quantities and rates.

r) Civil Engineering

Civil engineering includes the creation of manufacturing facilities required for the project. Proper blue print of the infrastructure required for the project should be created.

s) Plant Organization

Organizational planning is as important as project engineering. Effective implantation is difficult if the organizational structure is vague; there is likely to be overlap of functions and duplication of responsibilities, causing delays and interruptions in project construction. The consequences are cost and time overruns. There should be a proper grasp of the types of operations involved and the nature of services required for achieving the production objective. Production cost centers and service cost centers should be identified and defined in the organizational framework. Similarly, administration and finance cost centers should also be incorporated in the structure.

t) Overhead Costs

If the plant is organized into production, service and administrative cost centres, it should be possible to obtain realistic assessment of overhead costs. The tendency is generally, is to calculate overhead as percentage surcharge on material cost, or on direct labor cost, or on the sum of the two. This is too broad an approximation and is inadequate for a proper assessment of project feasibility. The cost items accruing in the different production, service and other cost centers should be identified, listed and the expenditure under the individual items estimated. Depreciation charges and financing cost should also be duly reckoned.

u) Labour

After deciding on the projected production capacity and the layout, process, etc. The requisite personnel at various levels of operations have to be assessed. The cost of recruitment, training, employment, and promotions have to be estimated and reckoned for working out the economics of the project. Keeping the organizational layout in view, the labour requirements in the skilled, semi-skilled and unskilled categories have to be assessed, and the availability of work-force in the required categories are examined. Depending on the number of production and service cost centers and the organization pattern of the selling and the distribution functions, the man-power inventory should be planned, and grouped into direct and indirect categories. The corresponding rates of wages and salaries and perquisites have to be worked out in detail and the direct and indirect labour costs and variable and fixed costs classifications identified and projected annually, for the project period. Training and other personnel related costs, such as provident fund contributions welfare expenditure commitments, etc., also have to be estimated, year by year, for the project period.

v) Staff

Lack of qualified and competent supervisory and managerial staff has very often been a major handicap for many a project. Advance planning and action is necessary to determine the manpower needs for supervisory and managerial positions, for the proposed organization structure and plant layout, and for requiting, inducting and training the key personnel in order to ensure smooth and efficient operations from the commencement of commercial production. While determining the manpower requirements during the production phase, the necessity to requite operators and managerial staff for certain operations and functions, well in advance, for training and familiarization with technology and related aspects even during the construction stage should not be overlooked. At the same time, the size of such workforce and stuff should be optimal, in order to avoid excessive pre-production costs.

w) Implementation Scheduling

The implementation phase commences from the time the decision to invest is taken, and extends up to commencement of commercial production. From the process plant initial concept, it proceeds through the stages of design, quotations, bid analysis orders and site contracts, scope variations work completion and start up. If these stages are not properly planned and managed, delays omissions and commissions will proliferate and cause avoidable and substantial cost and time overruns. Planning and executing project construction is no less important than planning and procuring equipment, facilities and services.

The feasibility study should spell out the project implementation programme and time schedule and describe the proposed action plans and time frames for acquisition of technology, detailed engineering of equipment, tendering, evaluation of bids and awards of contact thereof. Similarly, the arrangements for financing for project construction and the stages in which will be organized to be available for smooth flow of project work, the arrangements for phased recruitment of personnel at different levels for varying functions, for necessary and timely sanctions or approvals, clearances, etc., from the government, financial institutions or other agencies, for procurement of supplies and for marketing will have to be elaborated. Bar Charts, CPM, PERT techniques can be of immense help in effective implementation planning and management.

x) Financial evaluation

The feasibility study elaborates, as we have seen, element by element, from the project conception to the terminal stage of the project life, the status, the prospects the choices, the selection, the process, the specifications, the quantum, the price, the time schedule, the costs and the benefits. The building blocks should thus be well- defined and established. Unfortunately, this is where we seem to grossly underestimate the role of the techno-economic feasibility study and its comprehensiveness and credibility for the successful implementation and subsequent functioning of the project. Experimentation with pyrites and coal as feed stock for fertilizers after confirming, in the Detailed Project Report and the Techno-economic Feasibility Report, that they have been found suitable, has cost the nation dearly in terms of costs.

Conceding that the estimates and projections have been well and adequately prepared, the final acts in the feasibly study are the financial and economic valuations of the project. The inter-relationship between the estimated capital costs, the estimated annual revenues have to be analyzed to see whether the project is likely to pay its keep and leave a reasonable surplus for further growth. The discounted cash flow analysis and the sensitivity analysis are very useful tools to be applied at this stage of evaluation of financial and economic aspects of the project.

y) Economic Evaluation

In the case of the projects, it is particularly necessary to evaluate the contribution of the projects to the national economy. Rising of aggregate consumption could be one of the basic objectives in the project evaluation. Redistribution of income could be another. These different objectives will have to be weighted and combined to establish the net contribution of the project to the national economy.

Detailed Project Report (DPR)

Detailed Project Report is one which contains the complete details of the project and it is required to be submitted to banks and financial institutions for obtaining the financial assistance. Usually, all the con-tents of techno-economic feasibility studies will be covered in the DPR.

Detailed project report is a complete document for investment decision-making, approval. Detailed project report is base document for planning the project and implementing the project. Preparation of detailed project report is a step in firming up the proposal. When an investment propos-al has been approved on the basis of functional report and the proposal is a major proposal, it would be necessary for detailed project report to firm up the proposal for the capital cost as well as the various facilities. It includes:

- Examination of technological parameters.
- Description of the technology to be used.
- Broad technical specification.
- Evaluation of the existing resources.
- Schedule plan.
- General layout.
- Volume of work.

Feasibility-cum Detailed Project Report (FDPR)

The interested promoter should submit a Feasibility-cum-Detailed Project Report (FDPR) covering following aspects for getting financial assistance from banks and financial institutions:

1. Availability of raw materials and tie up (MOU document)/ willingness certification
2. A vailability of land and tie up (Lease document)/ willingness certification

3. Organization type and structure like (Entrepreneur/ Proprietary, Private limited, Entrepreneur/ Public limited, Co-operative, NGO etc.
4. Brief project description
5. Tie up with technology, equipment suppliers
6. Financial analysis and profitability study.
7. Incentives, concessions expected from other Government and public bodies for demonstration and future multiplications.
8. Initial contribution in terms of finance, technology development, technical and equipment tie up by the promoter and user agency (mention separately).
9. Organizations to operate and maintain the demonstration project.
10. Organization to replicate the project in a specific region or throughout India.
11. Fulfillment of statutory requirements (like PCB clearance, environmental clearance/ safety, etc.

The Detailed Project Report (DPR) is an essential building block for the projects and enabling sustainable quality service delivery. The DPR is to be prepared carefully and with sufficient details to ensure appraisal, approval, and subsequent project implementation in a timely and efficient manner. This document provides a reference format for preparing DPRs/ Project Reports across sectors.

4.2 DIFFERENT FORMS OF PROJECT CONTRACTING

A contract is an exchange of promises between two or more parties to do, or refrain from doing an act, which resulting contract is enforceable in a court of law. In the project or program context, contracts typically involve the exchange of money in return for goods or services.

Types of Contracts.

There are three basic types of contracts.

1. Fixed Price or Lump sum Contracts
2. Cost reimbursable contracts
3. Time and materials Contracts

1. Fixed Price Contracts:

This contract is also known as Lump sum contracts. The seller and the buyer agree on a fixed price for the project. The seller is bound to accept high risk in this type of contracts. The buyer is in least risk category as the price is already fixed and there is an agreement on the same from seller side as well. There must be fully detailed specifications, checklists, project scope statements from the seller side which buyer will use. Sometimes it seems that a seller try to cut the scope to deliver the projects on time and within budget. And this is a threat really for the buyer. If the project is finished on time with the desired quality, project is overfor that contract. However, if the project is delayed and there are cost overruns, then the seller will absorb all that extra costs. Fixed price contracts are typically used in government based projects. Advantages of fixed price contracts include throwing all the risk on the seller, disadvantages is that the seller starts cutting scope in order to finish on time and on budget.

Below are few kinds of fixed contracts:

- **Fixed Price Incentive Fee (FPIF)** – In this type of contract, the fee is fixed for the products or services. No incentives are given while cost overruns are borne by the seller. Seller is at the highest risk here. Scope of work has to be very clearly defined for such type of contracts. One of the example for this type of contract can be –a purchase order for delivering an off the shelf product for a specified price by a specific date.
- **Fixed Price Award Fee (FPAF)** – In such contracts, incentives are given to the seller in case the pre defined performance targets are met or exceeded. The performance targets &financial incentives are decided before the start of the work. In order to safeguard seller's interest, price ceiling is also decided. Any cost above the ceiling is borne by the seller. These contracts motivate sellers to try and get the incentives by way of over performing. One of the example for this type of contract can be- the seller will be given additional 5% of the total price if the required product is delivered 2 weeks earlier than the specified scheduled date.
- **Fixed Price Economic Price Adjustment (FPEPA)** –These types of contracts are usually signed where the project duration is spanning over the years. This safeguards the interest of both buyer & seller against any external conditions beyond the control.e.g.inflation rate, currency exchange rate fluctuation in case of outsourced projects.

2. Cost Reimbursable Contracts:

In these type of contracts, the seller will work for a fixed time period and after finishing the work he will raise the bill and the buyer will pay the amount after this. This is almost negative for a buyer. A seller can raise the unlimited or unknown amount which the buyer has to pay. Seller is advantageous in this type of contract and buyer is not. That's why it is rarely used in the real world. A buyer never wants to go for the same unless the situation demands.

Below are few kinds of cost reimbursable contracts:

- ***Cost Plus Fee (CPF) or Cost Plus Percentage of Costs (CPPC)*** *– The seller will get the total cost they incurred on the projects plus they will get a percentage of fee over cost. Always beneficial for seller.*
- ***Cost Plus Fixed Fee (CPFF)*** *– A fixed amount (for seller) will be there before starting of the work plus they will get the cost incurred on the projects.*
- ***Cost Plus Incentive Fee (CPIF)*** *– A performance based extra amount will be paid to the seller plus actual cost they have incurred on the projects.*
- ***Cost Plus Award Fee (CPAF)*** *– The seller will get a bonus amount plus the actual cost incurred on the projects. Very similar to previous one!*

3. Time and Material Contracts or Unit Price Contracts:

These type of contracts are mix of cost-reimbursable and fixed price contracts. Generally, the project durations are longer, scope of work is not clear known at the start. It resembles cost-reimbursable in a way because the actual cost is not known in advance and resembles fixed price in the sense that unit rate for the labor and /or material is agreed upon at the start of the work.

Unit price contracts are what we call an hourly rate. For example, if seller spends 1,200 hours on a project, and his or her charges are Rs.100 an hour, the seller will be paid for Rs.1,20,000 by the buyer. This type of contracts is typical in freelance work. The main advantage of this type of contract is that the seller will make money for every hour he spends on the project.

Now, the bottom-line is as a project manager you should obviously know which contract you will select for your seller so that you can manage them effectively and accurately within budget. As a project manager you should know the different types of contracts and their inner meaning. You can't tell that it is not your responsibility and accountability.

4.3 THE ROLE OF CONSULTANTS IN PROJECT MANAGEMENT

There is no specific definition of project consultant. Most definitions described management consultant by their roles and responsibility and services that they provide using tools and skills they have in delivering a task assigned by the client or the owner of the project. There is some confusion with the terms to describe the word consultant. Some of the contractors do some consulting, and some of the consultant also acts as contractors. This happens because the roles and responsibilities of consultants is very wide and depends on their skills and experiences. Consultation is happening if the clients seek expert knowledge or some opinions on some engineering problems or anything that involves engineering matters. Consultation maybe brief or extended which some involve only few hours of time, with the clients sitting across the desk of the consultant. Other consultation may require traveling, some period a substantial portion of a consultant's time over a period of several months, and repeated presentations and discussions with the client .

The "Institution of Project Management-Malaysian Chapters" has simplified six roles and responsibilities of Project Consultant, which are:

- Handling the project by analyzing the goal and works that will be done
- Handling all the people involve with the project
- Ensure that all the information is enough to make the project flow consistent by handling the connection with all the parties that involve with the project.
- Deal with the time according to plan.
- Survey the quality to ensure the work is satisfying
- Manage the cost of the project, hence the project will be done at the minimum cost which is according to the amount of money that been provided by the clients.

Project Management Consultancy (PMC) that been selected is basically to produce a product by considering the technical specification, cost and timetable by using the existing organization sources. PMC also responsible in making decision to ensure all the objectives of the project has been reached.

4.4 CASESTUDY

Chennai is the 4th largest metropolitan city in India. Chennai, often known as the Detroit of Asia, is widely known for its presence in the automotive industry and has attracted several global automakers to set up their factories in the city becoming one of the global leaders in the industry.

Apart from automobiles, it also has development centers set up by many software companies which contributed 14% of India's total software exports of 144,214 crore (US$28.77 billion) during 2006-07, making it the second-largest exporter of software in the country, behind Bangalore. Based on all these industrial and technological advancements, urban population has risen rapidly, requiring need for faster and safer transportation at all times. The city already has multiple modes of transportation. A bus system is run by the Chennai MTC and is augmented by the Chennai suburban railway network run by the Southern Railway. In addition to this, the Southern Railway has also implemented the Chennai MRTS project; an elevated railway system was sanctioned in 1984 to ease congestion in central Chennai. However, traffic congestion was still a big problem for both the citizens as well as the City's governing body. Hence, the Chennai Corporation has decided to implement the Chennai Metro project which will be another alternate transportation mode to a metropolis like Chennai.

Corridor 1 is intended to cover the Anna Salai stretch and corridor 2 is intended to cover Poonamalle High Road and Inner ring road. Both the corridors have underground and over ground structures.

If you are in the project planning and coordination department, list at least four functional areas which require close attention. What are the challenges (state briefly) in each these areas and how you propose to address through planning?

4.5 NOTES

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4.6 SUMMARY

Feasibility study is an analysis of the viability of an idea. It ensures that a project is legally and technically feasible and economically justifiable.

A feasibility study evaluates the project's potential for success; therefore, perceived objectivity is an important factor in the credibility of the study for potential investors and lending institutions

Five different areas of Project Feasibility

- Technical Feasibility
- Economical Feasibility
- Legally Feasibility
- Scheduling Feasibility

The various stages in the project feasibility studies include

- Opportunity studies
- Pre-feasibility studies
- Techno-economic feasibility studies

♦ Detailed Project Report is one which contains the complete details of the project and it is required to be submitted to banks and financial institutions for obtaining the financial assistance.

♦ A contract is an exchange of promises between two or more parties to do, or refrain from doing an act, which resulting contract is enforceable in a court of law. In the project or program context, contracts typically involve the exchange of money in return for goods or services.

There are three basic types of contracts.

1. Fixed Price or Lump sum Contracts
2. Cost reimbursable contracts
3. Time and materials Contracts

♦ Most definitions described management consultant by their roles and responsibility and services that they provide using tools and skills they have in delivering a task assigned by the client or the owner of the project.

♦ Project Management Consultancy (PMC) that been selected is basically to produce a product by considering the technical specification, cost and timetable by using the existing organization sources. PMC also responsible in making decision to ensure all the objectives of the project has been reached.

4.7 KEYWORDS

Project Feasibility

Detailed Project Report (DPR)

Project Contracts

Project Management Consultancy

4.8 SELF ASSESSMENT QUESTIONS

1) What are opportunity studies? Explain.
2) What are the various types of opportunity studies?
3) What are the various types of information for which the pre-feasibility studies are undertaken?
4) List and explain the components of techno-economic feasibility studies.
5) What is DPR? How does it differ from feasibility report?

4.9 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.
2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.
3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.
4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.
5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill.
6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011
7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002
8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012
9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.
10. Sanjiv Marwah. *Project Management.* New Delhi: Dreamtech Press, 2011.

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DEPARTMENT OF STUDIES AND RESEARCH IN MANAGEMENT

M.B.A III Semester

COURSE - 15: PROJECT MANAGEMENT

BLOCK

2

PROJECT PLANNING & PROJECT IDENTIFICATION

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BLOCK - 2 : PROJECT PLANNING AND PRAJECT IDENTIFICATION

Project idea generation and identification are the stepping stone for successful project management. Thus, a manager needs to take due care while identifiying a project. This block deals with project planning and project identification. This block is divided into four units.

Unit-5 is concerned with basic issues of project planning and project identification. At the outset this unit discusses project identification, types of opportunities available, then it stresses on the importance of project identification. Further, the unit continues to explain sources of project ideas. This unit also explains critirea for selection of a particular project.

Unit-6 deals with feasibility study/ report. All generated business ideas may not be practically viable. Thus, it import to conduct project feasibility report. This unit discusses types of feasibility and steps in feasbility study. Then it provides format of feasibility report, planning commission guide lines on project feasibility, further the unit provides checklist for feasibility report and explains project formulation.

Unit-7 is concerned with project risk management. Risk is part of all business no plan can completely eliminate risk . Projects also exposed to various risks. Thus, a proper risk management tools can minimize a projects risk for a greater extent. At the outset, this unit defines the risk and discuss objectives of risk management.Then, the unit explains various types of risk further this unit also explains steps in risk mangement process and applications of risk management in project management. Also the unit shed, light upon enterprise risk management.

UNIT-8 deals with project estimation. Proper finance management is another important source of value creation to an organization . Thus proper cost estimation can avoid exces or shortage of funds for projects. The unit begins with the meaning of project cost estimation importance of project cost estimation. Then the unit explains project cost estimation , types of cost estimation . Further the unit discusses contingency in capacity cost estimation, operation and maintenance cost. The unit also explains cost estimation process and techniques for developing cost estimates.

UNIT-5 : BASICS OF PROJECT PLANNING AND PROJECT IDENTIFICATION

Structure:

5.0 OBJECTIVES

After reading this unit, you should be able to:

- define project and project identification.
- explain the importance of Project Identification.
- identify project opportunities.
- discuss the various sources of Project Ideas.
- explain the criteria for selecting a particular project.

5.1 INTRODUCTION

An individual with motivation to start his own enterprise should have clear idea about different facets of his enterprise. First he should get a business idea, develop it, plan it and put that into practice.

You know that opportunity always exists in the environment. Hence, the given environment is analyzed by the Entrepreneur for sensing the opportunity available. Having sensed the entrepreneurial opportunities, the next step involved in enterprise creation or establishment is to properly identify the opportunities available in the given environment and, then, select the best one from amongst the available to be pursued as an Enterprise. But a simple question arises is: why is it necessary to identify and select an Opportunity? The simplest way to answer this question is to appreciate the need for Opportunity /project identification and justification. We will understand all that in this unit.

5.2 MEANING OF PROJECT AND PROJECT IDENTIFICATION

Let us first understand the meaning of project and project identification.

5.2.1 Meaning of Project

Dictionary meaning of a project is that it is a scheme, a design, a proposal of something intended or devised.

The directory of management regards it as an investment project carried out according to a plan in order to achieve a definite objective within a certain time and which will cease when the objective is achieved.

According to encyclopedia of management, project is an organized unit dedicated to the attainment of a goal, the successful completion of a development project on time, within budget, in conformance with predetermined programme specifications.

Gillinger defines project "as the whole complex of activities involved in using resources to gain benefits".

Thus, a project may be defined as a scientifically evolved work plan devised to achieve a specific objective within a specified period of time. The objective may be to create, expand and/or develop certain facilities in order to increase the production of goods and / or services in the community.

The projects may differ in their size, nature, objectives, time duration and complexity. But they partake of the following three basic attributes:

(i) A course of action,

(ii) Specific objectives, and

(iii) A definite time perspective.

5.2.2 Meaning of Project Identification

Project identification is concerned with collection, compilation and analysis of economic data for the eventual purpose of locating possible opportunities for investment and with the development of the characteristics of such opportunities.

Let us understand briefly about the types of opportunities and characteristics of such opportunities.

5.3 TYPES OF OPPORTUNITIES

According to Peter Drucker, opportunities are three types:

- **Additive Opportunities:** These opportunities enable the decision-maker to better utilize the existing resources without changing the characteristics of existing business. The element of risk would be less in additive opportunities when compared to the remaining two opportunities. It is because the additive opportunities involve the least amount of disturbance to the existing state of affairs of business.
- **Complementary Opportunities:** They involve introduction of new ideas and as such require certain amount of change in the existing structure. The element of risk is more here.
- **Break-through Opportunities:** These opportunities involve fundamental charge in both the structure and character of business. The element of risk is more here also.

5.4 PROJECT CHARACTERISTICS

Every project will have 3 features: Inputs, outputs, and social costs and benefits.

Input Characteristics will specify what the project will require in terms of raw materials, energy, manpower, finance and organizational setup. The nature and magnitude of these inputs should be clearly determined.

Output characteristics will define what the project will generate in the form of goods and services, employment, revenue, etc.

Social costs and benefits: It is necessary to assess the sacrifice the society is required to make and the benefits that will accrue to the society from the given project. It is to be ensured that benefits should be more than the costs.

5.5 IMPORTANCE OF PROJECT IDENTIFICATION

Project identification is the first step of new venture. Identification of suitable project is a very crucial decision to be taken by an entrepreneur. The success of a venture greatly depends upon the selection of the right type of opportunity. If an entrepreneur does not properly identify the project, he has to undergo a number of hurdles on his way. There are no set of rules and regulations for identification of the project. The entrepreneur has an infinitely wide choice with respect to his project. The important dimensions of choice are product or service, market technology, equipment, scale of production, location, incentives and time phasing. The task of identifying a feasible and promising project is difficult. So it is observed that most of the prospective entrepreneurs follow the herd mentality in identification and selection of a project.

Entrepreneur and enterprise go hand in hand. In a sense, the entrepreneur gets married with enterprise. Just as the success of marriage depends On the compatibility, or say, suitability of the partners-husband and wife, in the same way, the success of business enterprise also depends on the suitability of entrepreneur and enterprise. If one is suitable but other not or both are not suitable, the marriage is doomed to failure. Basically, the most of the enterprises fail due to non-suitability of either entrepreneur or enterprise or both. The same underlines the need for and significance of identifying and selecting a suitable business opportunity or enterprise.

The dynamics of suitability and / or non-suitability between the entrepreneur and enterprise can be better explained and understood by the following diagram:

Entrepreneur Not suitable	Failure 2	Failure 3
Entrepreneur Suitable	Success 1	Failure 4
	Suitable	Not suitable
	Enterprise	

The above four combinations can be interpreted as follows

Dynamics of combinations

1. Both entrepreneur and enterprise are **good (The result)**
2. Entrepreneur is not good but enterprise selection is good. **Failure (The result)**
3. Both entrepreneur and enterprise not good **Immediate failure (The result)**
4. Entrepreneur is good but enterprise selection is not goo **Failure (The result)**

5.7 OPPORTUNITY/PROJECT IDENTIFICATION

After going through the above process, one might have been able to generate some ideas that can be considered to be pursued as ones business enterprise. Imagine that someone have generated the five ideas as opportunities as a result of above analysis.

1. Nut and bolt manufacturing (industry)
2. Shoes manufacturing (industry)
3. Photocopying unit (service-based industry)
4. Computer Maintenance service (service-based industry)
5. Polythene bags for textiles industry (ancillary industry)

An entrepreneur cannot start all the five types of enterprises due to constraints of capital, capacity, and other resources. Hence, he/she needs to finally select one idea which he/she thinks the most suitable to be pursued as an enterprise. How does the entrepreneur select the most suitable project out of the alternatives available? This is done through a selection process discussed subsequently.

Having gone through idea generation, also expressed as 'opportunity scanning' and opportunity identification, we can distinguish between an idea and opportunity. We are giving below the two situations that will help you understand and draw the line of difference between an 'idea' and an 'opportunity'.

SITUATION-1	SITUATION-2
Having completed their master of business administration (MBA), Mrinmoy and Chandan met after about six months. The two were conversing with each other about who is doing what. Mrinmoy is running his business of travel agency and chandan is still searching for a job. mrinmoy suggests Chandan to start some business. Observe and read the market scenario and produce what the consumers actually want.	On completion of his engineering degree, Tridip got a job in Assam State Transport Corporation. He was in-charge of the purchase department for over ten years, he had gained good idea about which components have more demand and who are the buyers of these parts in bulk. He, therefore, thought good prospects of manufacturing some of the components having good demand in bulk.

Now, it is clear that, in the above mentioned two satiations, situation-1 is at the 'idea stage' and situation-2 at the 'opportunity stage'. At the idea stage, there is simply an idea about what to do. But at the opportunity stage, idea has actually been germinated about what to start/do. The understanding of such a difference between an 'idea' and 'opportunity' is very important for the intending entrepreneurs who are seriously trying to identify an 'opportunity' to be pursued as an enterprise.

5.8 SCANNING BUSINESS ENVIRONMENT

Opportunity or project selection starts from where project identification ends. After having generated and identified some project ideas, these are analyzed in the light of existing economic conditions, the government policy and so on. A tool generally used for this purpose is, what is called in the managerial jargon, SWOT analysis. The intending entrepreneur analyses his/her strengths and weaknesses as well as opportunities/competitive advantage and threats/challenges offered by each of the project ideas. On the basis of this analysis, the most suitable idea is finally selected to convert it into an enterprise. The process involved in selecting a project out of some projects is also described as the ''zeroing in process''.

What follows from the above analysis is that there is a time interval involved in between project identification and project selection. But exceptions are always there. In some cases, there may be almost no gap between project identification and project selection. The following anecdotes as illustrative ones, exemplify it.

In SWOT analysis, while S (strengths) and W (Weaknesses) relate to the entrepreneur concern, O (Opportunities) and T (Threats) relate to environment. The former is internal and latter is external to entrepreneur. Following is an illustration of SWOT of a business opportunity or project, namely Floriculture':

Entrepreneur (Internal)		Environment (external)	
Strengths	weaknesses	Opportunities	Threats
Possesses the required knowledge, skills, competencies, and financial resources.	Suffers from lack of motivation, laziness, inactiveness, poor in marketing knowledge, etc.	Changing requirements of the society, more demand at a particular time, etc.	Change in the government policies, increasing demand for substitutes, weather conditions, etc.

5.9 TYPES OF BUSINESS ENVIRONMENT

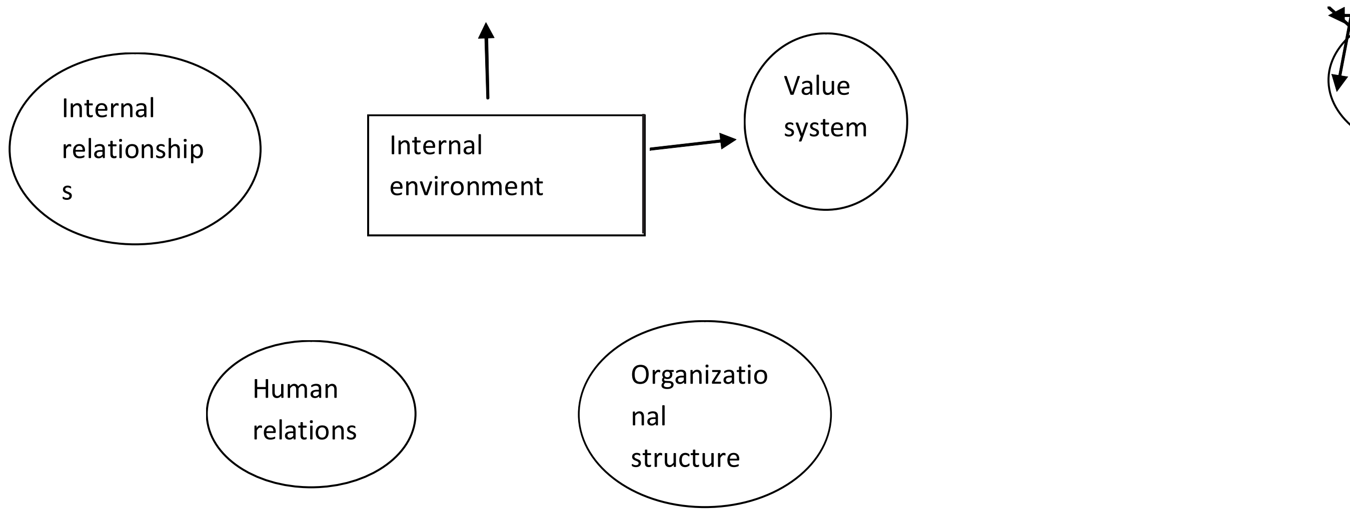
The business environment is broadly divided into:

1. Internal environment.
2. External environment.

Internal environment

Internal environment refers to all factors which are within the organization. In other words internal environment consists of the factors which are within the control of organization. These include organization's mission and vision, value system, organizational structure, human resource, and internal relationship. The internal factors of environment impart strengths and or cause weakness of strategic nature for the organization. The major components of internal environment are shown in the figure 5.1.

Fig-5.1: components of internal environment



External environment

External environment also called general environment consists of all those factors which are outside the organization and, hence, are beyond the control of organization. These factors provide opportunities and or pose threats to an organization. The same underlines the need for and significance of understanding and analyzing of external environment to run business successfully. External environment of business encompasses verity of factors. Researchers have identified and ranked the following a factors of external environment based to the magnitude of their impact on a business organization;

1. Market
2. Suppliers
3. Technological
4. Economic
5. Regulatory
6. Political
7. Socio-cultural
8. Global

Let us understand briefly about different kinds of environment which help in project identification.

1. Economic Environment: economic environment consists of economic factors that influence the business in a country. These factors include gross national product, corporate profits, inflation rate, employment, balance of payments, interest rates, consumer income etc...

2. Social Environment: it describes the characteristics of the society in which the organization exists and operates. Literacy rates, customs, value, beliefs, lifestyles, demographic features and mobility of population from the social environment of a business. It is important for entrepreneurs to notice the direction in which the society is moving and formulate progressive business policies according to the changing social scenario.

3. Political Environment: it comprises the political stability and the policies of the government. Ideological inclination of political parties, personal interests of politicians, influences of the party forums etc... On business create political environment. For example : Bangalore established itself as the most important IT centre known as ‘ info city ‘ of India mainly because of the political will and support. Just opposite is the case of west Bengal where political will and support were against the ‘Nano car ’.

4. Legal Environment: this consists of legislation that is passed by the parliament and state legislatures relating to business enterprise. Examples of such legislation specifically aimed at business operations include the Trade MARK ACT 1969, Essential commodities Act 1955, Standards of weights and measures Act 1969, and consumer protection Act 1986.

5. Technological Environment: it includes the level of technology available in a country. It also indicates the pace of research and development and progress made in introducing modern technology in production. Technology provides capital - intensive but cost - effective alternatives to traditional labour – intensive methods. In a competitive business environment, technology serves as competitive advantage and is considered as the key to industrial and economic development of a country. Hence, increasing emphasis has been given to research and development in every country.

Out of above five types of business environments, economic environment affects the business the most. Hence, it seems pertinent to discuss economic environment in India in some more depth and detail.

5.10 CRITERIA FOR SELECTING A PARTICULAR PROJECT

An entrepreneur can decide to sell a completely new product or modify the existing product and sell, or, sell a product which is existing in the market i.e., which is sold by another company.

The decision as to what to sell, how to sell and to who to sell the product depends upon several factors. They can be broadly classified as internal factors and external factors.

1. Internal factors

The factors within the organisation are called as internal factors. The selection of a product, to a great extent depends upon the internal factors. They are:

a) **Cost:** If the entrepreneur is thinking of a completely new product, the cost will be very high, as it includes cost of research and product development other than, initial investment on new machinery, training to employees and on raw materials. If it is just modification of any existing product, then the cost will be lesser and if the entrepreneur is planning to sell any existing product, the capacity to spend, the type of product can be determined.

Also, if an entrepreneur starts a new firm, the start-up costs will be quite high but if the entrepreneur is purchasing an existing business, these costs may be reduced considerably.

b) **Experience:** cost advantages are enjoyed by those who were first into the business or who have experience in the technology required. The first companies into biotechnology, such as Genentech established early leads in scientific knowledge, attracted important researchers, and stayed well ahead of new entrants.

Companies already experienced in electronics and the technology of business machinery, such as IBM, Hewlett-Packard, NCR and Xerox found it easier to enter the computer industry than others without similar experience.

c) **Differentiation:** The extent to which an enterprise can establish a brand image, service, product innovation or reputation describes its differentiation or distinct competency. An entrepreneur should select a product which is different from the competitor, and this difference need not be real / actual difference, but, it can just be psychological. For e. g., kinetic differentiates itself from all other scooters. Also, Mercedes-Benz has a distinct image and a small but secure market.

d) **Financial strength:** If an entrepreneur selects a luxury product /speciality product like cars, vehicles, jewellery, etc., then very high initial investment is required, which calls for finance from other sources like financial institutions, Shares, loans, etc.

If the product is semi-luxury or shopping goods like T.V., V.C.R., washing machine, etc., then investment is comparatively lesser. But if the product is a convenience good or perishables like cereals, vegetables, clothes etc, then very less investment is required. Hence, depending upon the financial strength (one's own or borrowings) the type of product can be selected.

e) **Functional departments:** All the departments in an enterprise have an impact on the entrepreneur's plans and actions. The finance department is concerned with the availability of funds, Research and Development department focuses on innovation, purchasing department has to obtain sufficient supplies of raw materials the manufacturing department is responsible for acquiring sufficient productive capacity to meet the production target. Therefore, to make a decision on selection of a product, the entrepreneur has to consult and get support of all the departmental heads.

f) **Personal factors of an entrepreneur:** The nature of an entrepreneur is also a deciding criterion for product. If he is self-confident, optimistic, able to take risk, responds positively to challenges, flexible, versatile, creative, dynamic, resourceful, perceptive with foresight and has knowledge of market, he can take up a completely new product. Otherwise, it is better to take up an already existing product.

2) External factors

The forces outside the organisation also affect the decision for selecting a product by an entrepreneur. They are:

a) **Demand of consumers:** Successful entrepreneurs are those that can recognize and respond profitably to unmet needs and trends of the consumers. Unmet needs always exist. Entrepreneurs can make a fortune if they could solve any of the problems like medicines for cancer or mental diseases, non-fattening tasty nutritious food, voice – controlled computers, etc.

Product can be selected by identifying the need or trends. A new product is likely to be more successful if it is in line with strong need of the consumer.

b) **Competition:** An enterprise is surrounded and affected by a host of competitors. These competitors have to be identified and monitored to capture and maintain customer loyalty. The strength of the competitors, and the number and type of competitors, are affected by the type of market structure within which the entrepreneur will operate. There are four basic type of market structure. They are: (i) Pure competition, ii) Monopolistic competition, iii) Oligopoly, IV) Pure monopoly

An entrepreneur with innovative ideas and good research and development facilities can invent something new and remain a monopolist by capturing the entire market.

The important characteristics of four types of market structure can be summarized as follows:

If an entrepreneur is selecting special – use products, such as medicinal equipment, he will have few direct or indirect substitute to consider. If it is commodity goods, such as soft drinks, he must consider many direct substitutes but few indirect ones because the consumer rarely makes a rational choice among dissimilar expenditures. If an entrepreneur is selecting higher- priced durable goods, such as furniture VCRs, he will have tremendous competition from direct and indirect substitutes

c) Suppliers are individuals or business firms who provide resources needed by the company and its competitors to produce goods and services. Supply shortages, labour strikes and other event can prevent fulfilling delivery promises and damage customer goodwill. In the long run, entrepreneurs, therefore, keeping the internal resources in mind, need to check up on the availability of raw materials for possible products that he wants to produce.

d) **Geographical distribution:** people living in different parts of world have different demand. Moreover in a country demand of different states vary, also, the demand of rural areas is different from urban area.

e) **Occupation:** occupation is also a criterion for selection of a product. Hence an entrepreneur should consider the distribution of people who are working and non- working population. People of a high position or status prefer, costly furniture's, garden, air conditions, cars, etc.

f) **Economic condition:** an entrepreneur requires people as well as purchasing power. The purchasing power is an economy depends on current income, prices, savings, and debt and credit availability. Entrepreneur should take into consideration trends in income and consumer – spending patterns. High economic growth assures higher level of employment and income and hence people will be ready to purchase expensive goods like cars, real estate, etc. low economic growth or currency devaluation leads to lesser spending, and hence, people will go in for products that are not very expensive or goods sold on instalments.

g) **Natural environment**: natural environment consist of raw materials, energy, population and government intervention in resources management. An entrepreneur should use the available resources carefully and conserve the scares resources. An entrepreneur, before selecting a product, should take into consideration the availability of resources and energy, whether it is free from population and, if any government restrictions are applicable on the selected resources. Now-a- day's government is interfering in proper disposal of chemicals and nuclear waste, littering problem, non- biodegradable bottles, plastic and other packaging materials which cause public apathy. Entrepreneurs, therefore, needs to pay attention to the natural environment.

h) **Political and legal rule:** political and legal rules are different in every country. Business is influenced by loss, government agencies, and pressure groups have the limit various activities of an organisation. Change in the government leadership itself can bring about various changes to an enterprise.

An entrepreneur should be aware of various laws protecting consumers, competition , societies interest , etc. an entrepreneur should not only produce goods products , but also show relevant advertisement , good package , reasonable price and required services.

For a selection of a product the legal systems related to taxation, licensing, bank lending, hiring practices, safety regulations, etc should be considered. For e.g. National traffic and safety act, provides for the creation of compulsory safety standards for automobiles and tires. Toy safety Act, gives the government power to recall dangerous toys quickly when they are found, etc.

Socio – cultural factors – it comprises the entrepreneur's relationship to society and society's cultures. It refers to the sum total of cognitive elements.

5.11 NOTES

5.12 SUMMARY

An individual with motivation to start his own enterprise should have clear idea about different facets of his enterprise. First he should get a business idea, develop it, plan it and put that into practice.

You know that opportunity always exists in the environment. Hence, the given environment is analyzed by the Entrepreneur for sensing the opportunity available. Having sensed the entrepreneurial opportunities, the next step involved in enterprise creation or establishment is to properly identify the opportunities available in the given environment and, then, select the best one from amongst the available to be pursued as an Enterprise.

Project identification is concerned with collection, compilation and analysis of economic data for the eventual purpose of locating possible opportunities for investment and with the development of the characteristics of such opportunities.

According to Peter Drucker, opportunities are three types:

- **Additive Opportunities:** These opportunities enable the decision-maker to better utilize the existing resources without changing the characteristics of existing business. The element of risk would be less in additive opportunities when compared to the remaining two opportunities.
- **Complementary Opportunities:** They involve introduction of new ideas and as such require certain amount of change in the existing structure. The element of risk is more here.
- **Break-through Opportunities:** These opportunities involve fundamental charge in both the structure and character of business. The element of risk is more here also.

Project identification is the first step in new venture creation. Identification of suitable project is a very crucial decision to be taken by an entrepreneur. The success of a venture greatly depends upon the selection of the right type of opportunity. If an entrepreneur does not properly identify the project, he has to undergo a number of hurdles on his way.

In a sense, opportunity identification and selection are akin to what is termed in marketing terminology, 'new product development'. Thus project opportunity identification and selection process starts with the generation of ideas, or say, ideas about some opportunities or products are generated in the first instance. The ideas about opportunities or product that the entrepreneur can consider for selecting the most promising one to be pursued by him/her as an enterprise, can be generated or discovered from various sources-both internal and external.

Opportunity or project selection starts from where project identification ends. After having generated and identified some project ideas, these are analysed in the light of existing economic conditions, the government policy and so on.

Criteria for selecting a particular project depend upon several factors. They can be broadly classified as internal factors and external factors.

Internal factors: The factors within the organization are called as internal factors. The selection of a product, to a great extent depends upon the internal factors.

External factors: The forces outside the organization also affect the decision for selecting a product by an entrepreneur.

5.13 KEY WORDS

Project: A whole complex of activities involved in using resources to gain benefits.

Project identification: It is concerned with collection, compilation and analysis of economic data for the eventual purpose of locating possible opportunities for investment and with the development of the characteristics of such opportunities.

5.14 SELF ASSESSMENT QUESTIONS

1. What is Project Identification? Explain its importance.
2. Write a brief note about the sources of project ideas.
3. Explain the Criteria for selecting a particular project.

5.15 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.
2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.
3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.
4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.
5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill

6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011
7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002
8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012
9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.
10. Sanjiv Marwah. *Project Management.* New Delhi: Dreamtech Press, 2011.

UNIT - 6 : FEASIBILITY STUDY / REPORT

Structure :

6.0 Objectives

6.1 Introduction

6.2 Pre-feasibility study

6.3 Types of feasibility

6.4 Steps in feasibility study

6.5 Feasibility Report

6.6 General Format of Feasibility Report

6.7 Planning Commission Guidelines

6.8 Checklist for Feasibility Report

6.9 Project formulation

6.10 Note

6.11 Summary

6.12 Self assessment questions

6.13 References

6.0 OBJECTIVES

After reading this unit, you should be able to:

- define feasibility study.
- explain the types of feasibility study.
- explain the steps in feasibility study.
- define feasibility report.
- define project formulation and explain its importance.

6.1 INTRODUCTION

A feasibility study is an analysis of the viability of an idea concerning a product or a service. The main objective of the feasibility study is to decide whether the organization should proceed with the project idea. Early identification of the fact that a project idea will not work, saves time, money and avoids backtracking of the project at a later stage.

A feasible project is one where the business will generate adequate cash-flow and profits, withstand the risks that it will encounter, remain viable in the long-term and meet the goals of the stakeholders. The project venture can be a new start-up business, the purchase of an existing business, an expansion of current business operations or a new enterprise for an existing business.

A Feasibility study is only one step in the business idea assessment and business development process. It has been estimated that only one idea out of fifty, is commercially viable.

The following are the reasons to do feasibility study.

- ♦ It gives focus to the project and outlines alternatives
- ♦ It narrows down business alternatives
- ♦ It surfaces new opportunities through the investigative process
- ♦ It identifies reasons not to proceed with the project in the event of non-profit from the project
- ♦ It enhances the probability of success by addressing and mitigating early the factors that could affect the project
- ♦ It provides quality information.

- It helps to increase investment in the company.
- It provides documentation that the business venture was thoroughly investigated.
- It helps in securing funding from lending institutions and other sources

Though conducting the feasibility study is mandatory, in some projects it may not be done because of the following reasons:

- We know that it is feasible, because it is an existing business and it is already feasible.
- Why do another feasibility study when one was done just few years ago?
- Feasibility studies are just a way for consultants to make money.
- The feasibility study has already been done by the business that is going to sell us the equipment.
- Why not just hire a general manger who can do the study?
- We feel that the feasibility study is a waste of time.

Though the above reasons seem to be justifying from the viewpoint of project leaders who are very busy and have certain risk-taking capacity, all the time it may not work out in their favour. So, a proper feasibility study is to be conducted for any project.

6.2 PRE-FEASIBILITY STUDY

Before conducting feasibility study, a pre-feasibility study is being conducted mainly to collect and analyse certain key data.

The pre-feasibility study includes the following.

- Preliminary recompilation of data as shown below.
  - General geography of the region.
  - Climate (temperature, wind, rain, evaporation).
  - General socio-economic conditions of the population.
  - Preliminary estimate of demand.
  - Existing products and their market shares.
  - Availability of the land to construct the project.
  - Availability of energy and energy cost.

- Proposing the potential limits of the project (physical limits and design horizon in time).
- Identifying potential alternatives for the project idea.
- Proposing different technology which can be deployed in the project firm.
- Performing a preliminary estimate of the project cost.
- Identifying lacking information which will be necessary for the feasibility study.
- Identification of potential financial sources for the project.
- Identification of general characteristics of the customers in the region of interest for project firm.
- Preparing a report on the pre-feasibility study. This will act as input for the feasibility study.

6.3 TYPES OF FEASIBILITY

The feasibility study includes the following types of feasibility analysis.

- Technical feasibility
- Managerial feasibility
- Economic feasibility
- Financial feasibility
- Cultural feasibility
- Political feasibility
- Environmental feasibility
- Market feasibility

The technical feasibility refers to the ability of the process to take advantage of the current state of the art technology. The technical capability of the personnel as well as the capability of the available technology in relation to the requirements of the proposed project idea should be considered and the extent of compatibility should be studied.

The managerial feasibility involves the capability of the infrastructure of a process to achieve and sustain process improvement. Management support, employee involvement and commitment are the key elements required to ascertain managerial feasibility.

The economic feasibility analyses the feasibility of the proposed project to generate economic benefits. A benefit-cost analysis and a break-even analysis are used while evaluating the economic feasibility of new industrial projects. In a benefit-cost analysis, all tangible benefits and costs as well as intangible benefits and costs are identified before obtaining the cost-benefit ratio. The break-even analysis helps to find the break-even quantity at which the project has no loss or gain.

The financial feasibility attempts to assess the capability of the project organization to raise the appropriate funds needed to implement the proposed project. Loan availability, credit worthiness, equity and loan schedule are important aspects of financial feasibility analysis.

The Cultural feasibility deals with the compatibility of the proposed project with the cultural setup of the project environment. In labour intensive projects, planned functions must be integrated with the local cultural practices and benefits. Some examples of cultural factors are religion, custom, life style, etc.

The political feasibility deals with the initial acceptance of the project and sustenance of the project in the long run by the prevailing political system. This is particularly true for the large projects with national visibility that may have significant government inputs and political implications. The issues on which political intervention may arise are conversion of land from agricultural use to industrial use, anticipated health hazard if the project is implemented, possible air pollution and water pollution, possible unemployment due to hi-tech projects, etc.

The environmental feasibility is very much important. If the commissioning of the project results with any kind of pollution, it will be visible to the public, administrators and politicians. If necessary corrections and preventive measures are not taken by the project firm to prevent or curtail pollution, the project will be forced to meet certain problems in terms of opposition from different circles. As a result, the project firm may sometimes, be pushed to the corner of closure or relocation of the project itself, which will be very costly to the organization.

The market feasibility deals with the uncertainty in the market which may have a direct impact on the demand of the product or services of the project firm. So, the market needs analysis to view the potential impacts of market demand, competitive activities, etc. and "convertible or divertible" percentage of available market share. Price war activities by competitors must also be analyzed for early contingency funding and debt service negotiations during the start-up and commercial start-up phases of the project.

6.4 STEPS IN FEASIBILITY STUDY

The steps of the feasibility study are as follows:

1. Determining the actual need to conduct feasibility study.
2. Creating an outline for the feasibility study.
3. Description of products/services.
4. Description of technology.
5. Description of market environment.
6. Analysis of competition.
7. Defining the industry.
8. Drafting business model.
9. Describing marketing and sales strategy.
10. Production and operating requirements.
11. Describing the management and personnel of the business.
12. Describing intellectual property that the company will develop and use.
13. Describing regulations and environmental issues.
14. Describing critical risk factors.
15. Outlining start-up schedule.
16. Documentation for financial projections.
17. Capital requirements and strategy.
18. Final findings and recommendations.
19. Drafting executive summary.

Let us understand all the above steps in little detail in the following paragraphs:

Determining the Actual Need to Conduct Feasibility Study

As stated earlier, conducting project feasibility study will certainly bring a lot of advantages for the project firm, in terms of having better insight into the proposed project and will boost the confidence of the promoters too. If a company is already in the same business that is being planned currently and that business is making a profit, then it can be inferred that the current business idea is novel or a new take on a current business, then conducting a feasibility study is a must.

Creating an Outline for the Feasibility Study

The outline will contain a cover page, executive summary, table of contents, descriptions of the products/services, and definition of the technology used, business model, marketing strategies, critical risk factors, financial projections and conclusion.

Description of Products/Services

The description of products/services includes the following:

- Description of the products or services in simple language. If the project firm deals with more than one product, the product mix must be given in full.
- Description of how the customers will buy and use the product or service. The pamphlets of the product or service should contain enough details on how the product would be used.
- The key components or raw materials that are used in the product and the sources of procurement of these components.
- The testing plan to check the quality of the product.
- Plans to upgrade product or expand product line.

Description of Technology

Technology is used at different levels in the project. It may be in the product itself. It may be in machine tools which are used to do the conversion process while producing the product.It may be relating to information system that is used to facilitate the flow of information between different sub-systems of the organization. And it may be the transfer of materials/semi-finished materials/finished product between appropriate stages. The technology will cost the organization a lot. Hence, a plan of establishing in-house research and development wing is to be prepared. The need for such wing depends on the cost of the technology, and criticality and confidentiality of the technology.

Description of Market Environment

The market environment mainly focuses on the target market in which there should be clear distinction between end-users and customers.

The type of benefits that will reach the end-users and customers through the product should be listed. Further, the project firm should be convinced about the reason based on which the end-users and customers will buy the product. Above all, the extent to which the products/services will satisfy the customer needs is to be judged. The demand of the product is to be projected, using the appropriate tools so that there will be less deviations of the actual demand from the projected demand.

The market can be classified into the following categories.

- Business-to business markets.
- Business-to-customer markets.

In business-to business-markets, the product will be sold to business firms who, in turn, will use the product for value addition process in their organizations. Some examples are selling paper to printing companies, machine tools to engineering companies, material handling systems to automobile companies, etc. In this segment, the frequency of product purchase, replacement needs, expansion needs and their purchasing process are to be studied in detail.

In business-to customer markets, the product will be sold to end-users. In such model, their demographic factors, such as income level, age interval, gender, educational level and ethnicity, psychographic factors and relevant behavioural factors, such as frequency of product purchase and shopping behaviour are to be studied.

Analysis of competition

Competition is an inevitable event in any business. The product of the business firm may be having a brand new technology or it may be based on incremental innovation of its own product or competitor's product. In all the cases, the project firm needs to analyse the following:

- The extent of direct competition and indirect competition for the product.
- The market share, resources, product, goals, strategies, and weaknesses of key competitors.
- Barriers to enter the market.
- The unique attributes of the product/service of the project firm. These attributes should fulfil the unsatisfied needs of the customers.
- The level of difficulty for the competitors to copy the product of the project firm.
- The likelihood reactions of the competitors during the post-launch period of the product and the project firm's response strategy.
- Estimation of likelihood time that would take to copy the know-how of the product by the competitors, which will help the project firm to plan and introduce products with

distinct technology/know-how, mainly to maintain/increase the market share of the project firm.

Defining the Industry

It is highly essential for the project firm to clearly identify the industry in which, it plans to operate. Sometimes, the product may have the advantage of being in more than one industry. In such case, the parent industry is to be identified, which will help the firm to plan for R&D activities mainly to compete in that industry. The size, growth rate and outlook of the industry need to be studied. The demand and supply factors and trends of the industry are to be analysed critically. The larger forces that drive the industry, such as innovation, cultural change, regulation, etc. need to be recognized and taken into account while planning for the product.

Drafting Business Model

Designing a business model for the company is an essential activity. The process of generating revenue from the project should be clearly stated. The revenue generation may be through selling the product, charging licensing, retail selling, etc. The business model may be a combination of one or more of these alternatives. There should be enough detail to support financial projections which are used in the model.

Describing Marketing and Sales Strategy

The description of marketing and sales strategy includes the following:

- Information about anticipated market partnerships.
- Information on market access for the project firm.
- Basic marketing and sales strategies. This will, in turn, include the following:
    - selling directly to customers,
    - selling through direct mail or internet,
    - selling through manufacturers 'representatives, wholesalers, distributors or retailers.
- Plan of the project firm to distribute merchandise or services.
- Method of pricing the product or services of the project firm.
- Amount set-out for the expenses relating to first year's marketing.
- Identification of any other factors which will affect the productivity of the proposed marketing campaign of the project firm.

- Payment terms for the customers.
- Details on warranties for the products or services.

Production and Operating Requirements

Production and operating requirements include the following:

- The method of manufacturing the products.
- The location of the plant and the locations of the facilities within the plant to produce the products.
- The transportation plan for shipping the items.
- Space requirement to manufacture the products.
- Option of Buying or renting warehouse facility for the project firm.
- If renovation is opted, the required budget.
- The degree of complexity of the manufacturing system used to manufacture the products.
- Information on the suppliers of the project firm and information of exiting contract if any with those suppliers.

If the project firm is to provide services, then the following must be attended:

- The design of the services;
- The arrangement of delivering the services;
- The ways of measuring, improving or modifying the services;
- Information on stakeholders who will be trading partners with the business and the terms of contract;
- Information on substitute partners.

Describing Management and Personnel of the Business

The size of the manpower in an organization depends on the type of industry and the level of automation deployed in the shop floor. In a fully automated factory, the supporting staff/staff at operational level will be very minimal. But, the positions at the level of managers and above will be irrespective of the level of automation.

The key managerial positions are to be defined with titles, responsibilities, relevant background, experience, skills and costs. Similarly, the type of people who will be required to take care of operational level requirements and their skills with financial projections to meet their salary and other benefits at least for next few years are too decided.

Describing intellectual property that the company will develop and use

Intellectual property rights if any or which will be developed and used by the project firm. They should list along with patents copyrights and trademarks. If the findings of a researcher in the project firm have been already published in a journal or in internet prior to the proposal for seeking patent or copyright for those findings, then the same cannot be granted because such findings will be treated as open domain knowledge. If the company is operating under licensing agreement or patent assignment, then the details of the licensor/ assignor, such as name, termination or renewal date should be listed.

Describing regulations and environment issues

These are considered to be very vital issues. Time to time the regulations and environmental concerns will vary from region to region. So, one should be doubly cautious on these issues, so that they have minimal disturbance on the performance of the project firm. Some of them which deserve attention and analysis by the project firm are as listed below:

- The compliance of the project firm with respect to government regulations.
- Environmental factors, views, waste disposal plans using appropriate technology, scheduling the production volume to suit to the local conditions on daily basis.
- Political stability.
- International trade policies.

Describing critical risk factor

The critical risk factor include economic stability and forecasts, investments, change in regulations, technical obsolescence, internal organization of the project firm, etc. The project firm should be in a position to mitigate each of these risks if they trigger during the course of operation of the project.

Outlining start – up schedule

To set the project in operational mood, a clear start–up schedule is to be prepared. These include important events such as having the financial resource and personal requirements and projected dates of completion of those events. It means that they should be in place for starting the project. Also, the milestones of the project against which the progress of the project can be compared are to be established before the start of project. Since, it is established at the beginning of the project, these milestones will never be static. As the project progresses, these are to be revised based on the actuals for the reminder of the project.

Documentation for financial projections

For any project, financial projection is very much important, because when the project goes for IPO, the public will be in position to understand the strength of the company. Further, the project itself gives a confidence on its financial soundness. The financial projection may require the following reports:

- Balance sheet projection for three years with highlight on inflow of capital.
- Cost – benefit analyses.
- Income projection for the first year.
- Cash flow projection for the first year.
- Break–Even analysis which gives the break–even quantity at which the project firm earns no profit or incurs no loss. For any increase beyond the break–even quantity, the profit of the project firm will go on increasing.

Capital requirements and strategy

The success of any project depends on the timely availability of capital and its cost. So, suitable strategies are to be devised to synchronize the capital requirements and capital availability. It is done through the optimal mix of resource mobilisation program. The key elements under these categories are as listed below:

- Amount of equity needed for the project firm.
- The projected revenue or assets of the company which is in place to secure the financing.
- The type of funding the company is looking for.
- The proposed debt–equity ratio of the company.
- The time of maiden return that will be paid to the investor and the expected return on investment.

Final findings and recommendations

The final findings and recommendations based on the feasibility study are reported in this section. Different feasibilities which are listed below must be examined.

- Project firms market feasibility.
- Exit strategy feasibility.

- Technical feasibility.
- Economic and financial feasibility.
- Business model feasibility.
- Management model feasibility.

Finally, recommendations to improve the start- up plan of the project firm and potential areas for research and development are to be made.

Drafting executive summery

Executive summery gives complete skeleton of the feasibility study summarizing the major sections and sub section on different item of the feasibility study. Though it is drafted at the end of the feasibility study, it is placed at the beginning of the report. This should be limited to a maximum of one page. If one reads the executive summary, he / she can have a bird's eye view of the feasibility study. For details, the person should read the entire report.

