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T.E. (E&Tc) Semester - VI

PROJECT MANAGEMENT

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PREFACE

The importance of **Project Management** is well known in various engineering fields. Overwhelming response to our books on various subjects inspired us to write this book. The book is structured to cover the key aspects of the subject **Project Management.**

The book uses plain, lucid language to explain fundamentals of this subject. The book provides logical method of explaining various complicated concepts and stepwise methods to explain the important topics. Each chapter is well supported with necessary illustrations, practical examples and solved problems. All the chapters in the book are arranged in a proper sequence that permits each topic to build upon earlier studies. All care has been taken to make students comfortable in understanding the basic concepts of the subject.

Representative questions have been added at the end of each chapter to help the students in picking important points from that chapter.

The book not only covers the entire scope of the subject but explains the philosophy of the subject. This makes the understanding of this subject more clear and makes it more interesting. The book will be very useful not only to the students but also to the subject teachers. The students have to omit nothing and possibly have to cover nothing more.

We wish to express our profound thanks to all those who helped in making this book a reality. Much needed moral support and encouragement is provided on numerous occasions by our whole family. We wish to thank the **Publisher** and the entire team of **Technical Publications** who have taken immense pain to get this book in time with quality printing.

Any suggestion for the improvement of the book will be acknowledged and well appreciated.

Authors
Rana S. Mahajan
Dr. Dipak P. Patil
Dr. Manoj V. Bhalerao

Dedicated to all Family Members, Friends and God.

SYLLABUS

Project Management - (304193)

Credit :	Examination Scheme :
03	In-Sem (Theory) : 30 Marks End-Sem (Theory) : 70 Marks

Unit I Fundamentals of Project Management

Basics of Project Management : Definition of Project, The Project Life Cycle, Definition of project management, Need of Project management, Project Management process and its importance, The Project Manager (PM), Phases of Project Management Life Cycle, Project Management Processes, Impact of Delays in Project Completions, Essentials of Project Management Philosophy, Project Management Principles. **(Chapter - 1)**

Unit II Project Identification, Selection & Planning

Project Identification and Selection : Introduction, Project Identification Process, Project Initiation, Pre-Feasibility Study, Feasibility Studies, Project Break-even point.

Project Planning : Introduction and need for Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS). **(Chapter - 2)**

Unit III Project Organizational structure & Issues

Organizational Structure and Organizational Issues : Introduction, Concept of Organizational Structure, Roles and Responsibilities of Project Leader, Relationship between Project Manager and Line Manager, Leadership Styles for Project Managers, Conflict Resolution, Team Management and Diversity Management, Change management. **(Chapter - 3)**

Unit IV Project Scheduling

PERT and CPM : Introduction, Development of Project Network, Time Estimation, Determination of the Critical Path, PERT Model, Measures of variability, CPM Model, Network Cost System.

Resources Considerations in Projects : Introduction, Resource Allocation, Scheduling, Project Cost Estimate and Budgets, Cost Forecasts. **(Chapter - 4)**

Unit V Project Risk & Financial Management

Project Risk Management : Introduction, Risk, Risk Management, Role of Risk Management in Overall Project Management, Steps in Risk Management, Risk Identification, Risk Analysis, Reducing Risks.

Introduction to Project Management Tools such as : Trello, JIRA and Asana.

Financial Management in Projects : Project Finance structure, Process of Project Financial Management : Conducting Feasibility Studies, Planning the Project Finance, Arranging the Financial Package, Controlling the Financial Package, Controlling Financial Risk, Options Models. **(Chapter - 5)**

Unit VI Product Development & Entrepreneurship

Product Development : Introduction, Development Process and organizations, product planning, identifying customer needs, Product Significations, concept generation, selection, testing, Design for Manufacturing, Prototyping, Robust Design.

Entrepreneurship : Concept, knowledge, and skills requirement; characteristic of successful entrepreneurs; entrepreneurship process; factors impacting emergence of entrepreneurship.

Legal issues related to Product development and Entrepreneurship : Intellectual property rights-patents, trademarks, copyrights, trade secrets, licensing, franchising. **(Chapter - 6)**

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UNIT I

1 Fundamentals of Project Management

Syllabus

Basics of Project Management : *Definition of Project, The Project Life Cycle, Definition of project management, Need of Project management, Project Management process and its importance, The Project Manager (PM), Phases of Project Management Life Cycle, Project Management Processes, Impact of Delays in Project Completions, Essentials of Project Management Philosophy, Project Management Principles.*

Contents

1.1 Definition of Project

- A project is a collection of tasks that must be completed in order to achieve a specific goal or result. These activities may be simple or complex, depending on the project's size and scope, but all projects can be broken down into objectives and what needs to be done to fulfill them.

1.2 The Project Life Cycle

- Projects are frequently organized into five project phases, each of which has its own set of activities, objectives and deadlines. By breaking down a project into phases, teams can stay on track throughout its full life cycle.

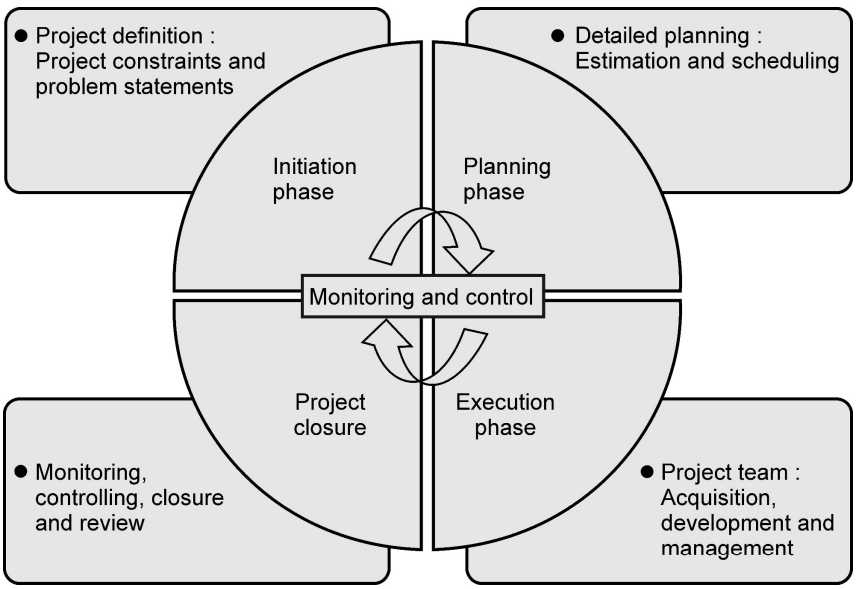

Fig 1.2.1 The project life cycle

- The Fig 1.2.1 shows the project life cycle in which the following phases are involved
  1. Initiation phase
  2. Planning phase
  3. Execution phase
  4. Monitoring and control phase
  5. Closing phase

1. Initiation phase

- Project initiation is the first stage of a project's life cycle. A project is formally launched here. It is given a name, and a broad strategy is laid out. The project's

constraints, hazards, and stakeholders are all recognised, as well as the project's goals. Shareholders must now decide whether they would like to invest or not in the project.

- Studies may be undertaken to determine the project's feasibility, depending on the project. Requirements are typically obtained and reviewed during the initiation phase of projects.

2. Planning

- During the planning step, a roadmap is created that will take teams from the creation of a project plan to the project's execution and closure phases. There must be deadlines specified and resources allocated. It is easier to manage project risks, costs, quality, time, and other factors when jobs are broken down into smaller, manageable operations.
- Simultaneously, breaking down duties into smaller portions will enable everyone involved to complete the project on schedule and on budget.

3. Execution phase

- During the project execution phase, the project plan is implemented. Teams will work on the deliverables at this time to ensure that the project satisfies the requirements.
- Everyone generally joins for a meeting to mark the project's official start, where teams may get to know one another and discuss their roles in the project's success. Before the project plan is implemented, communication modes and project management tools are identified.
- Furthermore, team members become familiar with the required status, regular meetings and reports that will be held during this phase to collect project data. The project execution phase is important in the life cycle of a project because it determines whether everyone's efforts will be profitable or not in the end.

4. Monitoring and control phase

- The project monitoring and control phase occurs simultaneously with the execution phase. The project manager's role is to monitor operations and ensure that everything is going according to plan.
- Project managers must monitor resources, manage risks, lead status meetings, and prepare reports, among other things, in addition to managing the project's performance. If unexpected problems occur, the project manager may also need to make changes to the plans and the schedule.

5. Closing phase

- The project closing phase, which comes at the end of the project management life cycle, isn't as easy as used in the result. During the project closing phase, project managers must keep track of all outcomes, organize records in a single environment, and hand over the project to the client or the team responsible to manage its operations.
- This is not because, but teams meet for a final meeting to review the points they've gathered and to appreciate each member's efforts.