6.5 FEASIBILITY REPORT

The details gathered from feasibility studies and presented in various tables, reports and statements are consolidated into one master report called Project Report or Feasibility Report. This report also gives background information about the industry to which the project belongs and about the enterprise submitting the report.

Project report means synchronization and synthesis of relevant data relating to the project. In simple words, it is a written statement of what an entrepreneur proposes to take up.

6.5 GENERAL FORMAT OF FEASIBILITY REPORT

1. **Introduction** about the industry and the project.
2. Summary and Recommendation.
3. **Product.** Detailed information about the product such as nature, properties, and chemistry of the project specifications, applications and uses of the project.
4. **Market Potential.** Existing installed capacity and actual production for the last five years. New capacities under consideration/implementation, end-users of the product, distribution, channels, etc.
5. **Process and know-how.** Description of the available processes, selection of the suitable process, selection of the suitable know-how.

6. **Plant and Machinery.** Details of machinery required, suppliers, cost, available alternatives, and cost of miscellaneous assets.
7. **Location.** Exact location of the project, locational advantages and disadvantages.
8. **Land and Building.** Land area, construction area, type and cost of construction, detailed plan and estimate along with plant layout.
9. **Raw Materials.** List of raw materials required by quality and quantity, sources of raw material, cost, tie-up arrangement, alternative raw material, etc.
10. **Utilities.** Requirements of power, water and others including fuel, gas, steam, compressed air requirements, etc.
11. **Effluents.** Nature, type and quantity of effluent. Effect of effluent if discharged, effluent treatment suggested.
12. **Manpower Requirement.** Number of skilled and semi-skilled required, sources, supply and cost of procurement, training and development.
13. **Capital Cost.** Project cost giving break-up details.
14. **Working Capital.** The amount required the sources of supply, nature and extent of credit facilities offered, etc.
15. **Mode of finance.** Whether debt or equity or both. Debt-equity norms prescribed and followed by financial institutions.
16. **Manufacturing Cost.** Cost of production per unit and the projected cost of production for 10 years are shown under this heading.
17. **Financial Analysis.** Projected profit and loss account and balance sheet for 10 years, break-even and sensitivity analysis, and payback period is calculated.
18. Implementation schedule.

6.6 PLANNING COMMISSION GUIDELINES

In order to process investment proposals and arrive at investment decision, the planning commission has issued guidelines for preparing industrial projects. The brief summary of the guidelines is as follows:

1. General Information: The feasibility report should start with the analysis of industry to which the project belongs. For example, the project relates to manufacturing Iron and Steel, it should give an analysis of the Iron and Steel industry as a whole. The promoters will have to examine the situation of Iron and Steel industry in the world and in the country. This section should also contain information about the enterprise which is submitting the feasibility report.

2. Preliminary Analysis of Alternatives: The present demand and supply for the product to be produced, available production capacity, and production of the project proposed, production capacity that is in the pipeline should be given here. All options that are technically feasible should be considered at this preliminary stage. The location of the project and its implications, foreign exchange requirements, profitability, the rate of return on investment, alternative cost calculations vis-à-vis return, should be presented here.

3. Project Description: The feasibility report should provide a brief description of the technology (process chosen for the project. Information about the basis for selection of location, impact of the project on environment and the society are to be provided in greater detail. The report should contain a list of important items of capital equipment and also the list of the operational requirements of the plant, requirements of water and power, requirements of personnel, organizational structure envisaged, transport costs activity wise phasing of construction and factors affecting it.

4. Marketing Plan: Marketing plan and the information about the Demand and Prospective supply in each of the areas to be served should be given. The other information to be presented is –

- The methods and the data used for making estimates of domestic supply and selection of market areas,
- Estimates of the degree of price sensitivity,
- Analysis of past trends in prices.

5. Capital Requirements and Costs: The amount of capital required and the cost of that capital is to be estimated properly. Information on all items of costs should be carefully collected and presented.

6. Operating Requirements and Costs: After commencement of commercial production, there are essentially operating requirements and costs are involved. Raw-materials, utilities, fuel, labour etc. are needed to operationalise the project. Information about tall items of operating costs should be estimated.

7. Financial Analysis: Financial analysis is essential to find out the financial viability of the project. A proforma of balance sheet for the project data should be presented.

Information about the allowable depreciation tax incentives and rebates available, the rate of return on investment should be presented here.

8. Economic Analysis: Social profitability analysis needs some adjustments in the data relating to the costs and return to the enterprise. One important type of adjustment involves a correction in input and cost, to reflect the true value of foreign exchange, labour and capital. The enterprise should try to assess the impact of its operations on foreign trade. Indirect costs and benefits should also be included in the report. If they cannot be quantified they should be analysed and their importance emphasised.

6.7 CHECKLIST FOR FEASIBILITY REPORT

1. Examination of public policy with respect to the industry.
2. Broad specifications of outputs and alternative techniques of production.
3. Listing and description of alternative locations.
4. Preliminary estimates of sales revenue, capital costs and operating costs of different alternatives.
5. Preliminary analysis of profitability for different alternatives.
6. Marketing analysis.
7. Specification of product pattern and product prices.
8. Raw material investigation and specification of sources of raw material supply.
9. Estimation of material, energy flow balance and input prices.
10. Listing of major equipment by type, size and cost.
11. Listing of auxiliary equipment by type, size and cost.
12. Specification of sources of supply for equipment and process knowhow.
13. Specification of site and completion of necessary investigation.
14. Listing of buildings, structure and yard facilities by type, size and cost.
15. Specification of supply sources, connection costs and other costs for transportation services, water supply and power.
16. Preparation of layout
17. Specification of skill-wise labour requirements and labour costs.

18. Estimation of working capital requirements.
19. Phasing of activities and expenditures during construction.
20. Analysis of profitability.
21. Determination of measures of combating environmental problems.
22. Analysis of the past performance of the enterprise responsible for implementing and running the project with respect to project completion, capacity utilization profitability, etc.
23. State of preparedness to implement the project rapidly.

6.7.1 Project Formulation

The entrepreneur in the developing country has to encounter a number of problems while establishing a new project. These problems cause a great concern to many enthusiastic entrepreneurs. However, they could be saved to a greater extent by undertaking a project formulation exercise at the appropriate time.

Concept of Project Formulation

- Project formulation is the systematic development of a project idea for the eventual objective of arriving at an investment decision.
- Project formulation involves a step-by-step investigation and development of project idea. It provides a controlled mechanism for restricting expenditure on project development.
- Project formulation is a process involving the joint efforts of a team of experts. Each member of the team should be familiar with the broad strategy, objectives and other ingredients of the project.

6.7.2 Significance of Project Formulation

- Project formulation provides a controlled mechanism for restricting expenditure on project development. One stage of the exercise leads to the other. In case a weakness is observed at any stage of implementation, the entrepreneur can exercise his discretion of calling off the exercise if the facts so warrant.
- It enables him to take decisions in a scientific way providing a concrete set of facts.
- It provides a mechanism for controlling expenditure.
- Since it is a step by step exercise any weakness at any stage will be observed immediately and corrective measures are taken without loss of time.

- It is necessary to obtain financial assistance from the financial institutions.
- It will be of great help to obtain government clearances. It will highlight the matter for which the government sanction is necessary.

6.7.3 Need for Project Formulation

An entrepreneur in a developing country can avoid many problems he encounters in establishing a project by undertaking project formulation. We will discuss these problems in the following paragraphs:

1. Selection of Appropriate Technology:

An entrepreneur faces the problem of selection of appropriate technology for his enterprise. Technology developed in the developed western societies may not be suitable for adoption in developing countries. For example, optimal size of plants in a highly industrialised countries may be too big for a developing country due to limited market for the product, limited availability of capital are skilled labour. Hence, the project idea is to be examined with respect to its design, production, marketing, after sales service, etc.

2. Influence of External Economies

No project can function in isolation in any economy. It has to depend on other industries for the supply of raw-materials, power, tools, spare parts, etc., or on ancillary enterprises which can provide technical, financial and managerial services. Entrepreneur needs communication and transport facilities. He needs an intricate system of business practices. We call all their facilities as external economies. If they are available in an economy, entrepreneur need not incur additional expenditure on them. They are available in advanced countries. In developing countries the entrepreneur is required to find out whether they are available or not. If they are not available entrepreneur should consider additional costs involved in creation of them.

3. Dearth of Technically Qualified Personnel

The third problem is the non-availability of technically qualified and appropriate personnel. Modern technology calls for a certain minimum supply of various skills that are generally lacking in developing countries.

4. Resource Mobilisation

The fourth problem is resource mobilisation. In the present day projects involve huge amount of capital which an entrepreneur may not be able to mobilise for himself. He needs the help of financing institution.

5. **Knowledge about Government Regulations**

The government will issue a number of regulations, procedures and policies from time to time. Entrepreneur has to understand all those which are directly applicable to him. But the difficulty is, these regulations are not available in a consolidated and detailed form in most of the developing countries. However, in India, a compendium entitled "Guidelines for Industries" has been published by the ministry of Industrial Development. It provides information regarding the industrial policy, licensing procedures, guidelines for foreign collaboration, import and export control orders, and foreign exchange orders. It also has information regarding the present status of capacities and possibilities of future development in various industrial fields like metallurgical industries, electronics equipment industries, transport industries and the like.

These problems make the entrepreneur to undergo a lot of harassment, disappointment and despair. However, a project formulation exercise undertaken at the right time mitigates the severity as well as magnitude of these problems.

6.7.4 Elements of project formulation

Project formulation is by itself an analytical management aid. It enables the entrepreneur to arrive at the most effective project decision. Project formulation exercise normally includes the following aspects:

1) Feasibility analysis
2) Techno-economic analysis
3) Project report and network analysis
4) Input analysis
5) Financial analysis
6) Social cost- benefit analysis
7) Project appraisal

1. **Feasibility analysis** financial analysis is the process of evaluating the future of a project idea within the limitations of the project implementing body and the constraints imposed on the project situation by the environment. The analysis is undertaken to determine the desirability of investing in future development of project idea. when project is taken for develop three alternatives can arise,

- The project may appear to be positive and in such a case the project assessing body can proceed to invest further resources in pre-investment studies and design development

- The project may turn out to be not feasible and , therefore further investment in the project idea as ruled out
- The data is not adequate to arriving at a decision about the feasibility of project. In such a situation additional information must be collected and the investment decision is deferred till the final decision.

Project identified are normally analyzed in order to establish their viability from different angles such as technical, marketing, financial. Etc. in other words various alternatives in marketing, technological and other considerations are studied and then findings with studied and then findings with the , supporting data are presented in a systematic form, generally the exercise in feasibility analysis is carried out dividing it formally into three stages , viz… pre-feasibility study , feasibility study and project report.

2. Techno-economic analysis:

Techno-economic analysis is preliminarily concerned with the identification of the project demand potential and selection of the optimal technology suitable for archiving the project objectives. This analysis is produces necessary information on which the project design can be based. It's also indicates whether the economy is in a position to absorb the output of the project.

The size of the project and technology used depend very much on the demand potential. Technology, in broader sense, includes methodology and process where the technical operations are not included. An optimal size and technology enable to achieve the economies of the scale. The techno- economic analysis, therefore, consists of two parts, viz.

- Determining of project demand potential
- Selection of optimal project strategy

A measure of performance is essential to develop a criterion of choice. Once it developed the benefits of various courses of action can be started in terms of common measure of value and used for the selection of optimal course of action , a project situation generally envisage the achievement of a number of secondary objectives such as creation of additional employment, removal of regional disparities , etc.,

The techno-economic appraisal report contains the recommendations of the project formulation team regarding the strategy which should form the basis of further development of the p\reject idea. Since the process of selection of project strategy is based on analytical considerations, the report also contains the details of the reasoning on which the recommendations are based the details of reasoning on which recommendations are based.

The contents of techno-economic analysis report will include preliminary status of the network at the beginning project objectives, project demand potential, possible alternative courses of action and optimal strategy and finally the techno-economic appraisal.

3. project design and network analysis:

Project design is heart of project. It defines the individual activities comprising a project and the interrelationship between these activities. It identifies the flow of events which must be take place before the project can start yielding the desired results. The inter-relationship between various constituent activities of a project is generally depicted in the form of a network diagram

Project design and network analysis are concerned primarily with the development of the detailed work plan of the project and its time profile. This plan is presented in the form of a network diagram. Network analysis is carried out to identify the optimal course of action, so as to execute the project within the minimum time keeping in view the available resources, thus network analysis and project design paves the way for detailed identification and quantification of the project inputs which is essential for developing the financial and cost-benefit profile of a project.

4. Input analysis:

After a project idea has withstood the test of feasibility analysis, techno economic analysis and network analysis, it become necessary to determine the resource requirement of the project. Input analysis is primarily concerned with the identification, qualification and evaluation of project inputs the objective is first to identify the nature of the resources that a project will consume secondly to estimate the magnitude of the required resources and thirdly to evaluate the possibility of uninterrupted supply of inputs resources is needed in all the three phases of a project. But the nature and the amount of resources required are differing widely from one phase to another. During the pre investment stage resources are needed to investigate various aspects of the project idea and developing the project design. During the construction stage, non recurring resources are needed to develop project structure during the normalization stage; the project requires raw materials and other consumables on recurring basis. The pre investment stage generally consumes the least and the construction stage maximum amount of resources. The best method of determining the resources required in the various activities involved in the project. Resource consists of raw materials and human resources and it uses the network plan for developing the input characteristics of the project.

5 Financial analysis :

Financial characteristics of an investment proposition have a significant impact on the acceptability or otherwise of a project. The purpose of a financial analysis is to identify these characteristics and to determine the financial feasibility of a project. Such analysis involves estimates about project cost and the funds required for the project. It seeks to find out whether the project will generate revenue to realize the ultimate objective for which it is undertaken. It reduces investment propositions to the common scale so as to permit comparison and eventual investment decision. Since investment proposition have a long time proposition. As a long time horizon, due care and foresight must be used in developing financial forecast of a project. The information obtained from the financial analysis could be used for employing commercial profitability analysis. It could be more effective by using break even analysis and ratio analysis. It generates data for computing different profitability criteria with a view to establish the projects worth to the enterprise

6 Cost benefit analysis

Under this analysis, estimates of social cost and social benefits are made and presented for computation of social profitability of project. While the costs and benefits under the financial analysis are estimated employing market prices based on financial objectives. This cost benefit analysis considers them only at a certain inputted prices based on social or national objectives. Generally, the purpose of this analysis would be to ascertain all social cost and benefits with a view to find out the impact of project on society the methods of estimating the shadow prices or inputted prices, social discount rate etc., are to be explained and the calculations are to be presented in separate statements or tables however most of the data obtained from financial analyst could be adjust to request the true social values and use. Similar most of the decision criteria for public sector project appraisal and evaluation. Social cost benefit analysis is now an internationally recognized system of project appraisal even though standard methodology is available for it.

The results of feasibility analysis, the techno economic analysis, design and network analysis, the input analysis, financial analysis and cost benefit analysis are consolidated so as to give a final and formal shape to the project. It involves selection of the appraisal format it contents and form of presentation. It is known as pre investment appraisal and its purpose is to enable the concerned authorities to take an investment decision about the project.

6.10 NOTES

6.11 SUMMARY

A feasibility study is an analysis of the viability of an idea concerning a product or a service. The main objective of the feasibility study is to decide whether the organization should proceed with the project idea. Early identification of the fact that a project idea will not work, saves time, money and avoids backtracking of the project at a later stage.

A Feasibility study is only one step in the business idea assessment and business development process. It has been estimated that only one idea out of fifty, is commercially viable.

Before conducting feasibility study, a pre-feasibility study is being conducted mainly to collect and analyse certain key data.

TYPES OF FEASIBILITY

The feasibility study includes the following types of feasibility analysis.

- Technical feasibility
- Managerial feasibility
- Economic feasibility
- Financial feasibility
- Cultural feasibility
- Political feasibility
- Environmental feasibility
- Market feasibility

The steps in carrying out feasibility study are as follows:

1. Determining the actual need to conduct feasibility study.
2. Creating an outline for the feasibility study.
3. Description of products/services.
4. Description of technology.
5. Description of market environment.
6. Analysis of competition.
7. Defining the industry.

8. Drafting business model.
9. Describing marketing and sales strategy.
10. Production and operating requirements.
11. Describing the management and personnel of the business.
12. Describing intellectual property that the company will develop and use.
13. Describing regulations and environmental issues.
14. Describing critical risk factors.
15. Outlining start-up schedule.
16. Documentation for financial projections.
17. Capital requirements and strategy.
18. Final findings and recommendations.
19. Drafting executive summary.

Feasibility Report

The details gathered from feasibility studies and presented in various tables, reports and statements are consolidated into one master report called Project Report or Feasibility Report. This report also gives background information about the industry to which the project belongs and about the enterprise submitting the report.

PROJECT FORMULATION

The entrepreneur in the developing country has to encounter a number of problems while establishing a new project. These problems cause a great concern to many enthusiastic entrepreneurs. However, they could be saved to a greater extent by undertaking a project formulation exercise at the appropriate time.

Concept of Project Formulation

- Project formulation is the systematic development of a project idea for the eventual objective of arriving at an investment decision.
- Project formulation involves a step-by-step investigation and development of project idea. It provides a controlled mechanism for restricting expenditure on project development.

Need for Project Formulation

An entrepreneur in a developing country can avoid many problems he encounters in establishing a project by undertaking project formulation. Project formulation is needed for the

Selection of Appropriate Technology, for understanding the Influence of External Economies on the project, Dearth of Technically Qualified Personnel, Resource Mobilisation, and Knowledge about Government Regulations.

ELEMENTS OF PROJECT FORMULATION

Project formulation is by itself an analytical management aid. It enables the entrepreneur to arrive at the most effective project decision. Project formulation exercise normally includes the following aspects: Feasibility analysis, Techno-economic analysis, Project report and network analysis, Input analysis, financial analysis, Social cost- benefit analysis, Project appraisal.

6.12 KEY WORDS

Feasibility Study: it is an analysis of the viability of an idea concerning a product or a service.

Feasibility Report: The details gathered from feasibility studies and presented in various tables, reports and statements are consolidated into one master report called Project Report or Feasibility Report.

Project Formulation: Project formulation is the systematic development of a project idea for the eventual objective of arriving at an investment decision.

6.13 SELF ASSESSMENT QUESTIONS

1. What is Feasibility Study? Why it is being carried out?
2. What is Feasibility Study? Explain the steps in Feasibility study.
3. Define Feasibility Report. Explain the planning commission guidelines for preparation of Project Report.
4. What is Project Formulation? What is the need for Project Formulation?
5. Define Project Formulation. Explain the elements of Project Formulation.

6.8 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.
2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.
3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.
4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.
5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill
6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011
7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002
8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012
9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.
10. Sanjiv Marwah. *Project Management.* New Delhi: Dreamtech Press, 2011.

UNIT - 7 : PROJECT RISK MANAGEMENT

Structure :

7.0 Objectives

7.1 Introduction

7.2 Definition of Risk

7.3 Meaning of Risk Management

7.4 Objectives of Risk Management

7.5 Types of Risk

7.6 Steps in Risk Management Process

7.7 Applications of Risk Management in Project Management

7.8 Enterprise Risk Management

7.9 Case Study

7.10 Notes

7.11 Summary

7.12 Key Words

7.13 Self Assessment Question

7.14 References

7.0 OBJECTIVES

After reading this unit, you should be able to:

- define risk and risk management
- explain the types of risks.
- state the objectives of risk management.
- explain the steps in risk management process.
- define enterprise risk management and explain the strategy of risk management.

7.1 INTRODUCTION

Risks are inherent in projects. No amount of planning can overcome risk completely. Because things we planned do not turn out exactly as planned. The risk has a cause and if it occurs, it has consequences. Some potential risk events can be identified before the start of the project. But it is highly impossible to predict all possible risks. For example, nobody predicted terrorist attacks on Twin Towers in New York City on September 11, 2001, that too using passenger aircrafts. Risk management attempts to recognize and manage potential and unforeseen trouble spots that may occur when the project is implemented. Risk management identifies as many risk events as possible, minimizes their impact, and provides contingency funds to cover risk events that actually happen. Let us understand in this unit the meaning of risk and risk management, the process of risk management, types of risks, strategies of managing risk, etc. in this unit.

7.2 DEFINITION OF RISK

Risk is an abstract term. In a given situation, risk is viewed differently by different people. **Risk generally signifies an uncertain event, situation, or condition which may occur.** It may have either positive or negative effect on the project objectives. Some risks may pose a threat to the achievement of project objectives, while some other risk may enhance achievements of objectives. Favorable risk events are called opportunities, whereas unfavorable risk events are termed as threats. Factors that induce unfavorable risky situations are called hazards. Risk increases with hazards but decreases with safe guards.

In the project context, risk is "the, uncertainty inherent in plans and the possibility of something happening that can affect the prospects of achieving business or project's goals".

The risk is "an uncertain event or condition that, if it occurs, has a positive or negative effect on a project's objectives."

Risk has three components:

(i) A situation leading to an event the occurrence of which is likely to deviate from the estimated or forecast value.

(ii) The probability of occurrence of that event.

(iii) The likely impact of that event, i.e. loss or gain.

Risk exposure is a function of the probability of occurrence and the consequences (amount of damage or gain) of not achieving a planned goal. Risk exposure is mathematically quantified by multiplying the probability of its occurrence with the financial impact of the occurrence of the risk event.

Risk exposure **=** probability of occurrence of risk **X** financial impact on occurrence of the risk event.

7.3 MEANING OF RISK MANAGEMENT

"Risk management is the process of identifying, measuring or assessing risk and developing strategies to manage it."

"Risk management is a systematic approach in identifying, analyzing and controlling areas or events with a potential for causing unwanted change."

It is through risk management that risk to any specific program are assessed and systematically managed to reduce risk to an acceptable level.

Risk management is the act or practice of controlling risk. It includes risk planning, assessing risk areas, developing risk handling options, monitoring risks to determine how risks have changed and documenting overall risk management program.

7.4 OBJECTIVES OF RISK MANAGEMENT

Risk management basically has the following objectives:

a. Anticipating the uncertainty and the degree of uncertainty of the events not happening the way they are planned.

b. Channelizing events to happen the way they are planned.

c. Setting right, at the earliest opportunity, deviations from plans, whenever they occur.

d. Ensuring that the objective of planned event is achieved by alternative means, when the means chosen proves wrong, and

e. In case the expected event is frustrated, making the damage minimal.

7.5 TYPES OF RISK

The risk factors and risk events are consolidated to form the risk check list; the check list will vary from project to project and agency to agency. A typical check list showing risk events categorized under risk sources, which may be encountered in a turnkey construction contract, is given below. The list is indicative and is not limited to the following:

1. Project scope Risks: High complexity, ill-defined project scope, and frequently changing scope requirements, not project character, no delegation of authority, ineffective control systems, no extra work, no analysis of changes and problems in quality control.

2. Design and specification Risks: Inadequate design information, incorporation of new construction technology ,unrealistic specifications ,likelihood of design changes, difficulties in interaction of design with method of construction , non-standardisation of resources , designer's delays, poor design and shop drawings, non-conformity with national and local specifications.

3. Quality Risks: No quality assurance plan, no soil investigation, no method statements, poor quality materials, untrained man power, absence of approved soil and material testing laboratories, unachievable quality specifications, problems in quality control and re-working of defects during construction.

4. Time overrun Risks: Inaccurate activity time estimates, unrealistic time schedules, incomplete work breakdown structures, no formal sequencing plan, poor allocation of resources, incomplete assessment of project time, cost, resources and quality implementation plans, no database, ineffective control system, inflexible and unrealistic project plans, unsatisfactory conduct of status review meetings, inability to take timely corrective action .

5. Cost Overrun Risks: Inaccurate cost estimates, inadequate cost planning and control, no extra work control and no analysis of changes, constantly changing market conditions, incomplete project closure.

6. Leadership Risks: No project vision, no team building, poor motivation of participants, high turnover of critical team members, indecisiveness, unreasonable stakeholders expectations, lack of senior management support, lack of team consensus over project plans, limited authority /control of the project manager, poor communications, poor industrial relations, high rate of sickness and absenteeism, unsafe working conditions resulting in accidents and poor turnover, conflicts among staff and participating organisations, lack of co-ordination, insufficient liaison with public services, barriers in information communication.

7. Organisational risks: Inappropriate organisation network, poor assignment/ allocation of tasks and responsibilities, lack of competent persons, no project manual/ documented procedures/processes, project being too compiled for the resources available, inadequate communications infrastructure, wrong selection of project management, no database inflexible and unrealistic project plans, poor quality control, unsatisfactory conduct of status review meetings, inability to take timely corrective action, incomplete project closure.

8. Physical Resources Mobilisation and Utilisation Risks: Inadequate and low quality procurement of resources, non availability of spare parts, special equipments and materials,transhipment delays, low productivity, bad weather and working conditions, non availability of suitable sub-contractors, damage during construction due to negligence, transportation or storage vandalism, accidents, wastage, theft and fraud, lack of safety and hygiene measures and local requirements.

9. Technology Risks: Inadequate information on new technology, non replacement of old technology, non-availability of competent and professional staff to use new technology, lack of managerial skills.

10. Contractual Risks: Non standard and inconsistent conditions of contract, insufficient to prepare bid tenders, delays in possession of site, errors or omissions in bills of quantities, payment problems, extra work variations, unrealistic tendered amount, no credit worthiness of contractor, high cost of legal decisions, insufficient insurance and surety, incorrect documentation of claims and disputes, unfamiliarity with local laws.

11. Force majeure and Ecological Risks: Natural calamitiessuch as earthquakes, floods, landslides, ecological damages, epidemics, etc.

12. Political , legal and Social Risks:- changes in government , policies , regulations, rules , laws , war , revolution , civil disorder , risks under criminal law and the law of tort , pollution , waste treatment, local regulations , constraints on the availability of labour , import - export restrictions and producers , joint ventures rules , inconsistency of regulations within the country, requirements of license permits, crime and insecurity, bribes and corruption, religious and cultural conflicts.

13. Financial and Economic Risks: Iinvestment risk, inflation , escalation of prices, availability and exchange rate fluctuations, local and national taxes, inadequate sources and availability of funds, cash flow problems , effect of time and cost overruns , default of stakeholders and suppliers , demand scenario and constantly changing market conditions.

7.6 STEPS IN RISK MANAGEMENT PROCESS

Risk management process refers to the process of identifying, measuring or assessing risk and then developing strategies to manage risk. Risk management is a proactive approach rather than reactive. It is preventive process designed to ensure that surprises are reduced and that negative consequences associated with undesirable events are minimized. Successful management of project risk gives the project manager better control over the future and can significantly improve chances of reaching project objectives on time, within budget, and meeting required technical Performance. Let us understand in detail the steps involved in risk management process.

The steps involved in the risk management process are as follows:-

7.6.1 Step-I: Identification of Risks

Identifying risk is the "process of determining which risks might affect the project and documenting their characteristics." The risk management process begins by trying to generate a list of all the possible risks that could affect the project. Typically the project manager pulls together, during the planning phase, a risk management team consisting of core team members and other relevant stakeholders. The team uses brainstorming and other problem identifying techniques to identify potential problems. In brainstorming activity, everyone present is repeatedly asked, what could to wrong? Classic rules for brainstorming are used. For example, every idea is treated as a useful idea. Later during the assessment phase, participants will have a chance to analyze and filter out unreasonable risks.

One common mistake that is made early in the risk identification process is to focus on objectives and not on the events that could produce consequences. For example, team members may identify failing to meet schedule as major risk. What they need to focus on are the events that could cause this to happen. Only by focusing on actual events can potential solutions be found.

Organizations use Risk Breakdown Structure (RBS) in conjunction with work breakdown structures to help management teams identify and eventually analyze risks. In the RBS first macro risks such as Technical risks, External risks, organisational risks, and project management risks are identified. Then specific areas are checked using work breakdown structure to identify specific risks. Use of the WBS reduces the chance a risk event will be missed.

Another useful tool for risk identification is Risk Profile. A risk profile is a list of questions that address traditional areas of uncertainty on a project. These questions have been developed and refined from previous, similar projects. The risk profiles are organization specific. They recognize the unique strengths and weaknesses of the firm. Risk profiles address both technical and management risks.

The third method is the use the historical records when formal risk profiles are not available. Project teams can investigate what happened on similar projects in the past to identify potential risks. Inquiries should not be limited to recorded data. Savvy project managers tap the wisdom of others by seeking the advice of veteran project managers.

Project risks can also be identified with process flowcharts. A flow chart illustrated the steps, procedures, and flows between tasks and activities in a process. Examination of a flowchart can pinpoint potential trouble spots and areas of risk.

One of the keys to success in risk identification is attitude. Project managers have to encourage critical thinking when it comes to risk identification. The goal is to find potential problems before they happen.

There are numerous other methods for identification of risk events. Some of these methods are:

- Project risk sources and project objectives interaction
- Project risk sources and work package breakdown matrix
- Project management functions analysis
- Performance analysis of past projects
- Brain storming
- Check-list

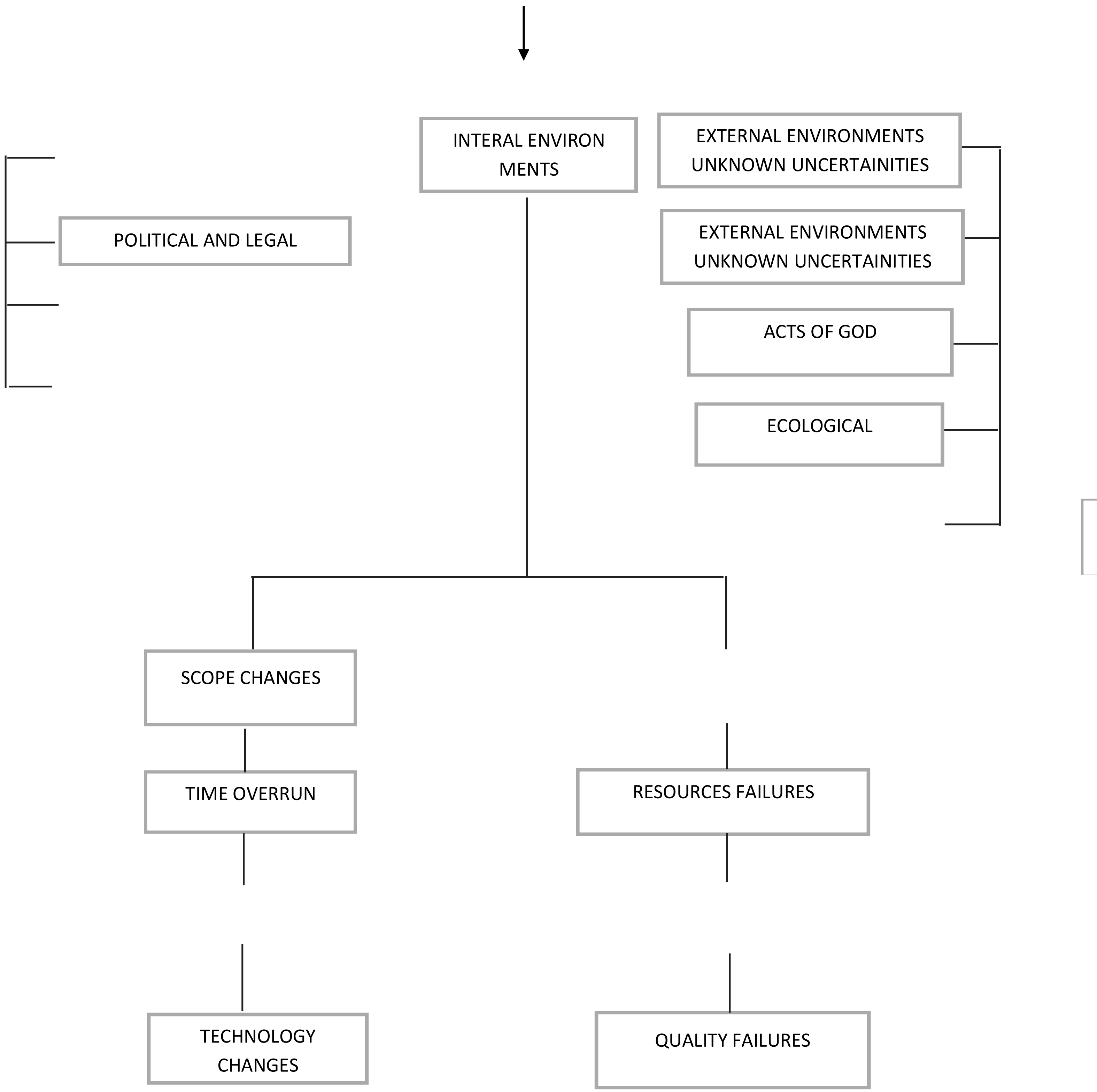

INTERAL ENVIRON MENTS
EXTERNAL ENVIRONMENTS UNKNOWN UNCERTAINITIES
POLITICAL AND LEGAL
EXTERNAL ENVIRONMENTS UNKNOWN UNCERTAINITIES
ACTS OF GOD
ECOLOGICAL
SCOPE CHANGES
TIME OVERRUN
RESOURCES FAILURES
TECHNOLOGY CHANGES
QUALITY FAILURES

Figure: Project risks.

Examples:

Risk sources – Project objective risk identification matrix

Risk Sources –project objectives, risks identification matrix

Risk sources	Scope	Time	Cost	Quality	Finance	Org.
Internal environment:						
Scope changes	✓	✓	✓			✓
Time overrun						
Cost overrun						
Technology change						
Leadership and organisational failures						
Resources failures	✓					
Contractor failures	✓	✓	✓			✓
Quality failures						
External Environments predictable sources						
Political and legal changes						
Design and Specifications failures	✓	✓	✓			✓
Financial and economic failures		✓	✓			✓
External Environments Unknown Uncertainties:						
Acts of god damages	✓	✓	✓	✓		✓
Ecological failures			✓			
Safety and health failures	✓	✓	✓			

Project Work Packages Risk Identification Matrix

Work Package Execution Risk Matrix

Risk Sources	WP-1	WP-2	WP-3	WP-
Time slippage risks	✓	✓	✓	✓
Resources	✓	✓	✓	✓
poor productivity	✓	✓	✓	✓
Cost overrun risks				✓
Quality risks	✓	✓	✓	✓
Prod. Tech change risk	✓	✓		

Leadership Functions Related Risks Identification:

Leadership Risk Factors	Risk Impact			
	Cost	Schedule	Quality	Org.
High turnover of critical team members	✓	✓	✓	✓
Lack of senior management support				✓
Poor communication skill	✓	✓	✓	✓
Poor motivation of participants	✓	✓	✓	✓

7.6.2 Step-2: Risk Assessment

All the potential risks listed under step -1 do not deserve attention. Some are trivial and can be ignored, while others pose serious threats to the welfare of the project. The notable risks require attention. What is considered notable depends on three things: risk likelihood, risk impact, and risk consequence.

Risk likelihood is the probability that a hazard or risk factor will actually materialize. It can be expressed as a numerical value between 1.0 (certain to happen) and (impossible) or as a qualitative rating such as high, medium, or low. Numerical values and qualitative ratings are sometimes used interchangeable.

Risk impact is what would happen if a risk hazard materialized. For example, a poorly marked highway intersection is a risk hazard; the risk posed is that of collision with the impact of injury or death. Risk impact in projects is specified in terms of time, cost, and performance measures. Risk impact can be expressed as a qualitative rating such as high, medium, or low. The rating is subjective and depends upon the opinion of mangers about the importance of the task. Risk impact can also be expressed as numerical measure between 0 and 1.0, where 0 is "not serious" and 1.0 is "catastrophic". Again rating is subjective and depends on opinion.

There are many statistical techniques available to the project manager that can assist in assessing project risk. Decision trees have been used to assess alternative courses of action using expected values. Statistical variations of net present value have been used to assess cash flow risks in projects. Correlations between past projects' cash flow and S-curves (cumulative project cost curve-baseline-over the life of the project) have been used to assess cash flow risks. PERT and PERT simulation can be used to review activity and project risk.

7.6.3 Step-3: Risk Response Development

When a risk event is identified and assessed, a decision must be made concerning which response is appropriate for the specific event. Responses to risk can be classified as mitigating, avoiding, transferring, sharing, or retaining.

Mitigating risk: reducing risk is usually the first alternative considered. There are basically two strategies for mitigating risk: (1) reduce the likelihood that the event will occur and/or (2) reduce the impact that the adverse event would have on the project. Most risk teams focus first on reducing the likelihood of risk events since, if successful, this may eliminate the need to consider the potentially costly second strategy.

Testing and prototyping is one way of mitigating risk. Often identifying the root causes of an event is another useful tool to mitigate the risk. Other examples of reducing the probability of risks occurring are scheduling outdoor work during the summer months, investing in up-front safety training, and choosing high-quality materials and equipment.

Another alternative mitigation strategy is to reduce the impact of the risk if it occurs.

Avoiding Risk. Risk can be avoided by altering the original project concept. For example, eliminating risky activities, minimizing system complexity, and reducing end-item quality requirements, changing contractors, incorporating redundancies and safety procedures, and so on. Even though many risk factors can be avoided, not all can be eliminated, especially in large, complex, or leading edge projects. Attempts to eliminate risk usually entail adding innumerable management controls and monitoring systems that increase system complexity and introduce new sources of risk. Also, avoiding risk can diminish the payoff opportunities.

Transferring Risk: Risk can be transferred partly or fully from the customer to the contractor, or vice versa, using contractual incentives, warranties, or penalties attached to project performance, cost, or schedule measures. Fixed-price contracts are the classic example of transferring risk from an owner to a contractor. The contractor understands his or her firm will pay for any risk event that materializes; therefore, a monetary risk factor is added to the contract bid price. Another more obvious way to transfer risk is insurance. Various other financial instruments also used to transfer risk.

Sharing Risk: Risk sharing allocates proportions of risk to different parties. For example , in international construction projects, host countries would prefer Build-Own-Operate-Transfer provisions in the contract. In such cases, the host country and project firm agree to share the financial risk or ownership until the project has been completed and capabilities proven.

Retaining Risk: in some cases a conscious decision is made to accept the risk of an event occurring. Some risks are so large t is not feasible to consider transferring or reducing the event (e.g., an earthquake or flood). The project owner assumes the risk because the chance of such an event occurring is slim. Before the project begins, if more efforts are given to risk response, the chances of minimizing project surprises are less.

7.6.4. Step-4: Risk Response Control

The last step in the risk management process is risk control— executing the risk response strategy, monitoring triggering events, initiating contingency plans, and watching for new risks. Establishing a change management system to deal with events that require formal changes in the scope, budget, and/or schedule of the project is an essential element of risk control.

Project managers need to monitor risks just like they track project progress. Risk assessment and updating needs should be a part of every status meeting and progress report system. The project team needs to be on constant alert for new, unforeseen risks. Project managers need to establish an environment in which participants feel comfortable raising concerns and admitting mistakes. The norm should be that mistakes are acceptable, hiding mistakes is intolerable. Problems must be embraced not denied. Participants should be encouraged to identify problems and new risks.

A second key for controlling the cost of risks is documenting responsibility. This can be problematic if the project involves multiple organizations and contractors. Responsibility for risk is frequently passed on to others with the statement, "that is not my worry." This mentality is dangerous

The bottom line is that project managers and team members need to be vigilant in monitoring potential risks and identify new land mines that could derail a project. Risk assessment has to be part of the working agenda of status meetings and when new risks emerge they need to be analyzed and incorporated into the risk management process.

7.7 APPLICATIONS OF RISK MANAGEMENT IN PROJECT MANAGEMENT

The risk evaluation and its minimization are to be made for the projects which are going to be implemented. The applications of risk management in new projects consist of the following steps:-

a. Plan should include risk management tasks, responsibilities, activities and budget.

b. Appointing a riskassessing officer, a team member other than a project manager, who is responsible for foreseeing potential project problems?

c. Maintaining live projects risk data base. Each risk should have the following attributes: opening date, title, short description, probability and importance.

d. Creating anonymous risk reporting channels. Each team member should have possibility to report risk that he foresees in the project.

e. Preparing mitigation plans for risks that are chosen to be mitigated.

f. Summarise the planned and faced risks, effectiveness of mitigation activities and effort made for the risk management.

Risk is the essence of entrepreneurship. In business the extent of risk varies with each investment. Enterprises should consciously considered the possibility or not, of realising the course and results of events as planned before venturing in to their investments.

7.8 ENTERPRISE RISK MANAGEMENT

The enterprise risk management is defined as " a process, effected by an entity's board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity , and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives".

ERM deals with risk and opportunities affecting value creations or preservation. ERM is the comprehensive and integrated approach to addressing corporate risk. ERM enables management to effectively deal with uncertainty and associated risk and opportunity, enhancing the capacity to build value. In ERM, a risk is defined as possible event or circumstances that can have negative influences on the enterprise in questions. Its impact can be on the very existence, the resources (human and capital), the products and services, or the customers of the enterprise, as well as external impacts on society, markets or the environment.

ERM is at the nascent stage in India and that Indian firms often tend to focus on the downside of risk and not the opportunity side. Global competition and rapid growth has forced many Indian companies to look into their ERM. ERM is an enterprise wide process allowing companies to identify, assess and respond to the social, political and economic risks.

7.9 CASE STUDY: INFINITY & BEYOND, INC.

Infinity & Beyond, Inc. is a producer of high-tech fashion merchandise. The company's marketing department has identified a new product concept through discussions with potential customers conducted in three focus groups. The marketing department is excited about the new "concept" and presents it to top management who gives its approval for further study. Lisa Denney, senior director of new product and Web site development, is asked to create a plan and cost breakdown for the development, manufacture, and distribution of the product. Despite the enthusiasm of top management and the marketing department, Lisa is unsure about the product's market potential and the company's ability to develop it at a reasonable cost. To Lisa's way of thinking, the market seems ill-defined, the product goals unclear, and the product and its production technology uncertain. Lisa asks her chief designer to create some product requirements, a rough design that would meet the requirements and marketing concept, and to propose how the product might be manufactured and marketed.

After a few weeks the designer reports back with requirements that seem to satisfy the marketing concept. She tells Lisa that because of the newness of the technology and the complexity of the product design, the company does not have the experience to develop the product on its own, let alone manufacture it. Lisa checks out several design/development firms, asking one, Margo-Spinner Works Company, to review the product concept. Margo-Spinner Works assures Lisa that although the technology is new to them it is well within their capability. Lisa reports everything to top management who tells her to ignore any misgivings and go ahead with the development.

Lisa sets a fixed-price contract with Margo-Spinner and gives them primary responsibility for the entire development offer. Margo-Spinner management had argued for a cost-plus contract, but when Lisa stipulated that the agreement had to be fixed-price, Margo-Spinner said okay, only under the condition that it be given complete control of the development work. Lisa, who has never worked with Margo-Spinner, feels uncomfortable with the proposal, but knows of no other design company qualified to do the work, so she agrees. Several people from Infinity & Beyond, Inc. will be assigned to work at Margo-Spinner during the development effort, and during that time they will determine whether Infinity & Beyond, Inc. will be able to make the product or will have to outsource production.

Questions:

1. Discuss the major sources of risk in this project.
2. What do you think about Lisa's handling of the project so far? If you were her, what would you have done differently?
3. Discuss the handling of stages of the project—product concept, definition, development, and production—and what Lisa and other parties did that served to increase or decrease the risks.

7.10 NOTES

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7.11 SUMMARY

Risk management is at the core of all business, organisational and individual activities regardless of their nature or size. In projects, all the stakeholders (owner, sponsor, consultants, designers, project manager and others) face risky situations. All aim to minimize their risks to the planned approach.

Despite the various strategies that stakeholders adopt in order to prevent risks, the fact remains that risks are unavoidable. Risks vary from project to project and with the role of the stakeholder. Project stakeholder cannot stop the fast-changing, unstable, risk –prone environments but they must prepare themselves to manage the resulting impacts of risks to their role in the project. All stakeholders should prepare contingency plans to handle risks. If the project risks can be identified well in time, quantified in a logical manner, assigned roles and responsibilities among the stakeholder, allocated budget and managed effectively, then the likelihood of risk and cost overruns significantly reduced.

Risk generally signifies an uncertain event, situation, or condition which may occur.

In the project context, risk is "the, uncertainty inherent in plans and the possibility of something happening that can affect the prospects of achieving business or projects goals".

"Risk management is the process of identifying, measuring or assessing risk and developing strategies to manage it."

There are different types of risks. They are: Project scope Risks, Design and specification Risks, Quality Risks, Time overrun Risks, Cost Overrun Risks, Leadership Risks, Organisational risks, Physical Resources Mobilisation and Utilisation Risks, Technology Risks, Contractual Risks, Force majeure and Ecological Risks, political , legal and Social Risks, Financial and Economic Risks.

Risk management process refers to the process of identifying, measuring or assessing risk and then developing strategies to manage risk.

Identifying risk is the "process of determining which risks might affect the project and documenting their characteristics." The risk management process begins by trying to generate a list of all the possible risks that could affect the project.

Risk analysis or risk assessment aims at quantifying risk exposures to enable mitigation and development of project risk response plan for managing risks during execution of the project. Quantifying risks involves the estimation of the probability of occurrence and the risk consequences of each risk element. This is followed by the ranking of risks.

The risk response process considers risk transfer, reduction and avoidance possibilities. A response risk plan ensures that the appropriate risk warning tools are in place to handle risks efficiently. A predetermined risk response plan can maximise the benefits of positive future events.

Risk control aims at controlling deviations to cut down risks and maximise the project value. It handles the risk in a manner that achieves project objectives efficiently and effectively and by efficiently monitoring and adjusting plans and evolving alternate plans to manage foreseeable risks, whenever necessary.

7.12 KEY WORDS

Risk: The risk is "an uncertain event or condition that, if it occurs, has a positive or negative effect on a project's objectives."

Risk Management: "Risk management is a systematic approach in identifying, analysing and controlling areas or events with a potential for causing unwanted change."

Identifying Risk: Identifying risk is the "process of determining which risks might affect the project and documenting their characteristics."

7.13 SELF ASSESSMENT QUESTIONS

1. Define risk and risk management. Explain different types of risks.
2. Explain the steps in risk management process.

7.14 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.
2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.
3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.
4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.
5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill
6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011
7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002
8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012
9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.
10. Sanjiv Marwah. *Project Management.* New Delhi: Dreamtech Press, 2011.

UNIT - 8 : PROJECT COST ESTIMATION

Structure :

8.0 OBJECTIVES

After reading this unit, you should be able to:

- define project cost and project cost estimating
- explain the types of cost estimation.
- state the importance of project cost estimation.
- explain different types of costs and their estimation.
- explain the process of cost estimation.

8.1 INTRODUCTION

When a company or promoter intends to set up a new project, or undertaking expansion, diversification, modernization or rehabilitation scheme, it is necessary to ascertain the cost of the project. Cost of project is the aggregate of costs estimated to be incurred on various heads for bringing the project into existence. Cost estimating is the process of forecasting or approximating the time and cost of completing project deliverables.

In project management, cost estimation is an important activity. It forms the base for evaluation of the project. Project cost estimation is an area where judgment and experience are used in the application of scientific principles and techniques to estimate the cost of a project. In this unit, let us understand in detail the different aspects of project cost estimation.

8.2 MEANING OF PROJECT COST ESTIMATION

Cost of project is the aggregate of costs estimated to be incurred on various heads for bringing the project into existence. Estimating is the process of forecasting or approximating the time and cost of completing project deliverables.

Estimate cost is "the process of developing an approximation of the cost of the resources needed to complete project activities." Cost estimating is lined very closely with scope, schedule, and resource planning.

8.3 IMPORTANCE OF COST ESTIMATION

Cost estimation is one of the most important steps in project management. A cost estimate establishes the baseline of the project cost at different stages of development of the project. A cost estimate at a given stage of the project development represents a prediction provided by the cost engineer or estimator on the basis of available data. All project stakeholders prefer accurate cost and time estimates, but they also understand the inherent uncertainty in all projects. Inaccurate estimates lead to false expectations and consumer dissatisfaction.

Cost, time, and budget estimates are the lifeline for control. They serve as the standard for comparison of actual and plan throughout the life of the project. Project status reports depend on reliable estimates as the major input for measuring variances and taking corrective action. Ideally, the project manager, and in most cases the customer, would prefer to have a database of detailed schedule and cost estimates for every work package in the project. Regrettably, such detailed data gathering is not always possible or practical and other methods are used to develop project estimates.

To understand cost well, a project manager needs to understand what the work of the project includes, what schedule demands exist, and what people and other resources can used. As more of this detail becomes known, the cost estimates can be more precise.

8.4 PROJECT COST ESTIMATION

The project cost consists of capital cost, operating cost and maintenance cost. Cost estimation for a project aims to provide answers to a range of questions, including the following:

- How much money does the total project cost?
- What is the cost of a single unit?
- How much profit can be made?
- How much money do we need and when?
- What is the risk and how much money should be held in reserve?
- Are the subcontractors asking for a reasonable price?

Virtually, all cost estimation is performed according to one or some combination of the following basic approaches:

8.4.1 Production Function

In microeconomics, the relationship between the output of a process and the necessary resources is referred to as the production function. In construction, the production function may be expressed by the relationship between the volume of construction, and a factor of production such as labour or capital. A production function relates the amount or volume of output with the various inputs of labour, material and equipment.

8.4.2 Empirical Cost Inference

Empirical estimation of cost function requires statistical techniques which relate the cost of development, production or operating a facility to a few important characteristics or attributes of the system of interest. The role of statistical inference is to estimate the best parameter values in an assumed cost function, usually, accomplished by means of regression analysis.

8.4.3 Unit Cost of Bill of Quantities

A unit cost is assigned to each of the facility component or takes as represented by the bill of quantities. The total cost is the summation of the product of the quantities multiplied by the corresponding unit costs. The unit cost method is straightforward, simple in principle but quite laborious in application. The initial step is to split (breakdown) or disaggregate a process into a number of tasks. Collectively, this task must be completed. A unit cost is assigned to each and then the total cost is determined by summing the cost incurred on each task. The level of detail in decomposing into tasks will vary considerably from one estimator to another.

8.4.4 *Allocation of Joint Costs*

Allocation of joint costs from existing accounts may be used to develop a cost of an operation. The basic idea in this method is that each expenditure item can be assigned to particular characteristic of the operation. Ideally, the allocation of joint costs should be casually related to the category of basic costs in an allocation process. In many instances, however, a causal relationship between the allocation factor and the cost item cannot be identified or may not exist, for example, construction equipment, construction supervision and general office overhead.

In order not to forget any item in the cost estimation, a cost breakdown structure (CBS) is a useful tool. The cost associated with includes both the initial capital cost and the subsequent operation and maintenance costs. Each of these cost categories consists of a number of cost components.

8.4.5 Capital Cost

This section discusses the components of capital cost and the types of cost estimates.

COMPONENTS OF CAPITAL COST:

The capital cost of a project includes the expenses related to the initial establishment of the project needed, which are listed below:

- Land acquisition, including assembly, holding and improvement
- Planning and feasibility study
- Architectural and engineering design
- Construction including materials, equipment and labour.
- Field supervision of construction
- Production and development financing
- Insurance and taxes during development , production and deployment
- Owners general office overhead
- Inspection and testing

8.5 TYPES OF COST ESTIMATES

In construction type projects, the types of cost estimates are listed below

1. Designing estimates
2. Bid estimates
3. Control estimates

1) Designing estimates

For the owners over its designated design professionals, the types of cost estimates that are encountered run parallel with the planning and design as follows

- Screening estimates (or order of magnitude estimates)
- Preliminary estimates (or conceptual estimates)
- Detailed estimates (or definitive estimates)
- Engineer estimates based on plans and specifications

Screening estimates is usually made before the facility is designated and must, therefore, relay on the cost data of similar facilities built in the past. A preliminary estimate is based on the conceptual design of the facility at the state when the basic technologies for the design are known. the detailed estimates are made when the scope of work is clearly defined and the detailed design is in progress so that both essential features of the facility are identifiable. The engineer's estimate is based on the completed plans and specifications when they are ready for the owner to solicit bids from construction contractor. In preparing these estimates, the design professional will include expected amounts for contractors overhead and profits.

2) Bid estimates

The contractors bid estimates often reflect the desire of the contractor to secure the job as well as the estimating tools at its disposal. Some contractors have well established cost estimating procedure while others do not have such procedures since only lowest bidder will be the winner of the contract. In most bidding contests, any effort devoted to cost estimating is a loss to the contractor who is not a successful bidder. Consequently, the contractor may put in the least amount of possible effort for making a cost estimate if the contractor believes that his chance of success is not high. If a general contractor intends to use sub contractors in the construction of a facility, the contractor may solicit price quotations for various tasks to be sub contracted to specially sub contractors. Thus the general contractors will shift the burden of cost estimating to sub contractors. If all or part of the construction is to be undertaken by the general contractor, a bid estimate may be prepared on the basis of the quantity take –off s from the plans provided by the owner or on the basis of the construction procedure devised by the contractor for implementing the project.

3) Control estimates

Both the owner and contractor must adopt some baseline for the cost control during the construction. For the owner, the budget estimate may be adopted early enough for planning long term financing of the facility. Consequently, the detailed estimates often used as the budget estimates since it is sufficient, definitive to reflect the project scope and is available long before the engineer's estimate. As the work progresses, the budgeted cost must be revised periodically to reflect the estimated cost to completion. A revised estimated cost is necessary either because of change order designed by the owner or due to unexpected cost overruns or savings for the contractors. The bid estimate is usually regarded as the budget estimate which will be used for control purpose as well as for planning construction financing. The budgeted cost should also be updated periodically to reflect the estimated cost to completion as well as to ensure adequate cash flows for the completion of the project.

8.6 CONTINGENCY IN CAPITAL COST ESTIMATION

Contingency is a key component of all cost estimates, from conceptualization of a technology or project to its final implementation. Among project managers, financial managers and project owners, the connotations of contingencies may differ, depending on the potential impact to a capital project and the resources needed to address them. proper contingency assessment is required for capital projects to achieve their technical and business objectives

.Contingency is defined as an amount added to a cost estimate for the established projects, scope to account for items, conditions , the requirements that the experience has already shown , will likely result in additional project costs.

Conceptual or early stage capital cost estimates are initiator prior to the expenditure of resources on process development, its scope is defined with more and more detail, and project elements that are not depicted in conceptual stage process flow diagram are identified. The requirements for the project's implementation are identified and then detailed in an evolutionary way.

Contingencies are not intended to account for major changes that do not add detail to the project scope, such as changes in overall process flows and unit operations, capacities, end-product specifications, facility sizes, major demolition work, start-up expenses, accelerated construction schedules, cost escalation, currency effects, and extraordinary events such as major strikes and natural disaster.

Scope definition refines the process flow sheets by adding detail to the already-identified unit operations with attractive economic returns, such as material recycle, energy and utilities conservation, process instrumentation, and controls and buildings and infrastructure requirements. In contrast, previously unidentified unit operations are considered as major scope changes, and are not included in the contingency for the defined project scope and corresponding cost estimate.

8.7 OPERATION AND MAINTENANCE COST

In order to analyze the life cycle cost of a proposed facility it is necessary to estimate the operation and maintenance cost over time after the start of the facility. The stream of operating costs over the life of the facility depends upon subsequent maintenance costs. The costs will be reduced if the facility undergoes periodic repairs and rehabilitation at periodic intervals. Since the trade-off between the capital cost and the operating cost is an essential part of economic evaluation of a facility, the operating cost is viewed not as a separate entity, but as a part of the larger parcel of life cycle cost at the planning and design stage itself. The techniques of estimating life cycle costs are similar to those used for estimating capital cost including empirical cost function and the unit cost method of estimating the labour, material and equipment costs. However, it is the interaction of the operating and capital costs which deserve special attention. The cost estimation of any rehabilitation project may also involve capital and operating costs.

COMPONENTS OF OPERATION AND MAINTENANCE COSTS

The operation and maintenance costs during subsequent years of the project life cycle include the following costs.

- Land rent, if applicable
- Operating Staff
- Labour and materials for Maintenance and Repairs.
- Insurance and taxes
- Financing costs
- Utilities costs
- Owner's other Expenses

The Magnitude of each of these cost components depends on the nature, Size and location of the project as well as the management organization, among many considerations. The owner is interested in achieving the lowest possible overall project cost that is consistent with Its Investment objectives. It Is Important to Note that the construction/Development cost is the Single Largest component of the capital cost, while other cost components are not significant.

8.8 COST ESTIMATING PROCESS

The cost estimating process begins by breaking the project down into work phases such as design, engineering, development, fabrication, and so on, or into work packages from the WBS. The project team, including representatives from the involved functional areas and contractors, meet to discuss the work phases or work packages, and to receive specific work assignments.

Classifying Work Tasks and costs: The team tries to identify tasks in the project similar to existing designs and standard practices that can readily be adopted. Work is classified either as developmental or as an adaptation of existing or off-the shelf designs, techniques, or procedures. Because developmental work required considerable effort in design, testing, and fabrication. Hence, cost estimating is thus, more difficult due to the greater uncertainty about what needs to be done. Overruns for developmental work are common, especially because of the difficulty in estimating labour hours. Estimation for standard, off-the-shelf work is more straightforward because it is based upon records of material and labour costs for similar systems or tasks. It is thus beneficial to try to make use of existing designs and technology in as many work packages as possible; this helps reduce estimating errors and may produce cost savings.

Estimated costs are classified as recurring and nonrecurring. Recurring cost are those that happen more than once; they are associated with tasks periodically repeated and include costs for labour, materials, tooling, quality assurance, and testing. Nonrecurring costs happen only once and are associated with unique tasks or procurement of special items; they include development, fabrication, and testing of one-of-a-kind items.

In the pure project form of organization, the project manager assigns responsibility for estimating, directs the estimating effort, and combines the estimate results for presentation to management. In a matrix organization, estimating is the joint responsibility of the project and functional managers, though the project manager coordinates the effort and accumulates the results. Close coordination and communication during the estimating effort is crucial for reducing redundancies and omissions—especially for estimates from groups working jointly on interfacing work packages.

Although this typifies the cost estimating process, the actual method used to estimate cost figures will depend on the required accuracy and the information available to make the estimate.

8.9 TECHNIQUES FOR DEVELOPING COST ESTIMATES

Techniques employed for developing the project cost estimate would depend on needs of the organization at a particular phase of the project life cycle. There are four basic techniques for cost estimation. They are: expert opinion, analogy, parametric, and cost engineering.

I. **Expert Opinion**: an expert opinion is an estimate provided by an expert—presumably someone who, from breadth of experience and expertise, is able to provide reasonable estimate. Expert opinion is usually limited to cost estimating at the conception phase of the project or for a project that is poorly defined or is unique and for which there are no previous, similar projects available for comparison.

II. **Analogy Estimate:** An analogy estimate is an estimate developed by reviewing costs from previous, similar projects. The analogy method can be used at any level: Overall project cost can be estimated from the cost of an analogous project; work package cost can be estimated form other analogous work packages; task cost can be estimated from analogous tasks; and so on. The cost for similar project or work package is analyzed and adjusted for differences between it and the proposed project or work package. The adjustment takes into account factors such as dates, project scale, location, complexity, exchange rates, and so on.

III. **Parametric estimate:** A parametric estimate is an estimate derived from an empirical or mathematical relationship. The parametric method can be used with an analogy project or can be applied directly- without an analogy project. The parameters can be physical features such as area, volume, weight, or capacity, or performance features such as speed, rate of output, power, or strength. Parametric cost estimating is especially useful when preliminary design characteristics are first being set and cost estimate is needed quickly.

IV. **Cost Engineering:** Cost Engineering refers to detailed cost analysis of individual cost categories at the work package or task level. It provides the most accurate estimate of all the methods, but also is the most time consuming, requiring considerable work definition detail and design information—both of which might not be available until later in the project. The method starts by first breaking down the project into activities or work packages, then further dividing these into cost categories such as labour, material, and equipment. For small projects the approach is simple and straightforward.

8.10 CASE STUDY: SHARP PRINTING, AG

Three years ago the Sharp Printing (SP) strategic management group set a goal of having a colour laser printer available for the consumer and small business market for less than $200. A few months later the senior management met off-site to discuss the new product. The results of this meeting were a set of general technical specification along with major deliverables, a product launch date, and a cost estimate based on prior experience.

Shortly afterward, a meeting was arranged for middle management explaining the project goals, major responsibilities, the project start date, and importance of meeting the product launch date within the cost estimate. Members of all departments involved attended the meeting. Excitement was high. Although everyone saw the risks as high, the promised rewards for the company and the personnel were emblazoned in their minds. A few participants questioned the legitimacy of the project duration and cost estimates. A couple of R&D people were worried about the technology required to produce the high-quality product for less than $200. But given the excitement of the moment, everyone agreed the project was worth doing and doable. The colour laser printer project was to have the highest project priority in the company.

Lauren was selected to be the project manager. She had 15 years of experience in printer design and manufacture, which included successful management of several projects related to printers for commercial markets. Since she was one of those uncomfortable with the project cost and time estimates, she felt getting good bottom up time and cost estimates for the deliverables washer first concern. She quickly had a meeting with the significant stakeholders to create a WBS identifying the work packages and organizational unit responsible for implementing the work packages. Lauren stressed she wanted time and cost estimates from those who would do the work or were the most knowledgeable, if possible. Getting estimates from more than one source was encouraged. Estimates were due in two weeks.

The compiled estimates were placed in WBS/OBS. The corresponding cost estimate seemed to be in error. The cost estimate was $1,250,000 over the senior management estimate; this represents about a 20 per cent overrun! The time estimate from the developed project network was only four months over the top management time estimate. Another meeting was scheduled with the significant stakeholders to check the estimates and to brainstorm for alternative solutions; the cost and time estimates appeared to be reasonable. Some of the suggestions for the brainstorming session are listed below.

- Change scope.
- Outsource technology design.
- Use the priority matrix to get top management to clarify their priorities.
- Partner with another organisation or build a research consortium to share costs and to share the newly developed technology and production methods.
- Cancel the project.
- Commission a break-even study for the laser printer.

Very little in the way of concrete savings was identified, although there was consensus that time could be compressed to the market launch date, but at additional costs.

Lauren met with the marketing (Connor), production (Kim), and design (Gage) managers who yielded some ideas for cutting costs, but nothing significant enough to have a large impact. Gage remarked, "I wouldn't want to be the one to deliver the message to top management that their cost estimate is $1,250,000 off! Good luck, Lauren."

Questions:

1. At this point, what would you do if you were the project manager?
2. Was top management acting correctly in developing an estimate?
3. What estimating techniques should be used for a mission critical project such as this?

8.11 NOTES

8.12 SUMMARY

Cost of project is the aggregate of costs estimated to be incurred on various heads for bringing the project into existence. **Cost estimating** is the process of forecasting or approximating the time and cost of completing project deliverables.

In project management, **cost estimation** is an important activity. It forms the base for evaluation of the project.

Estimate cost is "the process of developing an approximation of the cost of the resources needed to complete project activities." Cost estimating is lined very closely with scope, schedule, and resource planning.

Importance: Cost estimation is one of the most important steps in project management. A cost estimate establishes the baseline of the project cost at different stages of development of the project. A cost estimate at a given stage of the project development represents a prediction provided by the cost engineer or estimator on the basis of available data. All project stakeholders prefer accurate cost and time estimates, but they also understand the inherent uncertainty in all projects. Inaccurate estimates lead to false expectations and consumer dissatisfaction.

Cost, time, and budget estimates are the lifeline for control. They serve as the standard for comparison of actual and plan throughout the life of the project.

The project cost consists of capital cost, operating cost and maintenance cost. Cost estimation for a project aims to provide answers to a range of questions,

Virtually, all cost estimation is performed according to one or some combination of the following **basic approaches**:

In microeconomics, the relationship between the output of a process and the necessary resources is referred to as the **production function**.

A production function relates the amount or volume of output with the various inputs of labour, material and equipment.

Empirical estimation of cost function requires statistical techniques which relate the cost of development, production or operating a facility to a few important characteristics or attributes of the system of interest.

A unit cost is assigned to each of the facility component or takes as represented by the bill of quantities. The total cost is the summation of the product of the quantities multiplied by the corresponding unit costs.

Allocation of joint costs from existing accounts may be used to develop a cost of an operation. The basic idea in this method is that each expenditure item can be assigned to particular characteristic of the operation.

The capital cost of a project includes the expenses related to the initial establishment of the project needed,

In construction type projects, the **types of cost estimates** are listed below

1. Designing estimates
2. Bid estimates
3. Control estimates

Contingency is a key component of all cost estimates, from conceptualization of a technology or project to its final implementation.

Contingency is defined as an amount added to a cost estimate for the established projects, scope to account for items, conditions , the requirements that the experience has already shown , will likely result in additional project costs.

In order to analyze the life cycle cost of a proposed facility it is necessary to **estimate the operation and maintenance cost** over time after the start of the facility.

The stream of operating costs over the life of the facility depends upon subsequent maintenance costs.

The project team, including representatives from the involved functional areas and contractors, meet to discuss the work phases or work packages, and to receive specific work assignments.

The cost estimating process begins by breaking the project down into work phases such as design, engineering, development, fabrication, and so on, or into work packages from the WBS.

8.13 KEY WORDS

Cost of project: It is the aggregate of costs estimated to be incurred on various heads for bringing the project into existence.

Cost estimating: It is the process of forecasting or approximating the time and cost of completing project deliverables.

8.14 SELF ASSESSMENT QUESTIONS

1. What is cost estimation? Explain its importance in project management**.**
2. What is project cost estimation? What are the components of project cost?
3. Explain the different types of cost estimates.
4. Discuss the techniques of cost estimation.

8.15 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.
2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.
3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.
4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.
5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill
6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011
7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002
8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012
9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.
10. Sanjiv Marwah. *Project Management.* New Delhi: Dreamtech Press, 2011.

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DEPARTMENT OF STUDIES AND RESEARCH IN MANAGEMENT

M.B.A III Semester

COURSE - 15 : PROJECT MANAGEMENT

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3

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BLOCK - 3 : PROJECT IMPLEMENTATION

Once the project identified, it has to implement. This block is concerned with implementation project ideas. This block is divided into four units.

Unit-9 deals with enterprise location. Identification of proper location is the key element of success. This unit at the outset discusses the need for enterprise location, then it explains the importance of enterprise location and step, in identifying enterprise location.

Unit- 10 focusses on the selection of location and theories of location. Once various location identified the firm has to select best among the alternatives, the theories of location helps a projet manager in selecting better location. This unit further focusse on the important factors to be considered while selecting a site.

Unit- 11 deals with work breakdown structure, at the outset this unit defines WBS , and explains how WBS helps the manager, this unit also focusses as factors considering in developing a WBS , WBS uses and other important issues relating WBS.

Unit- 12 is concerened with project scheduling resource allocation . This unit at outset, focused on purpose of project scheduling, evolution of project scheduling. Further, this unit deals with the network techniques, resource allocation and resource loading.The unit also deals scheduling resource for utilization and given availability , crashing, allocating resources to several projects, resources allocation and project life cycle. The benefit of scheduling resources.

UNIT - 9 : INTRODUCTION ENTERPRISE LOCATION

Structure :

9.0 OBJECTIVES

After reading this unit, you should be able to:

- define project implementation,
- explain the need for enterprise location,
- explain the importance of enterprise location, and
- explain the steps in identifying enterprise location.

9.1 INTRODUCTION

A Large public or private sector organization usually will have project department as one of the departments in the total organization structure. In these organizations, activities for main business as well as construction work run concurrently. Hence, the project department exists along with other functional departments such as production, finance, marketing, personnel. Once the project organization, project administration, engagement of consultants, preparation of technical specifications, contract finalization and execution of contracts have been covered the next main activity is project implementation.

Project Implementation- defined.

The term project implementation consists of two terms, namely, project and implementation.

Project is a temporary endeavor undertaken to create a unique product or service. It is specific, timely, usually multidisciplinary and always conflict ridden. Projects are always part of overall programs and may be broken down into tasks, sub-tasks and further if desired.

Implementation means the act of providing a practical means for accomplishing something or putting something into effect.

So **project implementation** is the act of giving practical effect to the temporary Endeavour undertaken to create unique product or services with a specific time frame.

9.2 NEED FOR ENTERPRISE LOCATION

The need for enterprise location arises under the following circumstances:

1. When a new enterprise is to be established.
2. When there is a need for expansion, decentralization, and diversification of existing enterprise, the need arises to take location decision.

3. Whenever the existing factory is not in a position to obtain renewal of lease.
4. When an undesirable location is to be abandoned.
5. When there is shift in market, depletion of raw material source, changes in transportation facilities, new processes are to be introduced and which require a different location.
6. When a new branch or branches are to be opened for increasing the volume of production or distribution or both.

9.3 THE IMPORTANCE OF ENTERPRISE LOCATION

Everyone who wants to start a new business or wants to expand an existing business by opening a branch or by opening a new production facility must also decide the place to locate his business. He has to decide whether location is important for the success of his business or not. If he thinks that the location is important for his business, entrepreneur has to answer the questions such as what type of location is best for his business. Is proposed location appropriate for the business he/she has planned to start?

For some businesses choosing an appropriate location is very important. For some other enterprises, finding an affordable rental space is more important and location is irrelevant. For example, the service businesses that do all their work at their customers' locations (such as roofers and plumbers) and businesses that have little contact with the public (such as mail order companies, internet based businesses, and wholesalers). For these types of enterprises, picking up a low cost location is advantageous.

The decision to locate a business in a particular place is very important because it has far-reaching and often long-lasting effects on the business. Entrepreneurs will have to choose their locations keeping in mind their customers' preferences and their company' needs. Those who choose their business locations wisely can establish an important competitive advantage over rivals who choose their locations haphazardly. Because the availability of qualified workers, tax rates, quality of infrastructure, traffic patterns, and many other factors vary from one location to another. Hence, the location decision is an important one that can influence the growth rate and ultimate success of a company.

The characteristics that make for an ideal location often vary dramatically from one company to another due to the nature of their business. One has to ask the questions such as:

- Will customers come on foot?
- Will customers drive and, if so, where will they park?
- Will more customers come if you locate near other similar businesses?

- Will the reputation of the neighborhood or even of a particular building help draw customers?

Different types of businesses attract customers in different ways. Opening a restaurant where pedestrian traffic is high when the restaurant is open for business can attract lots of customers. On the other hand, for an auto repair shop, the choicest locale is a well travelled street where the shop will be seen by many drivers who can easily pull into the lot.

It would benefit a new business to be around similar businesses that are already drawing the type of customers the new business wants to attract. A women's clothing store, for example, would no doubt profit from being near other clothing shops, since many people shopping for clothes tend to spend at least a few hours in a particular area.

In early 20th century, companies gave importance to availability of natural resources and market to locate their enterprises. The reason is that the industries were based on natural resources and were consumer oriented. But over the period, the very consideration for locating industries in particular region has undergone a considerable change. Today, entrepreneurs are more likely to look for sites that offer high-speed internet access, skilled workers and accessible airports. Concentration of IT industry in Bengaluru, Hyderabad, pune is one such example.

Ultimately, the perfect location for any business is a very individual matter. Entrepreneur is required to spend more time figuring out the habits of the customers he wants to attract, and then choose a location that fits.

9.4 STEPS IN IDENTIFYING ENTERPRISE LOCATION

The location decision of a business is a step by step process. At each step in the decision process entrepreneurs must analyze how well the characteristics of a particular location match the unique requirements of their businesses.

The location decision process resembles a pyramid. The first level of the decision is the broadest, requiring an entrepreneur to select a particular region or country. Then choose right state. Then right city and finally the right site within the city.

The secret in selecting the ideal location lies in knowing which factors are most important to a company's success. And then find a location that satisfies as many of them as possible, particularly those that are most critical.

9.4.1 Choosing the region or country

First step in selecting the best location is to focus at the regional level. Which region of the country has the characteristics necessary for the success of a business? Above all, the entrepreneur must always place the customer first in his or her mind when deciding on a location.

Common requirements may include rapid growth in the population of a certain age group, rising disposable incomes, the existence of necessary infrastructure, non union environment and low cost. At the broadest level of location decision, entrepreneurs usually determine which region of the country is experiencing substantial growth. Every year many popular business publications prepare report on the various regions of the nations which are growing, which are stagnant and which are declining. Studying shifts in population and industrial growth will give entrepreneurs an idea of where the action is and is not.

The questions to be considered include the following:

- How large is the population?
- How fast is it growing?
- What is the makeup of overall population?
- Which segment is growing fastest?
- Which segment is growing slowest?
- What is the trend in the population income and is it increasing or decreasing?
- Are other businesses moving into the region, and if so, what kind of businesses are they?

Generally, entrepreneurs want to avoid dying regions. Such regions simply cannot support a broad base of potential customers. A small company's customers are the people, businesses and the industry in an area and if it is to be successful, it must choose a location that is convenient to its customers.

9.4.2 Choosing the state

Every state has an economic development office working to recruit new businesses. Even though the publications produced by these offices will be biased in favour of locating in that state, they still are an excellent source of information and can help entrepreneurs to assess the business climate in each state.

Some of the key issues to explore include the laws, regulations and taxes that govern businesses and any incentives or investment credits the state may offer to business that locate there.

Other factors entrepreneur should consider when choosing a location are explained below.

Proximity to markets

Locating close to markets they plan to serve is extremely critical to manufacturers, especially when the cost of transformation of finished goods is high relative to their value. Locating near customers is necessary to remain competitive. Service firms often find that proximity to their clients is essential, if a business is involved in repairing equipments used in a specific industry, it should be located where that industry is concentrated. The more specialized a business, or the greater the relative cost of transporting the product to the customer, the more likely it is that proximity to the market will be of critical importance in the location decision.

Proximity to needed raw materials

If a business requires raw materials that are difficult or expensive to transport, it may need a location near the source of those raw materials. Transporting the heavy, low value material over long distances would be impractical and unprofitable. In other situations in which bulk or weight is not a factor, locating manufacturing in close proximity to the suppliers can facilitate quick deliveries and reduce holding cost for inventories. The value of products and materials, their cost of transportation, and their unique function all interact to determine how close a business needs to be its sources of supply.

Wage rates:

Existing and anticipated wage rates will provide another measure for comparison among states. Wages can sometimes vary from one state or region to another, significantly affecting a company's cost of doing business.

When reviewing wage rates, entrepreneurs must be sure to measure the wage rates for jobs that relate to their particular industries or companies.

Entrepreneurs should study not only prevailing wage rate but also trends in rates. How does the rate of increase in wage rates compare to those in other states. Another factor influencing the wage rate is the level of union activity in a state.

Labor supply needs

For much business, especially technology driven companies, one of the most important characteristic of a potential location is the composition of the local work force. Entrepreneurs must consider two factors when analyzing the labour supply in a potential location: the number of workers available in that area and their levels of education, training, adaptability and experience. Some states have attempted to attract industry with the promise of cheap labour. Unfortunately, businesses locating these found exactly what the term implied- unskilled, low wage labor that is ill suited for performing the work the companies needed.

Knowing the exact nature of the labour needed and preparing job descriptions and job specifications in advance will help a business owner to determine whether there is a good match with the available labour pool. Reviewing the major industries already operating in an area will provide clues about the characteristics of the local work force as well checking with the high schools, colleges and universities in the state to determine the number of graduates in relevant fields of study will provide an idea of local supply of qualified workers.

Business climate

- What is the state's overall attitude toward your kind of business?
- Has it passed laws that impose restriction on the way a company can operate?
- Does the state impose a corporate income tax?
- Is there an inventory tax?
- Are there "blue laws" that prohibit certain business activity on Sunday?
- Does the state offer small business support program or financial assistance to entrepreneurs?
- Are you located in a rural area of the state that may offer special load and promotion programs?

These are the issues an owner must compare on a state by state basis to determine the most suitable location.

Tax rates

Entrepreneurs must consider when screening states for potential locations is the tax burden they impose on business and individuals. And entrepreneurs must evaluate the impact of payroll taxes, sales taxes, property taxes, inventory taxes, and specialized taxes on the cost of their operations.

Currently seven states impose no income tax on their residents, but state governments always impose taxes of some sort on businesses and individuals,\. In some cases, states offer special tax rates or are willing to negotiate fees in lieu of taxes for companies that will create job and stimulate the local economy.

Internet access

Speedy and reliable internet access is an increasingly important factor in the location decision. Fast internet access through cloud, DSL or T1 lines is essential for high tech companies and those engaging in e-commerce. Even those companies may not business over the web currently are finding it nearly certain that they will use the web as business tool. Companies that fall behind in high tech communication will find themselves at sever competitive disadvantage.

Total operating costs:

When scouting a state in which to locate a company, an entrepreneur must consider the total cost of operating a business. For instance, a state may offer low utility rates, but its labor costs and tax rates may be among the highest in the nation. To select the ideal location, entrepreneur must consider the impact of a states, total cost of operation on their business ventures.

9.4.3 Choosing the city

Population trends:

Analyzing over the time the lists of "best cities for business" compiled annually by many magazines reveals one consistent trend. Successful small companies in a city tend to track a city's population growth. In other words, potential customers mean that a small business has a better chance of success.

Entrepreneur should know about the cities in which their business are located and then do the people who live there. By analyzing population and other demographic data, an entrepreneur can examine a city in detail. And location decision becomes more than just an educated guess, or worse a shot in dark. Studying the characteristics of residents of city including population size and density, growth trend family size, age break downs, education income level, job categories, gender religion, race and nationality gives an entrepreneur the facts she or he needs to make an informed location decision.

A company's location should match the markets for its services or products. And assembling a demographic profit will tell the entrepreneur how well a particular site measures up to his targets markets profit likely want specific information an family income, size, age, education. Such a shop would need to be in an area where people appreciate the product and have discretionary income to purchase it.

Trends or shifts in population components may have more meaning than more population trends. For example, if a cities population is aging rapidly, its disposal income may be decreasing and the city may be gradually dying. On the other hand, the city may be experiencing rapid growth in the population of high income, young professionals.

The amount of available data on the population of any city or town is staggering. These statistics allow a potential business owner to compare a wide variety of cities or towns and to narrow the choices to those few that warrant further investigation. An analysis of the data makes it possible to screen out desirable locations to few, but it does not make the final location decision for an entrepreneur. Entrepreneur must see the potential locations on their "short list" first hand.

Competition:

For some retailers it make since to locate near competitor because similar businesses located near one another may serve to increase the traffic flow to both. This location strategy works well for products for which customers are most likely to comparison shop. The convenience of being able to shop for dozens of brands of cars all within a few hundred yards of one another draws customers from a sizable trading area. Locating near competitors is a common strategy for restaurants as well, off course this strategy has limits overcrowding of business of same type in an area can create an undesirable impact on profitability of all competing firms. Consider the nature of businesses in the area do they offer the same quality merchandise or comparable services? The product or service of a business may be superior to those that competitors currently after giving it a competitive edge.

Clustering:

Some cities have characteristics that attract certain industries and as a result company tend to cluster there, clusters are graphical construction of inter connected companies specialized suppliers and service providers that are present in a region.

Clusters are important because they allow companies in them to increase their productivity and to gain a competitive edge.

Compatibility with the community:

One of the intangibles that can be determined only by a visit to an area is the degree of compatibility the business as with the surrounding community. In other words a small company's image must fit in with the character of a town and needs and wants of residence.

Local laws and regulations:

Before setting on a city the entrepreneur must consider the regulatory burden Local government might impose. Government regulation affects many aspects of business operation from acquiring business licenses and building permits to creating business sight and dumping trash. Some cities are regulatory activist, creating so many rules that they discourage business creation \.other take the lazier faire approach, imposing few restrictions o business.

Zoning laws can have a major impact on an entrepreneurs location decision, zoning is a system that divides a city or country into small cells, or districts to controlee the use of land, building and sites, its purpose is to contain similar activities in suitable locations.\

Transportation networks:

Business owners must investigate the quality of local transportation systems, is an airport located nearby? All flights are available to necessary cities and are the schedules convenient? If a company needs access to the rail road's, is one available in the city? How convenient is the area access to major highways? What about to travel distance to major customers? How long will it take to deliver shipments to them? Is the transportation cost reasonable? Where it is nearest to see port? For efficient conduct of business.

Policies and fire protection:

Does the community in which you planned to locate offer adequate policies and fire protection? If these services are not adequate and crime rates are high, the cost of company's business insurance will reflect that.

Cost of utilities and public services:

A location should be served by a governmental unit that provides water and sewer services, trash and garage collection and other necessary utilities at reasonable cost, the streets should be in a good repair with adequate drainage, if the location is not within the jurisdiction of a municipality that provide these services, they will becoming continuing cost to the business.

9.4.4 Choosing a site

The final step in the location selection process is choosing the actual site for business. Again facts will guide the entrepreneur to the best location decision, every business has its own unique set of criteria for an ideal location a manufacturers prime consideration may be access to raw materials, suppliers, labors, transportation and customers service firms need access tom customers but generally can survive in lower rent properties,. A retailer prime consideration is sufficient customer traffic. The site location decision draws on the most information precious available on the makeup of the area, using the source of published statistic an entrepreneur can develop valuable insight regarding the characteristics of people and the business in the immediate community.

9.5 CASE STUDY

1. Mr. BhagavathiAchar, 35, hails from the traditional family of carpenters. He grew up observing his father do carpentry and helping him. After completing his Pre University education, he took to carpentry for his livelihood. He gets a lot of work such as planing, grooving, turning, drilling, edge cutting, etc. done from a local wood planing works. He observed that there is a lot of work for this machine and he was waiting for a day or two to get his work done. The population of the town where he lived is 6 lakhs and it is one of the fastest growing towns in the State. A lot of construction activity is going on and he has seen many of his fellow carpenters getting more than they can handle. Mr. BagavathiAchar wants to start a wood planing works in his town. But he is finding it difficult to take the decision as to where to locate his enterprise in the town. Help him explaining the factors he should consider in choosing the location for his wood planing enterprise.

2. Mr. Sandesh, has been working as a software engineer in a multinational company for the fast 10 years. His wife and few other close friends are also in the software field as engineers. Mr. Sandesh is planning to start a small software consultancy from in small town in Karnataka, away from Bangalore city. He thinks that he can get a lot of space for throw away price and there is no rush. But his wife and friends advice him that it would be very difficult to get the work and skilled workers in that small town where Sandesh wants to establish his software enterprise. You are approached by Mr. Sandesh for expert advice for location decision. Advice him keeping in view the business interests of Sandesh.

9.6 NOTES

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9.7 SUMMARY

Project implementation is the act of giving practical effect to the temporary endeavour undertaken to create unique product or services with a specific time frame.

The decision to locate a business in a particular place is very important because it has far-reaching and often long-lasting effects on the business. Entrepreneurs will have to choose their locations keeping in mind their customers' preferences and their company' needs. Those who choose their business locations wisely can establish an important competitive advantage over rivals who choose their locations haphazardly.

The location decision of a business is a step by step process. At each step in the decision process entrepreneurs must analyze how well the characteristics of a particular location match the unique requirements of their businesses.

First step in selecting the best location is to focus at the regional level. Which region of the country has the characteristics necessary for the success of a business? This question is to be answered in selecting the region.

The second step is selection of a state within the region. The factors which influence the decision to choose a state are: Proximity of markets, proximity to needed raw-materials, wage rates, labour supply needs, business climate, tax rates, internet access, and total operating cost.

The third step is choosing a city within the state. The important factors which influence this decision are: Population trends of the city, competition, clustering, compatibility with the community, local laws and regulations, transportation networks, police and fire protection, cost of utilities and public services.

The final step is choosing a site in the chosen city.

Choosing the right location requires an entrepreneur to evaluate potential sites with target customers in mind.

9.8 KEY WORDS

Project: it is a temporary endeavour undertaken to create a unique product or service.
Implementation: it means the act of providing a practical means for accomplishing something or putting something into effect.

Project implementation: it is the act of giving practical effect to the temporary endeavour undertaken to create unique product or services with a specific time frame.

9.9 SELF ASSESSMENT QUESTIONS

1. Why is selection of the right site so important? Why is it more vital in some industries than in others? Give two examples.
2. What factors should a manager consider when evaluating a region in which to locate a business?
3. Outline the factors important when selecting a state in which to locate a business.
4. What factors should a seafood processing plant, a beauty shop, and an exclusive jewelry store consider in choosing a location?
5. What intangible factors might enter into the entrepreneur's location decision?

9.10 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.
2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.
3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.
4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.
5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill
6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011
7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002
8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012
9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.
10. Sanjiv Marwah. *Project Management.* New Delhi: Dreamtech Press, 2011.

UNIT - 10 : SELECTION OF LOCATION AND THEORIES OF LOCATION

Structure :

10.0 OBJECTIVES

After reading this unit, you should be able to:

- explain selection of location for an enterprise,
- explain Weber's theory of Industrial location,
- explain the process of selecting general area, and
- discuss the important factors considered in the selection of a site.

10.1 INTRODUCTION

Location of an enterprise in a particular place is an important factor determining the ultimate success or failure of the enterprise. Entrepreneurs locate their industries in those places where the cost of production is the lowest at the time of their establishment. This is known a 'Location of Industries.' The major theories of industrial location were developed by the economists. Some of them were pioneering and useful in understanding the locational behavior of the firm. One such theory is the theory of Industrial location developed by Alfred Weber of Germany. We will understand this theory in greater detail in this unit.

10.2 SELECTION OF LOCATION

We have already understood in great detail the step by step process of selection of location. We will recollect them once again here.

In choosing a plant location, the entrepreneur is required to follow the under mentioned steps:

a) Selection of the region;

b) Selection of the locality or community;

c) Selection of the exact site; and

d) Selection of an optimum site.

10.3 WEBER'S THEORY OF INDUSTRIAL LOCATION

Alfred Weber, a German economist, has developed one of the earliest approaches to explain the location of industry. Weber's main interest was to construct a general theory of location which could be applied to all industries at all times. For this, he has taken into account the general factors of location which were relevant to all industries.

Weber's work was published in German in 1909. It was translated into English in 1929. Only after the publication of Weber's work in English, modern and rational thinking on ideal location of industries were started. This theory provided the foundation for later disposition of theories on Industrial location.

10.3.1 Assumptions made by Weber

Weber made some simplifying assumptions for his analysis. They are:

1. The locations of raw materials including fuel are fixed;
2. Situation and size of consuming centres are given; and
3. There are several fixed labour supply centres; labour is immobile and unlimited in supply at fixed wage rate.

Apart from these assumptions, Weber implicitly assumed the institutional factors like taxation, interest, insurance, etc., as insignificant locational factors. The economic culture and political system are treated to be uniform and stable across the locations. On the whole, Weber assumed perfect competition for his model.

Weber observed the massive movement of manufacturing industries from one location to another. He examines the general economic factors determining these movements. After a great lot of analysis and investigation, Weber discovers the factors that cause and determine the location of industry. Weber classifies all the causes of location of industry into two broad divisions: (i) primary causes called Regional factors; and (ii) Secondary causes called agglomerative and deglomerative factors.

Regional factors influence the inter-regional location of industries and the agglomerative and deglomerative factors influence intra regional location of industries.

10.3.2 Primary Causes (Regional Factors)

'Transportation costs' and 'labour costs' are the two regional factors on which the Weber's theory is based. **Weber argued that the location of industry will be pulled to those locations which have the lowest transportation costs having regard both for the place of consumption and the place of the deposits of materials.**

The key factors that determine transportation costs are:

a) The weight to be transported and

b) The distance to be covered.

Weber lists some more factors which influence the transportation costs besides weight and distance. They are:

(i) The type of transportation system and the extent of its use,

(ii) The nature of the region and kinds of roads,

(iii) The nature of the goods themselves, i.e., the qualities which, besides weight, determine the facility of transportation.

Weber classifies the materials used by an industry into 'ubiquitous' and 'localised' materials. The ubiquitous materials are those raw materials which are available everywhere, like brick, clay and water. The localized materials are those which are available in certain regions only, like minerals, coal, iron-ore, etc. It goes without saying that the localized materials play an important role on the industry than the ubiquitous.

Weber further categorized the raw-materials as 'pure' and 'weight losing' pure materials impart their total weight to the products. For example, cotton, wool, etc. The weight losing materials lose their weight considerably during the manufacturing process. For example, wood, coal, minerals, etc. Hence, the industries using weight losing raw materials are located close to raw material deposits and the industries using pure materials are located close to the consumption centres.

Weber's view is that the extent to which localised materials impart their weight to the final product is the governing factor on location of industry. The proportion of the weight of localised material to the weight of the product is known as 'material index' of an industry. The material index measures the total weight to be moved. In short, Weber's proposition is that a manufacturing unit tends to locate at the place where cost of transportation is minimum.

Weber further examines the cause of deviation of location from the centres of least transport costs. Existence of differences in labour costs is the reason for movement of industry from low transport cost location. According to Weber, an industry will choose a cheap labour site if the labour cost saving is greater than the increment in transport cost at this site above the minimum possible transport cost. To explain the effect of labour cost on the least-transport cost location of a plant, Weber used the 'isodapanes.' An isodapane is the locus of the points having equal additional transport cost around the least-transport cost location. There will be several isodapanes forming rings around the location for different levels of incremental transport cost.

10.3.4 Secondary Causes (agglomerative and deglomerative factors)

The next step in Weber's theory is to examine the effects of agglomeration. Agglomeration means concentration of production for commodity at one place. There will be two types of effects as a result of agglomeration: (a) economies of scale within a plant, and (b) economies from the association of several plants.

Economies of association is realized from specialized division of labour between plants, better repair facilities, a specialized labour market, development of markets for the materials and products of an industry, and lowering of social overhead costs. Deglomerative forces such as high cost of land, high rent, pollution, etc. are likely to be operative after a certain stage of localization of industries at a place. But Weber ignored them except possibility of high rent which he related to the size of a city. The basic approach followed by Weber in examining the effect of agglomeration on location of a plant is similar to the one used for cheap source of labour. A plant will tend to be located in an agglomeration if saving of production cost at this location offset the increase in transport cost as a result of a shift from the least-transport cost location. There will be several firms in the agglomeration. All of them will be having net benefits because of excess agglomerative economies over the additional transport cost.

10.3.5 Split Location

Productive activities could be divided depending upon the nature of raw materials, industry, and market. According to Weber, the split of production into several locations will be the rule for productive process which can technically be split. Hence, split location is possible if the different stages of production can be technically carried on at different places independently. The only cause which could lead to an actual split and to a resultant transfer of the parts of different locations would obviously be that some ton-miles would be saved in the process.

10.3.6 Locational Coupling

Just as split in location is advantageous, Weber conceives that it is feasible to have different types of industries in one locality. The production of quite different articles may be combined in one plant because several raw materials may diverge from a common source. This may be due to either technical or economic reasons. If the by-product of an industry happens to be the raw material of another industry, then the two industries may select a single place of location. For instance, the dye-stuff industry is connected with other industries using coke, because coal tar (upon which the dye-stuff industry is based) is a by-product of the burning coke. Similarly, molasses, which is a byproduct of sugar production, is used in distilleries as raw material. Hence, distilleries are invariably located near sugar factories.

10.3.7 Criticisms of the theory

Weber's original contribution on the theory of location provoked thinking and stimulated a great deal of research. It has paved the way for development of programming models for industrial location. However, the theory was criticized on some grounds. We will also understand the criticisms leveled against the theory.

1. The assumption of perfectly competitive situation is incompatible in the context of spatial analysis. Distance provides firms with monopoly advantages in proximate area and therefore, Locational specialization is but one aspect of the product differentiation which implies monopolistic competition. The assumption of maximization of profit would be appropriate for such situation and not the least-transport cost for industrial location.
2. The assumption of spatial uniformity of demand conditions is also criticized on the grounds that the demand for a product varies with its price and location of its production. The least-transport cost location approach is inappropriate when spatial variability of demand conditions is taken into account.
3. The assumption that the scale of production of the plant has no effect on costs is not realistic. Optimum location for a plant depends upon the production level. Further, if we allow substitution among the inputs or factors of production then the optimum location cannot be defined merely in terms o least-transport cost.
4. The agglomeration analysis as given by Weber is also incomplete.
5. Immobile and unlimited supply of labour as assumed by Weber has also been subjected to criticism.

In spite of all such criticisms, Weber's theory is an important contribution to industrial location analysis. It has been enjoying universal acceptance and application. All the other alternative suggestions are neither complete nor comprehensive.

10.4 SELECTING GENERAL AREA

The important factors which should be taken into account in the selection of a site are: a) availability of raw materials; b) availability of labour; c) nearness to the source of motive power; d) nearness to market; e) availability of transport facilities; f) no nuisance problems; and g) suitability of climate. Let us understand each one them in the following paragraphs:

a) **Availability of raw material:** The region in which an enterprise is proposed to be set up should provide greater part of the raw material required, thus ensuring a continuity of supply at reasonable prices.

b) **Availability of labour:** Availability of skilled and unskilled labour in the area is necessary. If the labour is to be brought from outside, its cost would go up.

c) **Nearness to the source of motive power:** the area should provide cheap power, soft water and sewage disposal facilities. Power failure has been one of the important reasons of production disruption in small scale enterprises.

d) **Nearness to market:** if production is meant for self-consumption, the location of a small scale enterprise is determined by nearness to market.

e) **Availability of transport facilities:** Transport cost has often been a decisive factor in choosing location for an enterprise. Availability of cheap and efficient transport facility will reduce the cost of finished product.

f) **Nuisance problems:** if there are any special nuisance problems such as smoke, noise, odor or smog, an arrangement for their control should either be available or necessary controls should be installed.

g) **Suitability of Climate:** Although the natural climate as factor has lost its importance due to technological advances, small scale industries have yet to pay adequate attention to this factor. The important factors to be considered are: topography of land, soil conditions, water supply, waste disposal, Position of plant to local transport facilities, availability of residential accommodation to works, local laws, community attitude towards industries, and tax concessions applicable to the area.

It is also important to ascertain the general facilities available in the area. Availability of construction facilities like cranes, earth moving equipments, welding sets, etc. in the vicinity will reduce the cost of construction as well as the time of project completion. Though the concentration of industries in a locality has advantageous, it also has the effect of outside interference in the form of unionization.

10.5 THE IMPORTANT FACTORS CONSIDERED IN THE SELECTION OF A SITE

Having decided upon the location, the selection of a suitable site for the project is important.

The process of site selection varies because each venture is unique. Suppose an entrepreneur wants to open a drugstore. Before selecting a site, the entrepreneur must ask the following questions:

On the city

- Is the city growing? If so, how fast? What parts of the city are growing most?
- What is the city's population breakdown by age, income, and occupation?
- How many drugstores are there now in the city? Where are they? How well are they doing?
- What is the civic spirit like? Is the city progressive? Do residents work well together on civic projects?
- What is the quality of the city's schools, places of worship, parks, and culture?

On an area within the city

- What do area consumers buy when they go to a drugstore?
- What is the area's population? It is growing? Are the people chiefly native born or foreign?
- How do people make their living? Are they mostly white-collar workers, labourers, or retired persons?
- Are there people of all ages or are they mainly old, middle-aged, or young?
- What is the average family income? What is their total buying power?
- How many other drugstores are in the area? How successful are they?

On a Specific site within the Area

- Are there consultant doctors, hospitals, nursing homes, etc. in the area?
- Are neighbouring businesses healthy?
- How close is the nearest competing drugstore?
- Is the site surrounded by well-kept homes?
- Is there plenty of parking space available next to or near the site? is the site accessible by bus?
- What zoning requirements must be met?
- How far will customers have to travel to shop in the drugstore?
- Is there a steady flow of foot traffic by the site?
- What is the floor area? Is there any room to expand?
- Can deliveries be made from the rear?

- Will nearby stores draw customers to the site?
- Is the appearance of the site pleasing? Will customers want to shop there?
- Is there a divider on the road that may discourage some potential customers?

Thus, to choose the best site, entrepreneurs must pay painstaking attention to detail, narrowing their choices and then ferreting out the facts about each one as suggested in this example.

The additional factors taken into account in the selection of a site are:

- Soil test indicating type and load bearing capacity of the soil at various depths, water table, terrain, etc.,
- Extent of site development required;
- Presence of mineral deposits;
- Proneness to natural and structural disturbance; and
- Leasehold or freehold nature of land/compensation, mode of acquisition, etc.

For a proper assessment of the locational features of a project, the borrowers are asked to enumerate the locational advantages and are also required to furnish copies of the location map, site plant showing the contour lines, internal roads, power receiving station, railway siding, tube well, factory lab out providing for flow of raw materials and finished products, etc. while appraising the project, it is examined whether the land at site is sufficient not only for the immediate but also for its future requirements. Care is also taken to ensure that the formalities connected with the acquisition of land are completed before the appraisal of the project.

10.6 CASE STUDY

Suppose you would like to open a retail store in your home town. Use census data and commerce department reports from the World Wide Web or the local library to choose a specific site for the business in the local region. What location factors are critical to the success of this business? Would it be likely to succeed in your home town?

10.7 NOTES

10.8 SUMMARY

Location of an enterprise in a particular place is an important factor determining the ultimate success or failure of the enterprise. Entrepreneurs locate their industries in those places where the cost of production is the lowest at the time of their establishment. This is known a 'Location of Industries.' The major theories of industrial location were developed by the economists. Some of them were pioneering and useful in understanding the locational behavior of the firm. One such theory is the theory of Industrial location developed by Alfred Weber of Germany.

Weber argued that the location of industry will be pulled to those locations which have the lowest transportation costs having regard both for the place of consumption and the place of the deposits of materials.

Weber's view is that the extent to which localized materials impart their weight to the final product is the governing factor on location of industry. The proportion of the weight of localised material to the weight of the product is known as 'material index' of an industry. The material index measures the total weight to be moved. In short, Weber's proposition is that a manufacturing unit tends to locate at the place where cost of transportation is minimum.

Weber further examines the cause of deviation of location from the centres of least transport costs. Existence of differences in labour costs is the reason for movement of industry from low transport cost location. According to Weber, an industry will choose a cheap labour site if the labour cost saving is greater than the increment in transport cost at this site above the minimum possible transport cost.

The next step in Weber's theory is to examine the effects of agglomeration. Agglomeration means concentration of production for commodity at one place. There will be two types of effects as a result of agglomeration: (a) economies of scale within a plant, and (b) economies from the association of several plants.

Deglomerative forces such as high cost of land, high rent, pollution, etc. are likely to be operative after a certain stage of localization of industries at a place. But Weber ignored them except possibility of high rent which he related to the size of a city. The basic approach followed by Weber in examining the effect of agglomeration on location of a plant is similar to the one used for cheap source of labour. A plant will tend to be located in an agglomeration if saving of production cost at this location offset the increase in transport cost as a result of a shift from the least-transport cost location. There will be several firms in the agglomeration. All of them will be having net benefits because of excess agglomerative economies over the additional transport cost.

Weber's original contribution on the theory of location provoked thinking and stimulated a great deal of research. It has paved the way for development of programming models for industrial location. However, the theory was criticized on some grounds.

The important factors which should be taken into account in the selection of a site are: a) availability of raw materials; b) availability of labour; c) nearness to the source of motive power; d) nearness to market; e) availability of transport facilities; f) no nuisance problems; and g) suitability of climate.

Having decided upon the location, the selection of a suitable site for the project is important. The process of site selection varies because each venture is unique.

10.9 KEY WORDS

Location of Industries: Entrepreneurs locate their industries in those places where the cost of production is the lowest at the time of their establishment.

Ubiquitous materials: The ubiquitous materials are those raw materials which are available everywhere, like brick, clay and water.

Localized materials: The localized materials are those which are available in certain regions only, like minerals, coal, iron-ore, etc.

Agglomeration: Agglomeration means concentration of production for commodity at one place.

Deglomerative forces: High cost of land, high rent, pollution etc. are Deglomerative forces.

Material index' of an industry: The proportion of the weight of localised material to the weight of the product produced using the localized material. The material index measures the total weight to be moved.

Locational Coupling. If the by-product of an industry happens to be the raw material of another industry, then the two industries may select a single place of location. This is called locational coupling.

Split Location: Productive activities could be divided depending upon the nature of raw materials, industry, and market into several locations.

10.10 SELF ASSESSMENT QUESTIONS

1. Explain Alfred Weber's theory of Industrial Location.
2. Discuss the influence of Agglomerative and Deglomerative factors in Industrial location.
3. Critically examine the theory of industrial location propounded by Alfred Weber.
4. Discuss the important factors considered in the selection of a site.

10.11 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.
2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.
3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.
4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.
5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill
6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011
7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002
8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012
9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.
10. Sanjiv Marwah. *Project Management*. New Delhi: Dreamtech Press, 2011.

UNIT - 11 : WORK BREAKDOWN STRUCTURE

Structure :

11.0 OBJECTIVES

After reading this unit, you should be able to:

- define what is work break down structure,
- explain uses of work breakdown structure,
- explain the process of developing work breakdown structure,
- explain the process breakdown structure,
- explain responsibility matrix.

11.1 INTRODUCTION

Once all of the stakeholders for a project have been identified, the project team members collect project requirements, define the project's scope, and create work breakdown structure (WBS). The breaking down of large activities into comprehensible or manageable units is a fundamental part of project management. Work breakdown structure is a tool that is used on virtually all projects. Once the scope and deliverables have been identified, the work of the project can be successively subdivided into smaller and smaller work elements. The outcome of this hierarchical process is called the work breakdown structure. The WBS is a map of the project. Use of WBS helps to assure project managers that all products and work elements are identified, to integrate the project with the current organization, and to establish a basis for control. Basically, the WBS is an outline of the project with different levels of detail. Let us understand in this unit all the facets of WBS, Process Breakdown Structure, and Responsibility Matrix.

11.2 WORK BREAKDOWN STRUCTURE (WBS)-DEFINED

Let understand first, what WBS is with the help of few definitions given by experts.

1. According to Project Management Body of Knowledge (PMBOK) "project breakdown structure as a deliverable oriented grouping of project activities that organizes and defines the total scope of the project. A deliverable is a measurable, tangible, verifiable outcome or result that must be produced to complete a project or a part of the project."

2. According to Samuel and Meredith, "WBS is simply a set of all tasks in a project, usually arranged by task level. It is sometimes presented as a tree, much like an organization."

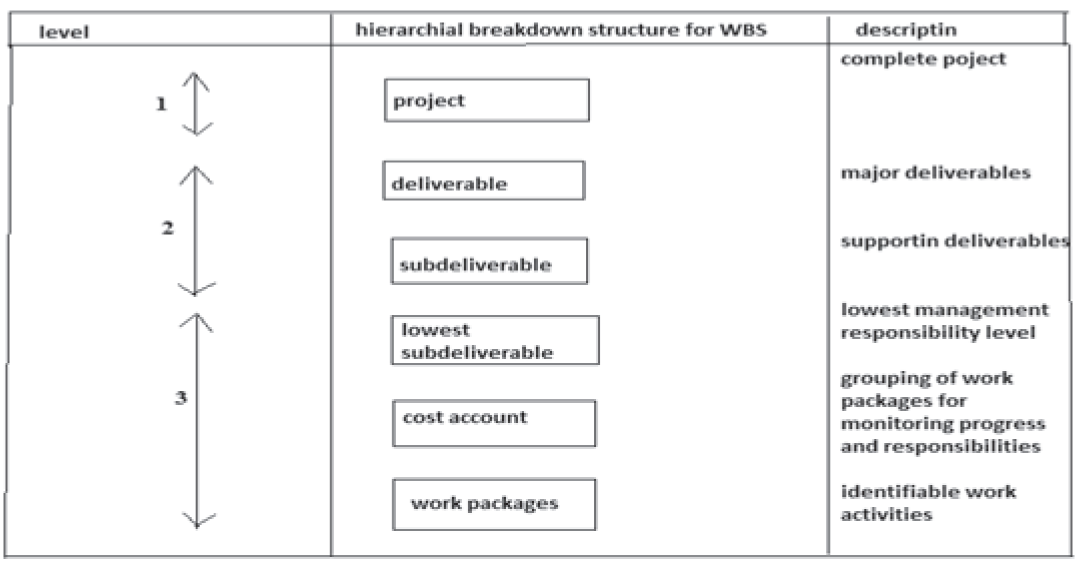
3. It is a hierarchical tree of end items that will be accomplished or produced by project team during the project. The accomplishment of all these items constitutes completion of project work scope.

Importance of WBS

Work breakdown structure helps the project management that all products and work elements are identified to integrate the project with current organization. And it establishes the basis for controlling.

The Work Breakdown Structure begins with the project as a final deliverable. Major project work systems are identified, first. Then the deliverables or sub-systems necessary to accomplish the large deliverables are defined, the process is repeated until the sub deliverable details is small enough to be manageable and one person can be responsible. These sub deliverables further divided into work packages, because lowest sub deliverable usually includes several work packages. The work packages are grouped by type of work. For example, computer installation project consists of hardware, programming and testing. These groupings facilitate a system for monitoring project progress by work and responsibility.

The following figure shows the major groupings commonly used in the field to develop a hierarchical work break down structure.



This work break down structure grouped work packages by type of work within a deliverable and allows assignment of responsibility to an organization unit. This extra step facilitates a system for monitoring project progress.

11.3 HOW A WBS HELPS THE PROJECT MANAGER

Work break down structure helps the project manager in the following ways:

Facilitates evaluation of cost, time, and performance of the project

The work break down structure defines all the elements of the project in hierarchical frame work and establishes their relationships to the project and items. The total project is the summation of all the smaller work packages. This hierarchical structure facilities cost, time and technical performance at all levels in the organization over the life of the project.

Helps for assignment of job to individuals

While work break down structure is developed, organizational units and individuals are assigned responsibility for accomplishment of work packages. This integrates the work and organization.

WBS makes it possible to plan, schedule and budget

It gives a frame work for tracking cost and work performance. Use of WBS provides the opportunity to "roll up" the budget and actual cost of smaller work packages into larger work elements so that performance can be measured by organizational units and work performance.

It defines communication channels and assists in understanding and coordinating many parts of the project. The structure shows work and organizational unit responsible and suggests where written communication should be directed. Problems can be quickly addressed and coordinated because the structure integrates work and responsibility.

WBS serves the basis for construction of PERT network.

11.4 FACTORS CONSIDERED IN DEVELOPING A WBS

The project manager must keep in mind the following issues while designing a work break down structure:

1. Every activity in the work break down structure should produce a single tangible deliverable.
2. Every activity at any level of the work break down structure is an aggregation of all its subordinate activities listed immediately below it.
3. Each activity should be unique and distinct from other activities of the project.
4. The activity should be decomposed logically from higher levels to lower levels.

5. There should be flexibility in the work break down structure development process, as the work break down structure might be updated when the project scope changes.
6. The work break down structure must specify the important reporting points. The activities should be compatible with organizational and accounting structures.

11.5 USES OF WORK BREAK DOWN STRUCTURE

Work breakdown structure has many uses. Let us understand them one by one.

Thought process tool

The work break down structure improves the thought process of the project manager and his team by designing the entire project in a structured manner. It helps them to see how the project work can be defined and managed.

Architecture tool

The work break down structure provides a complete picture of the project and represents how various activities are related to one another.

Planning tool

The work break down structure provides a series of activities to be performed to complete the project. It helps the project manager estimate resources required and build a schedule for the whole project.

Project status reporting tool

The work break down structure can also be used as a tool to report the status of the project. Completion of lower level activities implies the completion of the corresponding activity at one level above. Completion of some higher level activities indicates completion of project milestone events and this is reported to the top management and the project client.

11.6 DEVELOPING A WORK BREAK DOWN STRUCTURE

The process of developing a work break down structure can be top-down or bottom-up approach.

Top-down approach

In this approach, the project goal level is decomposed to lower levels until the project manager and his team is satisfied that the work has been sufficiently well defined.

The decomposition is continued till the activities of lower level satisfy the test of completeness.

Once all the activities are identified, the project manager ensures that each project activity is described in detail, with the time, cost, material and labor requirements for each activity being estimated. This is because the allocation of resources is easier at the activity level rather than at the project level. The sum of all resources allocated for all project activities provides the total resource requirements for the project.

After the activities are described, the project manager puts them in sequence, so that a schedule can be drawn up for the entire project. The project manager analyses the dependencies among the various project activities to see how many of the activities can be carried out simultaneously; it reduces the total project duration.

There are two variations in the top-down approach. These are team approach and sub team approach.

Team approach.

Here, the entire project team works on all parts of the work break down structure. A suitably qualified person is given the responsibility of decomposing each level of activity. As the entire team involved in developing the work break down structure, members can take note of discrepancies as and when they occur and take corrective measures.

Sub team approach

Here, the planning team is divided into as many sub teams as there are levels of activity. Each team is led by an expert who decomposes the level of activity assigned to his team taking into considerations the suggestions made by his team members. The process is continued till each lower level of activity of work break down structure meets the test for completeness of decomposition.

Bottom up approach

Here, as in top down approach, the entire planning team prepares the first level breakdown. Then the team is divided into as many groups as there are levels of activities. Each group makes a list of all the activities that must be completed to complete one level of activity. This is done by getting group members to identify different activities and present these to the group. Every activity that the group thinks appropriate is put down on a slip of paper. Once all the ideas are exhausted, related activities are grouped together and the final list is submitted to the planning team. The planning team prepares the final work breaker down structure by removing redundant activities and adding missing activities. The drawback in this approach is that the activities are not defined properly.

11.7 TEST FOR COMPLETENESS OF DECOMPOSITION OF ACTIVITIES

Preparing an appropriate WBS is of critical importance in planning the project. The project manager should ensure that no unnecessary activity is included in the WBS and that all the activities that are necessary to meet the ultimate project goals are included.

The decomposition of the project activities should be continued till all the lower level project activities fulfill the following conditions.

- The activity must be measurable.
- It must have clearly defined start/end events.
- It must have a clear deliverable.
- The time/cost of the activity must be measurable.
- The duration of the activity must be in acceptable limits.
- The activity must be independent.

If any activity does not satisfy all the six conditions, it should be further decomposed. The criteria for completeness are discussed in greater detail below:

Measurable

The project manager can ask for the current status of an activity any time during the project. So the status of the activity should be easy to measure. Let us assume the transportation activity in a building construction project takes 15 days, if 5 trucks are engaged. Assuming that the trucks are at equal capacity, the extent of completion of the activity can be measured at any point of time. The measure of the activities completion is the proportion of the work completed for a given period.

Bounded

Each activity should have clearly distinguishable start and end events. Once the start event has occurred, the project manager assumes that the activity has begun. The deliverable should result once the last event occurs. If the activity is not properly bounded then the activity has to be further decomposed.

Deliverable

Every activity on completion should produce a result or outcome. The deliverable is a visible proof of the completion of an activity. The outcome could be a document or a physical product. The next activity can be started only when the predecessor activity produces the desired outcome.

Simplicity in estimating cost/time

Every activity in a WBS should have an estimated cost and time of completion. By dividing the activities into lower level activities, a project manager can arrive at reasonably accurate cost and time estimates for all the activities listed in the WBS. If it is difficult to estimate the cost/time of an activity, it should be further broken-down.

Acceptable duration limits

In general, the duration of an activity is kept less than two weeks, even for big projects the activities are decomposed further till each activity has an acceptable duration. In the case of repetitive operations, further decomposition of activities is not required. Long duration for activities is not recommended, as a delay in that activity can seriously disturb the entire project schedule.

Activity independence

Each activity in the project should be independent. Once the work on an activity begins, it should be amenable to being continued till completion, without need for additional inputs and information. However, an activity can be scheduled in parts on the basis of resource available.

The WBS is decomposed to such a level that the lower level activity should allow for the effective planning, control and performance measurement. In order to plan for adequate resources, the project manager examines the following details:

- Is all the work planned for activity capable of producing the required deliverable?
- Is it practically feasible to manage the individual work assignments with the WBS structure?
- What kind of approach is to be adapted for identifying project activities; a top down or a bottom down approach?
- How will work be assigned to individual and controlled to receive the required deliverables?
- How will the budgets be allocated for each activity? How are the budgets proposed for the increments of work?
- How will the status of the project work activity be determined?