1.3 Definition of Project Management

- **Project Management** is the systematic working relationships with skills, knowledge, tools and systems, and leading resources to achieve the project goals and objectives by managing and regulating the project scope of work with available resources. The project management work process consists of initiating, planning, execution (implementation, monitoring, and controlling), and close-out in order to successfully finish the project by minimizing risks through efficient resource and information management, and optimizing company interests.
- **Project** is described as a planned activity or assignment that is completed within the agreed-upon time period, budget, and other resources to provide a committed product or service, usually with predefined objectives. The Project is a one-of-a-kind initiative with its own set of deadlines, resources, methods, and conditions. In order to achieve the specific goals for the entire project life cycle : initiation, planning, execution (implementation, controlling, and monitoring), and close-out activities, the project is executed by a team-work and systematic operation in internal and external organizations rather than individual work.
- **Management** is the action of managing and controlling resources (people, money, time, technology, procedure, etc.) efficiently and effectively in order to achieve defined objectives and goals in an organisation. Development of team objectives and goals, detailed execution plan and procedures, and coordination with internal and external partners are all part of management. The study of low efficiency and failures of certain enterprises done by the English statesman Sir Thomas More in the 16th century gave rise to current management practices (1478-1535). Management is also an academic field and a social science with the goal of studying social organizations.

1.4 Need of Project Management

Project management is used by organizations to create results that are measured, targeted, and predictable. Complex plans are kept structured by project management methods, which keep all parties involved aligned and focused on certain roles and duties. Project management is used by organizations for the following reasons :

- Project management establishes a focal point.
- Project management promotes quality management.
- Project management maintains risks to a minimum.
- Project management maintains project costs under control.
- Project management promotes teamwork.
- Project management uses all the available resources.
- Project management helps in learning.

Project management establishes a focal point

- Companies sometimes find it difficult to manage projects, especially those that continues for months or years. Project management is based on establishing a project's scope and assigning specified deadlines to each activity. Companies can keep focused on the aim and deadlines if they have a clear outline and strict deadlines.
- e.g. You're a member of a project team for a software firm that specializes in customizing solutions for the hospitality industry. A hotel wants your company to develop an integrated software solution that can be used by all workers. To determine the scope, your project manager gathers a team meeting. You continue working the system's requirements, such as visitor tracking, turnover rate, and billing, among others. Your team sets the length of each task based on these needs. This scope will keep you on target during the project.

Project management promotes quality management

- Delivering a high-quality project on time and in full is the most important aspect of project management. A project manager keeps a tight eye on their team's progress and quality of work in order to achieve a successful project. A project manager will observe their team's work, detect any possible quality issues, and come up with workable solutions.
- e.g Your project manager will conduct daily meetings and weekly individual team member sessions to monitor the project's progress throughout the hotel management system project. They also audit the quality of your team's work by

taking samples and getting them analyzed by individuals outside of your team. Your teammates provide essential input and a fresh perspective on the quality of your work, encouraging your team to improve.

Project management maintains risks to a minimum

- The first phase of project management involves deciding whether a projects claims its benefits. If an organization decides to continue with a project, project managers will review potential risks on a regular basis and develop strategies to mitigate them. Fewer risks ensure that the project is completed on time and on budget.
- e.g. You and your project manager realize during the execution phase that there may be a problem merging the hotel's current software solution with your new one. They hold a unique session where your project team formulates different solution options to remove this risk. Your project manager chooses the solution that provides the least risk to the rest of the project after analyzing all of the options.

Project management maintains project costs under control

- Project managers and stakeholders establish a budget for the project during the planning phase. Project managers can save money by knowing exactly how much they can spend on resources if they have a proper budget. Furthermore, if an organization has established successful project management phases, the methods can be reused in future projects.
- e.g. Each day, your project manager spends a portion of his or her time comparing the project's current cost to the budget. They ensure that the project does not go over budget by evaluating this information on a daily basis.
- The hotel owner also mentioned that they might be interested in developing a tablet application for housekeepers. Your team will already have a basic template to work from if they wish to carry forward with the project.

Project management promotes teamwork

- During a project, collaboration is essential to achieving objectives. Effective cooperation helps groups to focus on each individual's talents, resulting in more efficient processes.
- e.g. Your team meets weekly to share ideas, in addition to your daily meeting and individual team member meetings with your project manager. Members of the team exchange fresh information with the rest of the team during this session. Individual problems are also presented by members in order for the community to come up with a common solution. You complete the meeting by having each participant appreciate the work or accomplishment of another member.

Project management uses all the available resources

- To help reduce project time and stay under budget, it is vital for a corporation to make the best use of its resources. Time and costs such as travel, tools, and materials can all be considered resources by a project team. A big component of project management is determining the resources required to execute a project and developing a strategy for utilizing them effectively. When a project is completed on time, team members can rapidly move on to other projects, maximizing the company's resources.
- e.g. Each week, you must record your hours in a time tracking system, including how many hours you spent on each task. The system then generates a report that your project manager evaluates at the start of each week to see if you're spending enough time on each activity and if the project will be completed on time.

Project management helps in learning

- Project management teams reflect on the project during the closure phase. They hold retrospective sessions after each project to examine the process, successes, and obstacles. Assessments are an excellent opportunity for team members to identify their strengths and areas for improvement.
- When the hotel accepts the project, your project manager calls a meeting. They begin the meeting by congratulating individual team members and highlighting their accomplishments. After that, members are invited to discuss their experiences and lessons learnt.
- You mention how well you documented your procedure so that others could see exactly what you did and how you accomplished it. The documenting procedure, on the other hand, took longer than planned, and you felt rushed at times. You want to set aside some time in the future to record your work.
- Thus, Project management is necessary because –
  a) a project needs significant investments that should not be misused;
  b) each project failure has a direct or indirect influence on society;
  c) avoid project failures.
  d) The scope of the project activities may vary.
  e) During the project's execution, the technology used may change.
  f) Negativity in project-related issues could have catastrophic effects.
  g) Economic conditions may have an impact on a project

1.5 Project Management Process and its Importance

- Every project will vary slightly, depending on what you're working on, what team you're on, and how your team members like to collaborate. But in general, there are five main project phases that occur during the project management process.(Refer section 1.8)

1.6 The Project Manager (PM)

- A project manager is the person responsible for planning and executing the project : he or she is in charge of managing the team and arranging the work. The project manager is usually a certified Project Management Professional (PMP) by the Project Management Institute in a more formal, structured organization and on larger, more complex projects (PMI).
- The project manager is not required to be certified in less formal organizations, such as a startup firm. Project managers are in charge of all project management procedures that occur during the project life cycle, including risk management, task management, and resource management, among others. In simple terms, they control the project's planning, execution, monitoring, and completion.
- Most project managers, on the other hand, have similar tasks and responsibilities. The following are some of the more classic project manager responsibilities :
  - **Scope management :** Determining the amount of effort required to execute project activities.
  - **Task management :** Organizing and identifying tasks as well as their outcomes.
  - **Resource management :** Making efficient use of people, capital, materials, and other resources
  - **Team management :** Assembling and directing a team.
  - **Schedule management :** Analyzing the duration of operations in order to develop a project schedule. The project status must be monitored once the execution phase starts in order to keep the schedule baseline up to date.
  - **Quality management :** Creating a quality policy for the project's output and putting quality assurance and quality control procedures in place.
  - **Cost management :** It involves estimating costs and putting together a budget.
  - **Risk management :** Identifying, monitoring, and minimizing project risk
  - **Stakeholder management :** Meeting stakeholders' expectations and engaging with them throughout the project life cycle

- **Project risk management :** It identifies, monitoring, and reducing project risk.
- **Status reporting :** Creating reports and other documents to track and monitor progress and performance.

- The Project Management Institute (PMI), which has defined standards in the Project Management Book of Knowledge, teaches and certifies project managers (PMBOK). Although the PMI's Project Management Professional (PMP) certification is the industry standard for project managers, the PMI also offers more specialized training options such as Program Management Professional (PgMP) and Portfolio Management Professional (PMP) (PfMP).

1.7 Phases of Project Management Life Cycle

- The various phases in project management life cycle are
  - Analysis and evaluation
  - Marketing
  - Design
  - Inspecting, testing and delivery
  - Post completion analysis

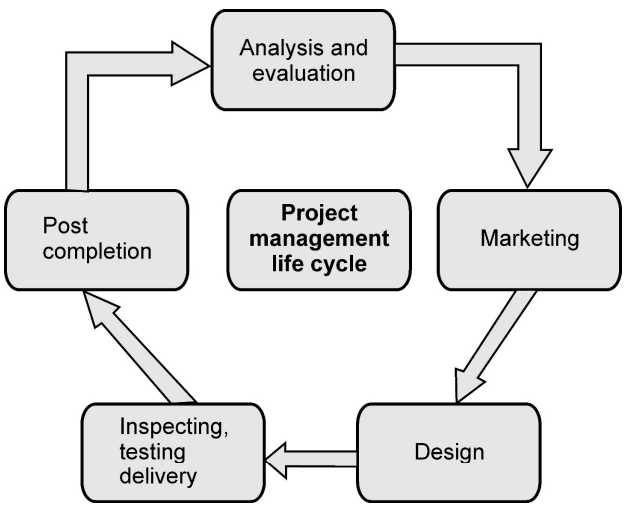

Fig.1.7.1 Project Management Cycle

Analysis and evaluation phase

- It begins with the client requesting that the matter be investigated. The project manager investigates the issue and presents a detailed report to upper

management. What the problem is, how to solve it, the goals to be accomplished, and the success rate of attaining the goal should all be included in the report.

- The tasks of this phase are as follows :
  - **Specification Requirements Analysis (SRA) :** It must be carried out in order to determine the project's essential requirements for attaining the goal.
  - **Feasibility study :** To determine whether the project is technically, economically, and practically feasible to undergo.
  - **Tradeoff analysis :** To evaluate and investigate the many options that could be explored.
  - **Estimation :** Estimate the project's cost, time, and effort, as well as the functionality of the project's various processes.
  - **System design :** Select a basic design that meets the requirements.
  - **Project evaluation :** Assess the project in terms of estimated profits, costs, and hazards.