11.8 REPRESENTING THE WORK BREAKDOWN STRUCTURE (WBS)

It can be represented in different ways. Whatever the structure type, the project goal that states the purpose of the project has to be written at the top. Then it is divided into several activities again and they are called level2 activities. The process is continued till all the activities satisfy the six criteria for completion described earlier.

Whatever the type used for representation, the main issue in representing the WBS is to know whether the work required achieving the desired outcome and meeting the project objectives has been captured in enough detail to identify the resources, assign the responsibilities, and set the activities in sequence.

Here the WBS is given in below exhibit for a telecom project

WBS for telecom project

1.0 Concept or feasibility

1.1 Develop concept/marketing plan

1.2 Conduct market analysis

1.3 Conduct technical analysis

1.4 Develop prototype

1.5 Prepare product development plan/cost/schedule

2.0 Requirements

2.1 Develop end user requirements

2.2 Develop application requirements

2.3 Develop infrastructure requirements

2.4 Develop operations /maintenance requirements

2.5 Develop service requirements

3.0 Decision

3.1 Present prototype

3.2 Presents financial statement and time schedule

3.3 Present technical capabilities

3.4 Obtain financial commitment

3.5 Go/no-go decision

4.0 Developments

4.1 Develop end user system

4.2 Develop application

4.3 Develop infrastructure system and network

4.4 Develop operations /maintenance structure

4.5 Develop service plan

5.0 Test

5.1 Develop test plans for each aspect or element

5.2 Conduct test

5.3 Validate results

5.4 Perform corrective action

5.5 Conduct retesting

5.6 Revalidate results

6.0 Deploy

6.1 Conduct a trial test

6.2 Conduct first live test

6.3 Complete deployment

7.0 Life cycles

7.1 Conduct customer training and education

7.2 Obtain customer acceptance

7.3 Perform support and maintenance.

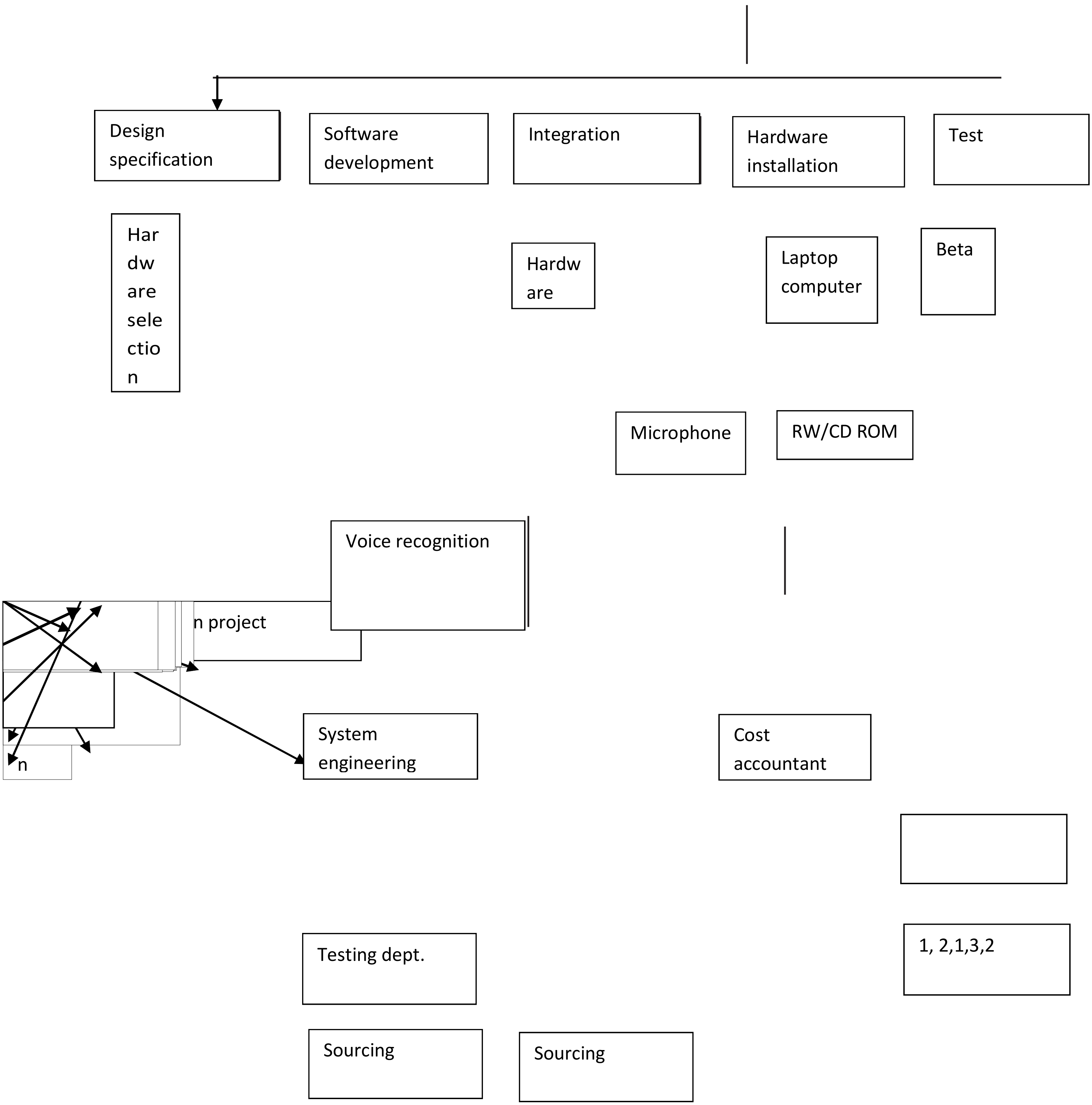
11.9 INTEGRATING THE WBS WITH THE ORGANIZATION

An integral part of creating the WBS is to define the organizational units responsible for performing the work. In practice, the outcome of this process is the organization breakdown structure (OBS). The organization breakdown structure depicts how the firm has organized to discharge work responsibilities. The purpose of the organization breakdown structure is to provide a frame work to summarize organization unit's work performance, to identify organization unit's responsibility for work packages, and to tie the organizational unit to cost control account group's similar work packages.

The OBS defines the organization sub deliverables in a hierarchical pattern in successively smaller and smaller units. Frequently, the traditional organizational structure can be used even if projects can be performed entirely by a team. It is necessary to breakdown the team structure for assigning responsibility for time and technical performance.

As in WBS, the OBS assigns the lowest organizational unit the responsibility for work packages with on cost account. Herein lies one major strength of using WBS and OBS. They can be integrated. The intersection of work packages necessary to complete the sub deliverables located immediately above and the organizational unit creates a project control point (cost account) that integrate work and responsibility. The intersection of WBS and OBS represents the set of work packages necessary to complete the sub deliverable located immediately above and the organizational unit on the left responsible for accomplishing the packages at the intersection. Later we will use the intersection as a cost account for management control of project.

The following figure shows the integration of WBS and OBS of voice data recognition project



Cost accountant number

11.10 PROCESS BREAKDOWN STRUCTURE

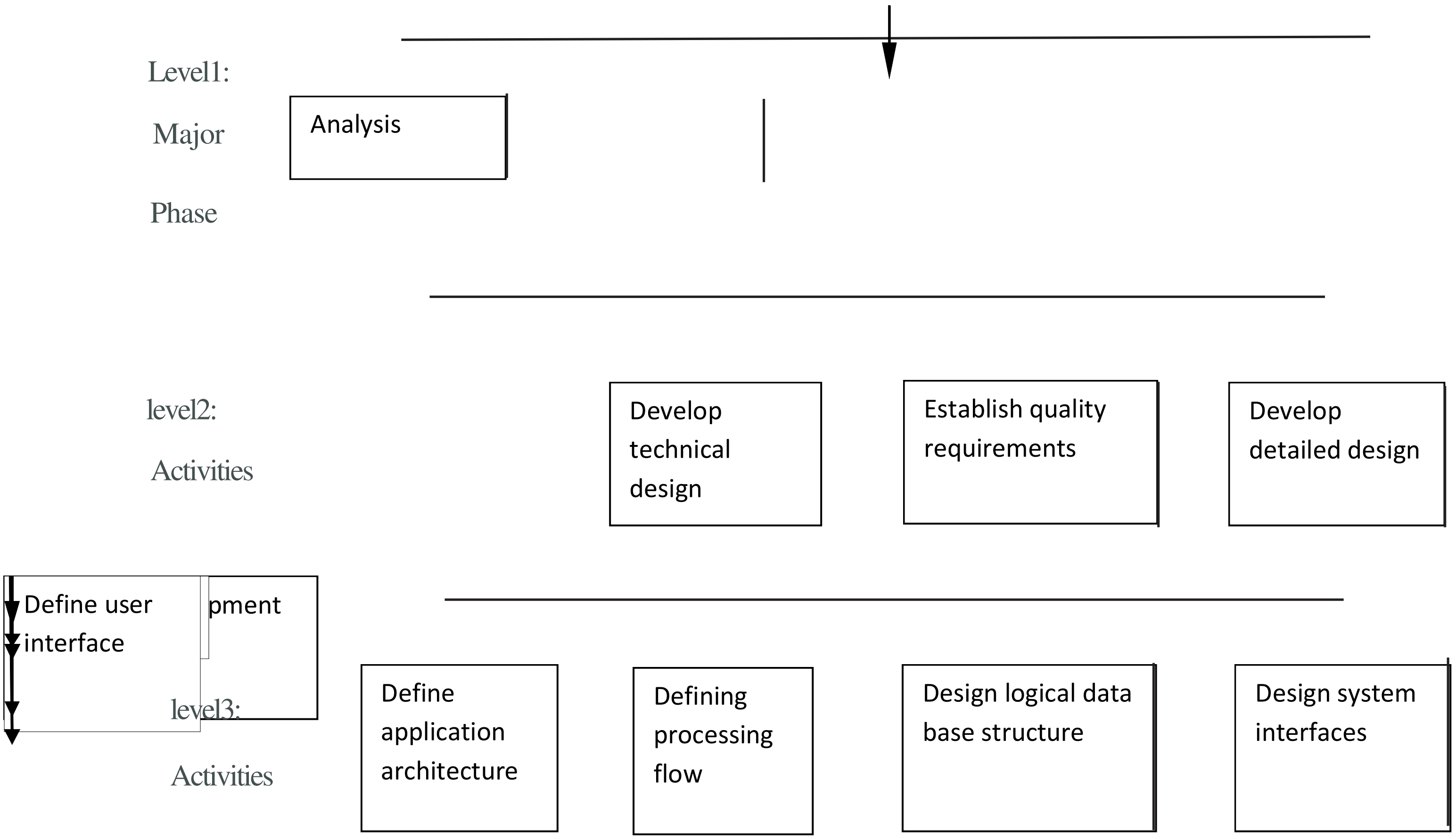
The WBS is best suited for design and builds projects that have tangible outcomes such as an offshore mining facility or a new car prototype. The project can be decomposed or broken down into major deliverables, sub deliverables, further sub deliverables, and ultimately to work packages. It is more difficult to apply WBS to less tangible, process oriented projects in which the final outcome is a product of a series of steps. Here, the big difference is that the projects evolve overtime with each phase affecting the next phase. Information technology projects typically fall in this category. For example, creating a website or an internal software database system. These projects are driven by performance requirements not by plan or blue prints. Some practitioners choose to utilize what we refer to as a process breakdown structure.

The following figure provides an example of a PBS for a software development project. Instead of being organized around deliverables, the project is organized around phases. Each of the five major phases can be broken down into more specific activities until a sufficient level of detail is achieved to communicate what needs to be done to complete that phase. People can be assigned to specific activities and a complimentary organization breakdown structure can be created just as is done for the WBS. Deliverables are not ignored but are defined as outputs required move to the next phase.

Checklists that contain the phase exit requirements are developed to manage project progress. These checklists provide the means to support phase walk-through and reviews. Each phase checklists vary depending upon the project and the activities involved but typically include the following details:

- Deliverables needed to exit a phase and begin a new one.
- Quality check points to ensure that deliverables are complete and accurate.
- Sign off by all responsible stake holders to indicate that the phase has been successfully completed and that the project should move on to the next phase.

Process breakdown structure for software development project



Outputs: design phase deliverables: Design document

Application architecture

Database design

End user interface design

Workflow diagram

User documentation outline

11.11 RESPONSIBILITY MATRIX

In many cases, the size and scope of work do not warrant an elaborate WBS or OBS. One tool that is widely used by managers and task force leaders of small projects is the Responsibility Matrix (RM). It is also called as linear responsibility chart. It summarizes the tasks to be accomplished and who is responsible for what on a project. According to Gido and Clements, responsibility matrix is a method used to display in tabular format the individuals responsible for accomplishing the work items in the work breakdown structure. It is a useful tool.

In the simplest form the responsibility matrix consists of charts listing all the project activities and the participants responsible for each activity.

The figure shown below illustrates a responsibility matrix for a market research study. In this matrix R is used to identify the committee member, who is responsible for coordinating the effort of other team members assigned to the task and making sure that the task is completed. The S is used to identify the members of five person's team, who will support or assist the individual responsible. Simple responsibility matrix like this one are useful not only for organization and assigning responsibility for small projects but also for sub projects of large, more complex projects.

More complex responsibility matrix not only identifies individual responsibility but also clarifies critical interface between units and individuals that require coordination.

Responsibility matrix provides a means for all participants in a project to view their responsibilities and agree on their arguments. They also help clarify the extent as type of authority excised by each participant in performing an activity in which two or more parties have overlapping involvement. By using a responsibility matrix and by defining authority, responsibility and communications within its frame work, the relationship between different organizational units and the work content of the project are made clear.

Below figure shows the responsibility matrix for a market research project

TASK	A	B	C	D	E
Identify target customers					
Develop raft questionnaire	R	S	S		
Pilot test questionnaire		R		S	
Finalize questionnaire	R	S	S	S	
Print questionnaire					R
Prepare mailing labels					R
Mail questionnaires					R
Receive and monitor returned questionnaires				R	S
Input response data			R		
Analyze results		R	S	S	
Prepare draft of reports	S	R	S	S	
Prepare final report	R		S		

11.12 NOTES

11.13 SUMMARY

Once all of the stakeholders for a project have been identified, the project team members collect project requirements, define the project's scope, and create work breakdown structure (WBS). The breaking down of large activities into comprehensible or manageable units is a fundamental part of project management.

Work Breakdown Structure is a hierarchical tree of end items that will be accomplished or produced by project team during the project.

Work breakdown structure helps the project management that all products and work elements are identified to integrate the project with current organization. And it establishes the basis for controlling.

The Work Breakdown Structure begins with the project as a final deliverable. Major project work systems are identified, first. Then the deliverables or sub-systems necessary to accomplish the large deliverables are defined, the process is repeated until the sub deliverable details is small enough to be manageable and one person can be responsible. These sub deliverables further divided into work packages, because lowest sub deliverable usually includes several work packages. The work packages are grouped by type of work. For example, computer installation project consists of hardware, programming and testing. These groupings facilitate a system for monitoring project progress by work and responsibility.

Work break down structure helps the project manager in the following ways:

- Facilitates evaluation of cost, time, and performance of the project.
- Helps for assignment of job to individuals.
- WBS makes it possible to plan, schedule and budget.

The process of developing a work break down structure can be top-down or bottom-up approach.

In many cases, the size and scope of work do not warrant an elaborate WBS or OBS. One tool that is widely used by managers and task force leaders of small projects is the Responsibility Matrix (RM). It is also called as linear responsibility chart. It summarizes the tasks to be accomplished and who is responsible for what on a project. According to Gido and Clements, responsibility matrix is a method used to display in tabular format the individuals responsible for accomplishing the work items in the work breakdown structure.

11.14 KEY WORDS

Work breakdown structure: The breaking down of large activities into comprehensible or manageable units.

Responsibility Matrix: It is a method used to display in tabular format the individuals responsible for accomplishing the work items in the work breakdown structure.

11.15 SELF ASSESSMENT QUESTIONS

1) Explain the meaning and importance of Work Breakdown Structure.

2) Discuss the process of creating Work Breakdown Structure.

3) Write a note on Responsibility Matrix.

11.16 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.

2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.

3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.

4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.

5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill

6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011

7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002

8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012

9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.

10. Sanjiv Marwah. *Project Management.* New Delhi: Dreamtech Press, 2011.

UNIT - 12 : PROJECT SCHEDULING AND RESOURCE ALLOCATION

Structure :

12.0 OBJECTIVES

After reading this unit, you should be able to:

- define project scheduling.
- explain the importance of project scheduling.
- explain the steps in project scheduling.
- construct a network diagram for a project.

12.1 INTRODUCTION

A schedule is the conversion of a project action plan into an operating time table. As such it serves as the basis for monitoring and controlling project activity and, taken together with the plan and budget, is probably the major tool for the management of projects. In a project environment, the scheduling function is more important than it would be in an ongoing operation because projects lack the continuity of day to day operations and often present much more complex problems of coordination. Indeed, project scheduling is so important that a detailed schedule is sometimes a customer specified requirement.

Once the Work Breakdown Structure is created, the first draft of Project Schedule can be constructed. A detailed scheduling for each and every activity along with the time estimate is a must to support the planning activities. Once a project is scheduled, the budget can be formulated, resource needs can be identified and resources assigned, risks can be identified and plans developed to deal with the identified risks, and a quality management plan can be created. The building blocks of a project schedule are activities. An activity is "a component of work performed during the course of a project." There are various techniques adopted for preparation of schedules. In this unit we will understand various aspects of scheduling and resource allocation.

12.2 PURPOSE OF PROJECT SCHEDULING

Projects are undertaken to accomplish important business purposes. In this fast moving world projects are to be completed in as short a time period as possible. Project scheduling helps in this aspect. The following questions can be answered by having a complete and workable schedule.

- When will the project be complete?
- What is the earliest date a particular activity can start, and when will it end?
- What activity must begin before which other activities can take place?

- What would happen if delivery of material was one week late?
- Can a key worker take a week of vacation the first week of March?
- If one worker is assigned to do two activities, which one must go first?
- Which worker or other resource is a bottleneck, limiting the speed of our project?
- What will the impact be if the client wants to add another module?
- If I am willing to spend an extra amount, how much faster can the project be completed?

12.3 EVOLUTION OF PROJECT SCHEDULING

It is interesting to know how project scheduling was evolved over a period of time. During the time of Scientific Management, Henry Gantt introduced a system of scheduling, which is named after him as Gantt chart. The chart consists of a graphical representation of various jobs, tasks or activities across time periods. Individual jobs, tasks or activities are described on the left-hand side of the graphical chart, and the scheduled times for completion of each job, task or activity are shown by open bars and plotted along a horizontal time scale.

In the 1950s, two project scheduling methods were developed. They are: Programme Evaluation and Review Technique, popularly known as PERT and Critical Path Method. Both the PERT and CPM were founded on the concepts of identifying activities, determining their logical order, and estimating the duration for each. Networks representing the activities were developed and the schedule calculated.

PERT and CPM originally used a method for displaying the work activities called Activity On Arrow (AOA) or arrow diagram method (ADM), in which schedule activities are represented by arrows and connected at points called nodes. Because it is often confusing to draw an accurate AOA network, this method is rarely used today. The more common method used today is called activity on node (AON) or the Precedence Diagramming Method (PDM). AON or PDM is "a schedule network diagramming technique in which the scheduled activities are represented by boxes or nodes. Schedule activities are graphically linked by one or more logical relationships to show the sequence in which the activities are performed."

Originally, the only relationship shown using AON was a finish-to-start relationship where the first activity must be complete before the next one can begin. While this is still the most common, other relationships can be shown with the AON, such as where one activity must start before the next one can start, or one activity must be complete two days before the next one can start. Most modern project scheduling software makes use of AON representation of the project schedule.

12.4 PROJECT SCHEDULING

Project scheduling is the most important function in the implementation stage of a project. A project consists of a number of activities. All the activities of a project cannot be started simultaneously from the very beginning of the project. Therefore, different activities need to be sequenced in a proper order. Project scheduling involves establishing a logical sequence among the different activities of the project and optimizing the total duration of the project. The project scheduling process initiates with the formulation of a project schedule that mentions the sequence of activities that need to be followed throughout the implementation phase of the project. The successful completion of all project activities depends on the effectiveness of the project schedule. We will understand how a project manager prepares and maintains project schedule to deliver the project end product within the desired frame.

A common method of developing the schedule is to first identify all of the activities and then determine the logical order by creating a network diagram. Once the order is determined, resources are assigned to each activity and an estimate of the time required for that activity is made. If the assigned resource is not available when the activity is scheduled, then an adjustment of some type may need to be made. The schedule can be computed with all of this information. Next, it is time to compare the emerging schedule with any imposed dates and cash flow estimates. Any in consistencies may cause the team to adjust the schedule. Other factors often need to be considered, such as quality demands and risk factors. When all these have been planned, the final schedule can be prepared and approved. We will understand each of these steps in the following pages.

12.4.1 Define Activities

"An activity is a specific task or set of tasks that are required by the project, use up resources, and take time to complete."

The first process in developing a project schedule is to define all of the work activities. The teams should be very careful in defining activities. They should omit any activity. It is a good idea to have someone on your project team play "devil's advocate" to challenge the team to identify additional activities. It is better to identify activities that do not need to be accomplished than to forget activities that will need to be added later. The team may think all of the activities have identified; however, when the next process is performed- activity sequencing-it may become obvious that some activities have been forgotten. Another activity can always be added later. Remember the schedule will not be approved until all of the related planning is in place. It is better to discover a missing activity in the later stages of planning than after the schedule is approved. Activities that need to be added after the final schedule is approved will add time and money to the project, perhaps driving it over budget and causing it to fall behind schedule. It is better to take extra time up front in order to make the activity list as comprehensive as possible.

In addition to the activity list, the project milestones should be listed. A milestone is an important point in a project schedule that the project sponsor and manager want to use as a checkpoint. Common milestones include completion of a major deliverable, completion of critical activity, and the time just before a large amount of money needs to be committed to the project. A team may also decide to put a milestone at a merging point in the project schedule where multiple activities need to be completed before progress can continue. The common denominator in each of these decisions is to identify a few key points in the life of project where management can determine if the project is progressing the way they want.

12.4.2 Activity sequencing

Once the activities have been identified, it is time to determine the logical order in which they can be accomplished.

1. While sequencing the activities, the project manager has to study various aspects such as the description of the end product, mandatory and discretionary dependencies among the activities, external dependencies, other constraints and assumptions of the project.
2. While analyzing the product description, the project manager has to consider the physical characteristics of the product and the logical sequence of the activities to achieve the end product.
3. Mandatory dependencies are those that are inherent in the nature of project. Here, the dependency between the activities is certain.
4. Discretionary dependency is those dependencies of the project that are defined by the project team. This dependency is also called as proffered logic.

The sequencing of activities is also affected by several other constraints and assumptions made by the project manager regarding the project.

12.4.3 Activity duration

First step in establishing project schedule is to estimate how long each activity will take from the time it is started until the time it is finished. This duration estimate for each activity must be the total elapsed time and the time for work to be done plus any associated waiting time

After the project activities are sequenced, the project manager estimates the duration of each activity to calculate the duration of the entire project. The duration of activity is the time period required to complete the activities

The activity duration is not synonymous with work effort suppose an activity takes 30 days to complete, we can't assume that the effort is made for 30 days , even though the activity duration is 30 days for example if the activity is to consult on external expert for a given problem. The actual consultation time is only about 3 hours, but the duration assigned for the activity will be about 30 days considering the time required to find the expert. Discuss the matter and solve the problem.

Activity duration could also be influenced by the amount of resources allocated generally speaking more the resources, the shorter the duration of activity.

However, it cannot be assumed that the relationship between the activity duration and resources allocated is completely proportional. Thus the project manager has to allocate more resources till the crash point is arrived at. Beyond this point, it is not possible to reduce the duration of an activity. The actual duration of activities may vary from the estimates.

12.5 NETWORK TECHNIQUES: PERT (ADM) AND CPM (PDM)

Once the individual activities are identified and their interdependency relationship is established, the activities can be portrayed in a network diagram, which is known as project network. Project network can be defined as a visual representation of different individual activities in a logical sequence by using arrows and nods. It helps in sequencing and scheduling different individual activities and managing the total time needed for the completion of the project.

The most common network techniques used project scheduling are PERT and CPM. The Programme Evaluation and Review Technique (PERT) was developed by the U.S. Navy in 1958. The Critical Path Method (CPM) was developed by DuPont, Inc., during the same period. For almost half a century, PERT and CPM networks have been used in project management. However, in 2005, the Project Management Institute renamed PERT as ADM (Arrow Diagram Method) and CPM as PDM (Precedence Diagram Method). In PERT network, the activities arre shown as *arrows* on the network, we will call it as AOA (Activity On Arrow) network. In CPM network, the activities are shown as *.nodes*; we will call it an AON (Activity on Node) network.

Terminologies used in project network

Activity

An activity indicates the physical work involved in a project. Each activity is sequentially arranged in order of its start and finish, linking with the start and finish of the other related activities of the project.

There are three types of activities:

Predecessor activity

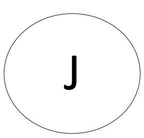
Activity, which must be completed prior to start of the next activity are called predecessor activity.

Successor activity

The activity that follows a predecessor activity.

Concurrent activity

Activities, which can run and can be completed concurrently, are known as concurrent activities.



Node or event

It is a time oriented reference point that signifies the start and end of an activity, and is represented by a circle.

The difference between the activity and a node is that the activity represents the passage of time and the nodes are points in time that denote the starting or ending of a specific activity.

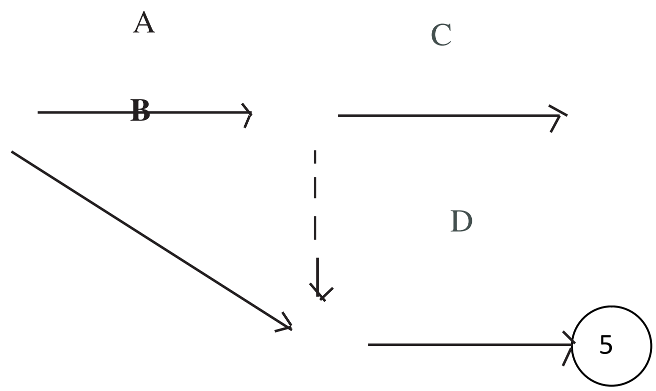
In the above diagram activity A is represented with I and j as the starting and ending nodes. The activity can also be written as I-j. Event I is called tail event and j is called the head event.

Dummy activity

Dummy activity are included in networks to define dependencies between events other dependencies imposed by worked activities.

"An activity of zero duration that is used to represent the logical relationship in the network diagram is called dummy activity."

Dummy activity does not consume any resources, but are used to maintain the proper precedence relationship between the activities that are not connected by the nodes. It is represented by a dashed line headed by an arrow.



For example, as shown in above diagram, in a project, A and B are concurrent activities. Activity is dependent on A and activity D is dependent on both A and B. then the project manager uses a dummy activity X to represent the relationship between activity A and activity D.

Critical activity

A project has many activities, taking into account the estimated duration of completion for each activity, total schedule for the project as a whole is estimated. In case of delay in any of the activity, the project is delayed. This activity is called critical activity.

Slack

For every event, there are two values: earliest achievement date (earliest event time)

Latest achievement date (latest event time)

Difference of these two is called slack.

Events with less or negative slack are critical events. If there is a positive difference, this will indicate that there is a margin of time, by which, commencement of an activity can be delayed without any risk of delay in the total project duration time.

Total slack or float

The difference between the calculated earliest finish time of the very last activity and the projects required completion time. This difference is the total slack or float. The total slack for a particular path of activities is common to and shared among all activities on that path.

Total slack can be calculated by subtracting the activities earliest finish (or start) time from its latest finish (or start) time.

Total slack= LF-EF or=LS-ES

Where

LF=latest finish time

EF=earliest finish time

ES=earliest start time

LS=latest start time

Free slack

It is the amount of time a particular activity can be postponed without delaying the earliest start time of its immediately succeeding activities.

"It is the relative difference between the amounts of total slack for activities entering into the same activity."

It is calculated by finding the lowest of the values of total slack for all the activities entering into a particular activity and then subtracting it from the values of total slack for the other activities also entering into that same activity.

Free slack is a relative difference between values of total slack it is always a positive value. It is the time by which an activity can be delayed or extended without delaying the earliest start of any other activity.

FS or FF= earliest achievement of activity succeeding event-earliest activity finish.

Critical path

It is a path from the start of the network node to the end of the network node having the least float. Thus, the longest path (which consists of critical activity) in the network diagram is called critical path.

It defines the minimum projection duration. Critical activities have no flexibility in the completion time. These critical activities which lie on critical path must be attended properly with care in order to complete the project in time.

Earliest start time: is the earliest occurrence time for the event.

Earliest finish time: is equal to earliest start time plus the time taken i.e. duration of the activity.

Latest start time: is equal to the latest finish time minus the time taken i.e. duration of activity.

Latest finish time: is the latest occurrence time for the events at which the activity get completed or terminated.

Forward path or forward pass: When the tracing of the network is done from start point, this process is called forward pass.

Backward path or backward pass: it is the opposite process of forward pass i.e. tracing of network is done from end point to start point. This process is called backward pass.

Figure- 4.1

SAMPLE ACTION PLAN

*12.5.1 Constructing the Network, AON Version*c

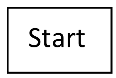
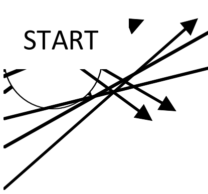


Figure-4.2: Sample Network construction

We begin with the node called ‘start’. Activities ‘**a’** and **b** have no predecessors, so we draw arrows out of ‘Start’ to each of them (Fig.4.2). The arrow heads show the direction of precedence. Activity **c** follows **b**, activity **d** follows **b**, and activity **e** also follows **b**. Activity **f** follows both **c** and **d**. the action plan does not indicate any further activity to complete the task. So we have reached the end of this particular plan. We thus draw arrows from activities **e** and **f** to the node End.



12.5.2 Constructing the Network, AOA Version

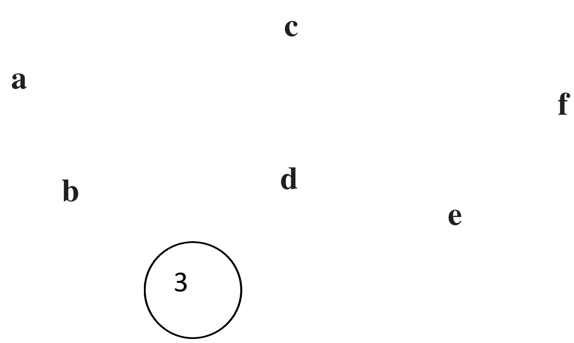


Figure-4.3: Sample Network construction

Again, we begin with a node (event) called ‘Start’. Activities **a** and **b** have no predecessors, so we draw arrows labeled “**a**” and “**b**” from Start and terminating in circle-shaped nodes numbered “**1**” and “**2**” for easy identification (Fig.4.3) Activity **c** follows **a,** activity **d** follows **b**, and activity **e** also follows **b**. Let us add these arrows to our AOA network, labeling the arrows and nodes sequentially as we go.

The choice between AOA and AON representation is largely a matter of personal preference. AON is typically used in the most popular PC-based commercially available computer software, and AON networks are easier to draw. AOA networks are slightly harder to draw because they sometimes require the use of dummy activities to aid in indicating a particular precedence, via a dashed arc. A dummy activity has no duration and uses no resources. Its sole purpose is to indicate a technological relationship. AON networks do not require the use of dummy activities.

12.5.3 Basic rules to follow in developing project networks

The following eight rules apply in general when developing a project network:

1. Networks flow typically from left to right (except for some computer printouts that need to fit network to a page size).
2. An activity cannot begin until all preceding connected activities have been completed.
3. Arrows on networks indicate precedence and flow. Arrows can cross over each other.
4. Each activity must have identification number
5. An activity identification number must be larger that of any activities that precede it.
6. Looping is not allowed. In other words, recycling through a set of activities cannot take place.
7. Conditional statements are not allowed. That is this type of statements should not appear; if successful do something; if not do nothing.
8. Experiences suggest that when there are multiple starts, a common start node can be used to indicate a clear project beginning on the network.

Similarly, a single project end node can be used to indicate a clear ending.

12.5.4 Advantages of network diagram

- It helps the project manager in project planning by detailing the project activities, estimating the required resources, and displaying the inter relationships among activities.
- It helps to determine the start and end dates of each activity during scheduling.
- It provides insights into possible tradeoffs while controlling the project.

12.6 RESOURCE ALLOCATION

We assumed that the resource required to perform the individual activities would be available when they were needed. These resources can include people, equipment, machine, tools, facilities and space. Among the people there may be many different types, like painters, designers, cooks, computer programmers, and assembly workers.

The consideration of resources adds another dimension to planning and scheduling. In many projects, the amounts of various types of resources available to perform the project activities are limited. Several activities may require the same resources at the same time, and there may not be sufficient resources available to satisfy all demands. In a sense, these activities are competing for the use of same resources. If sufficient resources are not available some activities may have to be rescheduled for a later time when resources are available for them. Therefore, resources are constraints for the project schedule. They can also be an obstacle to completing the project within budget if it is determined that additional resources are needed to complete the project on time.

12.7 RESOURCE CONSTRAINTS

The shortage of resources can alter technical constraints drastically. Parallel activities hold potential for resources conflicts, because it is impossible for an individual or piece of equipment to work on two activities that were assumed to be independent now become dependent.

Kinds of resource constraints

There are many resource constraints, the most important are

1) People

2) Materials

3) Equipment

4) Working capital

People: This is the most obvious project resource, human resources are usually classified by the skills they bring to the project egg programmer, mechanical engineer, welder, doctor, supervisor, etc...

In rare cases, some skills are interchangeable, but usually with of productivity. The many differing skills of human resources add to the complexity of scheduling projects.

Materials: Lack of availability of materials can constrain the project schedule. Material shortage has been blamed for the delay of many projects. When it is known that the lack of availability of raw materials is important and probable, material should be included in the project Network plan and schedule.

Scheduling materials has also become important in developing products where time-to –market can result in loss of market share.

Equipment: Equipment is often over looked as constraints, equipment is usually presented by type, size and quantity, in some cases equipment can be interchange to improve schedules, but this is not typical for specialized equipment. The most common over sight is to assume the resources pool is more adequate for the project.

For instance, if a project needs one earth moving tractor 6 months from now and the organization owns four, it is common to assume the resources will not delay the pending project. However, the earth moving tractor is due on site in 6 months; all four machines in the pool might be occupied on other projects.

In multi project environments, it is prudent to use a common resources pool for all projects. This approach forces a check of resources availability across the project and resource the equipment for specific project needs in the future. In large organizations, the project office may oversee resources use over more than one project. Recognition of equipment constraints before the project begins can avoid high crashing or delayed costs.

Working capital: In a few project situations such as construction, working capital is treated as a resource because it is limited in supply, if working capital is readily available, a project manager may work on many activities concurrently, if working capital is in shortage supply because progress payments are made monthly, materials and labor usage may have to be restricted to conserve cash. This situation represents a cash flow problem.

12.8 RESOURCE LOADING

From the first day on the job, the project manager is concerned with resource loading.

"Resource loading refers to the amounts of a specific resource that are scheduled for use on specific Activities or projects at specific times." It usually takes the form of a list or table.

12.9 SCHEDULING RESOURCE FOR UTILIZATION AND GIVEN AVAILABILITY

The times estimates for the work packages and network times were made independently with the implicit assumption that resources would be available, if resources are adequate but the demand varies widely over the life of the project, it may be desirable to even out resources demand by delaying non critical activities or lower peak demand and thus increasing resource utilization this process is called resource smoothing.

On the other hand if resources are limited and are not adequate to meet peak demands, the late start of some of activities must be delayed and the duration of the project may be increased.

Here the goal is to minimize project delay. this process is called resource limited scheduling and can create unforeseen problems because the cost of failing to consider resource usage and availability are hidden on not obvious, resource scheduling in practice often is not done or does not get the attention it deserves the consequences of failing to schedule limited resources are costly activity and project delays that usually manifest themselves

Midway in the project when quick corrective action is difficult an additional consequences of failing to schedule resources is the failure to reduce the peaks and valleys of resources usage over the duration of the project because project resources usually are over committed and because resources seldom line up by availability and need, procedures are needed to deal with these problems.

12.10 CRASHING

Crashing refers to decreasing the total project duration after analyzing a number of alternatives to determine how to get the maximum duration compression for the least cost. Here the project manager reduces the project duration by allocating more resources, sub contracting some activities, using more labor, etc.

The project manager considers the time-cost trade off, for all project activities this tradeoff reveals how the duration of project activity is reduced with additional cost. Normally the project manager focuses on time cost trade off for the critical activities of the project as they play a major role in deciding the project completion time.

Some people argue that crashing may decrease quality of project. As all project activities cannot be completed just by adding more resources. The project manager's hold ensures that the quantity of the project and product does not suffer as a result of crashing.

Activities like planning and inspection are not crashed in general, because they have an effect on the quality of the project.

The following are the types of activities that are considered for crashing.

1. The critical activity of the project.
2. And activity of longer duration.
3. An activity that sallow per unit crash cost
4. An activity that does not cause any quality problems, if crashed.
5. An activity that is labor intensive

12.11 ALLOCATING SCARCE RESOURCES TO SEVERAL PROJECTS

When the problem of allocating the scarce resources is extended to the case when several projects are being carried out concurrently, the size and complexity of the problem increases but the nature of the underlying problem remains the same. The project might be independent or members of one large super project. Consider a single project for a moment it is composed of set of first level task connected in a technological relationship of predecessor and successor of each first level is composed of or set of second level task also arranged technically determined ways. The second level tasks are divided into third level task and so on. If we take several projects we can link them together with pseudo activities, here defined as activities that have duration but do not require any resources. The set of projects linked in such a way become a sort of super projects and can be managed like any other. We can use pseudo activities to establish precedence's between the projects they connect and thus we can separate the project in time.

12.12 RESOURCE ALLOCATION AND PROJECT LIFE CYCLE

Whatever the scheduling rule, the scheduling method assigns scares resources to activities on the basis of the degree to which activities meet some priority conditions. Once the most urgent cases have been given resources, the next most urgent cases receive these resources. The process continues until there are no more activities qualified under the rule.

All critical activities demanding scarce resources are supplied, but the remaining stock of scares resources are depleted before all noncritical activities are resources loaded the less urgent activities go unsupplied. When this happens, the less urgent activities becomes more urgent as period passes until they rise for enough up the priority rank list and other resources. But what happen in stock of scares resources are depleted before all the critical activities receive resources? For example when using the minimum slack rule what happens if we run out of our scarce resources before we run out of critical activities.

When this condition occurs, it is often possible to borrow resources from another activity that is lower on the priority list, that is, has some slack in the case of the minimum slack rule, perhaps we could even deschedule such an activity and take all the scare resources being used, resorting the scares resources later when the descheduled activity is risen higher on the priority list.

12.13 BENEFITS OF SCHEDULING RESOURCES

1. the benefits of creating this schedule before the project begins are that time is available for considering alternatives. If the scheduled delay is unacceptable or the risk of being delayed too high, the assumption of being resource constrained can be reassessed. Time/cost tradeoffs can be considered. In some cases priorities may be changed.

2. resource schedules provide the information needed to prepare time phased work budgets with dates. Once established, they provide a quick means for a project manager to gauge the impact of unforeseen events such as turnover, equipment breakdown, or transfer of project personnel.

3. resource schedules also allow project managers to assess how much flexibility they have over certain resources. This is useful when they receive requests from other managers to borrow or share resources. Honouring such requests creates goodwill an “IOU” that can be cashed in during a time of need.

12.14 CASE STUDY

ABC Alloys and Steel Limited is a leading automobile component supplier. The organization is recently facing challenges in meeting the demands of its products due to capacity constraints. It needs to increase the production level by at least 10-15% to meet the increasing demand.

The top management of the organization has decided to install a new machine that would increase the production level significantly. Mr. Vinod is appointed as a project manager to handle the project of installation of machine. He first needs to procure a budget approval from the finance department. On an average, it takes three weeks to obtain an approval from the concerned department. If the purchase gets approved by the finance department, Vinod can make an order for the machine in the market. Generally, it takes six weeks to obtain a new machine after placing the order and two weeks for its installation. However, the organization needs to hire an operator for operating the machine. Vinod has been assured by the HR department to hire an operator in two weeks time. The operator needs at least seven weeks of training before he can operate the machine. Post-training, the operator is supposed to take another two weeks to start production from the machine.

Questions:

1. Help Vinod in identifying the activities in the project and establishing the predecessor and successors relationships of the activities.
2. Assist Vinod in drawing the network of the project.

12.15 NOTES

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12.16 SUMMARY

A schedule is the conversion of a project action plan into an operating time table. As such it serves as the basis for monitoring and controlling project activity and, taken together with the plan and budget, is probably the major tool for the management of projects.

It is interesting to know how project scheduling was evolved over a period of time. During the time of Scientific Management, Henry Gantt introduced a system of scheduling, which is named after him as Gantt chart.

In the 1950s, two project scheduling methods were developed. They are: Programme Evaluation and Review Technique, popularly known as PERT and Critical Path Method. Both the PERT and CPM were founded on the concepts of identifying activities, determining their logical order, and estimating the duration for each.

Project scheduling is the most important function in the implementation stage of a project. A project consists of a number of activities. All the activities of a project cannot be started simultaneously from the very beginning of the project. Therefore, different activities need to be sequenced in a proper order. Project scheduling involves establishing a logical sequence among the different activities of the project and optimizing the total duration of the project.

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However, in 2005, the Project Management Institute renamed PERT as ADM (Arrow Diagram Method) and CPM as PDM (Precedence Diagram Method). In PERT network, the activities are shown as *arrows* on the network; we will call it as AOA (Activity On Arrow) network. In CPM additional resources are needed to complete the project on time.

The consideration of resources adds another dimension to planning and scheduling. In many projects, the amounts of various types of resources available to perform the project activities are limited. Several activities may require the same resources at the same time, and there may not be sufficient resources available to satisfy all demands. In a sense, these activities are competing for the use of same resources. If sufficient resources are not available some activities may have to be rescheduled for a later time when resources are available for them. Therefore, resources are constraints for the project schedule. They can also be an obstacle to completing the project within budget.

12.17 KEY WORDS

Project scheduling involves establishing a logical sequence among the different activities of the project and optimizing the total duration of the project.

Network diagram: It is known as project network. Project network is a visual representation of different individual activities in a logical sequence by using arrows and nodes.

Gant Charts: refers to the graphical representation of data by the help of rectangular bars.

Activity On Arrow (AOA)or arrow diagram method (ADM), in which schedule activities are represented by arrows and connected at points called nodes.

AON or PDM is "a schedule network diagramming technique in which the scheduled activities are represented by boxes or nodes. Schedule activities are graphically linked by one or more logical relationships to show the sequence in which the activities are performed."

Critical path: the longest path (which consists of critical activity) in the network diagram.

12.18 SELF ASSESSMENT QUESTIONS

1. Explain the meaning and importance of project scheduling.
2. Discuss the process of constructing a network diagram with an hypothetical example.
3. Why Resource allocation is important in project scheduling?

12.17 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.
2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.
3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.
4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.
5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill
6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011
7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002
8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012
9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.
10. Sanjiv Marwah. *Project Management.* New Delhi: Dreamtech Press, 2011.

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DEPARTMENT OF STUDIES AND RESEARCH IN MANAGEMENT

M.B.A III Semester

COURSE - 15: PROJECT MANAGEMENT

BLOCK

4

PROJECT EVALUATION AND CONTROL

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BLOCK - IV : PROJECT EVALUATION AND CONTROL

It is the task of the project management to undertake the planning and to ensure that the various tasks of a project are completed in time. This block is concerned with project evaluation and control. This block is divided into four units (unit 13 to 16), unit-13 Initially discusses the significance of PERT/CPM which are an important project evaluation techniques, then the unit provides distinction between PERT and CPM . The unit provides example for CPM and explains steps in drawing CPM/PERT network. Further the unit also gives a pototype example and scheduling a paroject with PERT/CPM and the critical path.

The unit -14 is concerned with the network scheduling, it introduces scheduling individual activities, then discusses earliest start and finish time; latest start and finish time.Also the unit discuss float and slacks and provides solved examples.

The unit- 15 deals with project crashing structure. This unit at the beginning discusses reducing project cost, and briefs optimimum duration of which total project cost is lowest , then privides solved example.

The unit-16 focusses PERT/CPM using software. The manual calucalation of the techniques are time consuming and not cost effective. Today through spread sheet we can solve these problems, this unit show how CPM can be sloved by using spread sheets and costs and crash costs.

UNIT – 13 : PROJECT EVALUATION TECHNIQUES

Structure:

13.0 OBJECTIVES

After studying this unit you should be able to:

- construct activity networks
- translate appropriate real problems into a suitable form for the use of critical path analysis.

13.1 INTRODUCTION

In the Previous unit you have studied the basic of PERT and CPM, in this unit study in detail the PERT and CPM. A complex project must be well planned, especially if a number of people are involved. It is the task of management to undertake the planning and to ensure that the various tasks required in the project are completed in time. Operational researchers developed a method of scheduling

Complex projects shortly after the Second World War. It is sometimes called **network analysis**, but is more usually known as **critical path analysis** (**CPA**). Its virtue is that it can be used in a wide variety of projects, and was, for example, employed in such diverse projects as the Apollo moonshot, the development of Concorde, the Polaris missile project and the privatization of the electricity and water boards. Essentially, CPA can be used for any multi-task complex project to ensure that the complete scheme is completed in the minimum time. Although its real potential is for helping to schedule complex projects, we will illustrate the use of CPA by applying it to rather simpler problems. You will often be able to solve these problems without using CPA, but it is an understanding of the concepts involved in CPA which is being developed here.

The most challenging jobs that any manager can take on are the management of a large-scale project that requires coordinating numerous activities throughout the organization. Innumerable details must be considered in planning how to coordinate all these activities, in developing a realistic schedule, and then in monitoring the progress of the project. Fortunately, two closely related operations research techniques, PERT (program evaluation and review technique) and CPM (critical path method), are available to assist the project manager in carrying out these responsibilities. These techniques make heavy use of networks (as introduced in the preceding chapter) to help plan and display the coordination of all the activities. They also normally use a software package to deal with all the data needed to develop schedule information and then to monitor the progress of the project. Project management software, such as MS Project in your OR Courseware, now is widely available for these purposes.

PERT and CPM were independently developed in the late 1950s. Ever since, they have been among the most widely used OR techniques. The original versions of PERT and CPM had some important differences, as we will point out later in the chapter. However, they also had a great deal in common, and the two techniques have gradually merged further over the years. In fact, today's software pack- ages often include all the important options from both original versions.

Consequently, practitioners now commonly use the two names interchangeably, or combine them into the single acronym PERT/CPM, as we often will do. We will make the distinction between them only when we are describing an option that was unique to one of the original versions. The next section introduces a prototype example that will carry through the chapter to illustrate the various options for analyzing projects provided by PERT/CPM.

PERT – Program Evaluation & Review Technique – It is generally used for those projects where time required to complete various activities are not known as *a priori*. It is probabilistic model & is primarily concerned for evaluation of time. It is event oriented.

CPM – Critical Path Analysis – It is a commonly used for those projects which are repetitive in nature & where one has prior experience of handling similar projects. It is a deterministic model & places emphasis on time & cost for activities of a project.

PERT and CPM have been used for a variety of projects, including the following types.

- Construction of a new plant
- Research and development of a new product
- Space exploration projects
- Movie productions
- Building a ship
- Government-sponsored projects for developing a new weapons system
- Relocation of a major facility
- Maintenance of a nuclear reactor
- Installation of a management information system
- Conducting an advertising campaign

PERT and CPM were independently developed in the late 1950s. Ever since, they have been among the most widely used OR techniques.

- Critical Path Method (CPM)
  - E I Du Pont de Nemours & Co. (1957) for construction of new chemical plant and maintenance shut-down
  - Deterministic task times
  - Activity-on-node network construction
  - Repetitive nature of jobs
- Project Evaluation and Review Technique (PERT)
  - U S Navy (1958) for the POLARIS missile program
  - Multiple task time estimates (probabilistic nature)
  - An event oriented techniques.
  - Activity-on-arrow network construction
  - Non-repetitive jobs (R & D work)

13.2 SIGNIFICANCE OF PERT/CPM

- Network diagrams help translation of highly complex project into a set of simple and logical arranged activities and therefore,
  - Help in the clarity of thoughts and actions.
  - Clear and unambiguous communication developing from top to bottom among the people responsible for executing the project.
- Detailed analysis help project in charge to peep into future.
- Isolates activities which control the project completion and therefore, results in expeditious completion of the project.
- Helps in the division of responsibilities and therefore, enhance effective coordination among different department involved.
- Helps in timely allocation of resources to various activities to archive optimal utilization of resources.

13.3 DIFFERENCE BETWEEN PERT & CPM

PERT

1. PERT is used for non-repetitive jobs like planning the assembly of the space.
2. It is a probabilistic model.
3. It is event-oriented as the results of analysis are expressed in terms of events or distinct points in time indicative of progress.
4. It is applied mainly for planning and scheduling research programmes.
5. PERT incorporates statistical analysis and thereby determines the probabilities concerning the time by which each activity or entire project would be completed.
6. PERT serves as useful control device as it assists management in controlling a project by calling attention to such delays

CPM

1. CPM is used for repetitive job like building a house
2. It is a deterministic model.
3. It is activity-oriented as the result or calculations are considered in terms of activities or operations of the project.
4. It is applied mainly for construction and business problems.
5. CPM does not incorporate statistical analysis in determining time estimates, because time is precise and known.
6. It is difficult to use CPM as a control device for the simple reason that one must repeat the entire evaluation of the project each time the changes are introduced into the network.

13.4 CPM ANALYSIS STEPS, BY EXAMPLE

This document describes the steps for doing CPM analysis for this course. The steps will be illustrated by two examples. I recommend that you work through the examples, so that you can follow the steps yourself when you do the homework.

Example 2 is especially valuable for you to work through. Excel has bugs that vary from version to version. By working through Example 2, and comparing what you get with what I got, you can find out which bugs apply to you and how to work around them when you do the assignment.

Example 1: Activities, precedence, and times

This first example involves activities, their precedence (which activities come before other activities), and the times the activities take. The objective is to identify the critical path and figure out how much time the whole project will take.

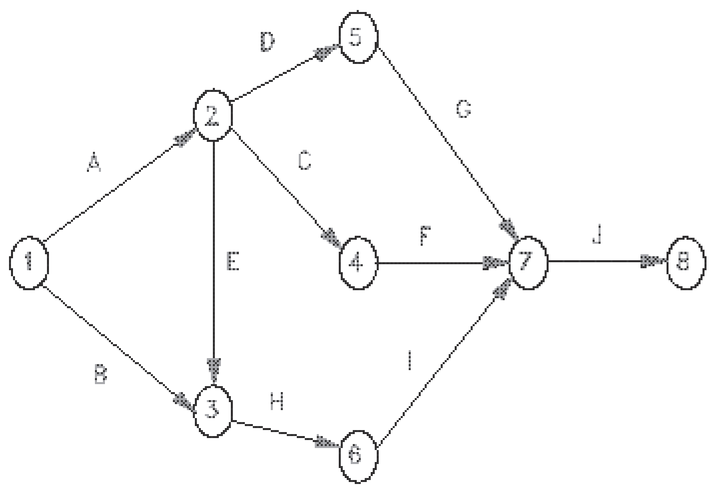
Example 1 Step 1: List the activities

CPM analysis starts when you have a table showing each activity in your project. For each activity, you need to know which other activities must be done before it starts, and how long the activity takes.

Example:

EXAMPLE 1 STEP 2: DRAW THE DIAGRAM

Draw by hand a network diagram of the project that shows which activities follow which other ones. This can be tricky. The analysis method we'll be using requires an "activity-on-arc" (AOA) diagram. An AOA diagram has numbered "nodes" that represent stages of project completion. You make up the nodes' numbers as you construct the diagram. You connect the nodes with arrows or "arcs" that represent the activities that are listed in the above table.



Some conventions about how to draw these diagrams:

- All activities with no predecessor come off of node 1.
- All activities with no successor point to the last node, which has to have highest node number.

In this example, A and B are the two activities that have no predecessor. They are represented as arrows leading away from node 1.

J is the one activity that has no successor, in this example. It therefore points to the last node, which is node 8. If there were more than one activity with successor, all of those activities' arrows point to the highest number node.

The trickiest part for me of building the above diagram was figuring what to do with activity H. I had drawn an arrow for activity B coming off node 1 and going to mode 3. I had later drawn an arrow for activity E coming off node 2 and going to node 6. Since H requires both B and E, I had to erase my first E arrow and redraw it so it pointed to the same node 3 that B did. H then comes off of node 3 and goes to node 6.

13.5 STEPS FOR DRAWING CPM/PERT NETWORK

1. Analyze & breakup of the entire project into smaller systems i.e. specific activities and/ or events.
2. Determine the interdependence & sequence of those activities.
3. Estimate the completion time, cost, etc. for each activity.
4. Draw the PERT/CPM network, showing the relationship activities.
5. Starting with the beginning node of the network, use the earliest start – earliest finish relationships to determine the project completion time (Forward Pass or Backward Pass)þ
6. Moving to the end node of the network, use the latest start – latest finish relationships to determine the activities on the critical path and the float for activities not on the critical path
7. Update the CPM/PERT diagram as the project progresses.

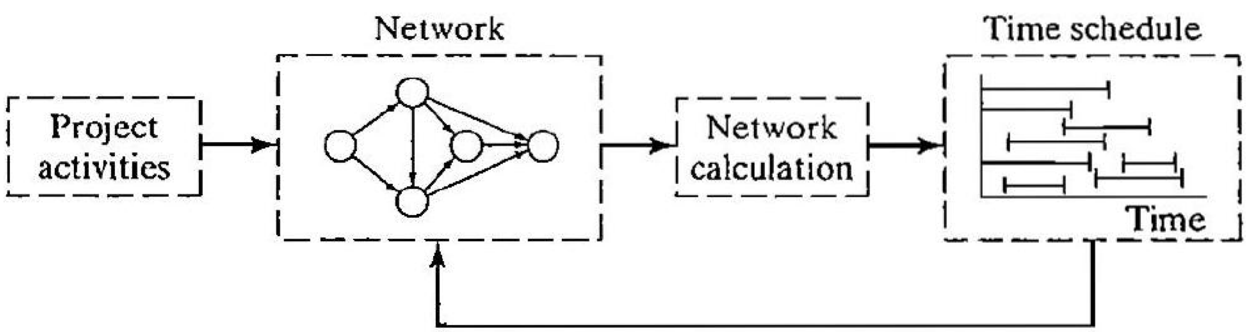


FIGURE Phases for project planning with CPM-PERT

NETWORK REPRESENTATION:

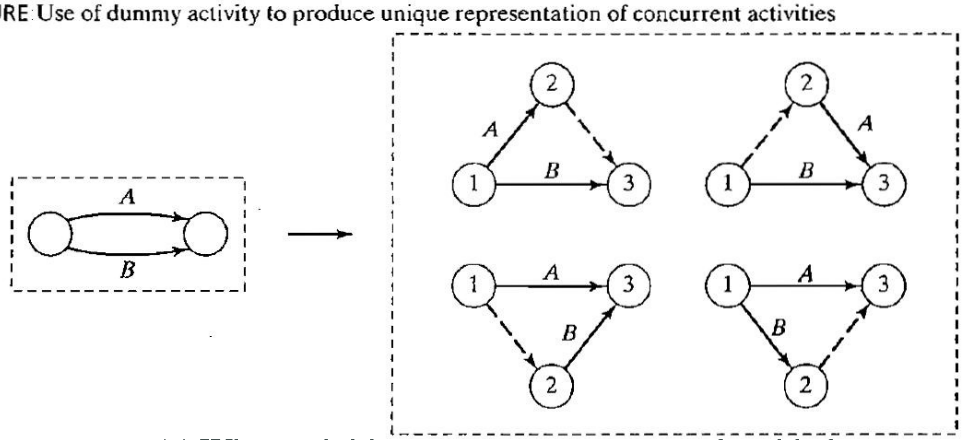
Each activity of the project is represented by arrow pointing in direction of progress of project. The events of the network establish the precedence relationship among different activities. Three rules are available for constructing the network.

Rule 1. Each activity is represented by one & only one, arrow.

Rule 2. Each activity must be identified by two distinct events **&** No two or more activities can have the same tail and head events.

Following figure shows how a dummy activity can be used to represent two concurrent activities, A & B. By definition, a dummy activity, which normally is depicted by a dashed arrow, consumes no time or resources. Dummy activity is a hypothetical activity which takes no resource or time to complete. It is represented by broken arrowed line & is used for either distinguishing activities having common starting & finishing events or to identify & maintain proper precedence relationship between activities that are not connected by events.

FIGURE Use of dummy activity to produce unique representation of concurrent activities

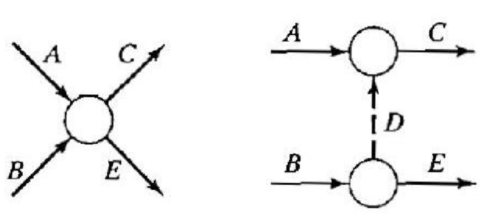


e, we maintain the concurrence
es (to satisfy Rule 2).

following questions must be

nt activity?

(c) What activities must occur concurrently with the current activity?



(a) (b)

FIGURE Use of dummy activity to ensure correct precedence relationship

The answers to these questions may require the use of dummy activities to ensure correct precedence's among the activities. For example, consider the following segment of a project:

1. Activity C starts immediately after A and B have been completed.

2. Activity E starts only after B has been completed.

Part (a) of the figure above, shows the incorrect representation of the precedence relationship because it requires both A & B to be completed before E can start. In part (b) the use of dummy rectifies situation.

13.6 A PROTOTYPE EXAMPLE—THE RELIABLE CONSTRUCTION CO. PROJECT

The RELIABLE CONSTRUCTION COMPANY has just made the winning bid of Rs 5.4 million to construct a new plant for a major manufacturer. The manufacturer needs the plant to go into operation within a year. Therefore, the contract includes the following provisions:

- A penalty of Rs 300,000 if Reliable has not completed construction by the deadline 47 weeks from now.
- To provide additional incentive for speedy construction, a bonus of Rs 150,000 will be paid to Reliable if the plant is completed within 40 weeks.

Reliable is assigning its best construction manager, Mr. David, to this project to help ensure that it stays on schedule. He looks forward to the challenge of bringing the project in on schedule, and perhaps even finishing early. However, since he is doubtful that it will be feasible to finish within 40 weeks without incurring excessive costs, he has decided to focus his initial planning on meeting the deadline of 47 weeks.

Mr. David will need to arrange for a number of crews to perform the various construction activities at different times. Table 1 shows his list of the various activities. The third column provides important additional information for coordinating the scheduling of the crews.

For any given activity, its immediate predecessors (as given in the third column of Table 1) are those activities that must be completed by no later than the starting time of the given activity. (Similarly, the given activity is called an immediate successor of each of its immediate predecessors.)

TABLE 1 Activity list for the Reliable Construction Co. project

Activity	Activity Description	Immediate Predecessors	Estimated Duration
A	Excavate	—	2 weeks
B	Lay the foundation	A	4 weeks
C	Put up the rough wall	B	10 weeks
D	Put up the roof	C	6 weeks
E	Install the exterior plumbing	C	4 weeks
F	Install the interior plumbing	E	5 weeks
G	Put up the exterior siding	D	7 weeks
H	Do the exterior painting	E, G	9 weeks
I	Do the electrical work	C	7 weeks
J	Put up the wallboard	F, I	8 weeks
K	Install the flooring	J	4 weeks
L	Do the interior painting	J	5 weeks
M	Install the exterior fixtures	H	2 weeks
N	Install the interior fixtures	K, L	6 weeks

For example, the top entries in this column indicate that

1. Excavation does not need to wait for any other activities.
2. Excavation must be completed before starting to lay the foundation.
3. The foundation must be completely laid before starting to put up the rough wall, etc.

When a given activity has more than one immediate predecessor, all must be finished before the activity can begin.

In order to schedule the activities, Mr. David consults with each of the crew supervisors to develop an estimate of how long each activity should take when it is done in the normal way. These estimates are given in the rightmost column of Table 1.

Adding up these times gives a grand total of 79 weeks, which is far beyond the deadline for the project. Fortunately, some of the activities can be done in parallel, which substantially reduces the project completion time.

Given all the information in Table 1, Mr. David now wants to develop answers to the following questions.

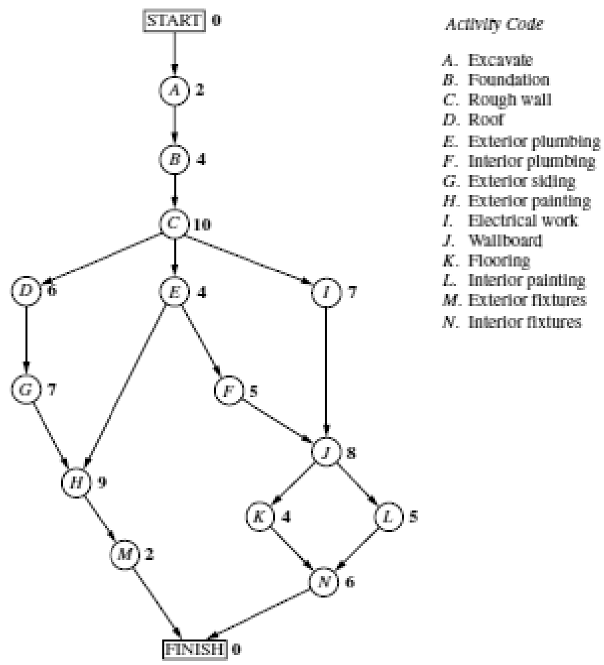
1. How can the project be displayed graphically to better visualize the flow of the activities?
2. What is the total time required to complete the project if no delays occur?
3. When do the individual activities need to start and finish (at the latest) to meet this project completion time?
4. When can the individual activities start and finish (at the earliest) if no delays occur?
5. Which are the critical bottleneck activities where any delays must be avoided to prevent delaying project completion?
6. For the other activities, how much delay can be tolerated without delaying project completion?
7. Given the uncertainties in accurately estimating activity durations, what is the probability of completing the project by the deadline?
8. If extra money is spent to expedite the project, what is the least expensive way of attempting to meet the target completion time (40 weeks)?
9. How should ongoing costs be monitored to try to keep the project within budget?

Being a regular user of PERT/CPM, Mr. David knows that this technique will provide invaluable help in answering these questions .

13.7 USING A NETWORK TO VISUALLY DISPLAY A PROJECT

The preceding chapter describes how valuable networks can be to represent and help analyze many kinds of problems. In much the same way, networks play a key role in dealing with projects. They enable showing the relationships between the activities and placing everything into perspective. They then are used to help analyze the project and answer the kinds of questions raised at the end of the preceding section.

Figure: 1 The project network for the Reliable Construction Co. project



13.8 SCHEDULING A PROJECT WITH PERT-CPM

At the end of we mentioned that Mr. David the project manager for the Reliable Construction Co. project, wants to use PERT/CPM to develop answers to a series of questions. His first question has been answered in the preceding section. Here are the five questions that will be answered in this section.

Question 2: What is the total time required to complete the project if no delays occur?
Question 3: When do the individual activities need to start and finish (at the latest) to meet this project completion time?

Question 4: When can the individual activities start and finish (at the earliest) if no de- lays occur?

Question 5: Which are the critical bottleneck activities where any delays must be avoided to prevent delaying project completion?

Question 6: For the other activities, how much delay can be tolerated without delaying project completion?

The project network in Fig.1 enables answering all these questions by providing two crucial pieces of information, namely, the order in which certain activities must be performed and the (estimated) duration of each activity. We begin by focusing on Questions 2 and 5

13.9 THE CRITICAL PATH

How long should the project take? We noted earlier that summing the durations of all the activities gives a grand total of 79 weeks. However, this isn't the answer to the question because some of the activities can be performed (roughly) simultaneously.

What is relevant instead is the length of each path through the network.

A path through a project network is one of the routes following the arcs from the START node to the FINISH node. The length of a path is the sum of the (estimated) durations of the activities on the path.

The six paths through the project network in Fig. 1 are given in Table 2, along with the calculations of the lengths of these paths. The path lengths range from 31 weeks up to 44 weeks for the longest path (the fourth one in the table).

So given these path lengths, what should be the (estimated) project duration (the total time required for the project)? Let us reason it out.

Since the activities on any given path must be done one after another with no overlap, the project duration cannot be shorter than the path length. However, the project duration can be longer because some activity on the path with multiple immediate predecessors might have to wait longer for an immediate predecessor not on the path to finish than for the one on the path. For example, consider the second path in Table 2 and focus on activity H. This activity has two immediate predecessors, one (activity G) not on the path and one (activity E) that is. After activity C finishes, only 4 more weeks are required for activity E but 13 weeks will be needed for activity D and then activity G to finish. Therefore, the project duration must be considerably longer than the length of the second path in the table.

TABLE 2 THE PATHS AND PATH LENGTHS THROUGH RELIABLE'S PROJECT NETWORK

Path	Length
START → A → B → C → D → G → H → M → FINISH	2 + 4 + 10 + 6 + 7 + 9 + 2 = 40 weeks
START → A → B → C → E → H → M → FINISH	2 + 4 + 10 + 4 + 9 + 2 = 31 weeks
START → A → B → C → E → F → J → K → N → FINISH	2 + 4 + 10 + 4 + 5 + 8 + 4 + 6 = 43 weeks
START → A → B → C → E → F → J → L → N → FINISH	2 + 4 + 10 + 4 + 5 + 8 + 5 + 6 = 44 weeks
START → A → B → C → I → J → K → N → FINISH	2 + 4 + 10 + 7 + 8 + 4 + 6 = 41 weeks
START → A → B → C → I → J → L → N → FINISH	2 + 4 + 10 + 7 + 8 + 5 + 6 = 42 weeks

However, the project duration will not be longer than one particular path. This is the longest path through the project network. The activities on this path can be performed sequentially without interruption. (Otherwise, this would not be the longest path.) Therefore, the time required to reach the FINISH node equals the length of this path. Furthermore, all the shorter paths will reach the FINISH node no later than this.

Here is the key conclusion.

The (estimated) project duration equals the length of the longest path through the project network. This longest path is called the critical path. (If more than one path tie for the longest, they all are critical paths.)

Thus, for the Reliable Construction Co. project, we have

Critical path: START –A- B – C – E – F – J – L – N - FINISH

(Estimated) project duration = 44 weeks.

We now have answered Mr. Questions 2 and 5 given at the beginning of the section. If no delays occur, the total time required to complete the project should be about 44 weeks. Furthermore, the activities on this critical path are the critical bottleneck activities where any delays in their completion must be avoided to prevent de- laying project completion. This is valuable information for Mr. David, since he now knows that he should focus most of his attention on keeping these particular activities on schedule in striving to keep the overall project on schedule. Furthermore, if he decides to reduce the duration of the project (remember that bonus for completion within 40 weeks), these are the main activities where changes should be made to reduce their durations.

For small project networks like Fig. 1, finding all the paths and determining the longest path is a convenient way to identify the critical path. However, this is not an efficient procedure for larger projects. PERT/CPM uses a considerably more efficient procedure instead. Not only is this PERT/CPM procedure very efficient for larger projects, it also pro- vides much more information than is available from finding all the paths. In particular, it answers all five of Mr. David's questions listed at the beginning of the section rather than just two. These answers provide the key information needed to schedule all the activities and then to evaluate the consequences should any activities slip behind schedule.

Numbering the Events (Fulkerson's Rule)

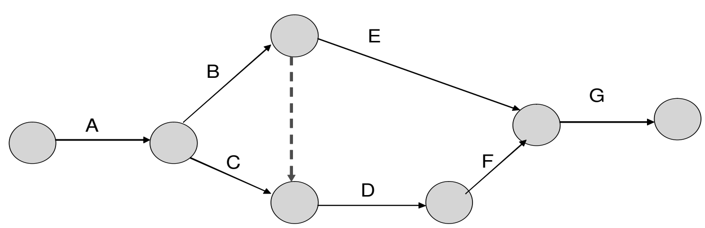
1. The initial event which has all outgoing arrows with no incoming arrow is numbered "1".
2. Delete all the arrows coming out from node "1". This will convert some more nodes into initial events.

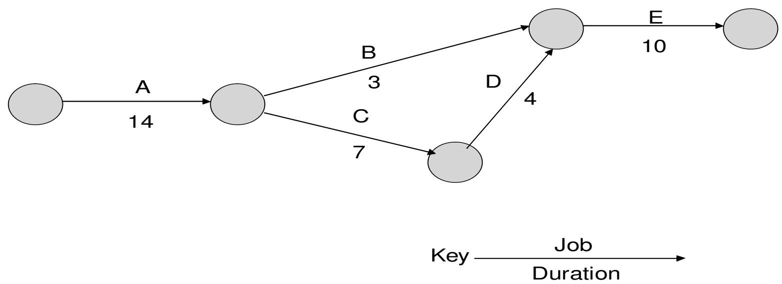
3. Number these events as 2, 3, 4…
4. Delete all the arrows going out from these numbered events to create more initial events. Assign the next numbers to these events.
5. Continue until the final or terminal node, which has all arrows coming in with no arrow going out is numbered.

13.10 CASE STUDY

Problem 1.
Construct an arrow diagram for the following project.

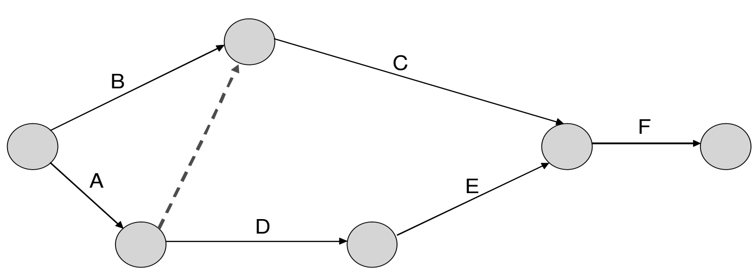
Activities	Relationship
A	Precedes B,C
B	Precedes D,E
C	Precedes D
D	Precedes F
E	Precedes G
F	Precedes G





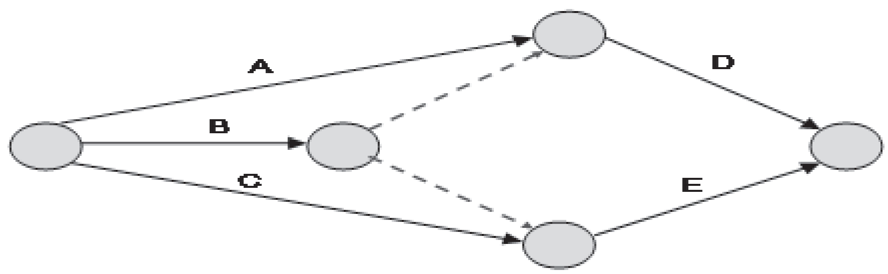
Problem 3.
Construct an arrow diagram for the following project.

Job	Immediate predecessor
A	-
B	-
C	A,B
D	A
E	D
F	C,E



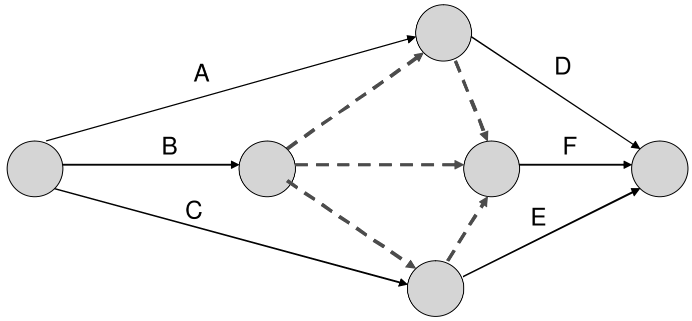
Problem 4.
Construct an arrow diagram for the following project.

Activity	Predecessor
A	-
B	-
C	-
D	A,B
E	B,C



Problem 5.
Construct an arrow diagram for the following project.

Activity	Predecessor
A	-
B	-
C	-
D	A,B
E	B,C
F	A,B,C



Problem 6.

Draw the PERT network for the following project

Event A is followed by events B & C

Event D is preceded by events B & C

Event H is the successor to event E

Event E is the successor to event B

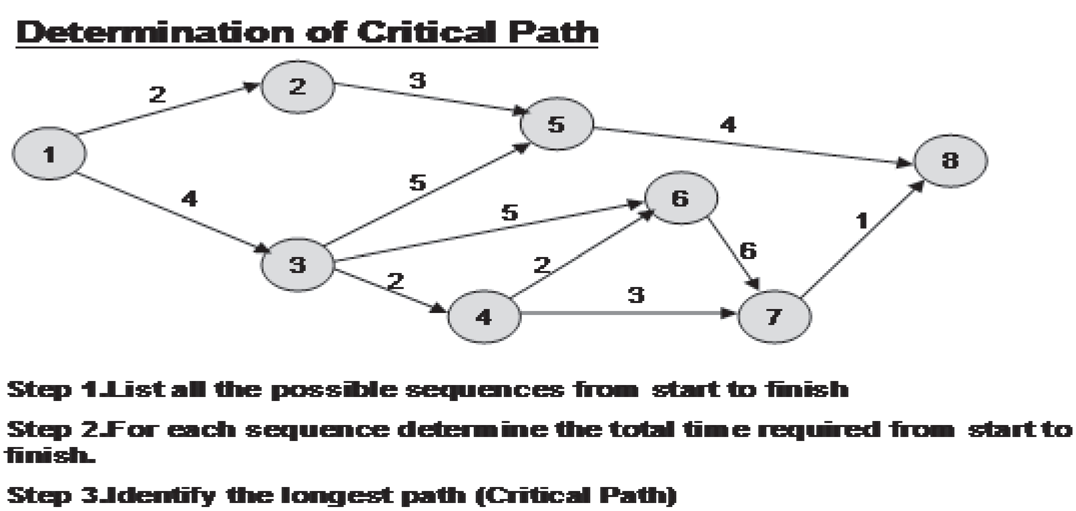
Event F is the successor to event D & G

Event C is the predecessor to event G

Event J is preceded by events F,G, & H

CRITICAL PATH

Meaning: The longest path in a project network which determine the duration of the project is known as critical path.



Step 1. List all the possible sequences from start to finish

Path A : 1 – 2 – 5 – 8

Path B : 1 – 3 – 5 – 8

Path C : 1 – 3 – 6 – 7 – 8

Path D : 1 – 3 – 4 – 7 – 8

Path E : 1 – 3 – 4 – 6 – 7 – 8

Step 2.For each sequence determine the total time required from start to finish.
Path A : 2 + 3 + 4 = 9 days
Path B : 4 + 5 + 4 = 13 days
Path C : 4 + 5 + 6 + 1 = 16 days
Path D : 4 + 2 + 3 + 1 = 10 days
Path E : 4 + 2 + 2 + 6 + 1 = 10 days

Step 2.For each sequence determine the total time

required from start to finish.

Path A : 2 + 3 + 4 = 9 days

Path B : 4 + 5 + 4 = 13 days

Path C : 4 + 5 + 6 + 1 = 16 days

Path D : 4 + 2 + 3 + 1 = 10 days

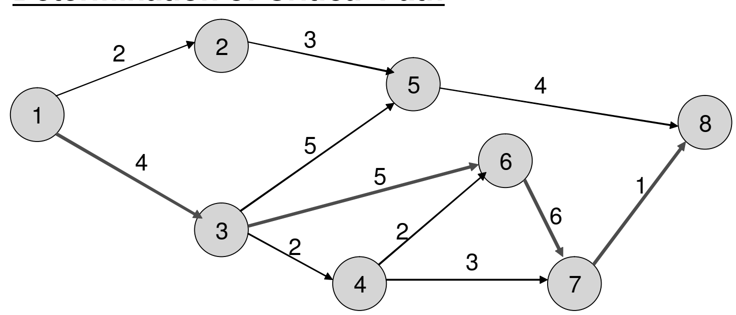
Path E : 4 + 2 + 2 + 6 + 1 = 10 days

Step 3.Identify the longest path (Critical Path)

Path C : 4 + 5 + 6 + 1 = 16 days

Path C : 1 – 3 – 6 – 7 – 8

Determination of Critical Path



Step 1.List all the possible sequences from start to finish

Step 2.For each sequence determine the total time required from start to finish.

Step 3.Identify the longest path (Critical Path)

13.11 NOTES

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13.12 SUMMARY

CPM helps you identify a complex project's critical paths. You can find how long a project will take and which activities must be on time. If you also have information about costs and crash costs and times, CPM helps you determine how long the project should take, and which activities should be sped up ("crashed"). As we are doing it in this class, the steps are:

1. Have a list of the activities.
2. Draw the network diagram.
3. Put activity names, node numbers, times, and costs in a spreadsheet.
4. Use Path find to generate code for the paths.
5. Put the path information into the spreadsheet.
6. Calculate the paths' times.
7. Identify the critical paths, and the activities in each path.
8. Set up the formula to calculate the project's total cost.
9. Fill in the Tools | Solver... form.
10. Solve, and fix errors, if any.
11. For an economic analysis, change the maximum time constraint and solve again. Repeat until costs, including penalties and bonuses, start to go up.

13.13 KEY WORDS

Critical path, network, event, activity

13.14 SELF ASSESMENT QUESTIONS

1. What do you mean by a dummy activity? Why it is used in networking?

2. Depict the following dependency relationships by means of network diagrams.

(The Alphabets stands for activities)

1. A and B control F; B and C control G.
2. A and B control F; B controls G while C controls G and H.
3. A controls F and G; B controls G while C controls G and H.

4. A controls F and G; B and C control G with H depending upon C.

5. F and G are controlled by A, G and H is controlled by B with H controlled by B and C.

6. A controls F, G and H; B controls G and H with H controlled by C.

3. Develop a network based on the following information;

Activity	**Immediate predecessors**
A	-
B	-
~~C~~	~~A~~
D	B
E	C,D
F	D
G	E

4. Construct the project network comprised of activities A to L with the following precedence relationships:

(a) A, B and C, the first activities of the project can be executed concurrently

(b) A & B precede D

(c) B precedes E, F, H

(d) F and C precede G

(e) E and H precede I & J

(f) C, D, F and J precede K

(g) K precede L

(h) I, G, and L are terminal activities of the project.

5. Construct the project network comprised of activities A to P that satisfies the following precedence relationships:

(a) A, B and C, the first activities of the project can be executed concurrently

(b) D, E and F follow A

(c) I and G follow both B and D

(d) H follows both C & G

(e) K and L follow I

(f) J succeeds both E and H

(g) M and N succeed F, but cannot start until both E and H are completed.

(h) O succeeds both M and I

(i) P succeeds J, L and O

(j) K, N and P are the terminal activities of the project.

6. A publisher has a contract with an author to publish a textbook. The simplified (activities) associated with the production of the textbook are given below. The author is required to submit to the publisher a hard copy and a computer file of the manuscript. Develop the associated network for the project.

7. A project consists of a series of tasks labeled A, B… H, I with the following relationships (W<X, Y means X and Y cannot start until W is completed; X, Y<W means W cannot start until both X and Y are completed). With this notation construct the network diagram having the following constraints:

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

8. The footing of a building can be completed in four consecutive sections. The activities for each section include (1) digging, (2) placing steel, and (3) pouring concrete. The digging of one section cannot start until that of the preceding section has been completed. The same restriction applies placing steel & pouring concrete. Develop the project network.

13.15 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.
2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.
3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.
4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.
5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill
6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011
7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002
8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012
9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.
10. Sanjiv Marwah. *Project Management.* New Delhi: Dreamtech Press, 2011.

UNIT – 14 : NETWORK SCHEDULING

Structure :

14.0 OBJECTIVES

After reading this unit, you should be able to :

- find earliest and latest starting times
- identify the critical path

14.1 INTRODUCTION TO SCHEDULING INDIVIDUAL ACTIVITIES

The PERT/CPM scheduling procedure begins by addressing Question 4: When can the individual activities start and finish (at the earliest) if no delays occur? Having no delays means that

- o The actual duration of each activity turns out to be the same as its estimated duration
- o Each activity begins as soon as all its immediate predecessors are finished.

The starting and finishing times of each activity if no delays occur anywhere in the project are called the earliest start time and the earliest finish time of the activity.

14.2 EARLIEST START AND FINISH TIME

These times are represented by the symbols

ES = earliest start time for a particular activity,

EF = earliest finish time for a particular activity,

Where

EF = ES + (estimated) duration of the activity.

Rather than assigning calendar dates to these times, it is conventional instead to count the number of time periods (weeks for Reliable's project) from when the project started. Thus,

Starting time for project = 0.

Since activity A starts Reliable's project, we have

Activity A: ES = 0,

EF = 0 + duration (2 weeks)

= 2,

Where the duration (in weeks) of activity A is given in Fig. 1 as the boldfaced number next to this activity. Activity B can start as soon as activity A finishes so

Activity B: ES = EF for activity A

= 2,

EF = 2 + duration (4 weeks) = 6.

This calculation of ES for activity B illustrates our first rule for obtaining ES.

If an activity has only a single immediate predecessor, then

ES for the activity = EF for the immediate predecessor.

This rule (plus the calculation of each EF) immediately gives ES and EF for activity C, then for activities D, E, I, and then for activities G, F as well. Figure 4 shows ES and EF for each of these activities to the right of its node.

For example,

Activity G: ES = EF for activity D

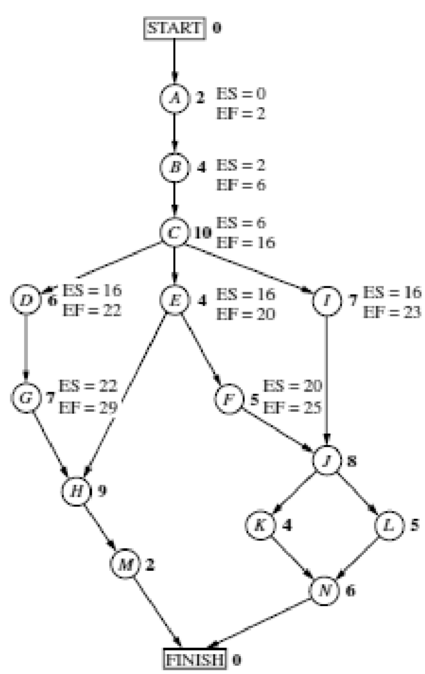
= 22,

EF = 22 + duration (7 weeks)

= 29,

This means that this activity (putting up the exterior siding) should start 22 weeks and finish 29 weeks after the start of the project.

Figure 4: Earliest start time (ES) and Earliest finish time (EF) values for the initial activities in fig1 that have only single immediate predecessor



Now consider activity H, which has two immediate predecessors, activities G and E. Activity H must wait to start until both activities G and E are finished, which gives the following calculation.

Immediate predecessors of activity H:

Activity G has EF = 29.

Activity E has EF = 20.

Larger EF = 29.

Therefore,

ES for activity H = larger EF above

= 29.

This calculation illustrates the general rule for obtaining the earliest start time for any activity.

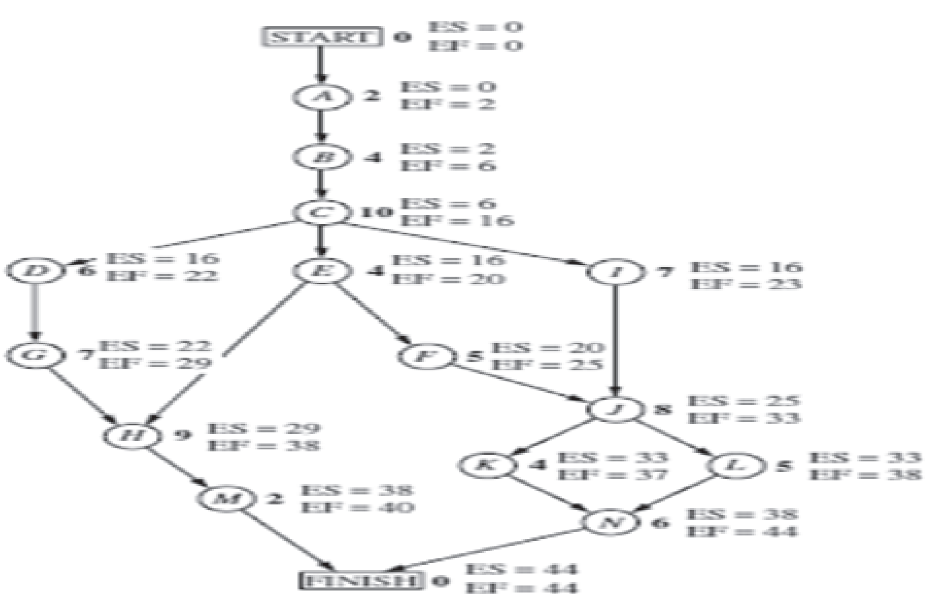
Earliest Start Time Rule

The earliest start time of an activity is equal to the largest of the earliest finish times of its immediate predecessors. In symbols,

ES = largest EF of the immediate predecessors.

When the activity has only a single immediate predecessor, this rule becomes the same as the first rule given earlier. However, it also allows any larger number of immediate predecessors as well. Applying this rule to the rest of the activities in Fig. 4 (and calculating each EF from ES) yields the complete set of ES and EF values given in Fig. 5.

Figure 5: Earliest start time (ES) and Earliest finish time (EF) values for all the activities (plus the START and FINISH nodes) of the Reliable Construction Co. project.



Note that Fig. 5 also includes ES and EF values for the START and FINISH nodes. The reason is that these nodes are conventionally treated as dummy activities that require no time. For the START node, ES = 0 = EF automatically. For the FINISH node, the earliest start time rule is used to calculate ES in the usual way, as illustrated below.

Immediate predecessors of the FINISH node:

Activity M has EF = 40.

Activity N has EF = 44.

Larger EF = 44.

Therefore,

ES for the FINISH node = larger EF above

= 44.

EF for the FINISH node = 44 + 0 = 44.

This last calculation indicates that the project should be completed in 44 weeks if everything stays on schedule according to the start and finish times for each activity given in Fig. 5. (This answers Question 2.) Mr. David now can use this schedule to inform the crew responsible for each activity as to when it should plan to start and finish its work.

This process of starting with the initial activities and working forward in time toward the final activities to calculate all the ES and EF values is referred to as making a forward pass through the network.

Keep in mind that the schedule obtained from this procedure assumes that the actual duration of each activity will turn out to be the same as its estimated duration. What happens if some activity takes longer than expected? Would this delay project completion? Perhaps, but not necessarily. It depends on which activity and the length of the delay.

The next part of the procedure focuses on determining how much later than indicated in Fig. 5 can an activity start or finish without delaying project completion.

14.3 LATEST START AND FINISH TIME

The latest start time for an activity is the latest possible time that it can start without delaying the completion of the project (so the FINISH node still is reached at its earliest finish time), assuming no subsequent delays in the project. The latest finish time has the corresponding definition with respect to finishing the activity.

In symbols,

LS = latest start time for a particular activity

LF = latest finish time for a particular activity,

Where

LS = LF - (estimated) duration of the activity.

To find LF, we have the following rule.

Latest Finish Time Rule

The latest finish time of an activity is equal to the smallest of the latest start times of its immediate successors. In symbols,

LF = smallest LS of the immediate successors.

Since an activity's immediate successors cannot start until the activity finishes, this rule is saying that the activity must finish in time to enable all its immediate successors to begin by their latest start times.

For example, consider activity M in Fig. 1. Its only immediate successor is the FINISH node. This node must be reached by time 44 in order to complete the project within 44 weeks, so we begin by assigning values to this node as follows.

FINISH node: LF = it's EF = 44,

LS = 44 - 0 = 44.

Now we can apply the latest finish time rule to activity M.

Activity M: LF = LS for the FINISH node

=44,

LS = 44 - duration (2 weeks) = 42.

(Since activity M is one of the activities that together complete the project, we also could have automatically set its LF equal to the earliest finish time of the FINISH node without applying the latest finish time rule.)

Since activity M is the only immediate successor of activity H, we now can apply the latest finish time rule to the latter activity.

Activity H: LF = LS for activity M

= 42,

LS = 42 - duration (9 weeks)

= 33.

Note that the procedure being illustrated above is to start with the final activities and work backward in time toward the initial activities to calculate all the LF and LS values. Thus, in contrast to the forward pass used to find earliest start and finish times, we now are making a backward pass through the network.

Figure 6 shows the results of making a backward pass to its completion. For example, consider activity C, which has three immediate successors.

Immediate successors of activity C:

Activity D has LS = 20.

Activity E has LS = 16.

Activity I has LS = 18.

Smallest LS = 16.

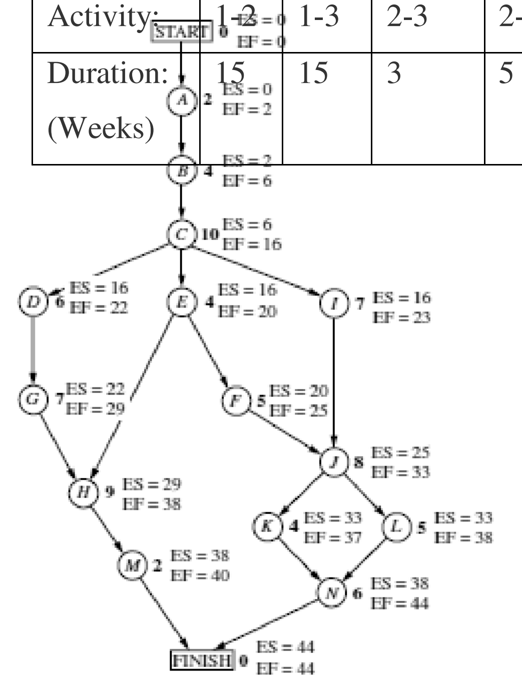
Therefore,

LF for activity C = smallest LS above

= 16.

Mr. David now knows that the schedule given in Fig. 6 represents his "last chance schedule." Even if an activity starts and finishes as late as indicated in the figure, he still will be able to avoid delaying project completion beyond 44 weeks as long as there is no subsequent slippage in the schedule. However, to allow for unexpected delays, he would prefer to stick instead to the earliest time schedule given in Fig. 5 whenever possible in order to provide some slack in parts of the schedule. If the start and finish times in Fig. 6 for a particular activity are later than the corresponding earliest times in Fig. 5, then this activity has some slack in the schedule. The last part of the PERT/CPM procedure for scheduling a project is to identify this slack, and then to use this information to find the critical path. (This will answer both Questions 5 and 6.)

Figure 6: Latest start time (LS) and Latest finish time (LF) values for the all activities (plus the START and FINISH nodes) of the Reliable Construction Co. project.



Activity:	1-2	1-3	2-3	2-5	3-4	3-6	4-5	4-6	5-6	6-7
Duration: (Weeks)	15	15	3	5	8	12	1	14	3	14

Forward Pass Computation: It is the process of tracing the network from START to

...st start & finish times for each activity.

...ne (Ej): The time that event *j* will occur if the preceding activities are

...ible. Ej is the **max**. of the **sums** Ei + tij involving each immediately

...rvening event *ij*.

Computation: It is the process of tracing the network starting from

...ackward.

...ne (Lj): The latest time that event *i* can occur without delaying

its earliest time. Li is the **min**. of the **differences** Li - tij involving

...edent event *j* & intervening event *ij*.

...me & Latest event time:

- In accordance with Zero Slack Convention, if no schedule date for completion of the project is specified, then we take L=E for the terminal event of the project.
- It is a convention to keep the earliest allowance time of the START event as zero.
- Flexibility of non - critical in case of event is known as slack & in case of activity is term as float. (Though some writers have used these terms interchangeably).

The critical path can be identified by determining the following four parameters for each *activity*:

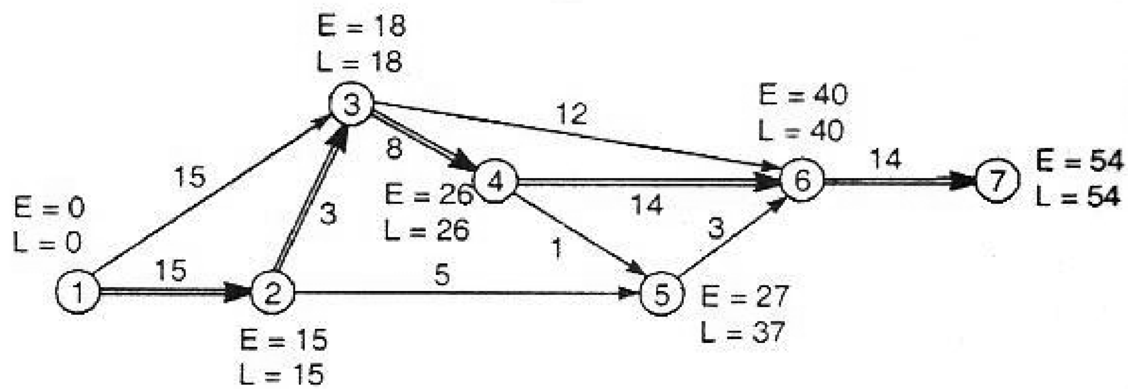
- **ES** - earliest start time: the earliest time at which the activity can start given that all its precedent activities must be completed first = **Ei**
- **EF** - earliest finish time, equal to the earliest start time for the activity plus the time required to complete the activity = **ES(i-j) + tij**
- **LF** - latest finish time: the latest time at which the activity can be completed without delaying (beyond its targeted completion time) the project = **Lj**
- **LS** - latest start time, equal to the latest finish time minus the time required to complete the activity **= LF (i-j) – tij**

CRITICAL PATH: The **critical path** is the path through the project network in which none of the activities have float (*total float is zero*) i.e. A critical path satisfies following 3 conditions:

- ES = LS
- EF = LF
- Ej – Ei = Lj – Li = tij

The duration of project is fixed by the time taken to complete the path through the network with the greatest total duration. This path is known as critical path & activities on it are known as critical activities. A delay in the critical path delays the project. Similarly, to accelerate the project it is necessary to reduce the total time required for the activities in the critical path.

Dummy Activity may or may not lie on critical path.



14.4 FLOAT AND SLACKS

The ***total*** *float time* for an *activity* is the time between its earliest and latest start time, or between its earliest and latest finish time. It is the amount of time that an activity can be delayed past its earliest start or earliest finish without delaying the project. = **LST-ES or LF-EF** = LF - ES -tij = LF - (ES + tij)

The slack time or ***slack*** of an *event* in a network is the difference the latest event time & earliest event time i.e. **Li-Ei**

The ***free*** *float time* of an *activity* is equal to the amount by which its duration can be increased without affecting either the project time or the time available for the subsequent activities. It indicates the value by which an activity can be delayed beyond the earliest starting point without affecting the earliest start, & therefore, the total float of the activities following it. **= Total Floatij – (Slack of event *j*)**

The ***independent*** *float time* of an *activity* is the amount by which the duration of an activity could be extended without affecting the total project time, the time available for subsequent activities or the time available for the preceding activities. **= [Free Floatij – (Slack of event i)] or ZERO, whichever is higher**. Also EST of following activity – LFT of preceding activity – Duration of current activity or Zero, whichever is higher.

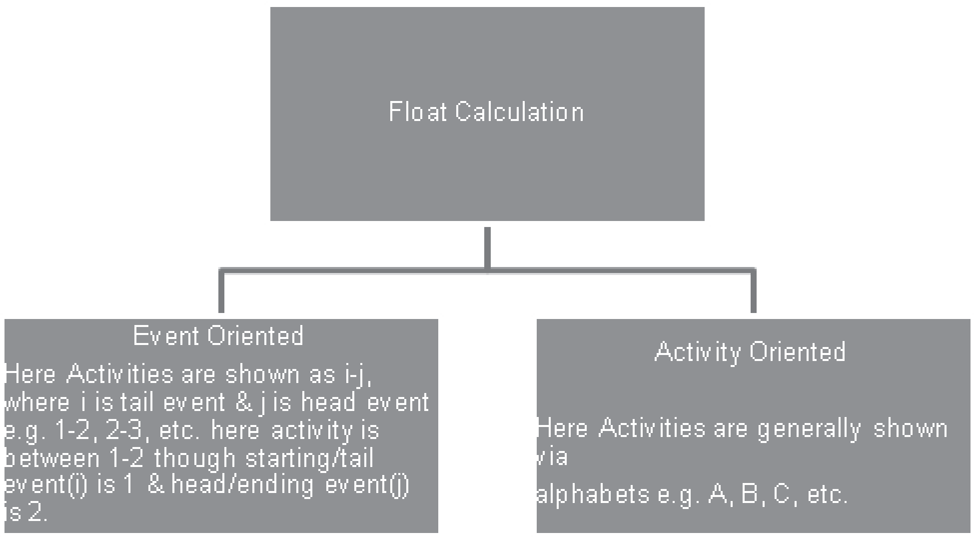
The ***interfering float time*** is the part of total float which causes a reduction in the float of successor activities. It is that portion of the activity float which cannot be consumed without affecting adversely the float of the subsequent activity or activities. **= LF – (ES of following activity) or ZERO, whichever is higher.**

While calculating floats, for just for our simplifying computations, we can write values of Slack of event j incolumn wherein we are supposed to write interfering float.

Subcritical Activity: Activity having next higher float than the critical activity.

Supercritical Activity: These Activities have negative float. It results when activity duration is more than time available. It indicates abnormal situation requiring as to how to compress the activity.

Subcritical path: The path with the next least floats than critical path is subcritical path.



FLOAT (SLACK)

- Float (Slack) refers to the amount of time by which a particular event or an activity can be delayed without affecting the time schedule of the network.
- Float (Slack) Float (Slack) is defined as the difference between latest allowable and the earliest expected time.

Event Float/Slack = LS – ES

Where LS = Latest start time

ES = Early start time.

Total float (TF) / Total slack (TS)

Total float of the job is the differences between its late start and Early start 'or' Late finish and Early finish i.e.

TF(CA) = LS (CA) - ES (CA)

Or

TF (CA) = LF (CA) - EF (CA)

CA = Current activity

Free float (FF)

Free float is the amount of time a job can be delayed without affecting the Early start time of any other job.

FF(CA) = ES(SA) – EF (CA)

CA = Current Activity

SA = Succeeding Activity

Independent Float (IF)

Independent Float is the amount of time that can be delayed without affecting either predecessor or successor activities.

IF = ES (SA) – LF (PA) - Duration of CA

ES = Early Start

LF = Late Finish

SA = Succeeding Activity

PA = Preceding Activity

CA = Current Activity

14.5 SOLVED EXAMPLES

Example 1

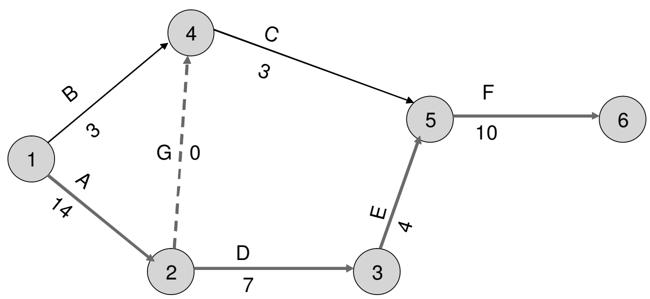
Construct the Network for the following Project and determine the following

i) Critical Path

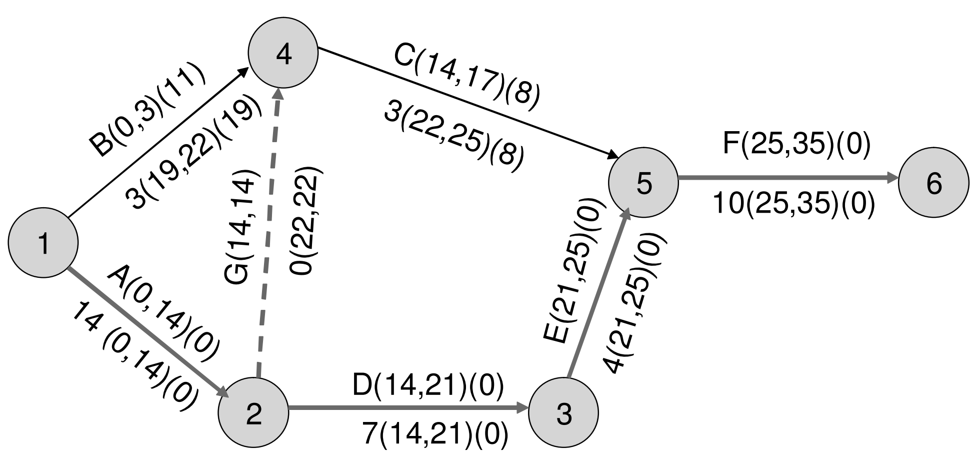
ii) ES,EF,LS,LF

iii) TF,FF

Construction of the Network and Determination Critical Path



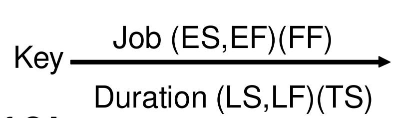
Determination of TF and FF



TF(CA) = LS (CA) - ES (CA)

FF(CA) = ES(SA) – EF (CA)

IF = (ES(SA) – LF(PA)) - Duration of CA



Activity	Duration	ES	EF	LS	LF	TF	FF
1-2	14	0	14	0	14	0	0
1-4	3	0	3	19	22	19	11
2-3	7	14	21	14	21	0	0
2-4	0	14	14	22	22	0	0
3-5	4	21	25	21	25	0	0
4-5	3	14	17	22	25	8	8
5-6	10	25	35	25	35	0	0

Example 2

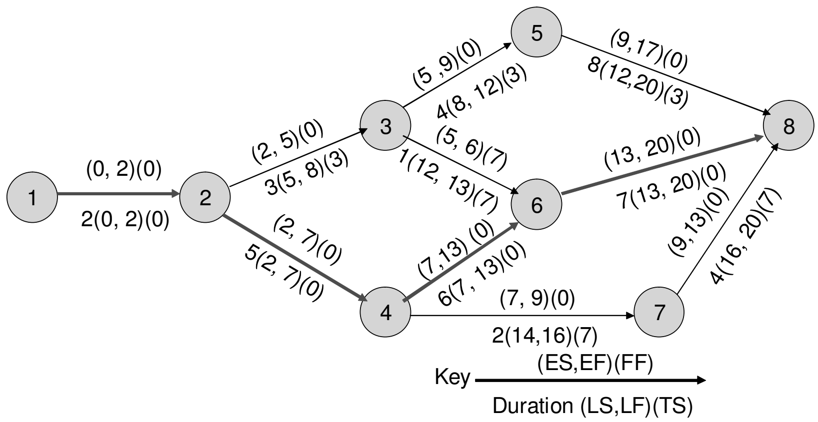
Construct the Network for the following Project and determine the following

i) Critical Path

ii) ES,EF,LS,LF

iii) TF,FF

Activity	Duration
1-2	2
2-3	3
2-4	5
3-5	4
3-6	1
4-6	6
4-7	2
5-8	8
6-8	7
7-8	4



Activity	Duration	ES	EF	LS	LF	TF	FF
1-2	2	0	2	0	2	0	0
2-3	3	2	5	2	8	3	0
2-4	5	2	7	5	7	0	0
3-5	4	5	9	8	12	3	0
3-6	1	5	6	12	13	7	7
4-6	6	7	13	7	13	0	0
4-7	2	7	9	14	16	7	0
5-8	8	9	17	12	20	3	0
6-8	7	13	20	13	20	0	0
7-8	4	9	13	16	20	7	0

14.6 DETERMINATION OF TIME TO COMPLETE EACH ACTIVITY

The CPM system of networks omits the probabilistic consideration and is based on a Single Time Estimate of the average time required to execute the activity.

In PERT analysis, there is always a great deal of uncertainty associated with the activity durations of any project. Therefore, t_e estimated time is better described by a probability distribution than by a single estimate. Three time estimates (*from beta probability distribution*) are made as follows:

1. The Optimistic Time Estimate (to): Shortest possible time in which an activity can be completed in ideal conditions. No provisions are made for delays or setbacks while estimating this time.
2. The Most Likely Time (tm): It assumes that things go in normal way with few setbacks.
3. The Pessimistic Time (tp): The max. Possible time if everything goes wrong & abnormal situations prevailed. However, major catastrophes such as earthquakes, labour troubles, etc. are not taken into account.

The expected time (mean time) for each activity can be approximated using the weighted average i.e.

Expected Time (te) = (to + 4tm + tp)/6

Example.

If a job has to = 5 days, tp = 17 days, tm = 8 days

Then Expected time for the job would be

te = (to + 4tm + tp) / 6

= (5 + 4 x 8 + 17) / 6

= <u>9 days</u>

<u>Variability of activity times</u>

- Standard deviation and Variance are commonly used in statistics to measure the variability of number.

In PERT model, to measure the variability of an activity time duration standard deviation and variance are used.

A large standard deviation represents high variability and vice-versa.

- <u>Calculation of Standard Deviation and Variance</u>

Variance = (Standard deviation)2

Standard deviation =(t p – t o) / 6

- Expected length of the Critical Path = te of all the activities along the Critical Path

Probability Estimate: It is used to calculate the probability of completing the time within given duration (*Using Normal Distribution*):

Probability of completing the project within a given date

Z = (TS – TE) / ó

Where TS = Scheduled time for project completion

TE = Expected time for the project completion

ó = Standard deviation for the Network

óNetwork = "Sum of variances along the

Critical Path

= " (ó i-j) 2

Where ó i-j is the variance of a activity i-j along the critical path

- In case there are two critical paths, variance of separate activities of both of them shall be added for calculating ót, but for calculating Z, we will take higher of two ót taken above.

- In case of event variance, if there are two longest paths, higher of the two would picked up.

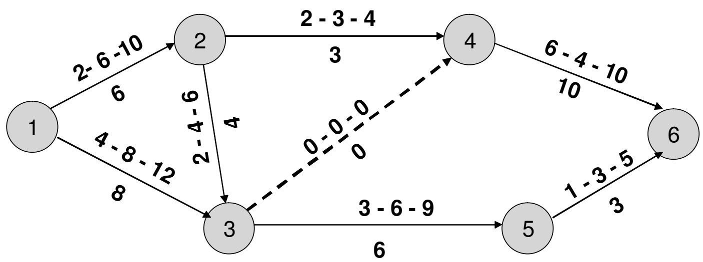
14.7 CASE STUDY (SOLVED EXAMPLES)

Example 1

Construct the Network for the following project and calculate the probability of completing the project in 25 days

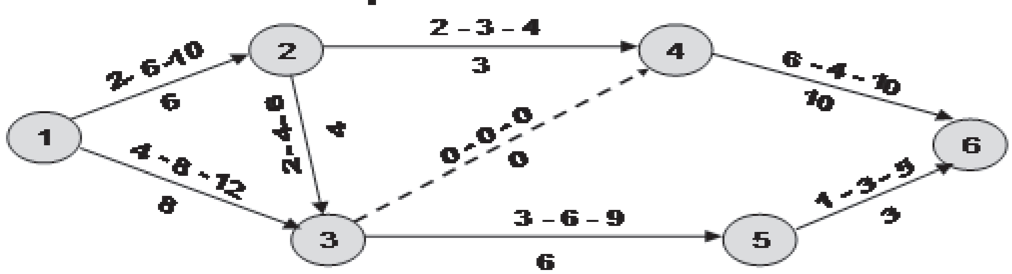
Activity	to	tm	tp
1-2	2	6	10
1-3	4	8	12
2-3	2	4	6
2-4	2	3	4
3-4	0	0	0
3-5	3	6	9
4-6	6	10	14
5-6	1	3	5

2. Calculation of Expected time for all the activities



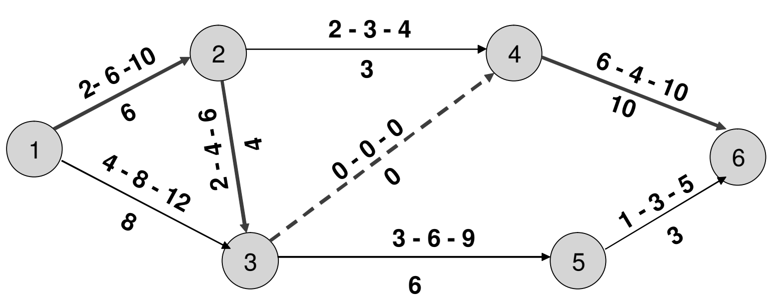
Expected Time (te):
'te' can be calculated by the following formula
te = (to + 4tm + tp) / 6

2. Calculation of Expected time for all the activities



Expected Time (te):
'te' can be calculated by the following formula
te = (to + 4tm + tp) / 6

3. Determination of Critical Path



Key $\xrightarrow[t_e]{\text{to - tm - tp}}$

Expected Duration of the project Te = 20 days

Activity	To	tm	tp	Critical activities	σ2 = ((t p – t o) / 6)2
1-2	2	6	10	1-2	1.78
1-3	4	8	12	-	
2-3	2	4	6	2-3	0.44
2-4	2	3	4	-	
3-4	0	0	0	3-4	0
3-5	3	6	9	-	
4-6	6	10	14	4-6	1.78
5-6	1	3	5	-	

Ó ó2 = 4.00

óNetwork = "Sum of variances along the Critical Path

= " (óNetwork)2

= " 4 = 2

Probability of completing the project within a given date

Z = (TS – TE) / ó

Where TS = Scheduled time for project completion

TE = Expected time for the project completion

ó = Standard deviation for the Network

= (25 – 20) / 2

= + 2.5

From the Normal distribution Table, we get the probability of completing the project in 25 days is 99.4%

Example 2

The following table lists the jobs of a network along with their time estimates.

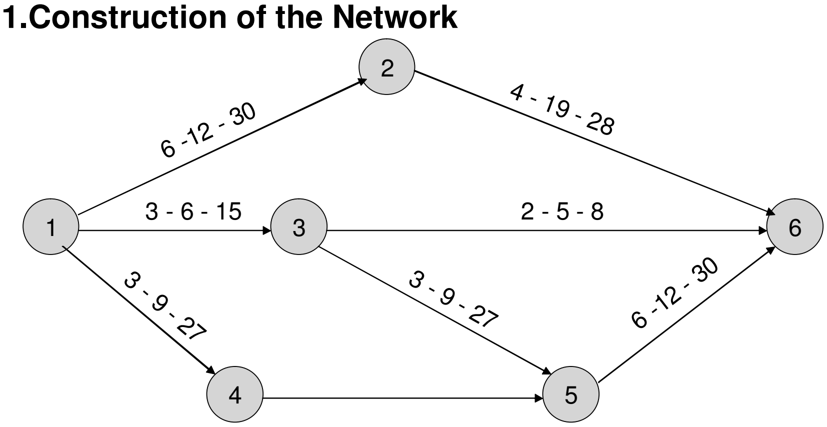
Activity	to	tm	tp
1-4	3	9	27
1-3	3	6	15
1-2	6	12	30
4-5	1	4	07
3-5	3	9	27
3-6	2	5	08
5-6	6	12	30
2-6	4	19	28

a) Draw the project network.