Marketing phase

- A group of persons, including the project manager, creates a project proposal.
- This proposal must include the marketing methods used to advertise the product to customers.

Design phase

Inputs received

- Project feasibility study
- Preliminary project evaluation
- Project proposal
- Customer interviews

Outputs produced

- System design specification
- Program functional specification
- Program design specification
- Project plan

Inspecting, testing and delivery phase

- The project team works under the direction of the project manager during this phase.

- The project manager must ensure that the team under his supervision accurately implements the project designs.
- The project has to be tracked or monitored through its cost, manpower and schedule.
- Managing the customer
- Marketing the future work
- Perform quality control work

Post completion analysis phase

- The staff performance has to be examine
- Document the lessons from the project
- Project feedback analysis
- Project execution report
- Analysis of the problems encountered during the project

1.8 Project Management Processes

- Project management consists of the following interacting processes organized in groups.
  A. Project processes
  B. Process groups
  C. Process interactions
  D. Customization

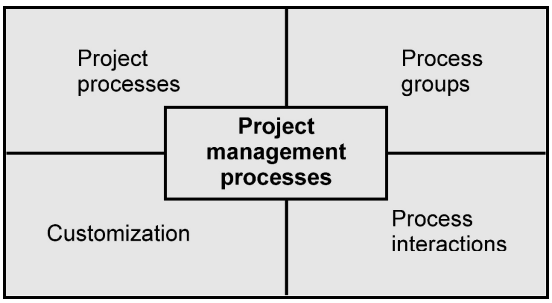

Fig.1.8.1 Project management process

A. Project processes

- A project process is a series of activities to achieve the target. Project process is classified into two main categories :
  a) Project management process - The organization defines the project management process. It defines and coordinates the project's work.

b) **Product oriented process -** The life cycle defines a product-oriented process. It defines and produces items as well as associated works.

B. Process groups

- It consists of the following
  - a) **Initiating processes :** It recognizes to start and establishing commitment.
  - b) **Planning processes :** It devising and maintaining a workable scheme to accomplish the business need.
  - c) **Executing processes :** It coordinating people to carry out the plan
  - d) **Controlling processes :** It monitoring and measuring progress and taking remedial action
  - e) **Closing processes :** It formalizing acceptance and bringing projects to an orderly end.

C. Process interactions

- The individual processes are linked by inputs and outputs
  - **Inputs :** It refers to the client documents converted to action plans to be acted upon.
  - **Tools and techniques :** It refers to the mechanisms applied on to the inputs to create desired outputs
  - **Outputs :** It refers to the documents that are results of the process.

Process interactions initiating processes

- Every process is initiated by a management group decision which results in the next phase of the project.

I. Planning processes

- Planning has the major importance
- Plans are nothing planning is everything
- Planning processes are highly interdependent
- If the cost is unacceptable, scope and time may need to be redefined

II. Executing processes

- Interactions depend on the nature of the work
- They are dynamic and dependent on team innovations

III. Controlling processes

- Measuring project performance [time, cost, quality]
- Identifying variances from the plan
- Updating project plans
- Taking corrective action

IV. Closing processes

- Review of the project
- Findings
- Analysis of the project performance with respect to various processes

D. Customization

- Large projects may need details. A detailed project management plan might be necessary to indicate every detail in the initial stages.
- Smaller projects may need relatively less details. A detailed plan may not be required in the initial stages.
- Process details might change for other reasons. Resource identification might be required for scope definition.

1.9 Impact of Delays in Project Completions

1.9.1 Causes of Project Delays

- The reasons for delays in projects generally vary from case to case. One or more of the following factors can lead a project to fail.

a) Probability of project failure :

- Projects are being started at all levels at random.
- The project's goal isn't linked with the corporate goals.
- No evidence of project management
- A project manager who has never worked on a project like this before.
- A team that is not even dedicated
- Clients' lack of full support

b) Factors that contribute to project success are not mentioned :

- The project's goal is linked with the corporate goals.
- Working within a project management framework

- Quality-focused scoping, planning, estimation, execution, controls, and reviews, as well as closing.
- Taking a proactive approach to resolving project bottlenecks
- Effective communication and expectation management with clients, team members, and stakeholders
- A project manager who has worked on a project like this before.

c) Projects involving Information and Communication Technologies (ICT) :

- Utilize information and communication technology such as the Internet, email, fiber optics, and satellites.
- Enable societies to produce, access, adapt, and apply knowledge in greater quantities, at lower prices, in a faster and more efficient manner.
- Provide tremendous opportunity to improve business and economic viability.

d) Issues that frequently arise throughout projects :

- From an organizational point of view, there is no priority of project work.
- Mismanagement of one or more project stages.
- Insufficiently qualified/dedicated manpower
- There isn't a smooth flow of communication between the people concerned.

1.9.2 Impact of Project Delays

- Project delays result in several of the challenges, some of which aren't immediately clear.
- Project expenses rise over time of delays. Every day you're late means you'll have to pay for staff and other resources that weren't budgeted for. After all, time is money. However, there are other charges to consider.
- That's why project time management is so important in project management.
- Delays are expensive for all parties involved, and they frequently lead to disagreements, cost overruns, arbitration, litigation, total project abandonment, and project infeasibility.
- When a project is postponed, finance expenses grow, and the project fails to deliver the expected revenue. Some of these disadvantages can be mitigated because, while some portions of the project may be delayed, others may be ready for service and income generating.
- Your company's reputation with customers and other stakeholders, as well as your reputation with your employers, could be harmed. By tying up resources that are

needed elsewhere, if your project is late, you may cause delays in other projects. If the delay is severe enough, the project as a whole collapses, resulting in project failure.

1.10 Essentials of Project Management Philosophy

A) What is a project ?

A project may be stated as

- A programme of non-routine work bringing about a beneficial change
- At least one well-engaged sponsor with both appropriate authorities and resources to charter the project endeavor
- Has a start and an end date
- A diverse team assembled for the project.
- A well-defined scope of work
- Constrained by cost, time and quality

B) Project parameters for negotiation

- A team negotiates for one or more of these during the course of a project :
  - Set goals, cost, and timeline
  - Changes to scope, cost or schedules
  - Contract terms and conditions
  - Resources

C) How does project management "Add Value"?

- One or more of the following may be used to finish a project :
  - Missed deadlines
  - Overworked team
  - Wasted resources
  - Unfulfilled client functional requirements
  - Budget overruns
- The processes are framed by a good project management methodology. It gives project execution principles that considerably boost the project's chances of success and hence add value to the project. The following are some of the steps that make up excellent project management :
  - Define the project
  - Break it down into manageable tasks

- Obtain the appropriate and necessary resources
- Assemble a team to carry out the project work
- Plan the work and assign resources to the tasks
- Monitor and control the work
- Report progress to senior management and/or the project sponsor
- Close the project when it is finished
- Review it to ensure that the lessons learned and widely understood

1.11 Project Management Principles

- On a project, there are five dimensions that must be handled.
  a) Features
  b) Quality
  c) Cost
  d) Schedule
  e) Staff
- These dimensions are unrelated to each other. If you hire more people, your timeline may be compressed and your costs will rise. The compromises between these five aspects aren't straightforward. We must select which dimensions are crucial for each project and how to balance the others in order to meet the project's main goals. On any given project, each of the five dimensions can play one of three functions. A constraint, a driver, or a degree of freedom.
- The project's main goal is to create a driver. A barrier is a limiting factor that is outside the project team's control. A degree of freedom is any project dimension that is neither a driver nor a constraint.
- A limitation limits the project team's flexibility to a minimum. A driver has a low degree of flexibility and a degree of freedom that gives him or her more freedom in balancing one dimension against the others. One of the most significant aspects of this approach is that the relative priority of the dimensions be agreed in advance by the project team, customers, and management, regardless of which of the five dimensions turns out to be drivers or restraints on any individual project.
- A "Kiviat diagram" is a graphical representation of these points.
- A Kiviat diagram is a graph that allows us to draw a collection of normalized axes as an irregularly shaped polygon with numerous values (in this case, five). The

relative degree of flexibility of each dimension for a given project is indicated by the position of each point on its axis. It is displayed on a 0 - 10 arbitrary scale.

- A value of '0' indicates complete constraint, while a value of '10' indicates entire flexibility.
- In project management, the kiviat graph is a valuable tool for comparing the relative flexibility of the factors under consideration.

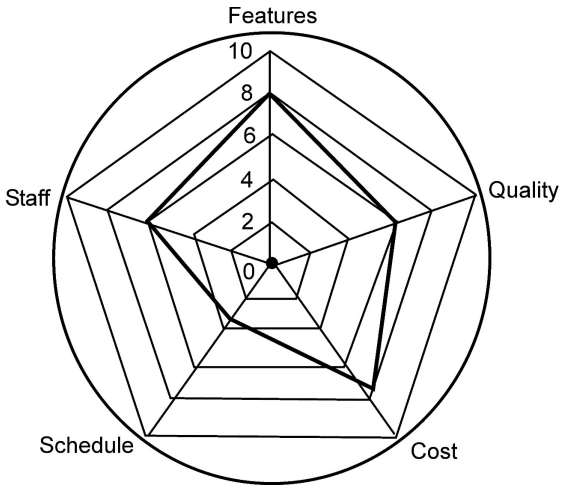

Fig.1.11.1 Project management principle

Review Questions

1. *Define project and explain project management*
2. *Explain project management life cycle.*
3. *What are the phases of project life cycle ?*
4. *What is project management*
5. *Explain the role of a project manager in detail.*
6. *Explain the responsibilities of a project manager in detail.*
7. *What is need of project management ?*
8. *Explain project management principle.*
9. *Explain project management processes.*
10. *Discuss on impact of delays in project completions.*
11. *Describe essentials of project management philosophy*

Multiple Choice Questions

Q.1 Which stage of project management life cycle requires the maximum time of completion

a Conceptualization b Planning

c Execution d Estimation

Q.2 In project management when does planning take place ?

a Before the project b During the project execution

c At the start of the project d After the project.

Q.3 Once the project is approved and moves into the planning stage, what happens in the next phase of the project life cycle ?

a Agreements for risk sharing need to be concluded.

b The total risk on the project typically reduces as activities are performed without loss.

c Risks must be weighed against the potential benefit of the project's success in order to decide if the project should be chosen.

d Risks are identified with each major group of activities.

Q.4 In the initial stage of the project the probability of completing the project is _____.

a zero b high

c low d medium

Q.5 Project manager must ensure that it develops appropriate trade off/s as _____.

a time, cost and performance

b time, value and performance

c men, materials and machines

d money, cost and return on investment

Q.6 Project management focuses on _____ goals.

a targeted b long - term

c tangible d intangible

Q.7 Which of the following is NOT a part of project management ?

a initiating b monitoring

c closing d all above are parts

Q.8 The basic nature of a project is a / an _____ one.

a permanent b temporary

c (a) or (b) d Both (a) and (b)

Q.9 Which of the following represents the correct project cycle ?

a Planning→Initiating→Executing→Closing

b Planning→Executing→Initiating→Closing

c Initiating→Planning→Executing→Closing

d Initiating→Executing→Planning→Closing

Q.10 The review of the successes and the mistakes is normally held during _____ phase.

a initiation b planning

c execution d closure

Q.11 The scope of the work is defined in which phase of the project management ?

a Initiating b Planning

c Executing d Closing

Q.12 If any one factor of a project changes, _____ other factor(s) is / are likely to be affected.

a all b one

c at least one d at most one

Q.13 Which of the following statement(s) is / are true about a project ?

I. It brings change

II. It has risk

III. The outcome is certain

a I only b II only

c I and II only d I, II, and III

Q.14 A program is usually a group of _____.

a plans b people and work

c related projects d unrelated projects

Q.15 How much value a project adds to the company is represented by _____.

a project benefits b net present value

c internal rate of return d none of these

Answer Keys for Multiple Choice Questions :

Q.1	c	**Q.2**	c	**Q.3**	d	**Q.4**	c
Q.5	a	**Q.6**	a	**Q.7**	d	**Q.8**	b
Q.9	c	**Q.10**	d	**Q.11**	a	**Q.12**	c
Q.13	c	**Q.14**	c	**Q.15**	b		

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Notes

UNIT II

2 Project Identification, Selection and Planning

Syllabus

Project Identification and Selection : *Introduction, Project Identification Process, Project Initiation, Pre-Feasibility Study, Feasibility Studies, Project Break-even point.*

Project Planning : *Introduction and need for Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS).*

Contents

2.1 Introduction

- The identification and selection of a project is a crucial phase in the project formulation process. These are designed with the goal of satisfying market demand, exploiting natural resources, or creating profit. Developmental project concepts are primarily derived from national planning processes, whereas industrial projects are typically based on the discovery of commercial prospects and profit potential.
- Because projects are a means of achieving certain goals, there may be multiple other projects that can help you achieve your goals. It is critical to list all other options that have been examined and justified in favour of the specific project under discussion.
- Sectoral studies, opportunity studies, support studies, and project identification fundamentally focus on screening a large number of project ideas that come up based on available information and data, as well as expert opinions, to come up with a small number of promising project possibilities.

2.1.1 Project Selection Criteria

- The decision maker should first determine the criteria for project selection. A project that works for one company or entrepreneur may not work for another. This is comprehensive list of several possible criterias for project selection are mentioned as under :

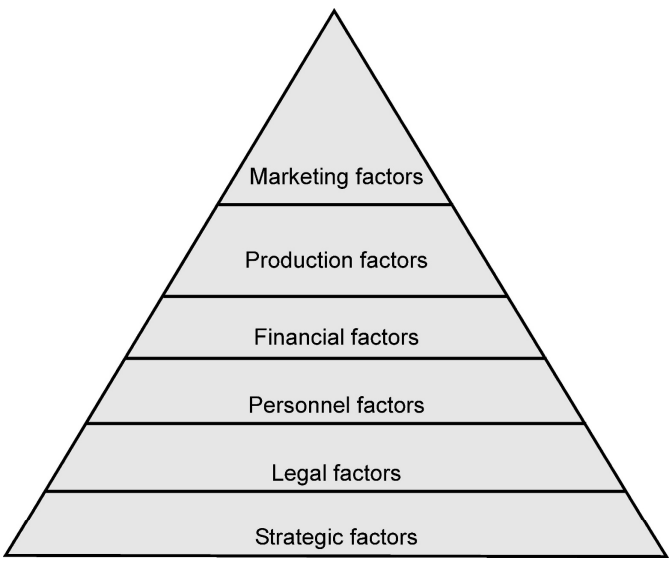


Fig. 2.1.1 Projection selection criteria

Marketing factors

- Size of potential market and focused customer segment
- Probability of extensions or expansion of market
- Export opportunity/import threat
- Customer acceptance
- Impact on current products
- Expected market share and current status of rival companies
- Time to achieve proposed market share
- Current stage of product life cycle.

Production factors

- Time to complete the project
- Availability of resources
- Flexibility of operations
- Connections with existing production lines
- Energy requirements and its sources
- Expected quality of the product or services
- Availability of technology and technology life cycle.

Financial factors

- Cost of project and means of sources
- Impact on current financial position of the firm
- Profitability in terms of profit margins and returns on investments
- Payback period
- Time period to reach the break even point
- Working capital needs.

Personnel factors

- Requirement of manpower and skills required
- Impact on existing employees
- Change in working environment
- Technical skill requirement.

Legal factors

- Government policies
- Patents and its protection
- Any other major legal complexity

Strategic factors

- Impact on the image of the company
- Acceptance by existing shareholders
- In line with long-term mission of the firm
- Ease to exit in the case of failure.

2.2 Project Identification Process

The main steps in the identification process of any project are :

i. Identify initial requirements.
ii. Validate them against the project objective.
iii. Identify the criteria for assessing the success of both the final project product and the process used to create it. Ex : Quality objectives, quantitative requirements for the project.
iv. Identify the framework of the solution.
v. Prepare a template of the framework of solution to illustrate the project feasibility.
vi. Prepare relevant charts to demonstrate the techniques of executing the project and its different stages.
vii. Prepare a proper project schema of achieving the defined business requirements for the project.
viii. Identify training requirement.
ix. Make a list of the training program necessary for the personnel working on the project.
x. Identify the training needs of the individuals working in various functions responsible in the project.
xi. Prepare a training plan and a training calendar.

2.3 Project Initiation

- The goal of project initiation is to examine potential initiatives and come to an agreement on which ones will be accepted. The project plan is provided during project start, and the strength of a project's strategic plan and the viability of the proposed solution are assessed. It is determined whether the project is in line with the organization's business and/or strategic plans and whether the project planning budget (high level) is reasonable.

- All required analysis is carried out at the start of the project to allow it to be planned. It normally involves a significant amount of time and money. Project initiation is considered to be a stage in and of itself, requiring formal authorisation to proceed as well as planning and budgeting as a phase of the project.
- The Project Initiation Document (PID) is the single most significant piece of documentation created at this point, and most likely throughout the project. If a business case exists, the Project Initiation Document builds on it using the information and analysis data gathered during the initiation activities.
- The following points should be included in a Project Initiation Document (PID) :
  - Detailed project goals and objectives, as well as the essential success factors that will be used to assess whether the expectations were achieved.
  - Details of the scope of the project in relation to the organization, functional areas and time as well as a statement about any related areas that are considered to be out of scope.
  - Identifying risks and any limits that may impact the project.
  - Any assumptions made regarding the project should be detailed. These assumptions could be based on the help you'll get from other areas of the organization or, if you're dealing with a third-party vendor, expectations about what they will deliver.

The project initiation document serves as the project's 'contract' (between the project manager and the project board)

It explains :

- Why is it critical to achieve it ?
- Who will be in charge of the process and what will their responsibilities be ?
- When and how will the project be completed ?

The PID must provide detailed answers to the above questions in order to retain project control.

2.4 Pre Feasibility Study

- A pre-feasibility study should be considered as a step between a project opportunity study and a full feasibility study, with the key distinction being the level of detail in the material gathered. It is the procedure for gathering information and comments on the project. This information is then scrutinized in order to determine whether the project concept is worth pursuing further. Pre-feasibility

studies focus on evaluating market potential, investment size, technological feasibility, financial analysis, risk analysis, and other factors. The scope and depth of pre feasibility are determined by the amount of time available and the decision maker's confidence. Pre-feasibility studies contribute in the creation of a project profile that can be presented to various stakeholders, including funding agencies, in order to get their support for the project. It also sheds light on project elements that are crucial in nature and require additional exploration through functional support studies.