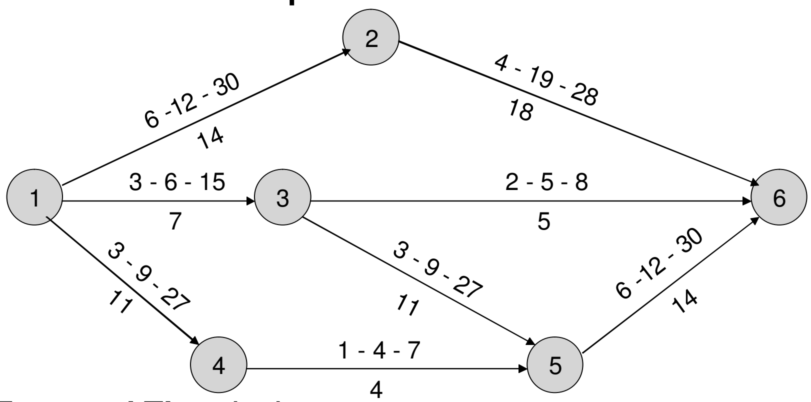
b) What is the probability that the job will be completed in 35 days?

c) What due date has 90% chance of being met?

1.Construction of the Network

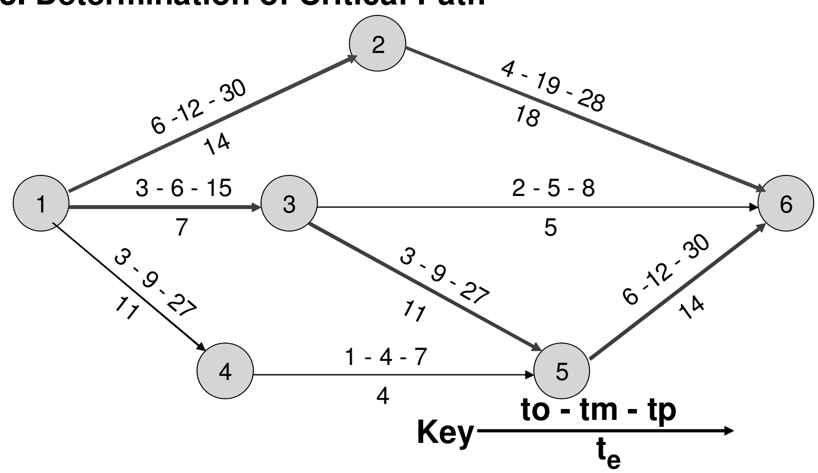


2. Calculation of Expected time for all the activities



Expected Time (te):
'te' can be calculated by the following formula
te = (to + 4tm + tp) / 6

3. Determination of Critical Path



Expected Duration of the project Te = 32 days

As there are two Critical Paths, the path which gives more variance(ó2) is taken as Critical Path

Path A

Activity	σ2 = ((t p – t o) / 6)2	σ2
1-2	((30 – 6)/6)2	16
2-6	((28 – 4)/6)2	16

Path B

Activity	σ2 = ((t p – t o) / 6)2	σ2
1-3	((15 – 3)/6)2	4
3-5	((27 – 3)/6)2	16
5-6	((30 – 6)/6)2	16

Ó ó2 = 32.00

Activity	σ2 = ((t p – t o) / 6)2	σ2
1-3	((15 – 3)/6)2	4
3-5	((27 – 3)/6)2	16
5-6	((30 – 6)/6)2	16

Ó ó2= 36.00

ó = "Ó ó2 = " 36 = 6

Therefore the Critical Path is 1 - 3 - 5 - 6

b)

Probability of completing the project within a given date

Z = (TS – TE) / ó

Where TS = Scheduled time for project completion

TE = Expected time for the project completion

ó = Standard deviation for the Network

= (35 – 32) / 6

= + 0.5

From the Normal distribution Table, we get the probability of completing the project in 35 days is 69.15%

c) The due date for 90% chance of being met.

Probability of completing the project within a given date

$Z = (TS - TE) / σ$

The value of Z from the table for a 90% probability is +1.28

TS =? (to be calculated) ,TE = 32, σ = 6

i.e. $1.28 = (TS - 32) / 6$

TS = 39.68 <u>days</u>

14.8 NOTES

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14.9 SUMMARY

The PERT/CPM scheduling procedure begins by addressing Question When can the individual activities start and finish (at the earliest) if no delays occur? Here no delays means, the actual duration of each activity turns out to be the same as its estimated duration and each activity begins as soon as all its immediate predecessors are finished. The starting and finishing times of each activity if no delays occur anywhere in the project are called the earliest start time and the earliest finish time of the activity.

The ***total*** *float time* for an *activity* is the time between its earliest and latest start time, or between its earliest and latest finish time. It is the amount of time that an activity can be delayed past its earliest start or earliest finish without delaying the project. The slack time or ***slack*** of an *event* in a network is the difference the latest event time & earliest event time.

14.10 KEY WORDS

Float, Slack, Critical path, PERT and CPM

14.11 SELF ASSESMENT QUESTIONS

1. (Critical Path): Tasks A, B, C… 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

Draw a network to represent the project and find the minimum time of completion of the project when time, in days, of each task is as follows:

Task:	A	B	C	D	E	F	G	H	I
Time:	8	10	8	10	16	17	18	14	9

Also identify the critical path.

[Ans.: Critical path is 1-2-4-5-6 with 44 days**]**

2. A project consists of seven activities for which relevant data are given below:

(i) Draw the network

(ii) Name and highlight the critical path.

Activity	Preceding activity	Activity duration (days)
A	_	4
B	_	7
C	_	6
D	A, B	5
E	A, B	7
F	C, D, E	6
G	C, D, E	5

[Ans.: B. E, F = 20 days]

4. **(Forward and Backward Pass):** A project schedule has the following characteristics:

Activity Time (weeks) Activity Times (week)

Activity	Time (weeks)	Activity	Times (week)
1-2	4	5-6	4
1-3	1	5-7	8
2-4	1	6-8	1
3-4	1	7-8	2
3-5	6	8-9	1
4-9	5	8-10	8
		9-10	7

(i) Construct the PERT network

(ii) Compute E and L for each event;

(iii) *Float for each activity*; and

(iii) Find critical path and its duration.

[**Note**: Float is to be calculated only after going through below text]

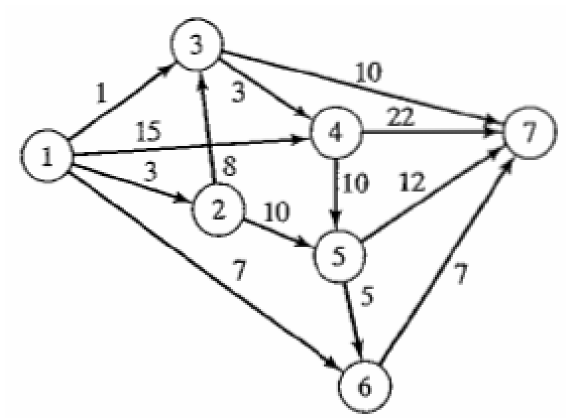
[Ans.: Critical path is 1-3-5-7-8-10 with 25 weeks**]**

5. **(Floats):** The utility data for a network are given below. Determine the total, free, independent and interfering floats and identify the critical path.

Activity:	0-1	1-2	1-3	2-4	2-5	3-4	3-6	4-7	5-7	6-7
Duration:	2	8	10	6	3	3	7	5	2	8

[Ans.: Critical Path is 0-1-3-6-7 with 27**]**

6. For the network given below, compute E and L for each event & determine the total, free, independent and interfering floats and identify the critical path.



7. The following table gives the activities in a construction project and the time duration of each activity:

Activity	**Preceding activity**	**Normal Time (Days)**
A	-	16
B	-	20
C	A	8
D	A	10
E	B, C	6
F	D, E	12

Required:

(i) Draw the activity network of the project.

(ii) Find critical path.

(iii) Find the total float and free-float for each activity.

[Ans.: (ii) A-C-E-F = 42 days. (iii) Total Float A-0, B-4, C-0, D-4, E-0, F-0; Free Float A-0, B-4, C-0, D-4, E-0, F-0**]**

8. Given is the following information regarding a project:

Activity	A	B	C	D	E	F	G	H	I	J	K	L
Dependence	-	-	-	AB	B	B	FC	B	EH	EH	CDFJ	K
Duration(days)	3	4	2	5	1	3	6	4	4	2	1	5

Draw the Network Diagram and identify the Critical Path and Project Duration.

Find the three types of float (viz. Total, Free and Independent) for each activity.

[Ans.: B-H-J-K-L = 16 days**]**

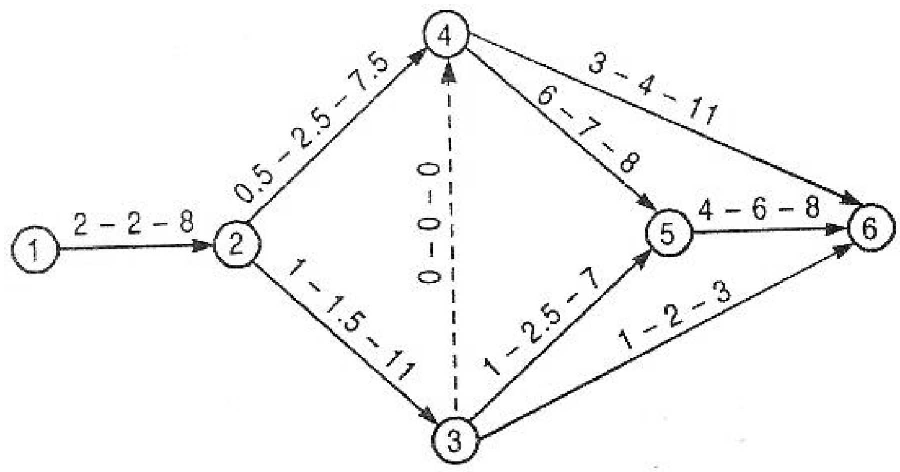
9. If the critical path of a project is 20 months along with a standard deviation of 4 months, what is the probability that the project will be completed within: (a) 20 months (b) 18 months (c) 24 months?

[Ans.: 0.50, 0.31, 0.84**]**

10. PERT calculation yield a project length of 60 weeks with variance of 9. Within how many weeks would you expect the project to be completed with probability of 0.99? (That is the project length that you would expect to be exceeded only by 1% of time if the project were repeated many time in an identical manner).

[Ans.: 67 weeks**]**

11. Consider the network shown below. The three time estimates for the activities are given along the arrows. Determine the critical path. What is the probability that the project will be completed in 20 days?



[Ans.: 0.6844**]**

12. Consider the schedule of activities and related information as given below, for the construction of a plant:

Assuming that the cost and time required for one activity is independent of the time and cost of any other activity are expected to follow normal distribution.

Draw a network based on the above data and calculate:

(a) Critical path

(b) Expected cost of construction of the plant.

(c) Expected time required to build the plant.

(d) The standard deviation of the expected time.

[Ans.: (a) 1-2-4-6-8; (b) Rs. 80 millions; (c) 20 months; (d) 3 months**]**

13. A project consists of seven activities and the time estimates of the activities are furnished as under:

Activity	Optimistic Days	Most likely Days	Pessimistic Days
1-2	4	10	16
1-3	3	6	9
1-4	4	7	16
2-5	5	5	5
3-5	8	11	32
4-6	4	10	16
5-6	2	5	8

Required:

(i) Draw the network diagram.

(ii) Identify the critical path and its duration.

(iii) What is the probability that project will be completed in 5 days earlier than the critical path duration?

(iv) What project duration will provide 95% confidence level of completion (Z0.95 =1.65)?

[Ans.: (ii) Critical Path is 1'!3'!5'!6 & its duration is 25 days (iii) Probability = 11.90%, (iv) 32 days (approx)**]**

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

Activity	to	tm	Tp
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

(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.

(d) What is the probability that the project will be completed?

1. at least 4 weeks earlier than expected time?

2. no more that 4 weeks later than expected time?

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

(f) The probability that the project will be completed on schedule if the scheduled completion time is 20

weeks.

(g) What should be the scheduled completion time for the probability of completion to be 90 %?

[Ans.: (c) Variance = 9 & Standard Deviation = 3; (d) (i) 0.0918 (ii) 0.9082 (e) 0.2514 (f) 0.8413 (g) 20.84]

15. Given the following project network, determine:

1. Earliest expected completion time for each event

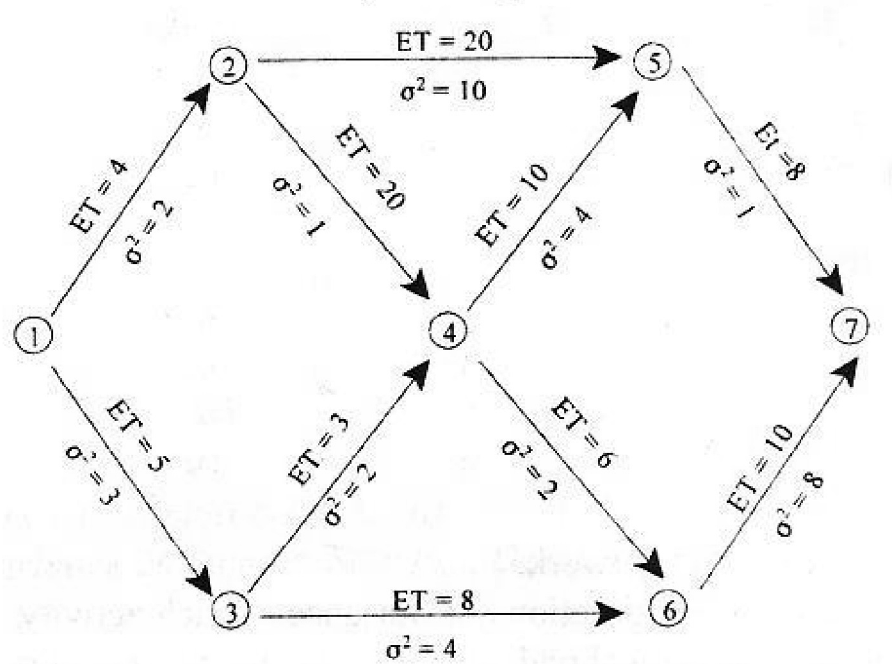
2. Latest allowable completion time for each event

3. Slack time for each event

4. Critical Path

5. The probability that project will be completed on schedule, if scheduled completion time is 38

Project Diagram



[**Hint:** Critical Path is 1-2-4-5-7 and probability = 7.93%]

15. A small project is composed of seven activities, whose time estimates are listed below. Activities are identified by their beginning (i) and (j) node number.

Activity (i – j)	**Estimated durations (in days)**		
	Optimistic	Most Likely	Pessimistic
1-2	2	2	14
1-3	2	8	14
1-4	4	4	16
2-5	2	2	2
3-5	4	10	28
4-6	4	10	16
5-6	6	12	30

(a) Draw the project network.

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

(c) What is the probability that project will be completed at least 8 days earlier than expected?

(d) If the project due date is 38 days, what is the probability of not meeting the due date?

[**Hint:** The expected duration of the project = 34 days; Probability of meeting the due date is 9.18%; Probability not meeting the due date is 25.14%]

16. A project consists of the following activities, whose time estimates are given against each as under:

Activity	Estimated duration (weeks)		
	Optimistic	Most likely	Pessimistic
1-2	3	6	15
1-3	2	5	14
1-4	6	12	30
2-5	2	5	8
2-6	5	11	17
3-6	3	6	15
4-7	3	9	27
5-7	1	4	7
6-7	4	19	28

Required:

(i) Draw the project net work.

(ii) Find the expected duration and variance of each activity.

(iii) Determine the critical path and the expected project duration.

(iv) What is the probability that the project will be completed in 38 weeks?

(v) What project duration will have 95% chance of completion? (Z0.95 = 1.65)

[Ans.: (iii) Critical path 1'!2'!6'!7, Expected project duration is 36 weeks. (iv) 66% (v) 44 weeks**]**

17. An Engineering Project has the following activities, whose time estimates are listed below:

Activity (i-j)	Estimated Duration (in months)		
	Optimistic	Most Likely	Pessimistic
1-2	2	2	14
1-3	2	8	14
1-4	4	4	16
2-5	2	2	2
3-5	4	10	28
4-6	4	10	16
5-6	6	12	30

(a) Draw the project network and find the critical path.

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

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

(d) What is the probability that the project will be completed at least eight months earlier than expected time?

(e) If the project due date is 38 months, what is the probability of not meeting the due date

[Ans.: (i) Critical path 1-3-5-6; (ii) Expected project length 34 months; (iii) Variance 36 months, Standard Deviation 6; (iv) 9.18%; (v) 25.14%**]**

14.12 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.
2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.
3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.
4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.
5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill
6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011
7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002
8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012
9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.
10. Sanjiv Marwah. *Project Management.* New Delhi: Dreamtech Press, 2011.

UNIT – 15 : PROJECT CRASHING STRUCTURE

Structure :

15.0 OBJECTIVES

After studying this unit you should be able to:

- explain how to reduce a project cost
- draw a network diagram and find the Optimum duration at which total project cost is lowest

15.1 REDUCING PROJECT COST

There are usually compelling reasons to complete the project earlier than the originally estimated duration of critical path computed on the normal basis of a new project.

Direct Cost: This is the cost of the materials, equipment and labour required to perform the activity. When the time duration is reduced the project direct cost increases.

Activity Cost Slope = (Cc- Nc) ÷ (Nt-Ct)

Where,

Cc = Crash Cost = Direct cost that is anticipated in completing an activity within crash time.

Nc = Normal Cost = This is the lowest possible direct cost required to complete an activity

Nt = Normal Time = Min. time required to complete an activity at normal cost.

Ct = Crash Time = Min. time required to complete an activity.

Indirect Cost: It consists of two parts: fixed cost and variable cost. The fixed cost is due to general and administrative expenses, insurance, etc. Variable indirect cost consists of supervision, interest on capital, etc.

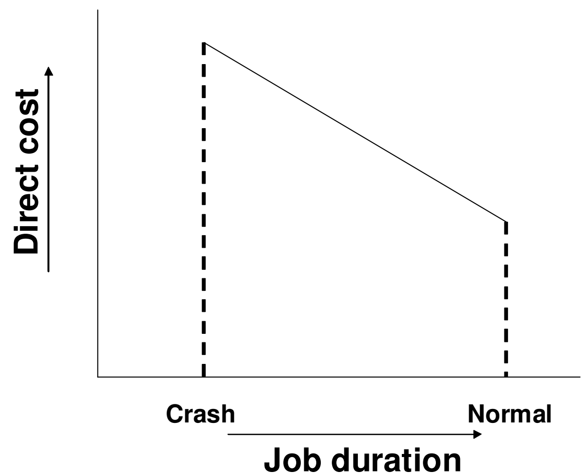
The total project cost is the sum of the direct & the indirect costs.

15.2 OPTIMUM DURATION IS THE PROJECT DURATION AT WHICH TOTAL PROJECT COST IS LOWEST

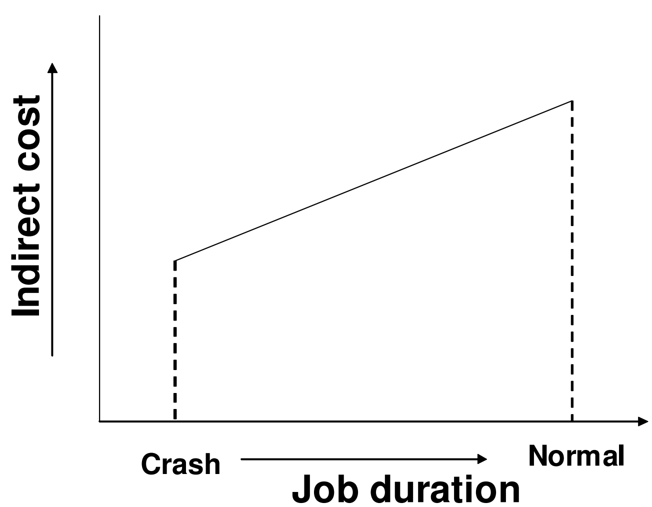
Cost considerations in PERT / CPM

The total cost of any project comprises of two costs.

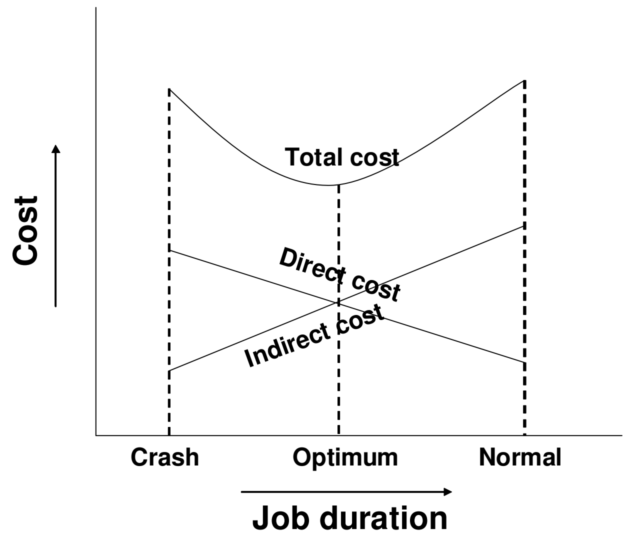
- Direct cost - material cost, manpower loading
- Indirect cost - overheads such as managerial services, equipment rent, building rent etc.



Shorter the duration higher will be the Direct expenses



Shorter the duration lesser will be the Indirect expenses



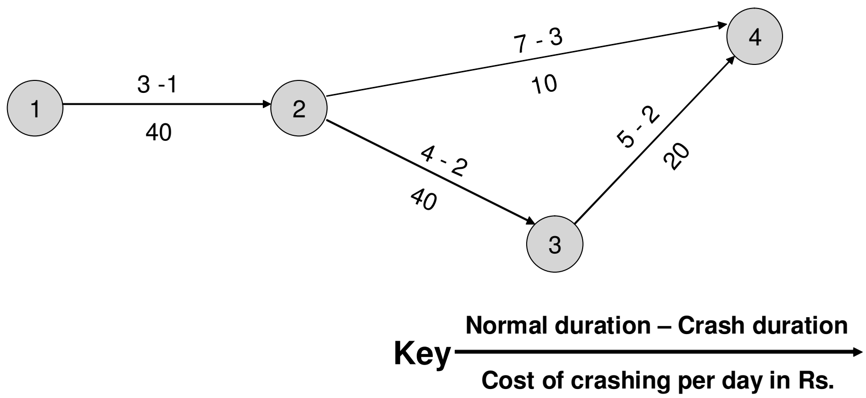
15.3 CASE STUDY (SOLVED EXAMPLES)

Example 1

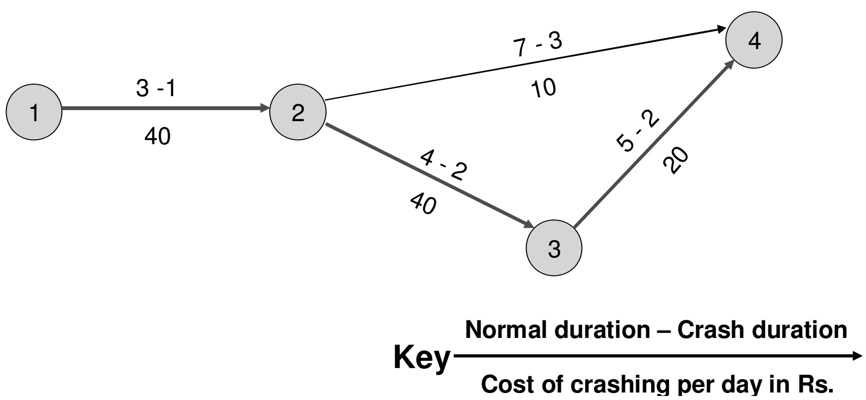
Find the lowest cost and optimum cost schedule for the following project, given the overhead expenses as Rs.45/-day.

Activity	Normal duration	Crash duration	Cost of crashing per day
1-2	3	1	Rs.40
2-3	4	2	Rs.40
2-4	7	3	Rs.10
3-4	5	2	Rs.20

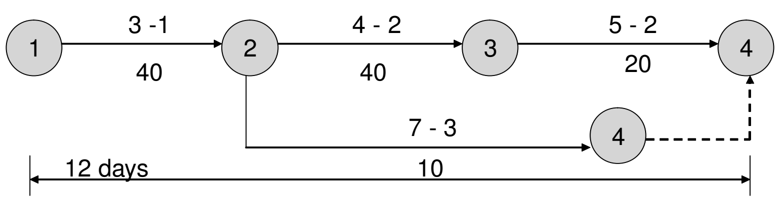
1.Construction of the Network



1.Determination of Critical path

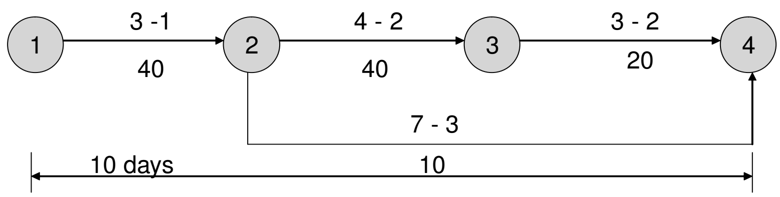


Step 1.



Activity crashed	Days saved	Project duration	Cost of crashing	Total cost of crashing	Over Head cost	Total cost
None	0	12	-Nil-	-Nil-	45 x 12	540
3-4	2	10	20 x 2 =40	40	45 x 10	490
3-4 &2-4	1	9	20x1+10x1 =30	70	45 x 9	475
1-2	2	7	40 x 2 =80	150	45 x 7	465
2-3&2-4	2	5	40x2+10x2 =100	250	45 x 5	475

Step 2.



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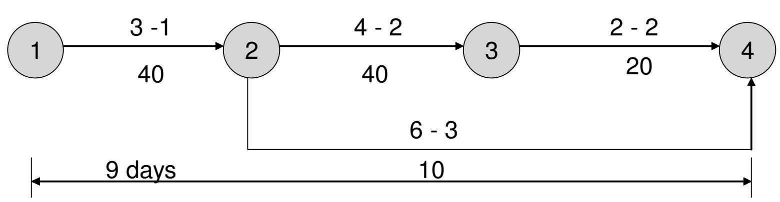
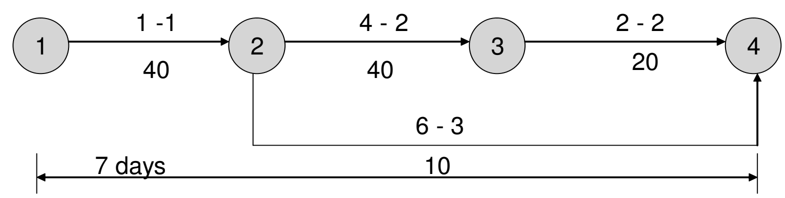
Step 3.



Activity crashed	Days saved	Project duration	Cost of crashing	Total cost of crashing	Over Head cost	Total cost
None	0	12	-Nil-	-Nil-	45 x 12	540
3-4	2	10	20 x 2 =40	40	45 x 10	490
3-4 &2-4	1	9	20x1+10x1 =30	70	45 x 9	475
1-2	2	7	40 x 2 =80	150	45 x 7	460
2-3&2-4	2	5	40x2+10x2 =100	250	45 x 5	475

Step 4.



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3-4	2	10	20 x 2 =40	40	45 x 10	490
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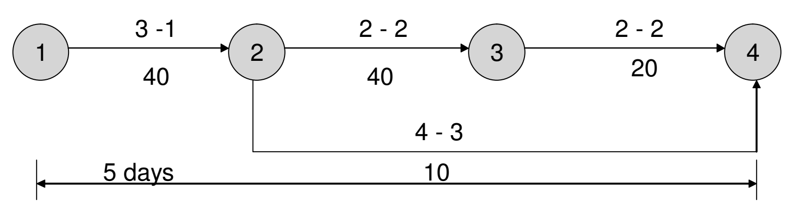
2-3&2-4	2	5	40x2+10x2 =100	250	45 x 5	475

Step 5.



Activity crashed	Days saved	Project duration	Cost of crashing	Total cost of crashing	Over Head cost	Total cost
None	0	12	-Nil-	-Nil-	45 x 12	540
3-4	2	10	20 x 2 =40	40	45 x 10	490
3-4 &2-4	1	9	20x1+10x1 =30	70	45 x 9	475
1-2	2	7	40 x 2 =80	150	45 x 7	460
2-3&2-4	2	5	40x2+10x2 =100	250	45 x 5	475

15.4 NOTES

15.5 SUMMARY

Today's competitive world everyone in the organization are facing pressure to complete the project earlier than the originally estimated duration of critical path computed on the normal basis of a new project. It is obvious that when you want reduce the time the project cost increases hence it's important to reduce the time as well as the cost of the project.

15.6 KEY WORDS

Critical path, network, optimum duration

15.7 SELF ASSESMENT QUESTIONS

i. A project is composed of seven activities as per the details given below:

Activity	Normal Time (Days)	Crash Time (Days)	Normal Cost (Rs.)	Crash Cost (Rs.)
1-2	4	3	1500	2000
1-3	2	2	1000	1000
1-4	5	4	1875	2250
2-3	7	5	1000	1500
2-5	7	6	2000	2500
3-5	2	1	1250	1625
4-5	5	4	1500	2125

Indirect cost per days of the project is Rs. 500.

Required:

(a) Draw the project network.

(b) Determine the critical path and its duration.

(c) Find the optimum duration and the resultant cost of the project.

[Ans.: (b) Longest path is 13 days; (c) Optimal project duration of 10 days.**]**

ii. The normal time, crash time and crashing cost per day are given for the following network:

Activity	Normal Time (Days)	Crash Time (Days)	Crash Cost (Rs.)
1-2	18	14	40
1-3	23	22	20
2-3	8	5	60
2-4	10	6	40
3-4	3	2	80
4-5	8	6	50

(i) Crash the project duration in steps and arrive at the minimum duration. What will be the critical path and the cost of crashing?

(ii) If there is an indirect cost of Rs. 70 per day, what will be the optical project duration and the cost of crashing?

[Ans.: (i) Min. Duration is 30 days & total cost of crashing is Rs. 360 (ii) Optimal Duration is 31 days & cost of crashing is Rs. 280

iii. A small project consists of jobs as given in the table below. Each job is listed with its normal time and a minimum or crash time (in days). The cost (in Rs. per day) for each job is also given:

Job (i-j)	Normal Duration (in days	Minimum (crash) Duration (in days)	Cost of Crashing (Rs. per day)
1-2	9	6	20
1-3	8	5	25
1-4	15	10	30
2-4	5	3	10
3-4	10	6	15
4-5	2	1	40

(i) What is the normal project length and the minimum project length?

(ii) Determine the minimum crashing cost of schedules ranging from normal length down to, and including, the minimum length schedule. That is, if L = Length of the schedule, find the costs of schedules which are L, L-1, L-2 and so on.

(iii) Overhead costs total Rs. 60 per day. What is the optimum length schedule in terms of both crashing and overhead cost? List the schedule duration of each job for your solution.

[Ans.: (i) Critical path is 1’!3’!4’!5; (ii) Rs. 1155; (iii) Optimum duration of the project is 15 days.**]**

iv. The following table gives data on normal time and cost and crash time and cost for a project.

a. Draw the network and identify the critical path.

b. What is the normal project duration and associated cost?

c. Find out total float for each activity.

d. Crash the relevant activities systematically and determine the optimum project time and cost.

Activity	**Normal**		**Crash**	
	Time (Week)	**Cost (Rs.)**	**Time (Week)**	**Cost (Rs.)**
1-2	3	300	2	400
2-3	3	30	3	30
2-4	7	420	5	580
2-5	9	720	7	810
3-5	5	250	4	300
4-5	0	0	0	0
5-6	6	320	4	410
6-7	4	400	3	470
6-8	13	780	10	900
7-8	10	1000	9	1200
		4220		

Indirect costs are Rs. 50 per week.

[Ans.: (b) Normal Project Duration is 32 weeks with cost of Rs. 5820; (d) Optimum Project Duration is 29 weeks with cost of Rs. 5805**]**

v. A small project is having seven activities. The relevant data about these activities is given below:

Activity	Dependence	Normal Duration (Days)	Crash duration (Days)	Normal cost (Rs.)	Crash Cost (Rs.)
A	-	7	5	500	900
B	A	4	2	400	600
C	A	5	5	500	500
D	A	6	4	800	1000
E	B,C	7	4	700	1000
F	C,D	5	2	800	1400
G	E,F	6	4	800	1600

(i) Find out the normal duration and the minimum duration.

(ii) What is the percentage increase in cost to complete the project in 21 days?

[Ans.: (i) Normal duration 25 days, minimum duration 18 days; (ii) 15.5%**]**

15.8 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.

2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.

3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.

4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.

5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill

6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011

7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002

8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012

9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.

10. Sanjiv Marwah. *Project Management*. New Delhi: Dreamtech Press, 2011.

UNIT – 16 : PERT & CPM USING SOFTWARE

Structure :

16.0 OBJECTIVES

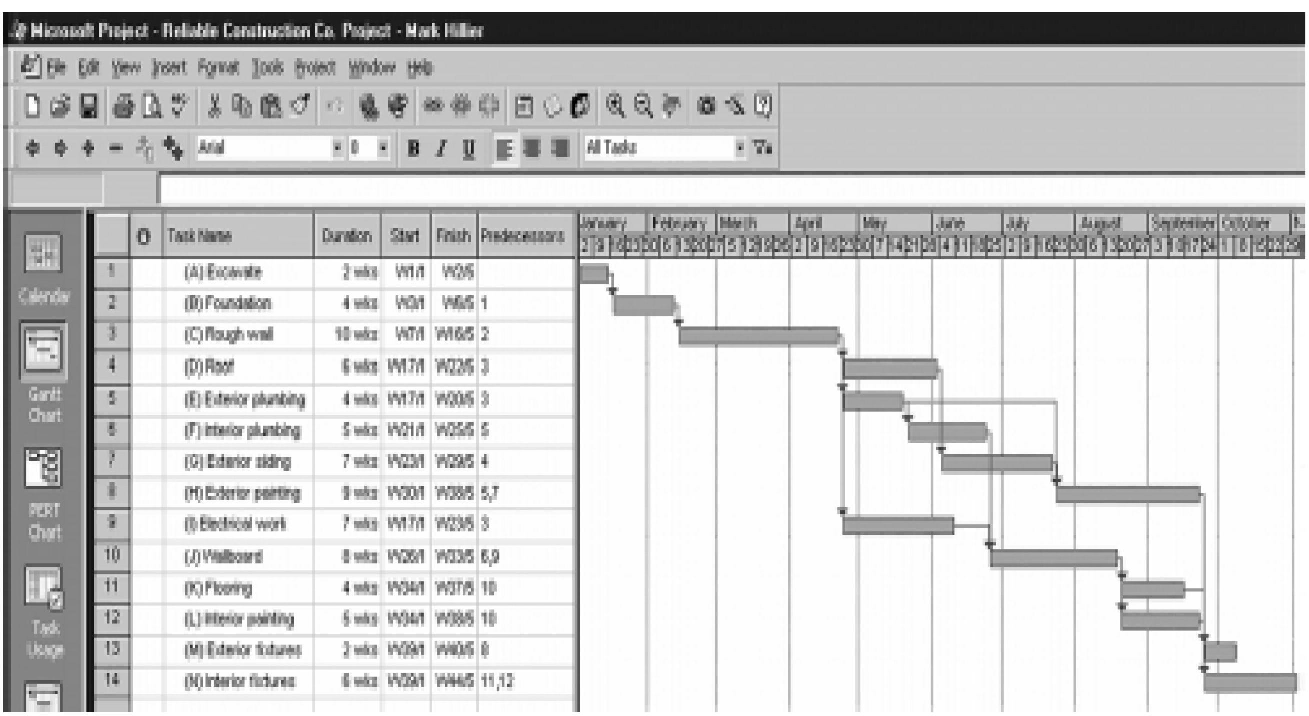
After studying this unit you should be able to:

- solves the CPM problems by using spread sheet
- find the costs and crash costs

16.1 USING MICROSOFT PROJECT

The first step with Microsoft Project (commonly called MS Project) is to enter the information in the activity list (Table 1). Choose the View menu and then select its option called Table. From the resulting submenu, choose the option called Entry to bring up the table needed to enter the information. This table is displayed in Fig. 1 for Reliable's project. You enter the task (activity) names, the duration of each, a starting date for the first activity, and the immediate predecessors of each, as shown in the figure. The program automatically builds up the rest of the table (including the chart on the right) as you enter this information.

Figure: 2 the spreadsheet used by MS projects for the activity list for Reliable Construction Co. project. On the right is a Gantt chart showing the project schedule.



The default duration is in units of days, but we have changed the units to weeks here. Such a change can be made by choosing Options under the Tools menu and then changing "Duration is entered in" under the Schedule options.

The default date format is a calendar date (e.g., 1/2/01). This can be changed by choosing Options from the Tools menu and then changing the "Date Format" option under the View options. We have chosen to count time from time 0. Thus, the start time for the first activity is given as W1/1, which is shorthand for Week 1, day 1. A 5-day work week is assumed. For example, since the duration of the first activity is 2 weeks, its finish time is given as W2/5 (Week 2, day 5).

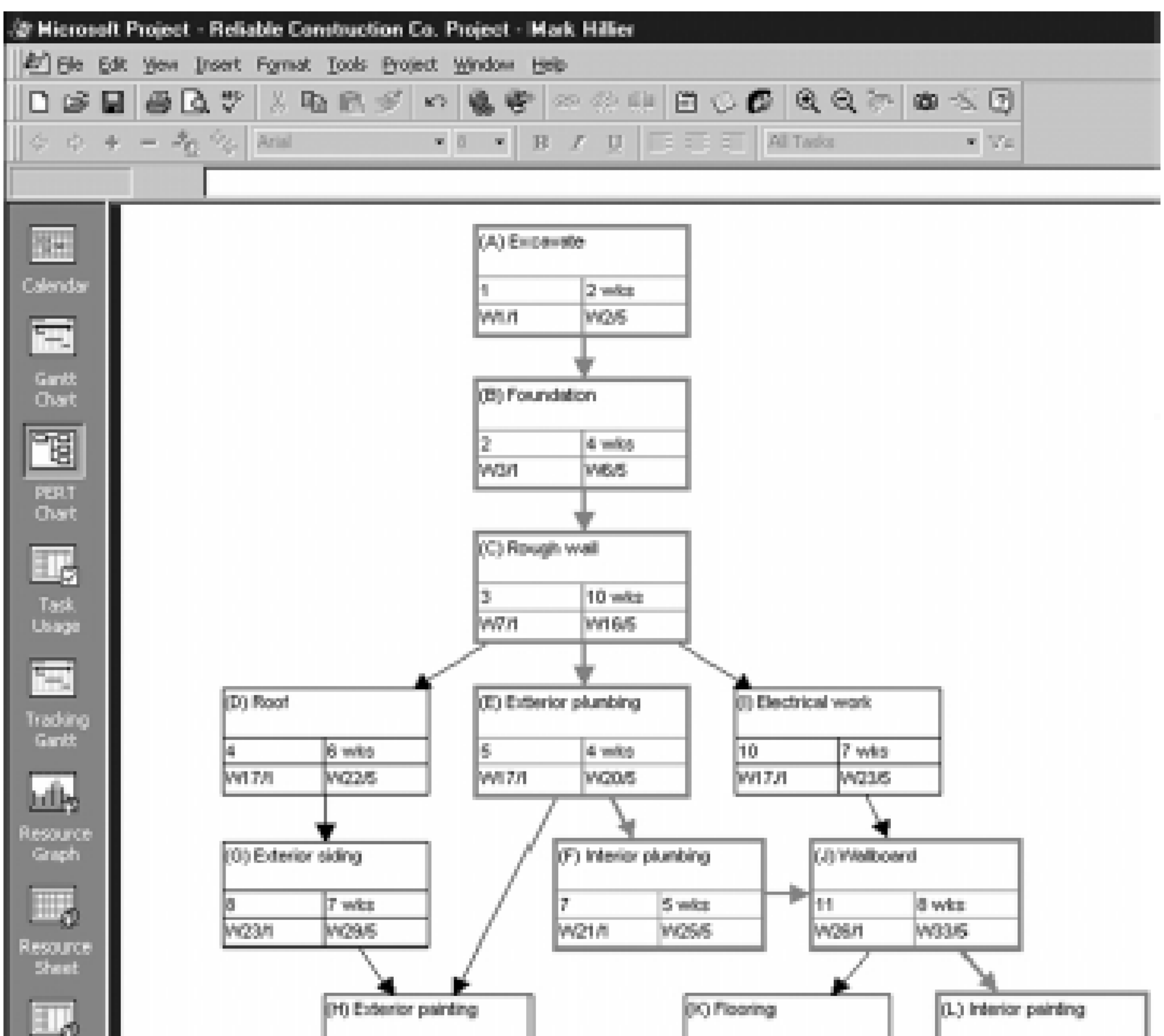
The chart on the right is referred to as a Gantt chart. This kind of chart is a popular one in practice for displaying a project schedule, because the bars nicely show the scheduled start and finish times for the respective activities. (This figure assumes that the project begins at the beginning of a calendar year.) The arrows show the precedence relationships between the activities. For example, since both activities 5 and 7 are immediate predecessors of activity 8, there are arrows from both activities 5 and 7 leading to activity 8.

This project entry table can be returned to at any time by choosing Table: Entry in the View menu.

You can choose between various views with the view toolbar down the left side of the screen. The Gantt chart view is the default. The PERT chart view shows the project network. This view initially lines all the activity boxes up in a row, but they can be moved as desired by dragging the boxes with the mouse. Figure 2 shows this project network after placing the activity boxes in the same locations as the corresponding nodes in Fig. 1 (except no boxes are included now for the start and finish of the project). Note that each box provides considerable information about the activity. After giving its name, the second row shows the activity number and duration. The last row then gives the scheduled start and finish times.

MS Project also provides additional information of the types described in some of the subsequent sections. However, rather than continuing to display the form of the out- put in the upcoming sections, we will show it in the MS Project folder for this chapter in your OR Courseware. (Begin with this folder's document entitled "Instructions.")

Figure: 3 *Reliable Construction Co. project network as constructed with MS projects*



16.2 CPM AND SPREADSHEET

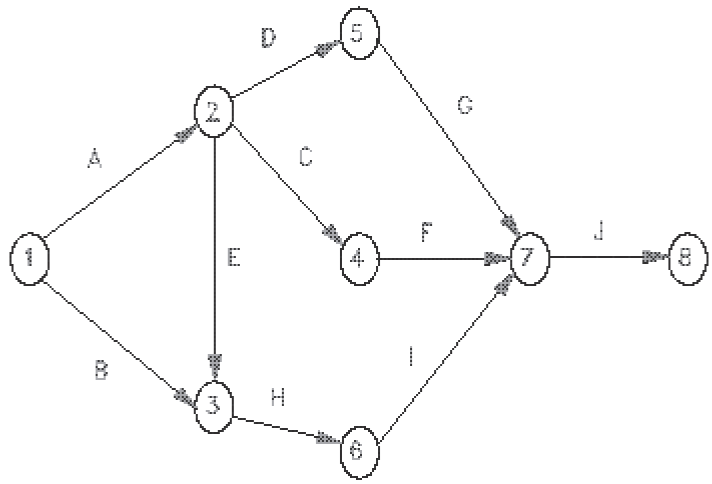
Step 1: List the activities

CPM analysis starts when you have a table showing each activity in your project. For each activity, you need to know which other activities must be done before it starts, and how long the activity takes.

Example

Step 2: Draw the diagram

Draw by hand a network diagram of the project that shows which activities follow which other ones. This can be tricky. The analysis method we'll be using requires an "activity-on-arc" (AOA) diagram. An AOA diagram has numbered "nodes" that represent stages of project completion. You make up the nodes' numbers as you construct the diagram. You connect the nodes with arrows or "arcs" that represent the activities that are listed in the above table.



Step 3: Set up the CPM spreadsheet

There are specialized commercial programs for doing CPM analysis. Rather than purchase and learn one of those, we'll leverage the spreadsheet knowledge we already have. We will use one freeware program written for this course and made available to you through the Internet.

Start up a new blank spreadsheet. If you are viewing this document on the web, minimize your browser window and then start *Excel*. That way you can switch from one to the other by pressing Alt+Tab.

In a blank spreadsheet, type the word "Activities" in cell A1. In row 2, type the names of the activities, or their letters. (To make my spreadsheet screen shots fit better on these pages, I set the column widths to 4. You do not have to do this.)

	A	B	C	D	E	F	G	H	I	J
1	Activities									
2	A	B	C	D	E	F	G	H	I	J

In row 3, type "Nodes". In row 4, type in each activity's start node — where the tail of its arrow is. Below that, in row 5, type each activity's end node — where the head of its arrow is. Do this carefully. Mistakes here mess up everything that follows.

To the right, in K2 and K3, type the words "Start" and "End" to label those rows.

	A	B	C	D	E	F	G	H	I	J	K
1	Activities										
2	A	B	C	D	E	F	G	H	I	J	
3	Nodes										
4	1	1	2	2	2	4	5	3	6	7	Start
5	2	3	4	5	3	7	7	6	7	8	End

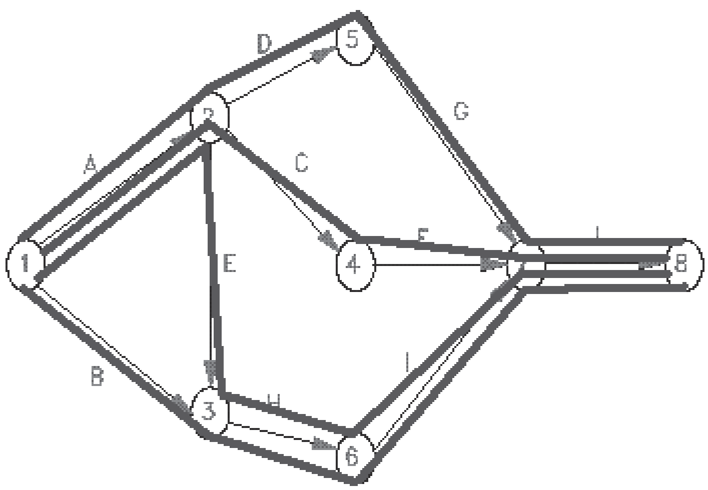
In cell A6, type “Times”. In row 7, type the time each activity takes. Then, select the range of cells containing the node numbers

	A	B	C	D	E	F	G	H	I	J	K
1	Activities										
2	A	B	C	D	E	F	G	H	I	J	
3	Nodes										
4	1	1	2	2	2	4	5	3	6	7	Start
5	2	3	4	5	3	7	7	6	7	8	End
6	Times										
7	5	1	2	3	2	3	4	2	1	1	

and copy it to the clipboard.

<u>Step 4: Use Path find to get the paths</u>

Pathfinder is a computer program that helps you find and enter into the spreadsheet all of the possible paths through your diagram along the arrows from the first node to the last. You could do this by hand, of course. This diagram shows the four possible paths in this example.



The four paths are A D G J, A C F J, A E H I J, and B H I J. We’ll code them in the spreadsheet with a matrix of 0’s and 1’s. Rather than do this all by hand, we’ll get pathfinder help do it.

To use pathfinder, start up your Internet connection and your browser (unless, of course, you are reading this document on the Internet already). Go to http://hspm.sph.sc.edu/Courses/J716/CPM/Pathfind.html

Loading this html file into your browser starts pathfinder, which is a Java applet that runs inside your browser. When pathfinder is loaded:

1. Click in Pathfind's upper text area.
2. Paste the range you just copied from your spreadsheet into that upper text area. (Click in the text area and press Ctrl+V or Shift+Insert.)
3. Click on Pathfind's button. Pathfind's lower text area will give you a block of numbers, all highlighted so you can copy them.
4. Copy the highlighted numbers to the clipboard for pasting later into your spreadsheet. (Ctrl+C or Ctrl+Insert copies what is highlighted.)

You can now close the Pathfind web page, if you wish.

Step 5: Paste the path information into your spreadsheet

When you're done with Pathfind, go back to your spreadsheet. Move your cell selector to cell A8. Type "Paths" in that cell. Then move the cell selector to A9, as shown here:

	A	B	C	D	E	F	G	H	I	J	K
1	Activities										
2	A	B	C	D	E	F	G	H	I	J	
3	Nodes										
4	1	1	2	2	2	4	5	3	6	7	Start
5	2	3	4	5	3	7	7	6	7	8	End
6	Times										
7	5	1	2	3	2	3	4	2	1	1	
8	Paths										
9											

Paste to that cell, to see this:

	A	B	C	D	E	F	G	H	I	J	K
1	Activities										
2	A	B	C	D	E	F	G	H	I	J	
3	Nodes										
4	1	1	2	2	2	4	5	3	6	7	Start
5	2	3	4	5	3	7	7	6	7	8	End
6	Times										
7	5	1	2	3	2	3	4	2	1	1	
8	Paths										
9	1	0	1	0	0	1	0	0	0	1	
10	1	0	0	1	0	0	1	0	0	1	
11	0	1	0	0	0	0	0	1	1	1	
12	1	0	0	0	1	0	0	1	1	1	

The pasted cells are all 0's and 1's. Each row represents a path. The 1's indicate which activities are in that particular path. For example, row 9 (cells A9:J9) has 1's under activities A, C, F, and J. This says that this path includes activities A, C, F, and J. This corresponds to the path through the middle of the diagram that goes: 1 -A-> 2 -C-> 4 -F-> 7 -J-> 8.

The diagram above shows four paths from node 1 to node 8. Sure enough, Pathfind gives you four rows of 0's and 1's, one row for each path.

Step 6: Calculate the paths' times

Move the cell selector to K9. Type =SUMPRODUCT (A9:J9, $A$7:$J$7) in that cell.

For Quattro Pro and Lotus, type @ instead of =.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Activities												
2	A	B	C	D	E	F	G	H	I	J			
3	Nodes												
4	1	1	2	2	2	4	5	3	6	7	Start		
5	2	3	4	5	3	7	7	6	7	8	End		
6	Times												
7	5	1	2	3	2	3	4	2	1	1			
8	Paths												
9	1	0	1	0	0	1	0	0	0	1	=sumproduct(A9:J9,$A$7:$J$7)		
10	1	0	0	1	0	0	1	0	0	1			
11	0	1	0	0	0	0	0	1	1	1			
12	1	0	0	0	1	0	0	1	1	1			

This formula multiplies each entry in row 9 by the corresponding entry in row 7. Because the entries in row 9 are all 0's and 1's, this has the effect of selecting the times from row 7 that go with the activities represented in row 7, and adding all those times.

When you enter the formula, the number 11 should appear in K9. That's the time it would take to complete activities A, C, F, and J. You can verify that A takes 5 months, C takes 2, F takes 3, and J takes 1, for a total of 11.

(If you are doing a CPM problem of your own, modify the formula so that the ranges cover the columns you actually have. This advice applies to all the formulas which follow.)

To fill in the other paths' times, copy cell K9, then paste it to K9:K12. The $ signs in the formula see to it that each path's 1's are multiplied by the corresponding numbers in row 7.

	A	B	C	D	E	F	G	H	I	J	K
1	Activities										
2	A	B	C	D	E	F	G	H	I	J	
3	Nodes										
4	1	1	2	2	2	4	5	3	6	7	Start
5	2	3	4	5	3	7	7	6	7	8	End
6	Times										
7	5	1	2	3	2	3	4	2	1	1	
8	Paths										
9	1	0	1	0	0	1	0	0	0	1	11
10	1	0	0	1	0	0	1	0	0	1	13
11	0	1	0	0	0	0	0	1	1	1	5
12	1	0	0	0	1	0	0	1	1	1	11

Step 7: Identify the critical path

The critical path is the path that takes the longest. In this example, the critical path is the one in row 10, which takes 13 months. The project will therefore take 13 months, if everything is done on schedule with no delays. The time a project takes is equal to the time of its critical path.

The 1's in row 10 tell us that the critical path is 1 -A-> 2 -D-> 4 -G-> 7 -J-> 8. As managers, we must be sure that activities A, D, G, and J are done on time. If any of those activities is late, the project will be late.

Other paths are not critical because they can waste some time without slowing the project. For example, activity C, in row 9's path, can take up to two extra months and not hold up the project.

To make it easier to see what activities are in each path, go to cell A14.
Type=if(A9=1,A$2,””) there.

The letter A should appear in cell A14.

This =if(A9=1,A$2,””) function works this way: Inside the parentheses are three expressions separated by commas. The first expression (A9=1) is something that can be either true or false. If the expression is true, the second expression (A$2) is shown in the cell. Otherwise, the third expression (“”) is shown in the cell.

In A14, the expression A9=1 is true, so the cell shows what is in A2, which is the letter "A". If A9 had not contained a 1, the A14 would have shown a blank, which is what "" means.

Copy A14 to the clipboard. Then, starting in A14, select a range of cells that goes over to column J and down four rows. The selected range should be the same size as the space that the paths' 1's and 0's take up.

Paste. You should get this:

	A	B	C	D	E	F	G	H	I	J	K
1	Activities										
2	A	B	C	D	E	F	G	H	I	J	
3	Nodes										
4	1	1	2	2	2	4	5	3	6	7	Start
5	2	3	4	5	3	7	7	6	7	8	End
6	Times										
7	5	1	2	3	2	3	4	2	1	1	
8	Paths										
9	1	0	1	0	0	1	0	0	0	1	11
10	1	0	0	1	0	0	1	0	0	1	13
11	0	1	0	0	0	0	0	1	1	1	5
12	1	0	0	0	1	0	0	1	1	1	11
13											
14	A		C			F				J	
15	A			D			G			J	
16		B						H	I	J	
17	A				E			H	I	J	

Now you can see which activities are in each path. If your results do not look like the above, make sure that there is one $ in your formula, and that it's in front of the 2 and not in front of the A.

Go to cell J13 and type "Max". Then go to cell K13. Type =MAX (K9:K12) to display the longest path time.

Move to cell K14 and type =IF(K9=K$13,"Critical","") there.

K13 = =MAX(K9:K12)

	A	B	C	D	E	F	G	H	I	J	K
1	Activities										
2	A	B	C	D	E	F	G	H	I	J	
3	Nodes										
4	1	1	2	2	2	4	5	3	6	7	Start
5	2	3	4	5	3	7	7	6	7	8	End
6	Times										
7	5	1	2	3	2	3	4	2	1	1	
8	Paths										
9	1	0	1	0	0	1	0	0	0	1	11
10	1	0	0	1	0	0	1	0	0	1	13
11	0	1	0	0	0	0	0	1	1	1	5
12	1	0	0	0	1	0	0	1	1	1	11
13										Max	13
14	A		C			F				J	

	A	B	C	D	E	F	G	H	I	J	K	L
1	Activities											
2	A	B	C	D	E	F	G	H	I	J		
3	Nodes											
4	1	1	2	2	2	4	5	3	6	7	Start	
5	2	3	4	5	3	7	7	6	7	8	End	
6	Times											
7	5	1	2	3	2	3	4	2	1	1		
8	Paths											
9	1	0	1	0	0	1	0	0	0	1	11	
10	1	0	0	1	0	0	1	0	0	1	13	
11	0	1	0	0	0	0	0	1	1	1	5	
12	1	0	0	0	1	0	0	1	1	1	11	
13										Max	13	
14	A		C			F				J	=if(K9=$K$13,"Critical","")	
15	A			D			G			J		
16		B						H	I	J		
17	A				E			H	I	J		

This will put the word "Critical" next to a path whose time equals the maximum of all the path times. Otherwise, it will put in a blank, as it does here, because the 11 in K9 does not equal the 13 in K13.

Copy K14 to the clipboard. (It will seem strange to copy what appears to be an empty cell, but do it anyway.) Select cells K14 to K17, and paste.