- Before conducting a pre-feasibility or feasibility study for projects needing large-scale investments, support studies are conducted. These investigations are also included in the feasibility studies. They go through one or more key components of the project in depth. The Support Study's material varies depending on the study's type and the project in question. Because it concerns a critical part of the project, the conclusions must be clear enough to guide the next step of project planning.

2.5 Feasibility Studies

- The feasibility study is the foundation of project formulation, and it gives a balanced picture that includes all potential sources of worry. The study looks into the realities, methods for reaching objectives, strategy possibilities and methodology, as well as the likelihood of each course of action's outcome, risk, and consequences. It serves as the foundation for project description and logic, ensuring that the quality of following project activities is maintained. A well-designed research gives a strong support to make decisions, clarifying objectives, rational planning, minimizing risk, and completing a cost-effective project.
- Understanding the STEEP elements is necessary for assessing the feasibility of a proposal. These fall into the categories of social, technological, ecological, economic, and political factors.
- A feasibility study isn't a goal in itself but it seems to be simply a means to an investment decision. The variety of possibilities (about the choice of technology, plant capacity, location, funding and so on) and assumptions on which decisions are made might make preparing a feasibility study report complex. The feasibility studies for projects are focused on

A. Economic and market analysis
B. Technical analysis
C. Financial analysis
D. Economic benefits
E. Project risk and uncertainty
F. Management aspects.

A. Economic and market analysis

- Market analysis has undergone a paradigm shift in recent years. Extension of past patterns utilizing statistical tools and methodologies can no longer be used to estimate and project demand supply gaps for products and services. Multiple factors that influence the market must be considered. Demand forecasts must take into account all potential developments. Many initiatives have failed, not because of technological or financial issues, but because they ignored client requirements and market pressures, according to a review of projects completed over the years.
- A variety of elements must be examined while conducting a market study, including product specifications, pricing, distribution methods, trade practices, threat of replacements, domestic and foreign competition, export potential and so on. It should seek to provide an analysis of future market scenarios so that project investment decisions can be made objectively while keeping market risk and uncertainty in mind.

B. Technical analysis

- Technical analysis is based on product descriptions and specifications, as well as quality-control criteria. The study covers accessible alternative technologies, selecting the most appropriate technology based on the best combination of project components, the implications of technology purchase and license contract terms. Technical factors, such as project selection, are given special consideration. The technology adopted should also take into account the quality requirements of raw materials and other inputs, as well as ensuring that manufacturing costs are competitive. In a summary, the technical analysis consisted of the following aspects :

Technology
- Availability
- Alternatives
- Latest / state-of-art
- Other implications

Plant capacity
- Market demand
- Technological parameters

Inputs
- Raw materials
- Components
- Power
- Water
- Fuel
- Others

Availability skilled man power

Location

Logistics

Environmental consideration - pollution, etc.,

Requirement buildings/ foundation

Other relevant details

C. Financial analysis

- The Financial Analysis looks at the project's viability from a financial or commercial standpoint and calculates the return on investment. The following are some of the most often utilized financial analysis techniques :
  1. Pay-back period.
  2. Return on Investment (ROI)
  3. Net Present Value (NPV)
  4. Profitability Index(PI)/Benefit Cost Ratio
  5. Internal Rate of Return (IRR)

1. Pay-back Period :

- This is the most basic way and it determines how long it will take to return the initial project expenditure from the subsequent cash flow. It is calculated by multiplying the investment amount by the total of the annual returns (revenue - expenditure) until the capital cost is equal.

Example 1. (Uniform annual return)

- A farmer has invested about ₹ 20000/- in constructing a fish pond and get an annual net return of ₹ 5000/- (difference between annual income and expenditure). The payback period for the project is 4 years (20000/ 5000).

Example 2. (Varying annual return)

- In a project ₹ 1,00,000/- an initial investment of establishing a horticultural orchard. The annual cash flow is as under.

Time	Annual income	Annual expenditure	Annual return	Cumulative return
1st Year	60,000	30,000	30,000	30,000
2nd Year	70,000	30,000	40,000	70,000
3rd Year	85,000	25,000	60,000	1,30,000
Pay-back period = Two and half years				

- The disadvantage of this strategy is that it ignores any returns obtained after the payback period and assumes that income and expenditure have equal value independent of time.
- It's also possible that projects with a high return on investment beyond the pay-back period will not be given the attention they deserve, i.e., two projects with the same pay-back period, one with no return and the other with a large return after the pay-back period, will be treated equally, which is logically incorrect.

2. Return on Investment (ROI) :

- Return on Investment (ROI) is the annual return expressed as a percentage of the initial investment. It is calculated by dividing the annual return by the initial investment. When the return is uniform, the calculation is simple.
- For example, The ROI of fish ponds in above two cases is $(20000 / 4) = (5000 / 20000) \times 100 = 25$ %. The average of annual returns over a period is employed when the return is not uniform. The average return on a horticultural orchard is $(1,30,000/3) = 43333$. ROI = $(43333/100000) \times 100 = 43.3$ %.
- The calculation of ROI has the same limitations as the pay-back period. It does not distinguish between two projects, one of which yields an instant return (lift irrigation project) and the other of which yields a return after a gestation period of roughly 2-3 years (developing new variety of crop).
- Both the pay-back period and the Return on Investment (ROI) are simple measures of project viability that are better suited for quick evaluation of initiatives. These approaches should be combined with other discounted cash flow methods like Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit-Cost Ratio.

3. Net Present Value (NPV) :

- Net Present Value is one of the most essential metrics for determining a project's financial sustainability. The present value of the cost is calculated by adding the discounted values of the stream of investments in different years of project implementation (say C). Similarly, the present value of benefits is calculated by adding discounted returns (say B). The project's Net Present Value (NPV) is the difference between these two figures (B- C). For any project, a higher NPV value is always preferable.

4. Profitability Index (PI) / Benefit-Cost Ratio (B-C Ratio) :

- The B-C Ratio, commonly known as the Profitability Index (PI), is a measure of a project's profitability and is calculated as the ratio of total present value of returns to total present value of investments (B/C). The higher the ratio, the higher the return.

5. Internal Rate of Return (IRR) :

- The limit or rate of discount at which the project total present value of return (B) equals total present value of investments (C), i.e. B-C = Zero, is known as the Internal Rate of Return (IRR). In other words, it's the discount rate at which the project's Net Present Value (NPV) is zero. Iteration is used to calculate the IRR, which involves computing the NPV at various discount rates until the value is almost zero. Projects having a greater IRR are preferable.

D. Economic Benefits :

- The feasibility study examines the project's economic benefits in addition to its financial benefits (in terms of Return on Investment). Economic benefits include job creation, economic development of the project region, foreign exchange savings in the case of import substitutes or foreign exchange earnings in the case of export oriented projects, and others.

E. Project Risk and Uncertainty :

- Every project involves some level of risk and uncertainty. Risk is quantified and is linked to the occurrence of negative consequences. Probability of occurrences is used to analyze it. Uncertainty, on the other hand, relates to characteristics that are essentially unpredictable and is measured via sensitivity analysis. As a result, these aspects must be examined during the program's conception and evaluation phases. The following are the factors that contribute to a project's risk and uncertainty.

- Technical - relates to project scope, change in technology, quality and quantity of inputs, activity times, estimation errors etc.
- Economical- pertains to market, cost, competitive environment, change in policy, exchange rate etc.
- Socio-political- includes dimensions such as labor, stakeholders etc.
- Environmental - factors could be level of pollution, environmental degradation etc

F. Management Aspects :

- In project feasibility assessments, management considerations are becoming increasingly relevant. The management factors include the promoters' backgrounds, management philosophy, organization setup and staffing for both the project implementation and operating phases, decentralization and delegation, processes and procedures, execution method and accountability.

2.6 Project Break-even Point

2.6.1 Introduction

- The profitability forecasts or working-results estimates addressed in the prevision lesson are based on the assumption that the project would operate at a specific level of capacity utilization in the future. It is also useful to know that the level of operation should be avoided lasses, in addition to understanding that the expected profits would be at certain levels of capacity utilization. The break-even point, which refers to the level of operation at which losses should be avoided, is used for this reason. The break-even point, which refers to the level of operation at which the project neither produces profit nor loses, is estimated for this reason.
- The identification of a company's break-even point is crucial in determining its profitability. In a company, it serves as a crucial control and planning tool. It shows the relationship between total cost and total income for a certain output level. In most cases, an industrial unit's profit is determined by the product's selling price (revenue), the volume of business (which is determined by pricing) and the product's cost price.
- If an entrepreneur knows how much a product costs and how much it sells for, he may plan the amount of his sales to make a particular profit. The break-even point is defined as the volume of sales at which total costs and revenues are equal.

2.6.2 Break-Even Point

- The break-even threshold is an essential metric used by promotions and banks when determining the profitability of a new project, particularly in manufacturing. This method is handy when dealing with a new project or an existing unit's new activity.
- The Break-Even Point (BEP) is the level of output/production at which costs and revenues are equally divided. It is the point at which the unit's turnover just covers its fixed overheads and it begins to profit. The details of BEP is as shown in the Fig. 2.6.1.
- According to the banker, the project should break even within a fair amount of time after it begins production. Bankers see a project that reaches break-even quickly as a viable project since they can not only expect early payback of their advances, but they can also be certain that the project can reasonably adjust to changing technology on a day-to-day basis. The bankers will not consider projects that are unlikely to break even in the third or fourth year after production begins.
- The margin of safety, or the excess of budgeted or actual sales over the break-even sales, is determined using the break-even analysis so that bankers may estimate how project is sensitive to recession. This is a critical component in determining the project's feasibility and ability to weather economic ups and downs. As lenders of funds, bankers need a reasonable margin of safety to ensure that fixed costs are covered sooner rather than later.

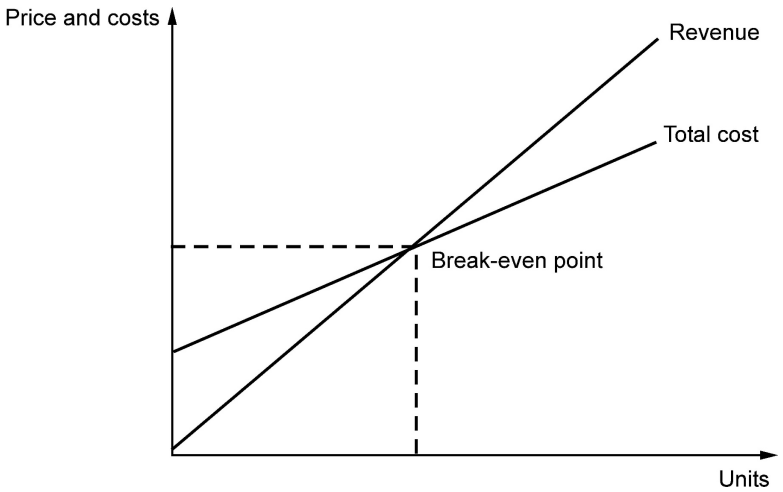


Fig. 2.6.1 Break even point

2.6.3 Calculation of BEP

- The costs are separated into two groups as a first step in calculating the break-even point that is fixed costs and variable costs, which can be described as follows :

Fixed cost :

- Almost every company insures certain costs that are unavoidable. Regardless of changes in input volume, their costs remain competitive. They mostly represent depreciation, property tax, insurance, and rent; they primarily represent employee pay; and they primarily represent interest burden on long-term debt. Fixed expenses arise as a result of capacity creation and are unaffected by changes in activity levels (or the level of capacity utilization). They are, at their core, a function of time.
- Thus, Fixed costs are the costs that are independent of the volume of sales, such as rent.

Variable cost :

- Several significant cost elements are directly proportional to output. The material cost, for example, is a function of output. Similarly, the cost of electricity and other utilities may be directly proportional to output. Variable costs are defined as those costs that fluctuate proportionally with production.
- Thus, Variable Costs are the costs that are dependent on the volume of sales, such as the materials needed for production or manufacturing.
- In the case of a new project where the capacity utilization level is expected to rise gradually over a period of 3 to 4 years, fixed costs are normally planned in such a way that they are stepped up as and when necessary to meet the projected increases in capacity utilization. Hence, the calculation of the break-even point for a new project must be with reference to the fixed costs expected to be incurred in the third year or fourth year when the project is supposed to reach the rated capacity utilization level.
- The break-even threshold can be determined in terms of physical units and sales turnover once the costs have been separated into fixed and variable costs.

i) In terms of physical units : The number of units required to be sold to achieve the break- even point can be calculated using the following formula :

$$BEP = (FC)/C$$

Where

FC = Fixed cost

VC = Variable cost

SP = Selling price

C = Contribution per unit (C = SP – VC)

ii) In term of sales volumes : Break-even point in terms of sales volume can be calculated using the following formula :

BEP = (Fixed expenses × Sales) / Total contribution

2.6.4 Utility of the Break-Even Analysis

The utility of Break-Even Analysis is as follows :-

- It is the most valuable and crucial managerial tool for analyzing the cost-output profit relationship at various output levels.
- It can be used to review pricing policies.
- It aids in capitalization planning for organizations.
- It allows the business owner to determine whether or not to purchase assets with additional fixed costs.

2.6.5 Shortcoming of Break Even Analysis

- The BEP analysis is predicated on a number of assumptions, including sales, costs, production and sales. Unless all of these assumptions are accurately computed, the technique will only be of financial use. Furthermore, the approach serves as a preliminary and additional tool in the ratio analysis process.
- Another essential aspect of the method is that it includes cost-escalation as a built-in precaution against price increases.
- However, the most essential aspect to consider when employing the technique is a good breakdown of various expenditures into fixed and variable costs, as there are some costs that do not fit into either category. These are the expenses, some of which are fixed and some of which are variable. These semi-fixed expenses cannot be considered separately in a break-even analysis and must be separated into the standard categories of fixed and variable elements.
- Break-even analysis may not be effective for fast developing organizations or enterprises that change their product mix regularly.
- In the case of several products, it is of limited use.
- It fails to account for elements like as uncertainty and risk when estimating costs, volume and profitability.

- Because of the faults in this technique's application, it is an important tool for determining the profitability of a new project.

2.7 Introduction - Project Planning

- Project planning helps to move on to the second phase of the project management life cycle, thorough project planning, after the project has been defined and the project team has been formed.
- The heart of the project life cycle is project planning, which tells everyone involved where you're going and how you're going to get there. The project plans are documented, the project deliverables and requirements are specified, and the project timeline is created during the planning phase. It consists of developing a set of strategies to guide your team through the project's implementation and closure phases. This phase's plans will aid you in managing time, cost, quality, modifications, risk and other associated issues. They will also assist you in maintaining control over your employees and external vendors to guarantee that the project is completed on time, on budget and on schedule.
- The project planning phase is generally the most difficult for project managers because they must make accurate guesses regarding the number of people, resources, and equipment required to finish the project. You may also need to schedule your communications and procurement efforts, as well as hire any third-party vendors.
- The purpose of the project planning phase is to :
  - Establish business requirements.
  - Establish cost, schedule, list of deliverables, and delivery dates.
  - Establish resources plans.
  - Obtain management approval and proceed to the next phase.

2.7.1 Need for Project Planning

- Project planning is critical in guiding stakeholders, sponsors, teams, and the project manager through the many phases of the project. To establish desired goals, reduce risks, avoid missed deadlines, and produce the agreed-upon product, service or outcome, planning is required.

2.8 Project Life Cycle (Refer Section 1.2)

2.9 Roles, Responsibility and Team Work

- Successful projects are frequently the result of careful preparation, as well as the talent and teamwork of the project's members. Without each of the project's core team members, it is impossible to move forward, yet it is not always clear who they are or what roles they perform. We will go over the responsibilities of five different roles : project manager, project team member, project sponsor, executive sponsor, and business analyst.

Project manager

- The project manager is in charge of the project's effective completion and plays a key part in it. The project manager's role is to ensure that the project is completed on schedule and on budget, while meeting the project's objectives. Project managers supervise the allocation of resources to projects while also managing relationships with contributors and stakeholders.

Project manager duties

- Develop a project plan
- Manage deliverables according to the plan
- Recruit project staff
- Lead and manage the project team
- Determine the methodology used on the project
- Establish a project schedule and determine each phase
- Assign tasks to project team member
- Provide regular updates to upper management.

Project team member

- Individuals that actively participate on one or more phases of the project are referred to as project team members. They could be in-house employees or outside consultants who work full-time or part-time on the project. The duties of team members can change depending on the project.

Project team member duties

- Contributing to overall project objectives
- Completing individual deliverables
- Providing expertise

- Working with users to establish and meet business needs
- Documenting the process.

Project sponsor

- The project sponsor is the project's driving force and internal supporter. They are usually members of senior management who have a strong interest in the project's success. The project manager and the project sponsor collaborate closely. They provide the project's goals validity and take part in high-level project planning. They also frequently assist in resolving issues and removing obstacles that arise throughout the project, as well as sign off on approvals required to move forward in each phase.

Project sponsor duties

- Make key business decisions for the project
- Approve the project budget
- Ensure availability of resources
- Communicate the project's goals throughout the organization.

Executive sponsor

- A high-ranking member of management is excellent for the executive sponsor. With the management team, he or she is the project's visible champion and the ultimate decision-maker, with final approval on all stages, deliverables, and scope adjustments.

Executive sponsor duties

- Be the project's ultimate point of contact
- Approve all changes to the project's scope
- Approve project deliverables
- Provide additional funding for scope modifications.

Business analyst

- To improve an organization, a business analyst defines needs and suggests solutions. When working as part of a project team, they guarantee that the project's goals are met, that the project solves problems or improves performance, and that the project adds value to the organization. They can also assist in increasing the value of project outputs.

Business analyst duties

- Assist in defining the project
- Gather requirements from business units or users

- Document technical and business requirements
- Verify that project deliverables meet the requirements
- Test solutions to validate objectives.