	A	B	C	D	E	F	G	H	I	J	K
1	Activities										
2	A	B	C	D	E	F	G	H	I	J	
3	Nodes										
4	1	1	2	2	2	4	5	3	6	7	Start
5	2	3	4	5	3	7	7	6	7	8	End
6	Times										
7	5	1	2	3	2	3	4	2	1	1	
8	Paths										
9	1	0	1	0	0	1	0	0	0	1	11
10	1	0	0	1	0	0	1	0	0	1	13
11	0	1	0	0	0	0	0	1	1	1	5
12	1	0	0	0	1	0	0	1	1	1	11
13										Max	13
14	A		C			F				J	
15	A			D			G			J	Critical
16		B						H	I	J	
17	A				E			H	I	J	

You've found the time the project will take, and you have identified the critical path, which tells you which activities must be done on time to make the project finish in the least time.

Take a moment to admire your work before plunging in to Example 2.

16.3 COSTS AND CRASH COSTS

Example 2:

This second example incorporates costs and the possibility of spending money to speed up the project. Our objective is to determine how quickly we should complete each activity, and thus the how long the project as a whole should take. The presumption is that there is some reward for getting finished sooner. We must decide whether the reward is worth earning, and, if so, what is the best way to earn it.

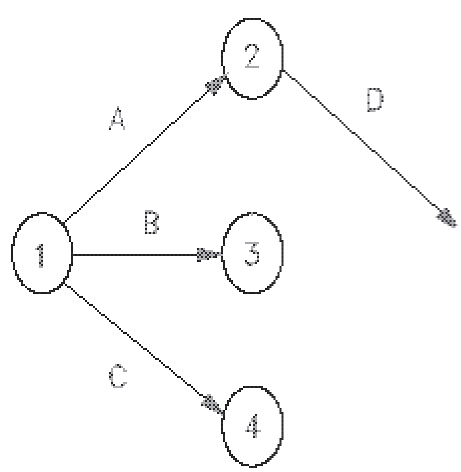
This example also shows how to use a dummy activity. A dummy activity is an activity that you add to the original activities list. A dummy activity takes no time, and it has no cost. You'll learn why you sometimes need such a thing in a CPM model.

Step 1: List the activities

Activity	Required Predecessor	Normal Time	Normal Cost	Crash Time	Crash Cost
A	(None)	3 weeks	$3000	2 weeks	$5000
B	(None)	4	$4000	2	$6000
C	(None)	5	$5000	3	$8000
D	A	8	$5000	6	$6000
E	A,B	3	$3000	2	$4000
F	C	5	$4000	3	$8000

Step 2: Draw the diagram

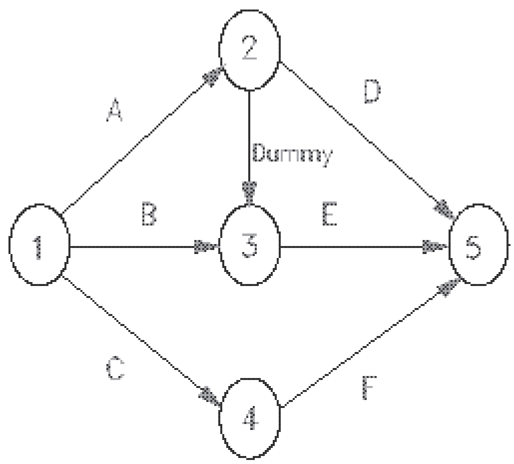
To start the network diagram, we notice that A, B, and C are the three activities with no predecessor. They all come off of node 1. A can go node 1 to node 2. B can go from node 1 to node 3. C also starts at node 1. D requires A, so D starts at node 2. Here's what we have so far:



Now for activity E. Activity E requires a special trick. The problem is where E should start. E requires A and B. A ends at node 2 and B ends at node 3. E is not allowed to start from both nodes 2 and 3. Activities can have only one start node and only one end node.

What do we do about E? You might consider connecting both A and B to node 2, but that would mess up Activity D. If both A and B were to run from node 1 to node 2 and D came off of node 2, that would be saying that D requires B as well as A. D is supposed to require A, not also B.

Here is the solution:



The solution is to add a dummy activity that runs from node 2 to node 3, as shown in the diagram. Then start E at node 3.

If E starts at node 3, it means that E requires B and the dummy activity, the two activities that come in to node 3. The dummy activity, because it starts at node 2, requires A. This makes E require B and A. That is what we want! Meantime, D starts at node 2, so D only requires A. All the requirements are satisfied!

Dummies activities add nothing to the time or the cost. Their purpose is to allow you to represent complex relationships among activities.

<u>Step 3: Set up the CPM spreadsheet</u>

This time we have 7 activities. That's the six lettered activities plus the one dummy activity, which we'll call Dummy.

These instructions will create the spreadsheet from scratch. Adapting the spreadsheet from example 1 is possible, but tricky, because example 2 has fewer columns and more rows than example 1.

If you start with a blank spreadsheet, move the cell selector to A1 and type "Activities". In row 2, type the activities' letters or names. Put the Dummy at the right end of row 2, for two reasons:

1. The other activities' names match will their column letters.
2. It will be easier to fill in the Solver Parameters box when we get to that stage.

In cell A3, type "Nodes".

In row 4, type in the activities' start nodes.

In row 5, type in the activities' end nodes.

	A	B	C	D	E	F	G	H
1	Activities							
2	A	B	C	D	E	F	Dummy	
3	Nodes							
4	1	1	1	2	3	4	2	Start
5	2	3	4	5	5	5	3	End

Type "Times" in cell A6.

In row 7, type each activity's normal time. The dummy's time is 0.

In row 8, type each activity's crash time. The dummy's crash time is 0.

Copy row 7 and paste it into row 9. Row 9 will be the variable cells when we do the optimization later. Be sure to copy the numbers themselves from row 7 to row 9. *Don't*put a formula like =A7 in A9.

Label each of the Times rows by typing "Normal" in H7, "Crash" in H8, and "Actual" in H9.

(Note: When you do the homework, your number of columns will be different. These labels go in the column to the right of the last activity's information. Whatever column that is, use its letter in place of "H" in all the following instructions and formulas.)

	A	B	C	D	E	F	G	H
1	Activities							
2	A	B	C	D	E	F	Dummy	
3	Nodes							
4	1	1	1	2	3	4	2	Start
5	2	3	4	5	5	5	3	End
6	Times							
7	3	4	5	8	3	5	0	Normal
8	2	2	3	6	2	3	0	Crash
9	3	4	5	8	3	5	0	Actual

When we do the optimization, we'll set a maximum time for the project and tell the spreadsheet to find the combination of numbers in row 9 that completes the project within that time for the lowest possible cost.

To do that, we need the costs. In cell A10, type "Costs".

In row 11, put each activity's normal cost. In H11, type "Normal".

In row 12, put each activity's crash cost. In H12, type "Crash".

In H13, type "Actual".

Type "0" in G13 for the Dummy's actual cost.

(*When you do the homework, your column letters will differ.*)

	A	B	C	D	E	F	G	H
1	Activities							
2	A	B	C	D	E	F	Dummy	
3	Nodes							
4	1	1	1	2	3	4	2	Start
5	2	3	4	5	5	5	3	End
6	Times							
7	3	4	5	8	3	5	0	Normal
8	2	2	3	6	2	3	0	Crash
9	3	4	5	8	3	5	0	Actual
10	Costs							
11	3000	4000	5000	5000	3000	4000	0	Normal
12	5000	6000	8000	6000	4000	8000	0	Crash
13	=A11+(A7-A9)/(A7-A8)*(A12-A11)						0	Actual

The diagram above also shows a formula we'll put in A13.

Row 13 will have formulas to calculate the actual cost for each activity. Each activity's actual cost depends on how much it is sped up, or "crashed." We assume a linear relationship between speed-up and cost. So, for example, if Activity A can be shortened by 2 weeks at an added cost of $2000, we assume that it can be shortened by 1 week for an added cost of $1000.

The formula to implement this goes first A13. Here it is:

=A11+(A7-A9)/(A7-A8)*(A12-A11)

If you are viewing this in a web browser, you can select and copy the above formula right off of the screen. Then paste it into cell A13 of your spreadsheet.

The logic of the formula:

(A7-A9) is the difference between the normal time and the actual time we use for activity A. This difference is how much time we are saving by speeding up activity A.

(A7-A8) is the difference between the normal time and the crash time. This is the most time we could save by speeding up activity A.

(A7-A9)/(A7-A8) is how much time we are actually saving, as a fraction of how much time we could save, for activity A. In other words, it is the proportion of the possible time savings that we are actually using.

(A12-A11) is the difference between the crash cost and the normal cost for activity A. This difference is how much cost would go up if we shortened activity A's time as much as possible.

Multiplying these, to get (A7-A9)/(A7-A8)*(A12-A11), tells us additional cost we are incurring by shortening activity A's time from its normal time to the actual time we chose. This embodies the linearity assumption — that if we go part way between the normal time and the crash time, our cost will be that same part way between the normal cost and the crash cost.

The full formula, A11+(A7-A9)/(A7-A8)*(A12-A11), adds that additional cost to A11, the cost of doing the activity in normal time. This gives us the cost of doing activity A in the amount of time in A9.

Don't paste the formula to cell G13, because that would give you a division-by-zero error. Similarly, if any of your other activities cannot be sped up (the crash time equals the normal time), put the normal cost number in the cell in row 13, not the formula.

Once that formula is in, copy cell A13 to the clipboard. Select cells A13:F13, and paste.

	A	B	C	D	E	F	G	H
1	Activities							
2	A	B	C	D	E	F	Dummy	
3	Nodes							
4	1	1	1	2	3	4	2	Start
5	2	3	4	5	5	5	3	End
6	Times							
7	3	4	5	8	3	5	0	Normal
8	2	2	3	6	2	3	0	Crash
9	3	4	5	8	3	5	0	Actual
10	Costs							
11	3000	4000	5000	5000	3000	4000	0	Normal
12	5000	6000	8000	6000	4000	8000	0	Crash
13	3000	4000	5000	5000	3000	4000	0	Actual

Right now, it may look like the formula isn't doing much, because the Actual costs match the Normal costs. This is because the Actual times match the Normal times. Later, when we shorten the project, this will change.

Now, select the range of node numbers, being sure to include the dummy activity's node numbers.

	A	B	C	D	E	F	G	H
1	Activities							
2	A	B	C	D	E	F	Dummy	
3	Nodes							
4	1	1	1	2	3	4	2	Start
5	2	3	4	5	5	5	3	End

Copy this range to the clipboard.

Step 4: Use Pathfind to get the paths

Go to http://hspm.sph.sc.edu/Courses/J716/CPM/Pathfind.html and paste in the node numbers you just copied. Follow Pathfind's instructions for copying its reply.

Step 5: Paste the path information into your spreadsheet

Go back to your spreadsheet. In cell A14, type "Paths". Then move your cell selector to A15, as shown here:

	A	B	C	D	E	F	G	H
1	Activities							
2	A	B	C	D	E	F	Dummy	
3	Nodes							
4	1	1	1	2	3	4	2	Start
5	2	3	4	5	5	5	3	End
6	Times							
7	3	4	5	8	3	5	0	Normal
8	2	2	3	6	2	3	0	Crash
9	3	4	5	8	3	5	0	Actual
10	Costs							
11	3000	4000	5000	5000	3000	4000	0	Normal
12	5000	6000	8000	6000	4000	8000	0	Crash
13	3000	4000	5000	5000	3000	4000	0	Actual
14	Paths							
15								

Paste to that cell, to see this:

	A	B	C	D	E	F	G	H
1	Activities							
2	A	B	C	D	E	F	Dummy	
3	Nodes							
4	1	1	1	2	3	4	2	Start
5	2	3	4	5	5	5	3	End
6	Times							
7	3	4	5	8	3	5	0	Normal
8	2	2	3	6	2	3	0	Crash
9	3	4	5	8	3	5	0	Actual
10	Costs							
11	3000	4000	5000	5000	3000	4000	0	Normal
12	5000	6000	8000	6000	4000	8000	0	Crash
13	3000	4000	5000	5000	3000	4000	0	Actual
14	Paths							
15	1	0	0	1	0	0	0	
16	0	1	0	0	1	0	0	
17	0	0	1	0	0	1	0	
18	1	0	0	0	1	0	1	

As with the first example, each row represents a path. The 1's indicate which activities are in that particular path. For example, row 15 has 1's under activities A and D. This represents the path 1 -A-> 2 -D-> 5 at the top of the diagram. There are four possible paths from node 1 to node 5, so you have four rows of 0's and 1's.

Step 6: Calculate the paths' times

In cell H15, put =SUMPRODUCT (A15:G15,$A$9:$G$9) . *(When you do the homework, your ending column letter may differ. You want this formula to cover all of the activities.)*

	A	B	C	D	E	F	G	H	I	J	K
1	Activities										
2	A	B	C	D	E	F	Dummy				
3	Nodes										
4	1	1	1	2	3	4	2	Start			
5	2	3	4	5	5	5	3	End			
6	Times										
7	3	4	5	8	3	5	0	Normal			
8	2	2	3	6	2	3	0	Crash			
9	3	4	5	8	3	5	0	Actual			
10	Costs										
11	3000	4000	5000	5000	3000	4000	0	Normal			
12	5000	6000	8000	6000	4000	8000	0	Crash			
13	3000	4000	5000	5000	3000	4000	0	Actual			
14	Paths										
15	1	0	0	1	0	0	0	=SUMPRODUCT(A15:G15,$A$9:$G$9)			

Copy that cell and paste it to H15:H18. *(When you do the homework, you will paste to a different range of cells. You will have a different number of activities and a different number of paths.)*

	A	B	C	D	E	F	G	H
1	Activities							
2	A	B	C	D	E	F	Dummy	
3	Nodes							
4	1	1	1	2	3	4	2	Start
5	2	3	4	5	5	5	3	End
6	Times							
7	3	4	5	8	3	5	0	Normal
8	2	2	3	6	2	3	0	Crash
9	3	4	5	8	3	5	0	Actual
10	Costs							
11	3000	4000	5000	5000	3000	4000	0	Normal
12	5000	6000	8000	6000	4000	8000	0	Crash
13	3000	4000	5000	5000	3000	4000	0	Actual
14	Paths							
15	1	0	0	1	0	0	0	11
16	0	1	0	0	1	0	0	7
17	0	0	1	0	0	1	0	10
18	1	0	0	0	1	0	1	6

We can now see how long each path takes.

Step 7: Identify the critical path

The critical path is in row 15, 1 -A-> 2 -D-> 5. It's the path with the longest time.

To make it easier to see which activities are in each path, go to cell A20 and type=if(A15=1,A$2,"") (Notice that the $ sign is before the 2, *not* before the A.) This should put an "A" in A20.

Copy cell A20 to the clipboard. Select the range A20:G23. Paste.

	A	B	C	D	E	F	G	H
1	Activities							
2	A	B	C	D	E	F	Dummy	
3	Nodes							
4	1	1	1	2	3	4	2	Start
5	2	3	4	5	5	5	3	End
6	Times							
7	3	4	5	8	3	5	0	Normal
8	2	2	3	6	2	3	0	Crash
9	3	4	5	8	3	5	0	Actual
10	Costs							
11	3000	4000	5000	5000	3000	4000	0	Normal
12	5000	6000	8000	6000	4000	8000	0	Crash
13	3000	4000	5000	5000	3000	4000	0	Actual
14	Paths							
15	1	0	0	1	0	0	0	11
16	0	1	0	0	1	0	0	7
17	0	0	1	0	0	1	0	10
18	1	0	0	0	1	0	1	6
19								
20	A			D				
21		B			E			
22			C			F		
23	A				E		Dummy	

You now should have four rows showing the letters of the activities that are in each path.

Go back up to cell G19 and type “Max”. Go to cell H19 and type =max(H15:H18) This shows how long the slowest path takes.

Go down to cell H20. Put in =IF(H15=H$19,”Critical”,””). In this example, “Critical” appears in cell H15, because this first path is the critical path. (*In your homework, if the first path does not happen to be critical, this cell will appear blank.)*

Copy cell H20. Highlight H20:H23. Paste.

	A	B	C	D	E	F	G	H
1	Activities							
2	A	B	C	D	E	F	Dummy	
3	Nodes							
4	1	1	1	2	3	4	2	Start
5	2	3	4	5	5	5	3	End
6	Times							
7	3	4	5	8	3	5	0	Normal
8	2	2	3	6	2	3	0	Crash
9	3	4	5	8	3	5	0	Actual
10	Costs							
11	3000	4000	5000	5000	3000	4000	0	Normal
12	5000	6000	8000	6000	4000	8000	0	Crash
13	3000	4000	5000	5000	3000	4000	0	Actual
14	Paths							
15	1	0	0	1	0	0	0	11
16	0	1	0	0	1	0	0	7
17	0	0	1	0	0	1	0	10
18	1	0	0	0	1	0	1	6
19							Max	11
20	A			D				Critical
21		B			E			
22			C			F		
23	A				E		Dummy	

Sure enough, the first path with activities A and D, is the only one labelled "Critical".

Step 8: Total cost formula

Go up to cell E14 and type "Total actual cost:". (In your spreadsheet, you may be able to use F14. The idea is to leave enough room so that this label does not spill over into the H column.)

In cell H14, add up the actual costs of all of the activities. The formula is =SUM(A13:G13)

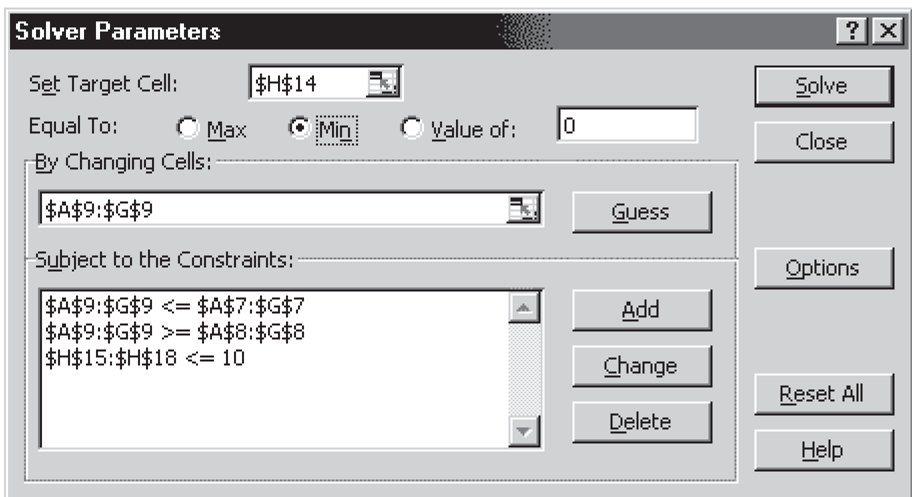
	A	B	C	D	E	F	G	H
1	Activities							
2	A	B	C	D	E	F	Dummy	
3	Nodes							
4	1	1	1	2	3	4	2	Start
5	2	3	4	5	5	5	3	End
6	Times							
7	3	4	5	8	3	5	0	Normal
8	2	2	3	6	2	3	0	Crash
9	3	4	5	8	3	5	0	Actual
10	Costs							
11	3000	4000	5000	5000	3000	4000	0	Normal
12	5000	6000	8000	6000	4000	8000	0	Crash
13	3000	4000	5000	5000	3000	4000	0	Actual
1R x 7C	...ths				Total actual cost:			=sum(A13:G13

When you complete the formula, you'll see that if we use all normal times for all activities, the total cost is $24,000.

Step 9: Fill in the optimizer form

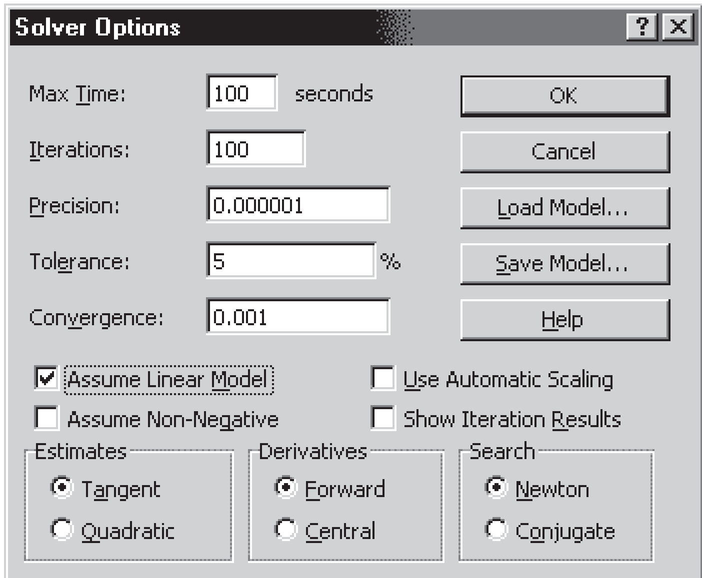
Crash analysis is linear programming in disguise. To perform crash analysis, we use the Solver tool. From *Excel*'s menu, select Tools, then Solver.

Fill in the Solver Parameters box as shown here. *(For the homework, modify the formulas so they cover the rows and columns that you have.)*



- The Target Cell is H14, the total cost.
- Click on Min. Very important and easy to overlook. We want to find the least-cost way to speed up the project.
- The Changing Cells are the Actual times, in A9:G9.
- The constraints, which you add by clicking the Add button, are:
  - A9:G9 <= A7:G7 All the Actual times must be less than or equal to the Normal times. We assume that we don't save any money by going slower than the Normal time. (Notice again that these formulas exclude the Dummy.)
  - A9:G9 >= A8:G8 All the Actual times must be greater than or equal to the crash times. The crash times are, by definition, the fastest possible times for each activity.
  - H15:H18 <= 10 The slowest path can take no more than 10 weeks. 10 is chosen because it's one less than 11, the normal completion time. Later, you can change this to 9, 8, etc., to see what happens when you try to finish the project in shorter and shorter times.

If you are using Excel 2000 or earlier, click on Options. Click the checkbox for assuming a linear model.



Excel 2007 and 2003 do not need this, but Excel 2000 seems to. If you do not check this box, Excel 2000 may tell you at some point that there is not a feasible solution when actually there is one. Some older Excel versions, though, give wrong answers if you check this box. For older versions of Excel, my advice is to first try telling it that this *is* a linear model, as shown here, and see what happens when you Solve. If it won't give you a solution, uncheck the linear model checkbox and solve again.

Step 10: Solve

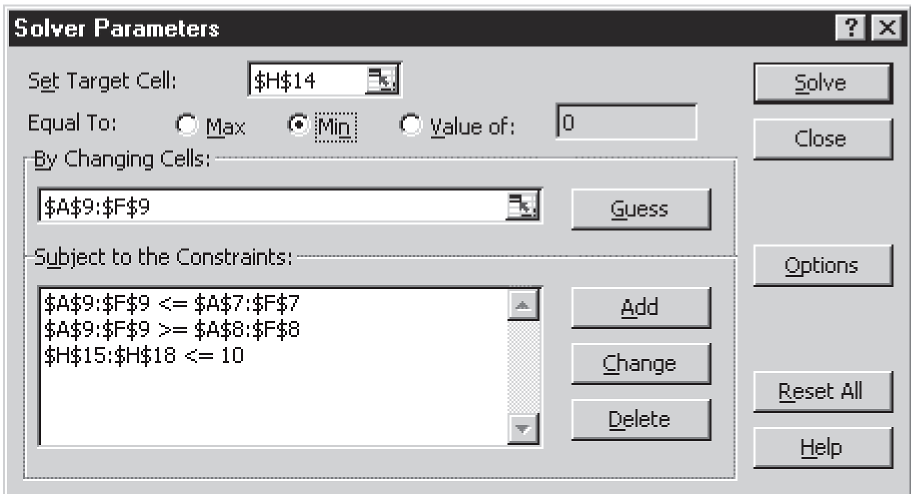
Click on OK in the Solver Options dialog box. Click on Solve in the Solver Parameters dialog box.

If an error message appears, bring back up the Solver Parameters dialog box.

- Make sure that Min is checked. A mistake here can cause an "unbounded solution" error.
- Verify that the target cell and the changing cells are correct.
- Verify that all the constraints are correct, with greater-thans and less-thans going in the right directions. Mistakes here can cause "unbounded solution," "non-linear," and "no feasible solution" errors.
- If tried all of those, without avail, you can try the following, which are workarounds for bugs in some versions of Excel.

If you get a message that there is no feasible solution, try changing the Assume Linear Model option. That is, click Solver's Options button, then check Assume Linear Model if it's unchecked, or uncheck it if it's checked.

If you still get the no-feasible-solution message, change the Solver Parameters as shown here to exclude the dummy activity from the Changing Cells and the Constraints.



The ranges for the Changing Cells and the Constraints stop at column F. Column G has the dummy activity.

Excel 2000 and later should not require this modification. Please let me know if you have to resort to this.

If everything is correct, a dialog box will ask you what reports you want. You can request whatever reports if you like, but I won't do anything with them here.

The result should be:

	A	B	C	D	E	F	G	H
1	Activities							
2	A	B	C	D	E	F	Dummy	
3	Nodes							
4	1	1	1	2	3	4	2	Start
5	2	3	4	5	5	5	3	End
6	Times							
7	3	4	5	8	3	5	0	Normal
8	2	2	3	6	2	3	0	Crash
9	3	4	5	7	3	5	0	Actual
10	Costs							
11	3000	4000	5000	5000	3000	4000	0	Normal
12	5000	6000	8000	6000	4000	8000	0	Crash
13	3000	4000	5000	5500	3000	4000	0	Actual
14	Paths				Total actual cost			24500
15	1	0	0	1	0	0	0	10
16	0	1	0	0	1	0	0	7
17	0	0	1	0	0	1	0	10
18	1	0	0	0	1	0	1	6
19							Max	10
20	A			D				Critical
21		B			E			
22			C			F		Critical
23	A				E		Dummy	

To get finished in 10 weeks (H19 now has 10), we'll have to spend $24,500 (H14 now has 24500).

As manager, you'll be busier. You now have two critical paths to worry about, 1 -A-> 2 -D-> 5, and 1 -C-> 4 -F-> 5. If any of the four activites in those paths is late, the project will take more than 10 weeks.

Let's add three more rows, to make it easier to see which activities have speeded up and at what extra cost:

Go to cell A24 and type "Crashed by how much"

Then go to A25 and put =A7-A9 there. This is the Actual time minus the Normal time.

Go to cell A26. Type in =A13-A11. This is the difference between the current Actual cost and the Normal cost.

Select A25:A26. Copy to the clipboard. Select A25:F25, and paste.

	A	B	C	D	E	F	G	H
1	Activities							
2	A	B	C	D	E	F	Dummy	
3	Nodes							
4	1	1	1	2	3	4	2	Start
5	2	3	4	5	5	5	3	End
6	Times							
7	3	4	5	8	3	5	0	Normal
8	2	2	3	6	2	3	0	Crash
9	3	4	5	7	3	5	0	Actual
10	Costs							
11	3000	4000	5000	5000	3000	4000	0	Normal
12	5000	6000	8000	6000	4000	8000	0	Crash
13	3000	4000	5000	5500	3000	4000	0	Actual
14	Paths				Total actual cost			24500
15	1	0	0	1	0	0	0	10
16	0	1	0	0	1	0	0	7
17	0	0	1	0	0	1	0	10
18	1	0	0	0	1	0	1	6
19							Max	10
20	A			D				Critical
21		B			E			
22			C			F		Critical
23	A				E		Dummy	
24	Crashed by how much							
25	0	0	0	1	0	0		
26	0	0	0	500	0	0		

We see that Activity D has been shortened by 1 week, at an extra cost of $500.

Step 11: Economic Analysis

Let's make up an economic problem to solve. Imagine that the Example 2 project is being done on a contract, with a scheduled completion time of 8 weeks. There is a $2500 per week penalty for being late. There is also a $1000 per week bonus for being early. Our objective is to find the best (least cost) schedule for the project. Does it pay to be on time, or are we better off paying some penalty? It is worth it to go for the bonus?

Step 11: Economic Analysis

Let's make up an economic problem to solve. Imagine that the Example 2 project is being done on a contract, with a scheduled completion time of 8 weeks. There is a $2500 per week penalty for being late. There is also a $1000 per week bonus for being early. Our objective is to find the best (least cost) schedule for the project. Does it pay to be on time, or are we better off paying some penalty? It is worth it to go for the bonus?

Here are our results so far. An explanation follows:

Weeks	Project cost	Penalty cost	Total cost
11	$24,000	$7,500	$31,500
10	24,500	5,000	29,500

If we use normal times, the project takes 11 weeks, which runs over the schedule by 3 weeks. We lose $7500 in penalties. The total project cost is $24,000 + $7,500 = $31,500.

If we crash by 1 week, the project takes 10 weeks. Our penalty cost is $5,000. Direct project cost is $24,500, as we just saw. The total is $29,500. This is less than $31,500, so ten weeks is better than eleven weeks.

To try getting done in 9 weeks, go back to the Solver (step 9). Change the H15:H18 <= 10 constraint to H15:H18 <= 9. Solve. The cost rises to $26,500. The penalty for being one week late is $2,500. Total cost is $26,500 + $2,500 = $29,000. This is less than $29,500, so nine weeks is better than ten weeks.

Weeks	Project cost	Penalty cost	Total cost
11	$24,000	$7,500	$31,500
10	24,500	5,000	29,500
9	26,500	2,500	29,000

Notice that cutting the second week added more to cost (second column) than cutting the first week. Cutting one week increased project cost by $500. Cutting the second week increased project cost by $2000, from $24,500 to $26,500. The law of diminishing returns is at work here.

Should we save three weeks and be on time? To try getting done in 8 weeks, go back to the Solver. Change the H15:H18 <= 9 constraint to H15:H18 <= 8. Solve. You should find that the cost is $30,000. There is no penalty, but $30,000 is more than $29,500, so we lose money by being on time. We are better off being one week late and paying the penalty.

What about saving four weeks and being early? Thanks to the law of diminishing returns, we don't need to consider shorter project durations than 8 weeks. Going from 9 weeks to 8 added $3,500 to cost. The law of diminishing returns implies that going from 8 weeks to 7 will add at least $3,500 more to cost. That is more than the $1000 bonus, so we know 7 weeks is a loser.

If the bonus is linear (in other words, if we get the same bonus for each additional week that we are early) then the law of diminishing returns implies that we can stop our analysis as soon as the total cost, including the bonus, starts to rise.

Here is the whole table. The bonus for being early is treated as a negative penalty.

Weeks	Project cost	Penalty cost	Total cost
11	$24,000	$7,500	$31,500
10	24,500	5,000	29,500
9	26,500	2,500	29,000
8	30,000	0	30,000
7	Don't bother	-1000	will be higher

We conclude that our optimal production schedule is 9 weeks. It has the least total cost.

16.4 NOTES

16.5 SUMMARY

The advancement in technology makes human work simpler. Earlier we used to calculate the problems manually. Today we have number of software. The manual calculation of PERT/ CPM take much time. The spread sheet is the useful tool where we can easily, accurately and with less time we can solve the problems and construct the network diagrams.

16.6 KEY WORDS

Spread sheet, solve, critical path, economic analysis,

16.7 SELF ASSESSMENT QUESTIONS

1. Explain the procedure of Solving CPM problems in spread sheet.
2. What are the uses of using spread sheet in solving CPM problems and constructing a diagram

16.8 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.
2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.
3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.
4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.
5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill
6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011
7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002
8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012
9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.
10. Sanjiv Marwah. *Project Management.* New Delhi: Dreamtech Press, 2011.

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DEPARTMENT OF STUDIES AND RESEARCH IN MANAGEMENT

M.B.A III Semester

COURSE - 15 : PROJECT MANAGEMENT

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5

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BLOCK - 5 : PROJECT TEAM MANAGEMENT

In the modern organisational structure the concept of team occupied greater relevance.The firm which asigns a specific task to a team which unusally completes the task sucessfully. This block deals with project team management , which is divided into four units.

The unit -17 deals with high performance project teams, this unit at the outset focussed on basic concepts; chacteristics and creating of high performance teams. Further, the unit discusses on project team development stages.

The unit-18 is concerned with managing virtual teams. The advancement in technology swept away old organizational concept, today an employee can work for his team or organization by sitting at home.The unit begins by defining virtual teams, discusses need of virtual teams, then the unit focuses on types and advantages of virtual teams.The unit also explains oppturnities and challenges of virtual teams. Further it breifs key attributes of sucessfull virtual team.

The unit -19 is related to project control and performance evaluation, this unit discusses importance , types and process of project control. Then it explains management by walking around, project performaaance measurement and evaluation . This unit also discusses on project quality.

The unit-20 deals with project closure and post completion audit . This unit discusses prepration of checklists and after action reviews, benefits of efficient project closure. Also the unit discusses on post project completion audit.

UNIT- 17: HIGH PERFORMANCE PROJECT TEAMS

Structure :

17.0 Objectives

17.1 Introduction

17.2 Basic Concepts

17.3 Characteristics of High Performing Teams

17.4 Creating a High Performance Project Team

17.5 Project Team Development stages

17.6 Case Study

17.7 Notes

17.8 Summary

17.9 Keywords

17.10 Self assessment questions

17.11 References

17.0 OBJECTIVES

After reading this unit, you should be able to;

- define project team, Project Team management, High Performing Team, Project manager.
- describe the characteristics of high performing teams
- evaluate the Project development stages.
- examine the issues relating to building high performing team

17.1 INTRODUCTION

The success of any project depends on the performance of the project team. Leader leads, but follower follows is the traditional or conventional style of group management. But the old theory of leadership does not suit the present scenario. There is a need for new theory which explains the role of team members in a group. The new theory must consider each member of the group as a performer rather than just follower. The project team management helps to understand new theory of leadership.

17.2 BASIC CONCEPTS

Team: A team can be defined as a group of people organized to work together to achieve a goal

Project team: A group of individuals assembled to perform activities that contribute toward achieving a common task related goal.\

Project Manager: A project manager is the person who has the overall responsibilities for the successful initiation, planning, controlling and closure of projects

High Performing Team: The team which delivers what is asked for, when it asked, without you as a project manager.

Project Team Management: Managing project team is termed as project team management.

17.3 CHARACTERISTICS OF HIGH-PERFORMING TEAMS

Terence R. Traut is the president of Entelechy, Inc., a company that helps organizations unlock the potential of their people through customized training programs in the areas of sales, management, customer service, and training. According to him the following are the characteristics of high performing teams,

Table: 1

CHARACTERISTICS AND STRATEGIES OF HIGH PERFORMING TEAMS

SL. No.	Characteristics	Strategies
1	***Participative Leadership***	✓ Envisioning leadership and organizing leadership ✓ Clear leadership role that is shared ✓ Enables people to make choices ✓ Shared norms ✓ Shared values ✓ Members drawn to the team ✓ Team identity ✓ Belonging/membership ✓ Synergism ✓ Future focused
2	***Aligned on Purpose and Vision***	✓ Common shared purpose ✓ Clear shared vision ✓ Self directing ✓ High morale ✓ Team goals align with personal goals and organization goals ✓ Problem solving, not laying blame ✓ Clear, shared understanding of team members' roles
3	***Task Focused***	✓ Challenging tasks ✓ Individual accountability/ownership ✓ Equality in workload ✓ Quality focus

Allows risks and mistakesü   Promotes group learning

17.4 CREATING A HIGH-PERFORMANCE PROJECT TEAM

The following figure 1.1 explains you how to create high-performance project teams

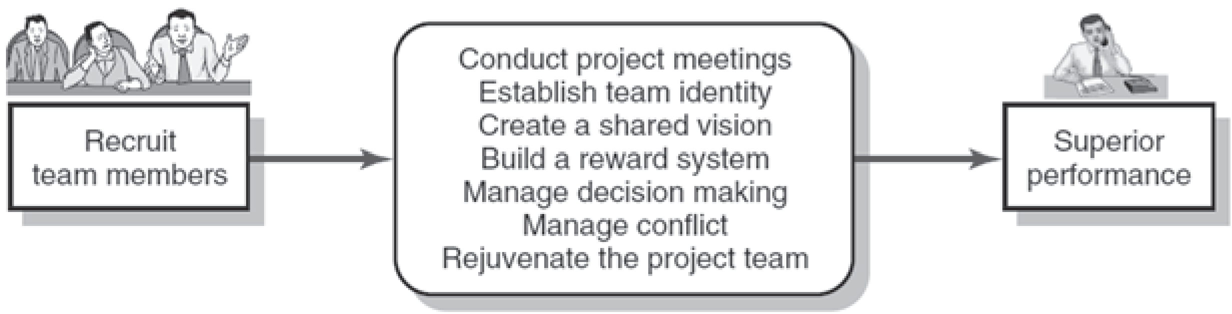

Figure: 1.1

a. Recruiting Project Members:

All organisations have a reason to exist and work to do - having active members may be crucial to implementing your plans successfully. This guide is aimed at organisations that have a membership base. It will help you to set up a system for membership, a strategy for recruitment and a plan for keeping your members involved and active.

i. Factors affecting recruiting

Two important factors affecting recruitment are:

- Importance of the project
- Management structure used to complete the project

ii. Whom to recruit?

When selecting and recruiting team members, project managers naturally look for the individuals with necessary experience and knowledge /technical skills critical for the project completion. At the same time the other factors includes

- **Problem-solving ability**. If the project is complex and fuzzy, then a manager wants people who are good at working under uncertainty and have strong problem identification and solving skills.

- **Availability**. Sometimes the people who are most available are not the ones wanted for the team. Conversely, if members recruited are already overcommitted, they may not be able to offer much.
- **Credibility**. The credibility of the project is enhanced by the reputation of the people involved in the project. Recruiting a sufficient number of "winners" lends confidence to the project.
- **Political connections**. Managers are wise to recruit individuals who already have a good working relationship with key stakeholders. This is particularly true for projects operating in a matrix environment in which a significant portion of the work will be under the domain of a specific functional department and not the core project team.
- **Ambition. Initiative and energy**. These qualities can make up for a lot of shortcomings in other areas and should not underestimate.

b. Conducting project meeting

One of the most overlooked skills is the ability to conduct effective meeting— and not have them be a drain on everyone's time. You know how it goes, it's 2:50 and you have a 3 p.m. conference call and you're looking for anything you can come up with to avoid it, right? The problem is that most meetings are boring, only semi-productive and are often held for self-serving purposes of the person who called the meeting. And how many times have you sat down to a meeting only to find it's a meeting about when to meet?!The conducting project meetings are not as simple. It should be planned well in before doing so. The given figure 1.2 below explains the essentials of conducting project meetings.

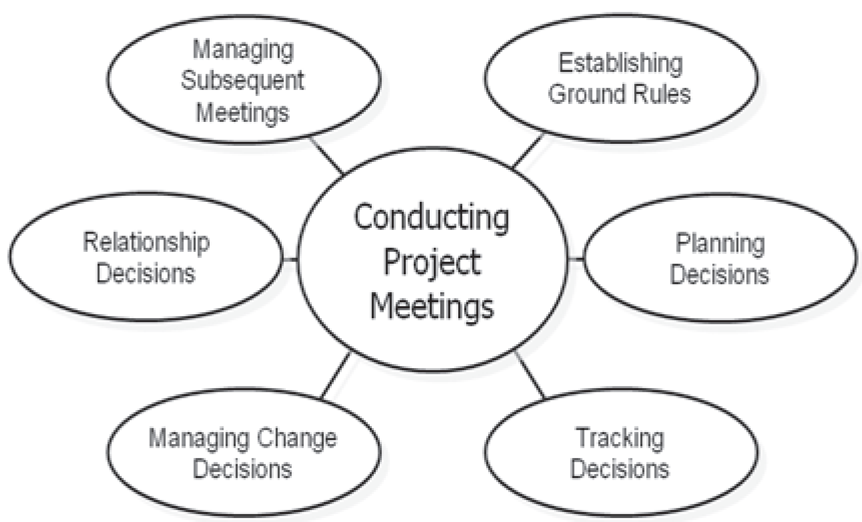

Figure: 1.2

A. The first project team meeting

The first project kick off meeting is critical to the early functioning of the project team. The objectives of first meeting is

- to provide an overview of the project, including the scope and objectives, the general schedule, method and procedures,
- to address some interpersonal concerns captured in the team development model such as who are the other team members?, how will I fit in?, will I be able to work with those people and
- to model how the team going to work together to complete the project

i. Establishing ground rules

By establishing the ground rules the team members are guided by how to work together. These ground rules involves not only organizational and procedural issues but also normative issues on how the team will interact with each other.

ii. Planning decisions

1. How will the project plan be developed?
2. What tools will be used to support the project?
3. Who will enter the planning information?
4. What are the specific roles and responsibilities of participants?
5. What are the relative importance of cost, time and performance?
6. What are the deliverables of project planning process?
7. What format is appropriate for each deliverable?
8. Who will approve and sign for each deliverable?
9. Who will receive the deliverables? And so on……

iii. Tracking decisions

1. How will progress be assessed?
2. At what level of the detail the project is tracked?
3. How will team members get data from each other?
4. How often will they get this data?

5. Who will generate and distribute reports?

6. Who needs to be kept informed about the project progress? And how will they be informed?

7. Regarding meetings

a) Where will be meetings located?

b) What kind of meetings will be held?

c) Who will run these meetings?

d) How will agendas be produced?

e) How will information be recorded?

iv. Managing change decisions

1. How will changes be instituted?

2. Who will have change approval authority?

3. How will plan changes be documented and evaluated?

v. Relationship decisions

1. What departments and organizations will the team need to interact with during the project?

2. What are the roles and responsibilities of each organization? (reviewer, approver, creator and user)

3. How will all involved parties be kept informed of deliverables, schedule dates, expectations etc?

4. How will the team members communicate themselves?

5. What information will and won't be exchanged?

B. Managing subsequent meetings

Other meetings include status report meetings, problem solving meetings, and audit meetings. The guidelines for running effective meetings include

1. Start meetings on time regardless of whether everyone is present.

2. Prepare and distribute an agenda prior to meeting

3. Identify an adjournment time.

c. **Establish team identity**

A team identity built on commitment to a shared goal. This commitment relies on goal and scope clarity, demonstrated support from the project sponsor, and understanding the strengths and contributions of all team members.

How to establish team identity?

1. By effective use of meetings.
2. By co-location of team members.
3. By creation of project team name.
4. By team rituals

d. **Create shared vision**

A shared vision for a project fosters commitment to the long term and discourages expedient responses that collectively dilute the quality of the project.

There appear to be four essential qualities of an effective vision (see Figure 1.3):

1. First, its essential qualities must be able to be communicated. A vision is worthless if it only resides in someone's head.
2. Second, visions have to be challenging but also realistic. For example, a task force directed at overhauling the curriculum at the college of business at a state university is likely to roll its eyes if the dean announces that their vision is to compete against the Harvard Business School. Conversely, developing the best undergraduate business program in that State may be a realistic vision for that task force.
3. Third, the project manager has to believe in the vision. Passion for the vision is an essential element of an effective vision.
4. Finally, it should be a source of inspiration to others.

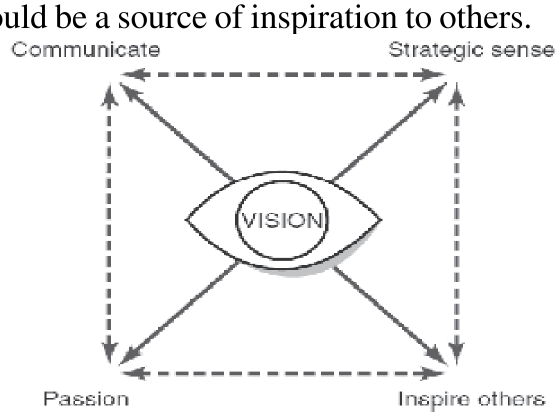

Figure 1.3

e. Build a reward system

While project managers tend to focus on group rewards, there are times when they need to reward individual performance. This is done not only to compensate extraordinary effort but also to signal to the others what exemplary behavior is. More specifically, among the rewards they use to motivate and recognize individual contributions are the following:

- **Letters of commendation**. While project managers may not have for their team members' performance appraisals, they can write letters commending their project performance. These letters can be sent to the workers' supervisors to be placed in their personnel files.
- **Public recognition for outstanding work**. Superlative workers should be publicly recognized for their efforts. Some project managers begin each status review meeting with a brief mention of project workers who have exceeded their project goals.
- **Job assignments**. Work should be rewarded with desirable job assignments. Managers should be aware of member's preferences.
- **Flexibility**. Being willing to make exceptions to rules, if done judiciously, can be a powerful reward. Allowing members to work at home when a child is sick.

f. Manage decision making

Most decisions on a project do not require a formal meeting to discuss alterative and determine solutions. Instead decisions are made in real time as part of the daily interaction patterns between project managers, stakeholders, and team members.

For example, as a result of routine "how's it going?" question, a project manager discovers that a mechanical engineer is stuck trying to meet the performance criteria for a prototype he is responsible for building. The project manager and engineer go down the hallway to talk to the designers, explain the problem, and ask what, if anything, can be done. The designers distinguish which criteria are essential and which ones they think can be compromised. The project manager then checks with the marketing group to make sure the modifications is acceptable. They agree with all but two of the modifications. The project manager goes back to the mechanical engineer and asks whether the proposed changes would help solve the problem.

g. Facilitating Group Decision Making

Project managers play a pivotal role in guiding the group decision-making must remind themselves that their job is not to make a decision but to facilitate the discussion within the group so that the team reaches a consensus on the best possible solution.

Facilitating group decision making essentially involves four major steps. Each step is briefly described next with suggestions for how to manage the process.

1. **Problem identification.** The project manager needs to be careful not to state the problem in terms of choices (e.g., should we do X or Rather the project manager should identify the underlying problem to which these alternatives and probably others are potential solutions. This allows group members to generate alternatives, not just choose among them.

One useful way of defining problems is to consider the gap between where a project is (i.e., the present state) and where it should be (desired state).

2. **Generating alternatives**: Once there is general agreement as to the nature of the problem(s), then the next step is to generate alter-native solutions.

If the problem requires creativity, then brainstorming is commonly recommended. Here the team generates a list of possible solutions on a flipchart or black- board. During that time the project manager establishes a moratorium on criticizing or evaluating ideas. Members are encouraged to "piggyback" on other's ideas by extending them or combining ideas into a new idea. The object is to create as many alterative as possible no matter how outlandish they may appear to be.

3. Reaching a decision: The next step is to evaluate and assess the merits of alterative solutions. During this phase it is useful to have a set of criteria for evaluating the merits of different solutions. In many Cases the project manager can draw upon the priorities for the project and have the group assess each alternative in terms of its impact on Cost, schedule, and performance as well as reducing the problem gap.

h. Manage conflict

Two types of conflict that can occur within a company are functional and dysfunctional. Functional conflict is healthy, constructive disagreement between groups or individuals, while dysfunctional conflict is unhealthy disagreement that occurs between groups or individuals.

- **Encouraging Functional Conflict**
  - Encourage dissent by asking tough questions.
  - Bring in people with different points of view.
  - Designate someone to be a devil's advocate.
  - Ask the team to consider an unthinkable alternative

- **Managing Dysfunctional Conflict**

Project managers have to decide among a number of different strategies to manage it; here are five possibilities:

1. **Mediate the conflict**. The manager intervenes and tries to negotiate a resolution by using reasoning and persuasion, suggesting alternatives and the like.
2. **Arbitrate the conflict**. The manager imposes a solution to the conflict after listening to each party. The goal is not to decide who wins but to have the project win.
3. **Control the conflict**. Reducing the intensity of the conflict by smoothing over differences or interjecting humor is an effective Strategy.
4. **Accept it**. In some cases the conflict will outlive the life of the project and, though a distraction, it is one the manager has to live with.
5. **Eliminate the conflict**. Sometimes the conflict has escalated to the point that it is no longer tolerable.

i. Rejuvenate the project team

The team can rejuvenated by informal and formal techniques

- **Informal Techniques**
  - Institute new rituals.
  - Take an off-site break as a team from the project.
  - View an inspiration message or movie.
  - Have the project sponsor give a pep talk.
- **Formal Techniques**
  - Hold a team building session facilitated by an outsider to clarify ownership issues affecting performance.
  - Engage in an outside activity that provides an intense common experience to promote social development of the team.

17.5 PROJECT TEAM DEVELOPMENT STAGES

The Forming – ***Storming*** – Norming – Performing model of group development was first proposed by Bruce Tuckman in 1965, who maintained that these phases are all necessary and inevitable in order for the team to grow, to face up to challenges, to tackle problems, to find solutions, to plan work, and to deliver results.

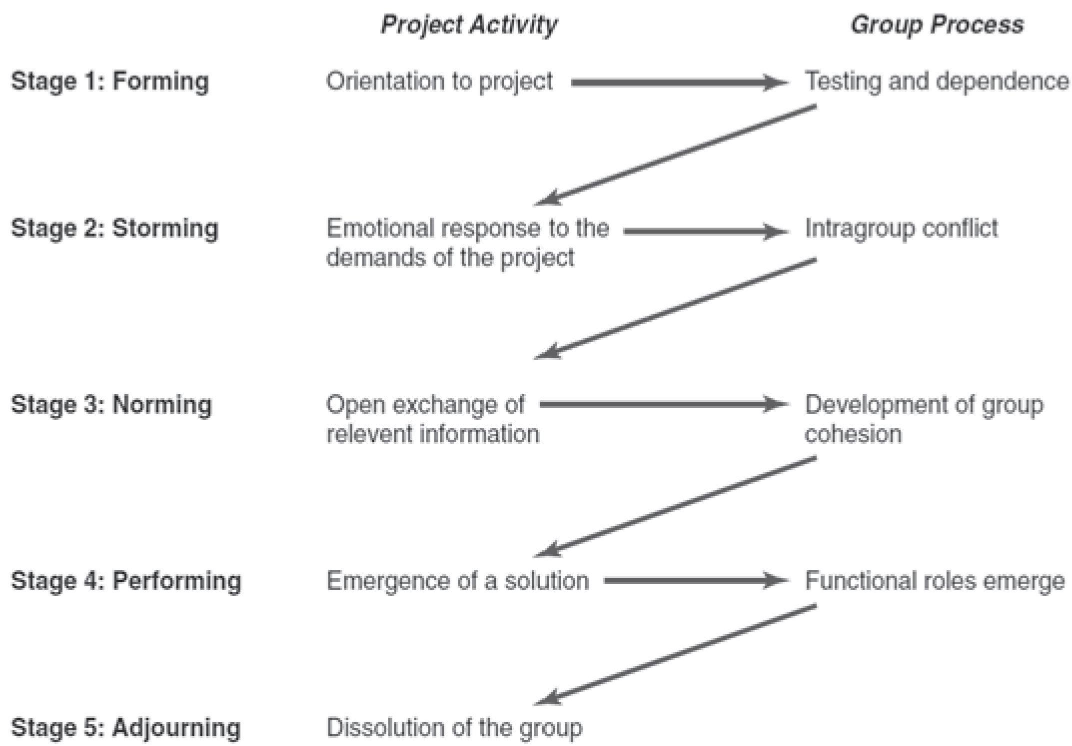

Figure: 1.4

Forming: The "trial balloon" phase. Someone has a bright idea and Starts building interest, sponsorship, and alliances.

During this phase, many discussions occur, serving to build support and consensus about the vision. The leader is selected and begins pulling together a team. Toward the end of this phase, you might get a ‘ ‘honeymoon" period. Everyone is excited about the project, getting to know each other, and busy ensuring that all the infrastructure and executive support is in place so that the project can succeed.

Managers can harness this initial burst of energy and productivity by setting appropriate expectations, ensuring a clear path free of bureaucratic obstacles, and directing activities.

Storming: Similar to the first year of marriage, this stage lays bare all the differences and conflicts about vision, expectations, work style, and communication style.

During this phase, the guidelines are honed, compromises are made, and often, real bonding takes compromises are made, and often, real bonding takes place.

Managers can help shorten this period of conflict by facilitating discussions, documenting decisions and guidelines, modeling expected behaviors, ensuring that everyone is heard, short-circuiting power struggles, and when necessary, redirecting people to the larger purpose.

Norming: Teambuilding begins in earnest as individuals become comfortable with each other and their roles.

The team begins identifying "low-hanging fruit,' those activities or solutions that are easy to implement and have a positive impact on the direction and pace of the project. Managers can assist the team by providing opportunities for social interaction and encouraging open discussions and creative problem-solving, as well as identifying the "go-to" people for specific activities.

Performing: The "zone." The team is working well together, knows where it is going and how to get there, and works interdependently.

Managers can maximize the benefit of this stage by ensuring that road-blocks get removed, verifying that the team has all the tools it needs to accomplish the tasks, ensuring that the criteria are established and known, and working to delegate tasks appropriately.

Adjourning: The "wrap-up." The team is finishing its tasks, evaluating how things went, and preparing to move on to other things. Conflict often occurs during this Stage because of deadline stress, and because of the uncertainty associated with transition and change.

Managers can ease the transition by making sure that team and individual efforts get recognized, providing an opportunity to discuss the project and evaluate les- sons learned, and providing clear direction on what on what team members focus on next.

17.6 CASE STUDY

Team Building at Global Green Books Publishing

Global Green Books Publishing is continuing to grow. As their eBook business continues to drive that growth, they now are continuing to add staff to be able to keep up with customer demand. Most all of the new people and many of the eBook staff have not worked together in the original print-based business area of the company, and indeed are new to the company and its culture.

These new employees have a diverse set of skills, backgrounds, and motivations. Their supervisors know how to manage their projects, but do not always have the expertise to step in and do each of the unique tasks assigned to team members. Most of the employees that have been around since the beginning of the eBook business have been trained in their project management techniques, so they can get the work done well; but not all of the newer employees have had this training. There is just too much work that needs to be done to take time out for training.

Supervisors need provide leadership, to provide inspiration for their team and to be good motivators of their team members, as well as be a good manager, worrying about the day-to-day and minute-by-minute accomplishment of the project's goals. Being a good motivator also means that the supervisors must be good listeners to understand what issues are confronting their team members and the needs of their team members.

Beyond this role as leaders, supervisors need to be a good manager. They need to identify the skills that they need for their projects. Supervisors at Global Green Books normally do this as they start from the standard job template for eBook projects and build the Work Breakdown Structure (WBS) for their eBook project. Next, they need to identify team members that have those skills, and work with their current project managers and with human resources to make sure that they will be available to support the new project. Based on the lessons learned analyses, a supervisor might also identify a person as a back-up for a critical role on the project, in case they run into difficulties or assigned staff are not available as planned.

Once the team is assembled, challenges can arise. Some of the challenges teams face have to do with knowing the status of the work, as part-time employees come in and hand a piece of a project off to another worker. Some deal managing conflicts as they arise – both technical issues as permissions are delayed and content cannot yet be incorporated, leading to scheduling changes, and inter-personal issues among staff. Some of these conflicts occur between a mostly young, part-time contingent of student workers and the full-time employees. Supervisors are often drawn into mediating or resolving these conflicts. They really need to meld together their staff to create highly capable, productive project teams for these fast-paced eBook projects. The staff needs to trust each other and their leadership to be fair and to balance work priorities with the times that they are available.

Supervisors are finding it is very important to make sure every team member understands the goals of the project, the roles of each team member and how they inter-relate, and the sense of urgency about completing the project. This urgency comes from understanding the intense schedules for completing eBooks and from understanding why it is important that all of the work come together to create a finished eBook – any part not completed keeps the final eBook from going into quality check and release. Because of the issues around employee absence and the use of part-time employees, they are also trying to make sure that employees are able to do their role, but can also help out in related roles as needed.

To help build a common understanding of the project work and minimize some of the conflicts, Samantha is working with some the supervisors to hold a project kick-off meeting where the team reviews the goals and plan for the project, and develops and agrees to a project team charter. Letting the team develop their charter gives the supervisor an opportunity to observe how the team works together, and gives the team the ability to set ground rules for how they will work together. The team charter starts with the project goals. The team may set their goals in order to accomplish these project goals. Other topics that the team might address in their team charter include agreed-upon guidelines for how they want to participate in the project, conduct (or behavior), communications among project members, communicating status and problems, problem solving, and holding meetings. This charter and its guidelines that they team have agreed to can then serve as a basis for team building and team behaviors during the project.