2.10 Project Planning Process

- Project planning follows the project initiation phase. Countless hours during the succeeding phases can be saved with proper planning.
- The purpose of the project planning phase is to :
  - Determine project requirements
  - Decide project cost and schedules
  - Search for sources of all resources.
- The basic processes of the project planning phase are :
  - **Defining the scope :** Define the scope of the project and its limitations.
  - **Preparing the work breakdown structure :** Divide the whole project into smaller activities.
  - **Role assignment :** Assign jobs to individuals or groups of individuals as predefined activities or tasks.
  - **Project scheduling :** Determine optimum schedule of the project and show it on a Gantt Chart.
  - **Fund allocation :** Allocation of funds for individual activities.
- Other subsidiary processes in the planning stage are :
  - **Risk management planning :** It includes identification of possible causes and effects of the risks and trying to reduce the impact of risk.
  - **Procurement planning :** Decisions regarding all products, services or resources needed to accomplish the project.
- In the planning stage, various steps are taken which includes :
  - **Final techno-economic feasibility of the project :** This is the last chance for changing the decision, as after this stage, it proves too closely to shut down the project or change the project.
  - **Basic engineering and process design :** The process is selected and basic engineering is done. The documents with respect to equipment specification are prepared.
  - **Division of work/responsibilities :** Different activities are allocated to individuals or groups.

- **Identify potential vendors and subcontractors :** No project is complete without the help of outside expert agencies called subcontractors. The potential suppliers of various equipment, civil construction agencies and similar agencies are identified and negotiated.
- **Detailed engineering design :** Based on the designs of equipment supplier, detailed engineering is performed. The final layout is prepared and the work schedule prepared.
- **Final estimation of the cost of the project :** The above steps leads to finalizing quite accurate cost of the project. This is essential as the next step would involve arrangement of funds.
- **Decision of capital structure and means of finance :** The final decision with respect to financing the project is needed during the planning phase. It is a crucial decision generally taken by the core strategic group with the advice of finance managers.
- **Final schedule of implementation (next phase) :** The next phase will be implementation. A proper schedule of implementation is essential to avoid confusions. The schedule of implementation tells all the members of the team when a particular activity should start and end. It will provide the milestones of every activity. The techniques used are PERT, CPM, Gantt chart, crashing resource allocation and resource leveling.

2.11 Work Breakdown Structure (WBS)

- The work breakdown structure, as the name implies, is a method of breaking down a project into subsequent segments. Work breakdown structure, on the other hand, isn't just about disintegration or breakdown; it also builds links between different jobs or activities. The following is an example of a breakdown :

1. **Agency-oriented :** In this type of breakdown, different agencies or types of agencies are allocated to a group or individual. For example, dealing with civil contractors, equipment suppliers, liasoning with government bodies.
2. **Function-oriented :** Like departmentalisation, the activities are divided on the basis of type of work. A project can be divided into engineering works, accounting works, financial works, procurement works, and human resource works, and so on.
3. **Location-oriented :** This type of WBS is generally useful when the project is multi-locational.

4. **Cost-orientation :** Different cost centers are identified and allocated to various groups or individuals.

5. **Life cycle-oriented :** There exists a project life cycle, so work can be divided on the basis of different phases of the life cycle, like identification team, planning team, implementation team and so on.

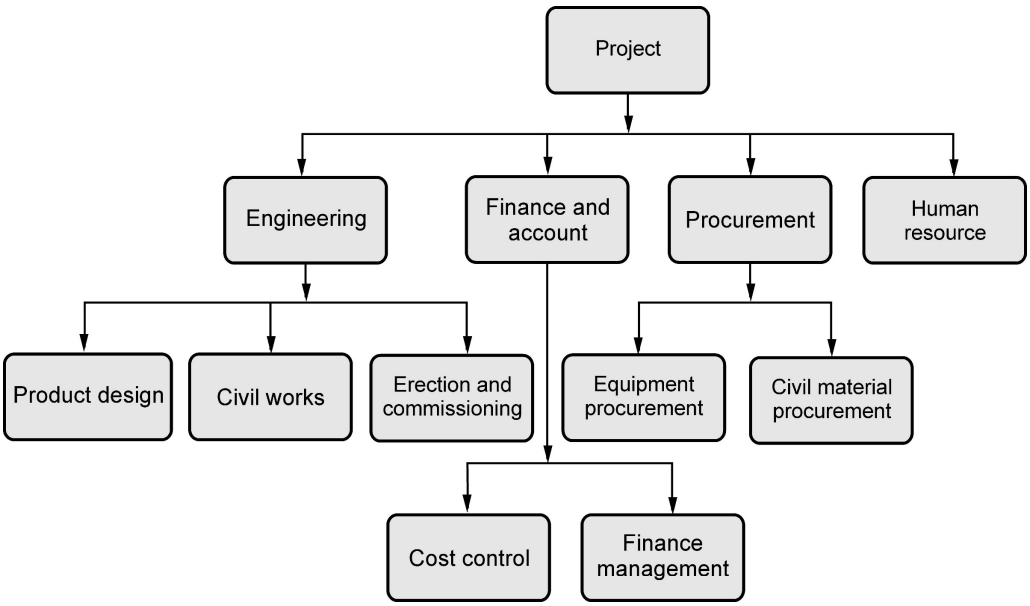


Fig. 2.11.1 Work breakdown structure

Review Questions

1. *Describe work breakdown structure with suitable figures.*
2. *Explain the concept of planning process.*
3. *Write a short notes on project initiation.*
4. *Brief in details roles, responsibility and team work.*
5. *Explain the project planning process.*
6. *Explain the need for project planning.*
7. *Write a note on project break-even point.*
8. *Write a note on feasibility studies.*
9. *Write a note on pre- feasibility studies.*

Multiple Choice Questions

Q.1 Which one of the following is captured in the Work Breakdown Structure (WBS) ?

a The life cycle phases
b The logical order of tasks
c The scope of the project
d Project costs

Q.2 Feasibility study determines _____ .

a whether the project is possible with resources
b comparing the project with world class
c manufacturing norms
d add duration to each unit

Q.3 People participated in a project or affected by a project activities are known as _____.

a stockholders
b stakeholders
c project team
d project managers

Q.4 How the project work will be carried out, monitored and controlled ? These questions are answered in which phase of the project management ?

a Initiating
b Planning
c Executing
d Closing

Q.5 Assembling project team and assigning their responsibilities are done during which phase of a project management ?

a Initiation
b Planning
c Execution
d Closure

Q.6 Which of the following are characteristics of B.E.P ?

a There is no loss and no profit to the firm
b Total revenue is equal to total cost
c Contribution is equal to fixed cost
d All of the above

Q.7 Which of the following are limitations of break-even analysis ?

a Static concept
b Capital employed is taken into account
c Limitation of non-linear behavior of costs
d Limitation of presence of perfect competition

Q.8 Using equation method, break-even point is calculated as _____.

a Sales = Variable expenses + Fixed expenses + Profit

b Sales = Variable expenses + Fixed expenses – Profit

c Sales = Variable expenses – Fixed expenses + Profit

d None of the above

Q.9 Which one of the following is not a characteristic of a team ?

a Minimal and formal knowledge sharing

b Collective output

c Fluid dimension to roles and tasks

d Individual and collective responsibility

Q.10 Which of the following is not a reason to train team members of an organization to make a successful team ?

a To train them in problem-solving techniques

b To train them in team dynamics

c To train them in communication skills

d To train them in threatening customers

Q.11 Which of the following is not a characteristic of a successful team in an organization ?

a Appropriate leadership

b Balanced participation

c Cohesiveness

d Mutual enmity

Q.12 Feasibility study _____.

a includes a statement of the problems

b considers a single solutions

c both (a) and (b)

d a list of alternative solution considered

Q.13 By economic feasibility of a system we mean that _____.

a it is economical to operate

b it is expensive to operate

c it will be cost-effective if implemented

d finances are available to implement the system and it will be cost

Q.14 By technical feasibility of a solution we mean that _____.

a technology is available to implement it

b persons are available to implement it

c persons have technical ability to implement it

d funds are available to implement it

Q.15 During feasibility analysis it is necessary to examine several alternative solutions because

(i) A comparison of alternatives will lead to a cost-effective solution

(ii) A pre-conceived single solution may turn out to be unimplementable

(iii) It is always good to examine alternatives

(iv) Management normally looks at alternatives

a i and iii b i and iv

c i and ii d ii and iv

Answer Keys for Multiple Choice Questions :

Q.1	c	**Q.2**	a	**Q.3**	b	**Q.4**	b
Q.5	a	**Q.6**	d	**Q.7**	a	**Q.8**	a
Q.9	a	**Q.10**	d	**Q.11**	d	**Q.12**	a
Q.13	d	**Q.14**	a	**Q.15**	c		

❑❑❑

Notes

UNIT III

3 Project Organizational Structure and Issues

Syllabus

Organizational Structure and Organizational Issues : *Introduction, Concept of Organizational Structure, Roles and Responsibilities of Project Leader, Relationship between Project Manager and Line Manager, Leadership Styles for Project Managers, Conflict Resolution, Team Management and Diversity Management, Change management.*

Contents

3.1 Organizational Structure and Organizational Issues

3.1.1 Introduction

- A project organization is a structure that makes it easier to plan and execute project operations. Its fundamental goal is to create an environment that encourages team members to interact with each other with the least amount of disruptions, overlaps and conflict as possible. The type of organizational structure that will be employed for the project is one of the most essential decisions that project managers must undertake.
- Each project has its own features and the design of an organizational structure should take into account the organizational environment, project characteristics and the level of authority assigned to the project manager. A project structure can take many different shapes, each with its own set of benefits and drawbacks.
- One of the structure's main goals is to limit the amount of uncertainty and misunderstanding that happens during the project's initial stages. The structure establishes the ties between project management members as well as those with the outside world. An organization structure, which is a graphical representation of the system, defines the authority.