Comment on the following aspects of the case study:

a) What are some of the challenges facing project teams? Have you encountered any of these problems in teams that you have been part of? What other team problems have you experienced?

b) Are there skills that team members need to be effective team members in a project? If so, what are these skills?

c) Why is it important that team members understand the goals and scope of the project?

d) Think about creating a team charter. What categories of guidelines would you you're your team to agree on before beginning work? Why would you include these categories?

e) Brainstorm and identify some guidelines that you would suggest teams follow for each of these categories?

   i. Team member participation in the project

   ii. Team member conduct (or behavior)

   iii. Communicating among project members (including communicating status and problems)

   iv. Holding meetings

f) What are the advantages of a kick-off meeting? What are the advantages of developing a team charter?

17.7 NOTES

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17.8 SUMMARY

High Performing Team is the team which delivers what is asked for, when it asked, without you as a project manager The High performing team creates positive synergy. (1+1+1=10). High performing teams work well together to achieve the set goals. They do not lean/depend on the project manger heavily to get work done. The communication among team members is good. The issues relating building high performance project team includes recruitment of project managers, conducting project meetings, establishing team identity, creating shared vision, building reward system, managing decision making, managing conflicts and rejuvenating the project team leading to superior performance. The project manager must consider the problem solving ability, availability, credibility, political connections, ambition, initiative and energy of the members includable in team. The project meetings should be planned well by establishing ground rules and the kind of decisions to be taken by whom and when. The subsequent meetings should be managed effectively by proper guidelines. The time and agenda must be considered while managing subsequent meetings. The shared vision is created by passion, strategic sense, and effective communication and by inspiration to others. The reward system can be build by letter of commendation, public recognition for outstanding work, by job assignments and flexible work. The decisions are managed by facilitating group decision making. While managing the conflicts the functional conflicts are encouraged and dysfunctional conflict are managed by mediating, arbitrating, controlling, accepting and eliminating strategies. The project team is rejuvenated through formal and informal techniques. The project development stages include forming, norming, storming, performing and adjourning.

17.9 KEY WORDS

1. **High performing team:** the team which delivers what is asked for, when it asked, without you as a project manager.
2. **Team identity:** the phenomena of individual team members who feel a positive attitude towards, and identify with, their team
3. **Shared vision:** is a picture that everyone in the company carries in their heads and hearts.
4. **Functional conflict:** is healthy, constructive disagreement between groups or individuals.

5. **Dysfunctional conflict:** is unhealthy disagreement that occurs between groups or individuals.

6. Kick-off meeting: is the first meeting with the project team and the client of the project, which energizes the team members.

7. **Letter of commendation**: is a letter to recognize a job well done by the team member.

8. **Rejuvenate:** make (someone or something) look or feel better, younger, or more vital. To restore to an original or new condition.

17.10 SELF ASSESSMENT QUESTIONS

1. What is high performing team?
2. What are the characteristics of high performing team?
3. Explain the issues involved in building high performing teams.
4. What are the factors affecting recruitment of project member?
5. Explain the essentials of conducting project meetings.
6. What is the objective of first project meeting?
7. State the decisions involved at the time of project meeting.
8. State the guidelines for running effective meetings.
9. How team identity is established?
10. What are the essential qualities of an effective vision?
11. Why to create shared vision?
12. Explain the group decision making steps.
13. How to encourage functional conflict?
14. How to manage dysfunctional conflict?
15. Explain the project team development stages

17.11 REFERENCES

1. Clifford F Gray, Frik W Larson (2003), "Project Management- the managerial process", Mc Graw Hill Publishers
2. Dufrene and Lehman (2011), "Building High-Performance Teams", 4thed ,Cengage Learning
3. Eric Verzuh (2016), " the fast forward MBA in Project Management" 5th ed , John Wiley & Sons
4. Gray " Project Management- the managerial process", 4th ed TATA McGraw-Hill Companies
5. James William Martin (2008), " Operational Excellence: Using Lean Six Sigma to Translate Customer Value", Auerbach Publications
6. Martha Finney(2008), "Building High Performance People and Organizations", Greenwood Publishing Group
7. Ralph L Klien (2004), "Leading High Performance Projects", J.Ross Publishing
8. Sandy Pokras (1995), "Rapid Team Development: Building High-Performance Project Teams", Crisp Publications.

UNIT-18 : MANAGING VIRTUAL PROJECT TEAMS

Structure :

18.0 OBJECTIVES

After reading this unit, you should be able to;

- define virtual project team
- describe the need for virtual project team
- identify the types of virtual project team
- identified the advantages of virtual project
- identify the opportunities and challenges of virtual project teams
- explain the challenges faced by virtual leader
- identify key attributes to become successful virtual leader

18.1 INTRODUCTION

Walk into any office today and you know that things are not as they were a decade ago. If you engage employees in conversation, many of them will say that they are working on some projects with colleagues who do not work in the same building, the same city, or even the same country. Ask them if they have met these teammates and some employees may claim to have viewed pictures posted on the Internet, while others may describe introductions made during webcam meetings or a visit to a corporate off-site event. Clearly our business landscape has changed.

The virtual team, VT for short, is a work arrangement in which a group of people share responsibility for goals that must be accomplished in the total, or near total, absence of face-to-face contact. With the rise of technology and globalization, virtual teams are now reshaping the way we think and do business.

18.2 BASIC CONCEPTS

Virtual Project team: a virtual project team can cross time, distance, and organizational boundaries and make decisions to meet task goals. The team members are located in disparate geographic locations.

Virtual teams on the other hand are teams of people who primarily interact electronically and may occasionally meet face-to-face. They include teams of people working at different geographic sites or a project team whose members telecommute.

Example for virtual team

Hewlett-Packard's integrated circuit business headquarters and a portion of the R&D facilities are located in Palo Alto, California; the two wafer fabrication operations are located in Corvallis, Oregon, and Fort Collins, Colorado; and the packaging assembly process is primarily in Singapore and Korea. It is not uncommon for professionals at each of these locations to be involved in the same project. When team members are spread across different time zones and continents, the opportunity for direct communication is severely limited. Electronic communication such as the Internet, e-mail, and teleconferencing takes on much more importance in virtual projects because this is the primary means of communication.

18.3 DEFINITIONS OF VIRTUAL TEAM

Some of the definitions on virtual team by Yale's studies are as follows

"People who need to work together who aren't currently in the same office. They can also be working in different departments, or cities and countries, and still operate virtually as well."

—VT MANAGER, HUMANITARIAN RELIEF ORGANIZATION

''Any team that doesn't have a set office that people show up in regularly. There are really two sides to it: 1) pulling together an ad hoc team and creating a virtual team to work on a project on an 'as needed' basis, and 2) virtual teams working across tune zones using technology."

—VT MEMBER, TECHNOLOGY COMMUNICATIONS COMPANY

"A group of people who get together without a solid line reporting relationship to solve a problem. The key attribute is that virtual teams have some accountability to deliver results, but their players do not have a formal reporting relationship to the team leader."

—VT LEADER, ELECTRONICS/BIOCHEMICAL COMPANY

"I see the virtual team having two definitions: 1) there are people who work only from home. They are telecommuting and never go to the office. 2) There are people who are geographically dispersed. They go to an office somewhere else and may never meet. Virtual teams work according to what needs to be done and once the project is completed, these teams are gone."

—SCIENTIST, TELECOM COMPANY

"A virtual team—whether across the street or across the world— is a team whose members simultaneously work together to a common purpose, while physically apart."

-Yael Zofi

18.4 THE NEED FOR VIRTUAL TEAMS

1. Virtual team arrangements have become increasingly popular as companies rethink their human capital resources and real estate expenditures.
2. Of course, teamwork has long been a common work value, with many companies using teams organized around successive tasks; so, the virtual team is only the latest accommodation to the realities that govern work process.
3. The virtual team is unique; however, because the most appropriate expertise is pulled together from many locations and even organizations—and yet team members may never meet in person.
4. With virtual work arrangements, recruiting talent and expertise is possible, regardless of where people are based.
5. More than any other factor, information technology has enabled the proliferation of virtual teams. With mobile devices, text messaging, e-learning modules, and cloud computing, team members are able to interact in more accessible ways, anywhere, anytime.
6. Thanks to high- speed networking technology and wireless connectivity, instantaneous communication across the world is possible, at low cost, at a touch of a button, screen, or keyboard.

18.5 TYPES OF VIRTUAL TEAMS

The seven types of virtual teams have been identified by Duarte and Snyder

a. **Project or Product Development Team**: Team has fluid membership, clear boundaries, a defined customer, and a clear mission. Longer-term team task is non-routine. Team has decision-making authority

b. **Network Team**: Team membership is diffuse and fluid; members come and go as needed. Team lacks clear boundaries and organization.

c. **Parallel Team:** Team has clear boundaries and distinct membership. Team works in short-term to develop recommendations for an improvement in a process or a system

d. **Work or Production Team**: Team has distinct membership and clear boundaries. Members perform regular and ongoing work, usually in one functional area.

e. **Service Team:** Team has distinct membership and supports ongoing customers. High network activities

f. **Management Team:** Team has distinct membership and works on a regular basis to lead corporate activities.

g. **Action Team:** Team deals with immediate action, usually in an emergency situation. Membership can be fluid or distinct.

18.6 ADVANTAGES OF VIRTUAL TEAMS

Virtual teams offer definite benefits:

1. **Cost savings**.

   a) Virtual teams offer flexibility and the ability to overcome geographic distance.

   b) Organizational expenses can be reduced when physical meetings are eliminated.

   c) Aside from the cost of plane tickets, hotel rooms, food, and car rentals, a significant cost of face-to-face meetings is associated with the time involvement of each expert.

   d) Travel time to meetings removes participants from productive activities they could otherwise be pursuing.

2. **Labor pool enhancement**.

a) People who could not participate in traditional settings can be part of the labor pool.

b) Parents of young children, caregivers, and persons with various disabilities can be effective members of virtual teams.

3. Virtual team participation also encourages appreciation of diversity through increased exposure to workers from various backgrounds and locations.

Facility and environmental benefits.

a) The need for office facilities and parking spaces is reduced when some workers are able to work from remote locations.

b) Air pollution and traffic congestion are also reduced when fewer workers commute daily.

4. Employer efficiencies.

a) Virtual teams can increase efficiency by eliminating layers of management and valuable time lost to bureaucratic processes.

b) Such teams also enable organizations to combine the specific talents of employees located in various places.

5. Employee efficiencies.

a) Worker satisfaction is increased due to greater flexibility in balancing work and personal life.

6. Participation in virtual teams can raise worker satisfaction by helping people feel participative in shaping their own jobs.

Better decision making.

a) Virtual teams allow organizations to draw on a wide pool of talent distributed through the workforce.

b) Teams offer a depth of expertise unavailable at the individual level and the opportunity for synergy of ideas.

18.7 OPPORTUNITIES AND CHALLENGES OF VIRTUAL TEAMS

A. OPPORTUNITIES

- Technology enables quick information gathering and an increased knowledge base (access to data and experience of others).
- Speed is essential since virtual teams are expected to form quickly, select the right members, understand each member's role/tasks, develop appropriate processes, and carry out work efficiently.
- More ideas can be generated because members are not stifled by dominant members, as usually happens in face- to-face teams.
- Communication technologies can equalize the opportunity for participation of every member
- Virtual teams provide flexibility in balancing personal and professional life.
- Virtual teams offer self-direction and a high degree of autonomy.

- Virtual teams can change members more easily, depending on the task or expertise needed, and thus tap into a greater talent pool.
- Virtual teams get involved in project work and share accountability with team members quickly, making better quality decisions.

B.CHALLENGES

Technological challenges are involved with setting things up (investment in equipment, support, and training) as well as the learning curve.

- Speed brings potential misunderstandings, particularly in the early stages of team setup (role and task clarity, getting deliverables out the door).
- The brainstorming aspect becomes more difficult when members are physically separated.
- Running regularly scheduled remote meetings takes tact, cultural sensitivity, and creativity.
- Virtual work occurs anywhere, anytime, and might interfere with personal life.
- Virtual teamwork might be missing; social isolation creates a feeling of "I'm by myself."
- Leaders/managers may find it more difficult to motivate employees and establish team spirit.
- Building trust may be challenging because it requires mechanisms different from those used in face-to-face teams.

18.8 VIRTUAL TEAM LEADER AND CHALLENGES FACED BY HIM

A virtual team leader is one who leads the virtual team. Usually the virtual team leader is the virtual project manager.

Challenges faced by virtual team leader

- Establishing credibility and trust between leader and team members, and across the team, takes more work, planning, and time.
- Creating a healthy, open team environment that encourages cooperation and fosters collaboration is hampered with few opportunities for socialization.

- Without the ability to assess the skills, competencies, styles, and preferences of team members, it's harder to match the best people to the given tasks.
- Ensuring that all share the same understanding of team goals, deliverables, roles, accountabilities, and success metrics requires more time and means frequent check-
- Creating a truly level playing field where all team members feel equally valued, respected, and able to contribute fully to the team's success takes a lot of energy, time, and planning, and many may still feel that some are favored over others.
- Developing and agreeing on norms governing vital aspects of communications and collaboration as a team are often skipped (at great peril) due to the time and planning that's really required.
- With fewer opportunities for firsthand observation, determining team members' true performance can be tricky, and as a result, performance feedback may be inaccurate or incomplete. Delivering feedback and performance coaching requires exceptional planning and special skills in the absence of nonverbal cues.
- Detecting when team members have become disengaged, and then offering the appropriate interventions, takes longer without visual cues or frequent contact.
- Maintaining focused productive conversations during virtual team meetings requires special skills that many team leaders don't have.

o As a result, many team meetings waste time and sap the energy of the team.

18.9 KEY ATTRIBUTES OF SUCCESSFUL VIRTUAL TEAM

A. Leadership Skills

Understands what it takes to establish credibility, and takes deliberate actions to earn it. Knows that credibility is a privilege and not a right.

i. Knows how to influence without authority, and goes out of the way to reach and engage each team member, rather than assuming everyone's on board.

ii. Creates a safe environment where team members know they can surface issues, ask for help, or admit they're struggling without fear of repercussion.

iii. Finds creative ways to size up skills and strengths to enable effective collaboration.

iv. Values ability to see problems in different ways.

v. Encourages debates and discussions to get to better ideas and new solutions.

i. Communication Skills

Can clearly articulate and communicate a compelling vision to galvanize the team

ii. Actively listens so team members feel they are being heard correctly. Knows how and when to paraphrase to ensure shared meaning.

iii. Discerns communications preferences of each team member, and knows which communication vehicles and styles work best for different team members.

iv. Detects when team members have become disengaged, disaffected, or otherwise need help getting back on track. Can sense when empathy is needed, even from a distance.

v. Knows how to ask the right questions. Understands how certain questions have a way of evoking needed responses.

vi. Communicates effectively in all respects, including listening, writing, conversational, and persuasive skills.

vii. Understands that different approaches may be needed with a diverse group, and is aware how own style can affect the quality of communications.

viii. Values two-way communications and is authentic about the desire for candid feedback, ideas, suggestions, and comments.

A. Behaviors and Attitudes

i. Shows patience and copes well with ambiguity and constant change, and helps others to do so as well.

ii. Projects enthusiasm and energy. Can be a good cheerleader, both for whole team and for each member.

iii. Demonstrates sensitivity to cultural, generational, and other differences.

B. **Coaching Skills**

i. Assesses emotional content of a situation and knows how to dig deeper, resolve, and otherwise address problems.

ii. Understands motivators for team members, and knows that different members are motivated differently.

C. Technology Skills

i. Understands the range of virtual communication and collaboration tools, and understands how each one can be successfully applied to a given objective.

ii. Is comfortable using a variety of tools, and helps inspire confidence in others to do the same.

iii. Know which how and when to use a certain combination of tools to produce the best results.

18.10 CASE STUDY

Can a Team That Shares a Common Office Be Virtual?

A manager of a sales team at the high-tech distribution giant CDW told us that she struggled with the challenges of managing people who were never in the office. Her sales team was almost always in the field working with customers. She was a good manager and had a track record of positive accomplishments, but many of her leadership practices were based on the traditional management model that assumed regular face- to-face interactions. She knew how to pop over a cubicle and help someone she could see was struggling with an assignment, how to gather an obviously confused group together for an emergency meeting, how to correct a misconception she overheard in the lunchroom, how to take full advantage of those fortunate moments when you run into someone in the hallway you need to speak with, or how to watch people and tell from their expressions and body language whether they understood or agreed with her. When she observed gossiping, whining, blaming, or other behaviors she knew would erode the effectiveness of the team, she intervened immediately. If she saw cliques forming, behaviors that indicated disunity or silo thinking, or indications of the early stages of conflict brewing, she resolved them. She knew how to rally the troops when the tone of their comments indicated that they were discouraged. To continue the military analogy, she liked being on the frontlines, helping the wounded, and personally leading charges far into enemy territory. “But,” she asked in an interview, “How do you lead a team over the Internet?”

It felt to her like calling in orders to the battlefield when she was located in a tent, blinded and deafened by separation from her army, a million miles away.

Questions:

1. What are the challenges faced by the manager in the given case?
2. What are the suggestions you give to overcome those challenges?
3. How to lead the virtual team

18.11 NOTES

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18.12 SUMMARY

The virtual team, VT for short, is a work arrangement in which a group of people share responsibility for goals that must be accomplished in the total, or near total, absence of face-to-face contact. More than any other factor, information technology has enabled the proliferation of virtual teams. With mobile devices, text messaging, e-learning modules, and cloud computing, team members are able to interact in more accessible ways, anywhere, anytime. There are seven types of virtual teams being identified namely project or product development team, network team, parallel team, work or production team, service team, management team and action team. Cost savings labor pool enhancements, environment benefits, increase in employer and employee efficiencies and better decision making are some of the benefits offered by virtual teams. There is equal number of opportunities and challenges of virtual team functioning. The virtual team leader also faces the challenges which can be overcome by leadership skills, communication skills, behavior and attitudes, coaching and technology skills.

18.13 KEY WORDS

1. **Virtual project Management:** is the system by which *virtual* teams collaborate for a finite period of time towards a specific goal.
2. **Virtual project teams:** are teams of people who primarily interact electronically and may occasionally meet face-to-face.
3. **Virtual team leader:** A virtual team leader is one who leads the virtual team.

18.14 SELF ASSESSMENT QUESTIONS

1. Define virtual team.
2. Give an example for virtual team
3. What is the need for virtual team?
4. What are the types of virtual project team? Discuss.
5. What are the advantages of virtual team?
6. Bring out the opportunities and challenges of virtual teams.
7. What are the challenges faced by virtual project team leader?
8. What are the key attributes for successful virtual team leader?

18.15 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.
2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.
3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.
4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.
5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill
6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011
7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002
8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012
9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.
10. Sanjiv Marwah. *Project Management.* New Delhi: Dreamtech Press, 2011.

UNIT - 19 : PROJECT CONTROL AND PERFORMANCE EVALUATION

Structure :

19.0 OBJECTIVES

After reading this unit, you should be able to;

- define the Project control process.
- describe MBWA- Management by Walking Around
- discuss about the Performance measurement and evaluation
- dlaborate Project quality, project planning, project assurance and project audit

19.1 INTRODUCTION

Project controls are the data gathering, management and analytical processes used to predict, understand and constructively influence the time and cost outcomes of a project or program; through the communication of information in formats that assist effective management and decision making.

This definition encompasses all stages of a project or program's lifecycle from the initial estimating needed to 'size' a proposed project, through to reflective learning (lessons learned) and the forensic analysis needed to understand the causes of failure (and develop claims).

19.2 IMPORTANCE OF PROJECT CONTROL

1. The successful performance of a project depends on appropriate planning.
2. The execution of a project is based on a robust project plan and can only be achieved through an effective schedule control methodology
3. The development of a suitable Project Control system is an important part of the project management effort.
4. Furthermore, it is widely recognized that planning and monitoring plays a major role as the cause of project failures.
5. It has been proved time and again that Project performance can be improved if dedicated Project Controls systems are in place.

19.3 TYPES OF PROJECT CONTROL

A. Informal Control

i. **Weekly status meetings:** establish the status of a project. The goal is to take stock of what has been accomplished, what is due to be completed and what roadblocks or challenges are anticipated. Status meetings are intended to ensure a project stays on track and to give team members the chance to intervene early if problems arise.

ii. **Management by Wandering Around**: refers to a style of business management which involves managers wandering around, in an unstructured manner, through the workplace(s), at random, to check with employees, or equipment, about the status of ongoing work.

iii. **Action item list**: Action items are usually documented in the meeting minutes and are recorded in the task list of the group. As people complete action items, the items are documented as being completed and the item is removed from the list of outstanding action items.

iv. **Informal peer reviews:** One on one with peers, no agenda or preparation time. Informal reviews do not have the rigor of a formal review. The reviews may not be planned, or metrics may not be captured to measure review effectiveness. They are typically used to confirm understanding, test ideas, brainstorm, etc.

B. Formal Control

i. **Formal peer review results:** Peer review is the evaluation of creative work or performance by other people in the same field in order to maintain or enhance the quality of the work or performance in that field.

ii. **Q/A reports**: Q/A reports include the questions and answers. The details can be obtained in the form of question and answer.

iii. **Formal technical reviews**: A method involving a structured encounter in which a group of technical personnel analyzes or improves the quality of the original work product as well as the quality of the method.

iv. **Deliverables reviews and approvals**: deliverables are the end results of the project. It can be project deliverables or process deliverables. The review report on end results of the project and process.

v. **Updated and distributed project plan:** As a project progresses, events may occur to alter the way information is accessed or change communications requirements. During Project Execution, the Project Manager and Project Team must again review whether the Communications plan is still current and applicable to the present phase of the project.

19.4 PROJECT CONTROL PROCESS

The project control process cycle includes:

1. **Project planning -** converts project requirements or corrective action ideas into plans for investing resources in project activities.
2. **Project activity implementation –** project plans and requirements are communicated to and executed by project team members.
3. **Project performance measurement -** includes measurement of project activity progress and performance.
4. **Project performance assessment –** performance measurements are compared to the plan, and corrective, mitigating, or improvement actions are taken as may be determined.

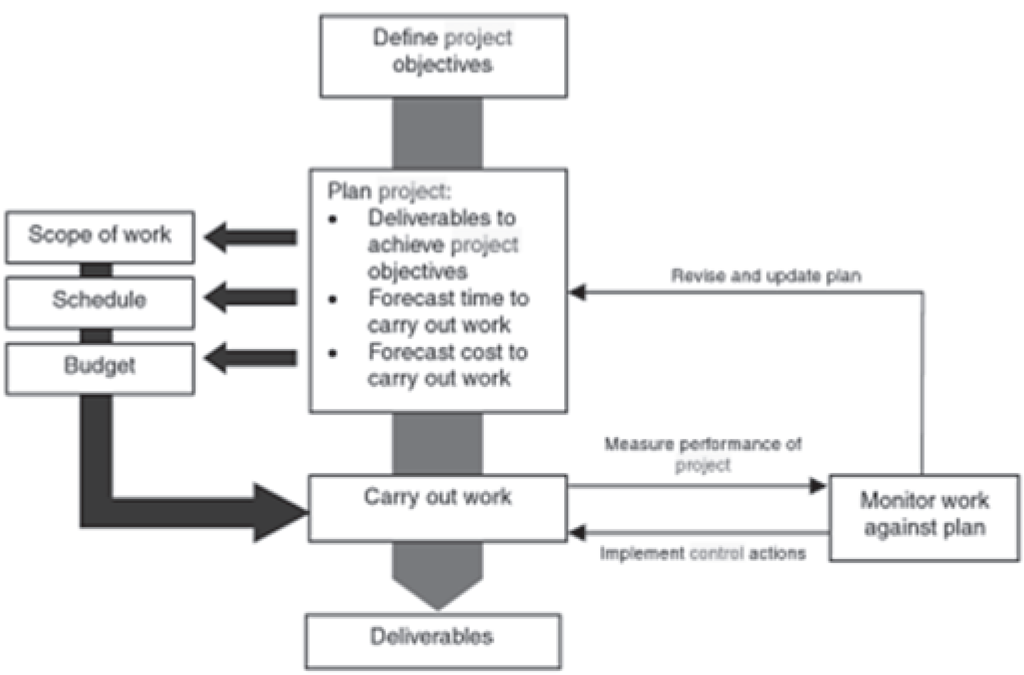

Figure 3.1

Defining project objective

- This step defines the projects outcome and the steps required to achieve that outcome. People, including project managers, do not spend sufficient time on this step or complete it incorrectly thereby ensuring an unsuccessful project completion.
- Poorly defined goals and objectives, or goals without objectives, pushes a project into overruns, territory battles, personality clashes, missed milestones, and unhappy clients.
- Goals and objectives must be clear statements of purpose. Each with its own purpose that drives the end result of the project. Goals and objectives MUST be measurable.

Project planning

Project planning is part of project management, which relates to the use of schedules such as Gantt charts to plan and subsequently report progress within the project environment. Initially, the project scope is defined and the appropriate methods for completing the project are determined.

A project is successful when the needs of the stakeholders have been met. A stakeholder is anybody directly or indirectly impacted by the project.

As a first step, it is important to identify the stakeholders in your project. It is not always easy to identify the stakeholders of a project, particularly those impacted indirectly. Examples of stakeholders are:

- The project sponsor
- The customer who receives the deliverables
- The users of the project outputs
- The project manager and project team

The key to effective project control is to measure actual progress and compare it to planned progress on a timely and regular basis and to take required corrective action immediately. Establish a regular reporting period. During each reporting period, collect: data on actual performance information on any changes to project scope, schedule and budget. Changes mean a new plan must be established.

Project monitoring

Monitoring can be defined as the set of procedures and management practices used to collect information about the performance achieved or forecasted in a project, based on a set of performance metrics. Monitoring includes performance analysis of the project, which is the process of determining performance variances based on monitored and forecasted performance. Control adjusts the project to meet its initial goals by analyzing the causes of performance problems, designing changes to address problems that are determined to need attentions, and implementing those changes through control actions

A typical control process, which has the following ten steps:

Determine the most recently approved version of the execution plan.

- Collect current status information for open work packages.
- Collect estimates-to-complete for open work packages.
- Determine current and forecast variances from the plan.
- Determine the impact of variances to decide whether corrective action is required.
- Identify alternatives for corrective action.
- Select the preferred alternative.
- Secure necessary approvals and authorizations
- Update the plan
- Publish and distribute the revised plan.

19.5 MBWA- MANAGEMENT BY WALKING AROUND

Management by Walking Around, or what is known as MBWA, refers to a controlling technique in which the manager spends a significant amount of his time regularly in the work area, and interacts directly with the employees.

William Hewlett and David Packard, founders of Hewlett Packard (HP), famously used this approach in their company.

Management by walking around can be useful

a) In collecting intangible information about morale, operations, and the market place. It also helps provide context to the numbers.

b) Management by walking around is another important source of information.

c) Can identify trends, good or had, before they are reflected in the numbers.

d) Management by walking around can also help identify emerging trends for which measures have not yet been developed, Generates ideas for new and more relevant measures of performance.

e) This technique involves regular contact with front line workers, first line supervisors and customers.

19.6 PROJECT PERFORMANCE MEASUREMENT AND EVALUATION

Meaning: A process of assessing progress toward achieving predetermined goals, including information on the efficiency with which resources are transformed into goods and services (outputs), the quality of those outputs (how well they are delivered to clients and the extent to which clients are satisfied) and outcomes (the results of a program activity compared to its intended purpose), and the effectiveness of government operations in terms of their specific contributions to program objectives.

19.7 PROJECT PERFORMANCE MEASUREMENT: EARNED VALUE ANALYSIS

Now, the challenge here is to measure and forecast the project cost and time performance using monetary information. As discussed, the problem of traditional comparison between actual costs versus scheduled cost does not take into account the progress status of the project. Earned Value Analysis is an extremely effective way to overcome the problem. Earned Value Analysis (EVA) integrates cost, schedule, and work performed by ascribing monetary values to each. EVA is a method for measuring project performance. Earned Value Analysis is based on three key values:

1. BCWS (Budgeted Cost of Work Scheduled) is the planned cost of work scheduled to be accomplished in a given period of time;
2. ACWP (Actual Cost of Work Performed) is the cost actually incurred in accomplishing the work performed within the control time;
3. BCWP (Budgeted Cost of Work Performed) is called Earned Value. It is the budget value of the work actually performed within the control time.

19.8 APPROACHES TO PERFORMANCE MEASUREMENT OF PROJECT TEAM

Measuring team-related performance can be approached in at least four ways. Two of those approach measure performance at the individual level and two measure performance at the team level.

A. Individual Level: An Individual's Contribution to the Team

i. Individual Behavior. Employees can be measured on how well they work with team members. Examples of these types of measures could include the degree to which:

- the employee participates in team meetings;
- the employee volunteers for team projects;
- the employee communicates with members in a constructive and non-threatening manner;
- Other members find that the employee is pleasant to work with and fosters cooperation.

ii. Individual Results. Employee work products that contribute to the final team product or service can be assessed and verified. Examples of these types of measures could include

- Error rates,
- The timeliness of the product,
- The number of suggestions made,
- The accuracy of the data provided.

B. Team Level: Measuring the Team's Performance

i. The Team's Processes. The team can be measured on its internal group dynamics. These types of measures could address:

- how well the team works together as a group;
- the effectiveness of team meetings;
- the ability of the team to reach consensus; and
- the team's problem-solving techniques.

ii. The Team's Results. The team can be measured on its work results or products. These types of measures could include:

- the number of cases completed;
- the use, acceptance, and understandability of the team's final report;
- the number of customer requests for the team's report;
- the subscription rate of the team's newsletter.

These types of measures can be applied with the three types of performance elements that can be used in the performance appraisal process.

a. **A critical element is a work assignment or responsibility of such importance that unacceptable performance on the element would result in a determination that an employee's overall performance is unacceptable.**

Because critical elements are limited to addressing individual performance, only the individual level measures of contribution to the team and individual results could be used as critical elements.

b. **Non-critical elements can be a dimension or aspect of individual, team, or organizational performance that is measured and used in assigning a summary level.**

♦ In the past, "non-critical" meant "not as important." However, programs can be designed so that non-critical elements have as much weight or more weight than critical elements in determining the final summary level.

♦ Since it is only through non-critical elements that group or team level performance can be factored into an employee's summary level determination,

♦ Using non-critical elements can be a useful tool for setting group goals, planning group work, measuring group performance, and providing feedback on group performance.

c. **Additional performance elements address a dimension or aspect of individual, team, or organizational performance that is not used in determining summary levels.** Additional elements are used for various other purposes,

- such as setting goals,
- providing feedback on individual or group performance, and
- Recognizing individual or group achievements.

19.9 PROJECT QUALITY

1. A generic definition of quality is simply 'meeting the customer requirements
2. Quality is the consistent conformance to customer expectations
3. Basu (2004) proposes a three-dimensional model of quality is shown in diagrammatic form in Fig 3.2:

Figure: 3.2

Basu's organization quality dimensions

i. Top management commitment means that organizational quality cannot exist without the total commitment of the top executive team.

ii. Sales and operations planning is a monthly senior management review process to align strategic objectives with operation tasks.

iii. A single set of numbers provides the common business data for all functions in the company.

iv. Using tools and techniques relates to the fact that without the effective application of tools and techniques, the speed of improvement will not be assured.

v. Performance management includes the selection, measurement, monitoring and application of key performance indicators.

vi. Knowledge management includes education, training and development of employees, sharing of best practice and communication media.

vii. Teamwork culture requires that communications and teamwork should be practised in cross-functional teams to encourage a borderless organisation.

viii. Self-assessment enables a regular health check of all aspects of the organisation against a checklist or accepted assessment process such as that of the European Foundation of Quality Management (EFQM).

Wild's definition of quality

The quality of a product or service is the degree to which it satisfies customer requirements.

It is influenced by:

Design quality: the degree to which the specification of the product or service satisfies customers' requirements.

Process quality: The degree to which the product or service, which is made available to the customer, conforms to specification.

Project quality is the philosophy of the adherence of standards to fulfill acceptable delivery objectives throughout the life cycle of a project and there are three clear dimensions of project quality given by design quality, process quality and organisation quality.

The guidelines for the formal quality review in a project are useful and comprise three steps:

A) *Preparation:* where the project deliverable or product is measured against quality criteria contained in the product description and question lists are created.

B) *Review:* where the product is 'walked through' against question lists and follow-up actions are agreed.

C) *Follow-up:* where the identified errors in the product are fixed, agreed and signed off.

19.10 QUALITY PLANNING, QUALITY ASSURANCE, QUALITY AUDIT

Quality planning allows quality to be designed into the deliverables of the project before the first task has begun. It is therefore done during the development phase of the project life cycle. It may involve identifying standards or best practices. Design of experiments is one tool that identifies which variables will have the most influence on the final quality of a product.

Quality assurance is what must be done during the actual tasks to ensure that the standards identified during quality planning are met. It is therefore done during the implementation phase of the project life cycle. There are several tools available for a project manager to assure the quality of products.

One is **quality audits**, a structured review of quality with an eye towards improving performance. Another is **benchmarking**, comparing methods or products with others of recognized quality. Thus, a benchmark is not something created in the project, but something recognized by the project and used for comparison with products or methods in the project. Sometimes benchmarks may be recognized throughout an industry. Other times they may be identified uniquely for use in one particular project.

19.11 PREPARING FOR QUALITY AUDIT

Thorough procedures need to be defined, controlled, communicated and used.

Thorough	Procedures should cover all aspects of work where conformity and standards are required to achieve desired quality levels. For example, one might decide to control formal program testing, but leave the preliminary testing of a prototype to the programmer's discretion.
Procedures	Any recurring aspect of work could merit regulation. The style and depth of the description will vary according to needs and preferences, provided it is sufficiently clear to be followed.
Defined	A major tenet is that the defined procedures are good and will lead to the desired levels of quality. Considerable thought, consultation and trialing should be applied in order to define appropriate procedures. Procedures will often also require defined forms or software tools.
Controlled	As with any good quality management, the procedures should be properly controlled in terms of accessibility, version control, update authorities etc.
Communicated	All participants need to know about the defined procedures - which they exist, where to find them, what they cover. Quality reviewers are likely to check that team members understand about the procedures.
Used	The defined procedures should be followed. Checks will be made to ensure this is the case. A corrective action procedure will be applied to deal with shortcomings. Typically the corrective action would either be to learn the lesson for next time, or to re-work the item if it is sufficiently important.

19.12 CASE STUDY

HORIZON RESORT HOTELS

The Horizon Resort Hotel uses a proactive approach to controlling quality whenever it undertakes a project, because its intensive personalized service environment. 'Virtually all our changes to processes and systems, as well as improvements to our fabric are undertaken using project-based portfolio management techniques": says Lance New Operations Director. Systems for collecting and using quality related measures are widely deployed and used extensively throughout the hotel. For example, each hotel tracks a set of service quality indicators (SQls) on a daily basis throughout the project. The Horizon Resort recognizes that many customer requirements are sensory and thus difficult to measure. However, by selecting training and certifying employees in their knowledge of Horizon Resort Platinum Standard of service, the company is able to assess their projects through appropriate sensory measurements.

The company uses three types of control processes to deliver quality in their projects:

a. Self-control of individual employees based on their spontaneous and learned behavior.

b. A basic control mechanism carried out by every member the project team,' the first person to detect a problem is empowered to break away from routine duties, investigate and correct the problem immediately. Document the incident and then return to their routine.

c. An important success factor is controlling for critical processes. Process teams use customer and organizational requirement measurements to determine quality, dependability, speed and cost performance.

In addition, Horizon Resort conducts both self and outside audits. Self audits are carried cut internally at all levels, from one individual or function to an entire hotel throughout the execution of the project. Process walk-through occurs daily in hotels and senior leaders assess field operations during formal reviews at various intervals. Outside audits are performed by independent advisor organizations. All audits must be documented and any findings must be submitted to the senior project manager. The senior project managers are responsible for action and for assessing the implementation and effectiveness of recommended corrective actions to ensure that the project gets back on track.

1. What would be your criticisms of Horizon Resort Hotel's approach to quality assurance and quality control procedures?
2. Conversely, what redeeming features does it have?

19.13 NOTES

19.14 SUMMARY

Project controls are the data gathering, management and analytical processes used to predict, understand and constructively influence the time and cost outcomes of a project or program; through the communication of information in formats that assist effective management and decision making. The successful performance of a project depends on appropriate planning. The types of project control include formal and informal control. The project control process cycle includes project planning, project activity implementation, project performance measurement and assessment. The very first step in the process of project control is to define the project objective. Monitoring includes performance analysis of the project, which is the process of determining performance variances based on monitored and forecasted performance. Management by Walking Around, or what is known as MBWA, refers to a controlling technique in which the manager spends a significant amount of his time regularly in the work area, and interacts directly with the employees. EVA is a method for measuring project performance. Earned Value Analysis (EVA) integrates cost, schedule, and work performed by ascribing monetary values to each. Measuring team-related performance can be approached in at least four ways. Two of those approach measure performance at the individual level and two measure performance at the team level. Project quality is the philosophy of the adherence of standards to fulfill acceptable delivery objectives throughout the life cycle of a project and there are three clear dimensions of project quality given by design quality, process quality and organization quality. *Quality planning* allows quality to be designed into the deliverables of the project before the first task has begun. *Quality assurance* is what must be done during the actual tasks to ensure that the standards identified during quality planning are met. ***Quality audit*** *is* a structured review of quality with an eye towards improving performance. Thorough procedures need to be defined, controlled, communicated and used while performing quality audit.

19.15 KEY WORDS

1. **Project control**: are the data gathering, management and analytical processes used to predict, understand and constructively influence the time and cost outcomes of a project or program; through the communication of information in formats that assist effective management and decision making.
2. **Project planning**: is a phase stating how to complete a project within a certain timeframe, usually with defined stages, and with designated resources.

3. **MBWA- Management By Walking Around**: refers to a style of business management which involves managers wandering around, in an unstructured manner, through the workplace(s), at random, to check with employees, or equipment, about the status of ongoing work.

4. **Performance Measurement:** is the process of collecting, analyzing and/or reporting information regarding the performance of an individual, group, organization, system or component.

5. **EVA-Earned Value Analysis**: is an industry standard method of measuring a project's progress at any given point in time, forecasting its completion date and final cost, and analyzing variances in the schedule and budget as the project proceeds.

6. **Project Quality**: is the philosophy of the adherence of standards to fulfill acceptable delivery objectives throughout the life cycle of a project

7. **Quality Planning**: It is a process of ensuring quality at every developmental stage to satisfy the level of quality set by the client.

8. **Quality Assurance**: The planned and systematic activities implemented in a quality system so that quality requirements for a product or service will be fulfilled.

9. **Quality Audit**: a structured review of quality with an eye towards improving performance.

10. **Deliverables:** the end results of the project. The project outcome**.**

19.16 SELF ASSESSMENT QUESTIONS

1. Define project control.
2. What is the importance of project control?
3. What are the steps involved in project control process cycle?
4. Explain the project control process.
5. What is project planning?
6. What are the steps involved in typical control process?
7. What are the types of project control?
8. What is MBWA?
9. What is the relevance of MBWA?

10. What is performance measurement?

11. What is Earned Value Analysis?

12. How individual level and team level performance is assessed in project management?

13. Define project quality.

14. What are the dimensions of quality according to Basu?

15. How to prepare for quality audit?

16. Define quality planning.

17. Define quality assurance.

19.17 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.

2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.

3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.

4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.

5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill

6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011

7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002

8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012

9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.

10. Sanjiv Marwah. *Project Management.* New Delhi: Dreamtech Press, 2011.

UNIT - 20 : PROJECT CLOSURE & POST COMPLETION AUDIT

Structure :

19.0 Objectives

20.1 Introduction

20.2 Meaning of Project Closure and Project Closure Report

20.3 Objective of Project Closure

20.4 Preparation of checklists and after action reviews

20.5 Benefits of efficient project closure.

20.6 Benefits of project accomplishments and celebrations.

20.7 Post completion Audit

20.8 Objective of Post completion Audit

20.9 Who should do post completion audit?

20.10 Whether to share the findings of post completion audit?

20.11 Guidelines to auditors before and during post completion audit.

20.12 Case study

20.13 Notes

20.14 Summary

20.15 Keywords

20.16 Self assessment questions

20.17 References

20.0 OBJECTIVES

After reading this unit, you should be able to:

- define the project closing phase
- evaluate the benefits of project closure and acknowledging and celebrating project closure
- define and objectives of post completion audit.
- have clarity about who can perform post completion audit.
- find whether the post completion audit findings can be revealed
- discuss the guidelines to be followed before and after post completion audit by the audit team.

20.1 INTRODUCTION

This unit gives the short and clear picture about the project closure phase and post completion audit. The project will be ended meaningfully only when the project team starts assessing themselves in their work before closing the project. The project needs to be audited for better improvements in the task and reaching the fixed goals. With this background the unit guides you to understand how the project can be closed and what actually to be done before closure.

20.2 PROJECT CLOSURE AND CLOSURE REPORT

a. Meaning: Project closure is the last or end stage of project management. The stage of the project that begins with final delivery and ends with a project review.

- The project review is done through gate review meetings. Gate review meetings could result in the closure of life-cycle phase or the closure of entire project.
- There are two forms of closure pertinent to gate review meetings namely contractual and administrative closure Harold R Kerzner (2009).
- Contractual closure is the verification and signoff that all deliverables required for the phase have been completed and all action items have been fulfilled.
- Administrative closure is the updating of all pertinent recorder required for both the customer and the contractor.

b. Project Closure Report

A project closure report is a document which formalizes the closure of a project. It provides confirmation that the criteria for customer acceptance have been met and requests sign-off from the project sponsor to close the project.

i. A project closure report includes:

ii. A detailed list of project completion criteria,

iii. Confirmation that all completion criteria have been met,

iv. A list of outstanding business activities, risks and issues,

v. A set of actions to hand over project deliverables and documentation, terminate supplies agreements, release resources to the business and inform stakeholders of the closure;

vi. A request for project closure approval.

20.3 OBJECTIVE OF PROJECT CLOSURE

The objectives are to close the project to the satisfaction of all critical stakeholders and to learn the important lessons the project has taught the project team.

20.4 PREPARATION OF CHECKLISTS AND AFTER ACTION REVIEW

- The final phase of a project is typically hectic as the project staff hurry to complete final contract requirements.
- During this period, it is easy to forget important details and activities that are not directly and substantively related to the main project deliverables.
- When working with clients, a simple check-list is a very nice tool to make sure all the bases are covered in a project's closedown.
- As the project nears the end of the execution phase, all project leads should produce checklists for their own areas as well.
- The entire staff should participate with the construction of these checklists to minimize the risk of things being forgotten.
- One area requiring particular attention—simply because it is so often overlooked—is the administrative side of the project.

- Reports often need to be produced, presentations given, payroll and budgets finalized for the host organization, signatures attained, and the like.
- Meeting with clients personally should be high on a project leader's list, to make sure that they are satisfied with the project's deliverables.

The final act of closing a project is an after-action review, completed when the project has effectively closed down.

- In the military, **after-action reviews** and reports are a principal means for institutional learning make sure the lessons learned from the action can be applied in the future.
- Project leaders need to review the project once it has closed down to make sure they, too, have learned the lessons taught by the project.
- When decid-ing who will participate in such a review, project leaders should make sure that the exercise remains a constructive one, not an opportunity to vent about problems.
- Leaders should choose participants who can offer candor, insight, and a wide range of perspectives but who are also committed to learning, not advancing other agendas.

After-action reviews can cover a wide range of topics. Broadly consid-ering what was both successful and in need of future change can be a good start. Focusing on specific aspects of the project, including administrative and managerial issues as well as the technical work, can help confront issues normally overlooked.

Reviewing how well different staff performed in the project can help leaders in their future recruiting. Also, reviewing relationships with important stakeholders—where things went well and where improvements might be made—can help attend to any leftover ten-sions as well as help leaders deal with them more effectively in the future.

20.5 BENEFITS OF EFFICIENT PROJECT CLOSURE

- Project closure provides a unique opportunity for the project manager to capture and distribute the experience, skills and knowledge that have been developed during a project.
- This knowledge and intellectual capital should be captured and passed on to other project in the organization. So even though the project is complete, it can still contribute to the strategic objectives of the firm.
- A well planned project closure provides benefit to all the project stakeholders. For example, project closure has value for the client if it results in a thorough project record with easy to retrieve information.

- A good closure plan paves the way for the project team members' feelings of personal accomplishments.
- Items such as deliverables, project references, project resumes, project evaluations provided by the client, project write-ups, press releases and publication all help to provide tangible sense of personal satisfaction and recognition.

20.6 BENEFITS OF PROJECT ACCOMPLISHMENTS AND CELEBRATIONS

A. Recognize individual contributions.

1. Every person wants and needs to be acknowledged. Small acknowledgements of the good work performed result in large performance boosts.
2. Superior leaders give credit where credit is due and reap enormous benefits in the form of loyalty and even devotion.
3. Acknowledging performance demonstrates a caring spirit.
4. Individuals and teams react positively when they have proof that the leader cares how they perform.
5. The performance deteriorates when the individual or team feel that the leader does not care in acknowledging his/their performance.

B. Celebrate accomplishments

Timothy (2015) has identified the following benefits and qualities by celebrating accomplishments.

Challenge **E**nergize **L**imit **E**xert **B**elieve **R**ecognize **A**cknowledge **T**ransition **E**ase Stress

- When people are reminded for their recent accomplishments realize they just met a large **challenge** and are motivated to undertake new challenges.
- The team members are frequently **energize**d to finish the last few administrative chores so they are done.
- By recognizing their accomplishments, they are now ready to say "the project is over; we will **limit** any additional work on their project".
- The team members **exert** themselves to finish the last few items.
- Celebrations can persuade members to **believe** they can do just a bit more than they might otherwise think is possible.

- Celebrations are excellent times to **recognize** and **acknowledge** both efforts and results,
- Celebrations mark **transition** points as people leave one project and move on to another.
- Finally, celebrations of success **ease the stress** of working hard for a prolonged period of time trying to accomplish a project.

20.7 POST COMPLETION AUDIT

Meaning and Definition

- "Audit is generally defined as an examination of documents and results to find out whether they are in desired order". Thus post completion audit is an attempt at assessing the actual profile of the given project in terms of results vis-a-vis the intended profile besides focusing on whatever matters the senior management desires.
- Many authors have defined post completion audit in different ways. Some definitions and meanings are given below
- Murdich and Deming define "It is a check on whatever the planned benefits are being realized after the project has been operating for some period of time".
- Kohler defines "it is an audit at some point after the occurrence of a transaction or a group of transactions".
- Donald Istvan define " it is a study made to ascertain the actual performance results with those predicted in the proposal, and to take action regarding any differences between the two"

20.8 OBJECTIVES OF POST COMPLETION AUDIT

i. The post completion audit help the project team in their decision making regarding future actions that are necessary or expected in their project by providing required information.

ii. It aims at removing certain psychological and/or political impediments usually associated with asset control and abandonment.

iii. It creates psychological impact on the individuals proposing capital investments.

20.9 WHO SHOULD DO POST COMPLETION AUDIT?

A person or a team who would conduct the post completion audit need not be identified at the planning stage, but certain policy decisions must be taken before hand. The alternative policy decisions in these regard could be as given below.

a) The group that evaluates the project may conduct the post completion audit.

b) The project team may conduct.

c) Some other internal agency which is not associated with the project planning and implementation can conduct the post completion audit.

d) A team representing the planning group, execution group, and neutral members can be assigned the task.

e) An external agency can be entrusted with the task.

f) The task can be assigned to single person or to a team of persons.

g) The individual assigned with task should not be involved in the process of project implementation.

h) The managers who are associated with investment decisions are better than independent reviewers to perform post completion audit. Where the project can be assessed in an unbiased manner.

20.10 WHETHER TO SHARE THE FINDINGS OF POST COMPLETION AUDIT?

- This is very sensitive decisions to be taken by the higher management to whom the post completion audit report is submitted.
- It is not necessary that the findings of the post completion audit be shared with all concerned parties.
- The need and sensitivity of the matter must be taken into account while deciding on this issue.
- The morale of the project team may be badly affected if the post completion audit findings of the project are negative and shared with them.

- In such cases secrecy has to be maintained and at the same time action must be taken by the appropriate authority without disturbing the team spirit.
- The single senior officer who is not associated with the project should be involved in conducting the post completion audit.

20.11 GUIDELINES TO AUDITORS BEFORE AND DURING POST COMPLETION AUDIT

Post completion audit is many times, avoided by project managers because they fear that it is an attempt to identify their mistakes and punish them. Thus they avoid or at least do not support Post Completion Audit Team. Some important guidelines should be taken care of before and during the project audit. They are

a) It should be communicated to the project team that it is not an exercise to highlight their mistakes. It is an attempt to improve future implementation.

b) While project auditing, instead of identifying the individuals, and making them responsible for any action leading to delay or overrun project issues should be highlighted.

c) Audit process should be completed as early as possible.

d) The project team members should never be threatened.

e) It is necessary to have third part audit to avoid personal bias and willingness to hear and learn.

f) Should highlight the corrective measures more than mistakes committed.

20.12 CASE STUDY

Closing Projects at Global Green Books Publishing

Global Green Books Publishing is continuing to grow. The customized e-Books line of work is continuing to grow, and they now have a lot of experience from the eBook projects that they have completed for their first eBook customer, a local college, and for their newer customers.

However, as new projects come in and start to run into problems, some of the project managers in the project management office and their manager, Samantha, were discussing how it seems like it is déjà vu all over again – some of the same problems that they thought they had solved in working with supervisors and their teams on past projects keep on occurring.

The eBook projects are functioning well, and customers are happy with the results. Repeat orders are coming in and new customers are turning to Global Green Books for their eBook production needs.

But, there are just some problems that seem to keep popping up. One of the project managers even described dealing with these problems as being like playing the popular arcade game of "Whack-a-Mole" - as soon as you deal with one to make it disappear, the same one or another one just pops up. It seems like a never-ending struggle to try and solve some of these problems, especially when some seem like they were already solved on another earlier project.

In the PM handbook that Samantha had implemented, when projects completed the supervisors finished tracking all of the actual effort and costs and turned that information over to cost accounting for billing purposes. As Samantha and colleagues implemented the project management office, they modified the PM manual to have a copy of this information also shared with the project management office. They have found this information to be sometimes useful as historical data to help develop estimates for new projects as requests for new eBooks come in from their customers.

The PMO team was discussing making changes to the PM manual and holding a short training for supervisors to implement some improvements to their project completion processes. They wanted to change their standard job template to incorporate these additions:

a. a planned task for supervisors to close out the project,

b. a task to create a lessons learned report, and

c. an optional task for a closing celebration for the team to mark the end of the project,

They felt that it was important that the PMO start capturing lessons learned. These could be collated by the supervisors at the end of the project, or they could encourage supervisors to plan, schedule and hold a project closing meeting with their team members to thank the team members and to collect lessons learned from all of the team. They could also invite feedback or participation from the relevant Customer Service Representatives and account managers.

The PMO received management approval for these changes, updated the PM manual, and held a brief training for supervisors. Supervisors liked the ideas, especially because the close-out meeting or team celebration would give them a chance to recognize and reward team members and would serve to motivate the teams for future projects. As time went on, the PMO started collecting these lessons learned from many projects.

As they collected these lessons learned from these projects, the PMO staff started to look at the data from the lessons learned across the projects. They examined frequency of the six kinds of issues that were being encountered on the projects. The histogram below shows their results.

Based on feedback from the leadership training that they had done with the supervisors, they had thought that the major cause of delays and extra costs on projects were part-time student employees calling off from work at the last minute, leaving planned work not performed until another resource could be assigned to it, which was often difficult as there were few slack resources. This made tasks late and sometimes delayed projects from completing on time.

Their analysis showed that that wasn't the case at all. In fact only three of the problems on projects were caused by unplanned absences. In their Pareto analysis, the PMO staff identified three key problems, which they highlighted in red. Delays in obtaining necessary reprint permissions from certain publishers were the largest cause of problems, accounting for 34% of the problems encountered by eBook projects. Production staff calling in sick was the next most frequent problem, accounting for 28% of the problems. Customer changes, which often caused rework and delays, were the root cause of another 20% of the problems.

The PMO now knew what the most important issues were that were causing eBook projects to be delayed, and could make recommendations to mitigate each of these problems.

Comment on the following aspects of the case study:

a) What are some of the reasons why it is important to close out a project? What can project managers accomplish in closing out a project?

b) Why should projects capture lessons learned? What are some ways that the project team members, project managers and the organization can use lessons learned?

c) What benefits come from celebrating project accomplishments? Do you believe that rewards and recognition can serve as motivators for staff?

d) Explain what a Pareto chart is. Why would you use this technique to identify and prioritize problem areas? Are there some limitations on interpreting the results of a Pareto analysis?

e) If you were the PMO looking at this Pareto analysis, what recommendations might you make to address the three key problem areas in eBook projects that this analysis identified?

Note: A Pareto chart is a bar graph. The lengths of the bars represent frequency or cost (time or money), and are arranged with longest bars on the left and the shortest to the right. In this way the chart visually depicts which situations are more significant.

20.13 NOTES

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20.14 SUMMARY

Project closure is the final stage of the project. It helps the project team in their future projects by applying the continuous learning principal. The project closure is done by gate review meetings. The project closure includes contractual and administrative closure. The efficient project closure is needed for successful completion of the project. The project closure report and after action reviews helps in performing the task of project closure in an effective manner. The post completion audit help the project team in their decision making regarding future actions that are necessary or expected in their project by providing required information. There is a need of certain guidelines to be followed by the post completion audit team to avoid biased results of the report. The successful project has to be identified, acknowledged and celebrated which is the essential part of project closure tasks. The project team can be motivated through awards and rewards.

20.15 KEY WORDS

1. **Project closure:** The stage of the project that begins with final delivery and ends with a project review.
2. **Gate review meeting:** The meetings which result in the closure of life-cycle phase or the closure of entire project.
3. **Contractual closure:** the verification and signoff that all deliverables required for the phase have been completed and all action items have been fulfilled.
4. **Administrative closure:** the updating of all pertinent recorder required for both the customer and the contractor.
5. **After action review:** A process used by a team to capture the lessons learned from past successes and failures, with the goal of improving future performance
6. **Project closure report:** A project closure report is a document which formalizes the closure of a project.
7. **Post completion audit:** is an attempt at assessing the actual profile of the given project in terms of results.

20.16 SELF ASSESSMENT QUESTIONS

1. *Why the project needs to be closed?*
2. *What is gate review meeting?*
3. *What are the forms of project closure?*
4. *What does project closure report includes?*
5. *What is after action reviews?*
6. *What are the benefits of efficient project closure?*
7. *Define post completion audit.*
8. *What are the objectives of post completion audit?*
9. *Who performs the post completion audit?*
10. *Whether the findings of post completion audit is shared and how?*
11. *What are the guidelines for auditing team to be considered while doing post completion audit?*
12. *What do you do after you successfully complete a major project?*

20.17 REFERENCES

1. Clifford F. Gray and Erik W. Larson, *Project Management*, Tata McGraw Hill,New Delhi, 2007.
2. Gobalakrishnan, P. & V.E. Ramamoorthy, *Project Management*, MacMillanIndia Ltd, New Delhi, 2006.
3. Nagarajan, K., *Project Management*, New Age International Publishers,New Delhi, 2007.
4. Prasanna Chandra, *Projects*, Tata McGraw Hill, New Delhi, 2007.
5. Bruce T. Barkley, Sr. Integrated Project Management, Tata McGraw Hill
6. Rajeev M.Gupta, *Project Management*, PHI Learning Limited,2011
7. JackR. Meredith, Samuel, Mantel,JR. *Project Management-A Managerial Approach*, Wiley, Fifth Edition ,2002
8. Timothy J. Kloppenborg. *Contemporary Project Management*. Delhi: CENGAGE Learning. 2012
9. Subhash Chandra Das. *Project Management*. New Delhi: PHI Leaning (p) Ltd. 2012.
10. Sanjiv Marwah. *Project Management*. New Delhi: Dreamtech Press, 2011.