3.1.2 Organizational Issues

When deciding on a project organization, the company must consider the following factors :

- How much independence should the project team be given ?
- How does a project organization fit into the overall structure ?
- What method should be used to assign individuals to the project ?
- What level of directive / authority (i.e., degree of empowerment) should managers have ?

The answers to these questions will vary depending on the type of organization. In 1982, a survey of Fortune 500 companies found the following findings on project organization and project team powers :

- In most cases, all capital expenditures must have gained corporate approval or have been budgeted accordingly.
- Only a few divisions were authorised to raise funds outside, and then only from short - term sources.

- The key justification provided was that capital investment decisions were of such importance to the entire organization that they required central control.
- Divisional managers, on the other hand, have significant influence over projects submitted for approval, therefore formal authorization was viewed as organizational monitoring of decisions that are primarily duty of divisional managers (due to the use of the idea of "investment centres").
- Informal concepts with central management ensured planning ahead for the entrepreneurial spirit of divisional managers because it allowed them know which proposals would be accepted.
- The principle of 'delegation within guidelines' helped to maintain the balance indicated earlier.

3.2 Concept of Organizational Structure

- The framework within which management and operational duties are conducted is referred to as the organization structure. It describes the connections between people, work and resources in a company.
- Various posts are created under the organizational structure to execute various operations in order to achieve the enterprise's set objectives. Managers and other staff can use the structure as a foundation or framework to carry out their duties.
- The number of subordinates that a superior can effectively manage is referred to as the span of management. The organization's structure is mostly shaped by the span of management. This determines the management levels.

3.2.1 Types of Organization Structure

Project organization can be set up in different forms. Various types of organization are :

1. Functional organization
2. Divisionalized organization
3. Projectized organization
4. Matrix organization
5. Task force organization

1. Functional organization

- 'Functional organization' refers to the division of operations based on the organization's functions. This may allow for the recruitment of experts, but it may also result in a greater coordination challenge, resulting in a loss of control. When dealing with repetitive tasks, this form of organizing is ideal. Because project

activities are not predictable, functional organizations are not well suited to project development. The following is an example of a simple functional organization structure.

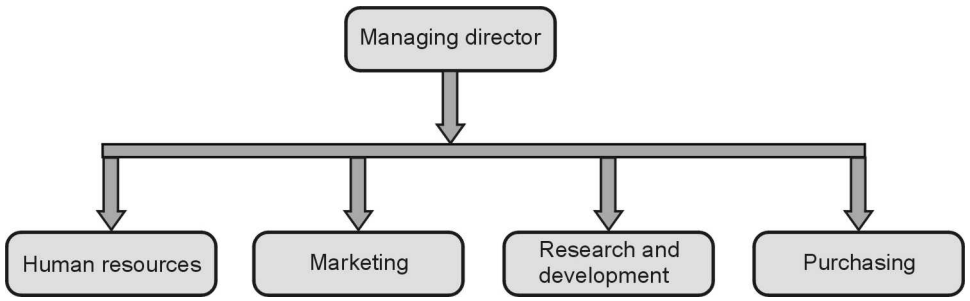


Fig. 3.2.1 Functional organization

Advantages of functional organization

- There will be no changes to the parent organization's design or operations.
- Staff use should be as flexible as possible.
- The functional department's in - depth experience can be put to good use in projects.
- The transfer after the project is simple because specific functions are emphasised, functional organization leads to occupational specialisation.
- Encourages the efficient use of human resources.
- Encourages departmental control and coordination.
- It aids in the improvement of managerial and operational effectiveness.
- It decreases the amount of work that needs to be done twice.
- It makes it simple to teach personnel.
- It guarantees that different functions are given the attention they deserve.

Disadvantages of functional organization

- A functional structure prioritises the goals of functional heads over the goals of the organization.
- There is a lack of collaboration across departments.
- Within various departments, there will be a conflict of interest.
- Employees' limited perspectives may lead to inflexibility.

2. Divisional organization

- Some businesses are either too big or too spread out in terms of geography, product or market, making it difficult to put together a fully working organization. These

businesses generate divisions or subunits. Each division operates as if it were its own company, however there is a high level of collaboration with the headquarters. Divisional activities are categorised based on their role. This structure is also appropriate for normal work rather than project work.

- The division organizational chart shows how staff are organized into product line divisions in a company. Each of the company's products is treated as a separate entity with its own set of functional departments. This structure is best suited for large companies with extensive production lines.

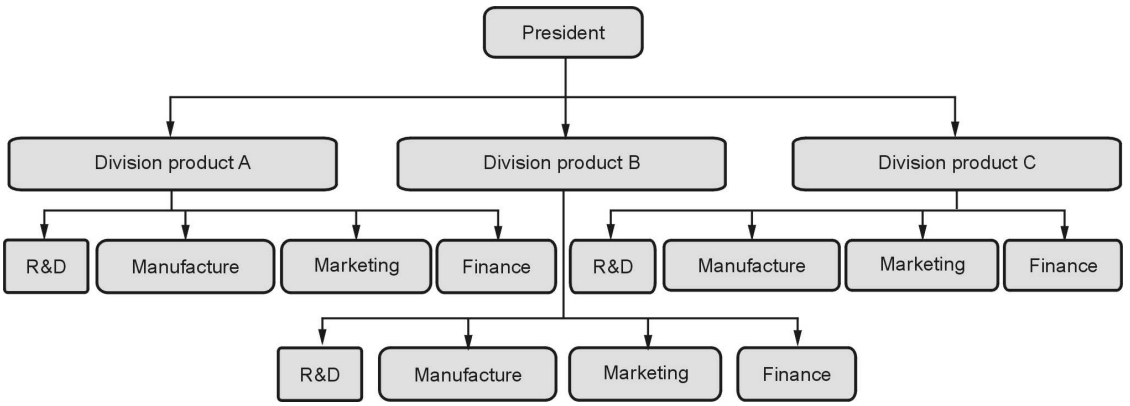


Fig. 3.2.2 Divisional organization

Advantages of Divisional Organization

- Product specialisation helps in the overall development of the skills of departmental heads.
- It helps in the fixation of responsibility and accountability of departmental heads.
- Provides a proper basis for assessing performance and results of each division.
- It facilitates expansion and growth, as new divisions can be added without interrupting existing divisions.

Disadvantages of divisional Organization

- Conflicts may arise among different divisions on allocation of resources.
- It may lead to increase in costs since there may be a duplication of activities in different product divisions.
- It provides managers with the authority to supervise all activities related to a particular division.

3. Projectized organization

- A projectized organization is a structure that is totally self - contained. In this arrangement, a project manager is fully responsible for the project's construction. He has a full team of people working for him who are capable of performing a variety of expert jobs as part of the project. The project team is self - contained. When (a) The project must be performed at a different location than the firm's existing operations, (b) Maximum control and flexibility are necessary and (c) The project necessitates alternative accounting policies and procedures, this structure is recommended.
- In a projectized organization, project managers work directly with the CEO or senior management lead. A projectized organization could look something like this :

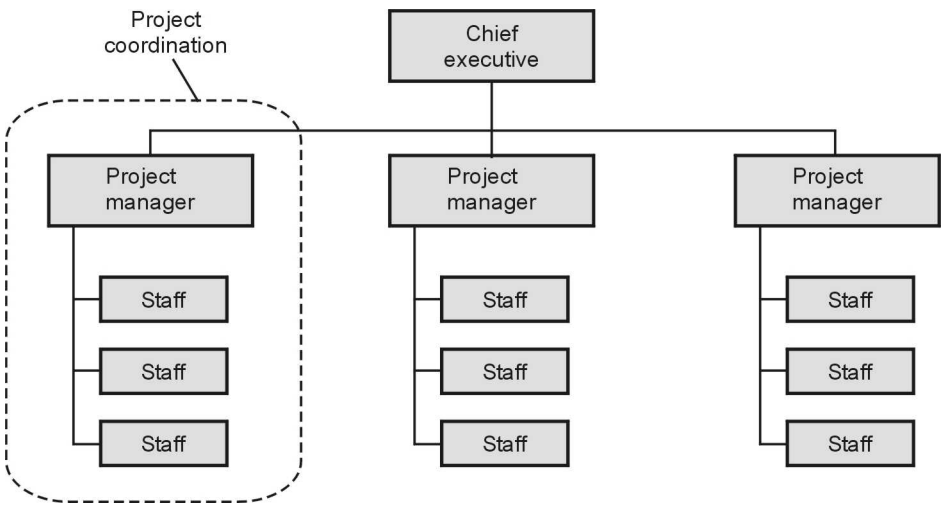


Fig. 3.2.3 Projectized organization

Advantages of projectized organization

- This type of projectized organizational structure exhibits transparency.
- The project team members report directly to the project manager, making it easier to address difficulties and making decisions quickly.
- There are fewer lines within the project team, it promotes good communication.
- Another benefit is that project team members become more flexible and versatile
- Previous project experience promotes success.
- Instantaneous cooperation, clear communication and goals are also encouraged in a project - based organization.

Disadvantages of projectized organization

- If the organization has multiple initiatives, the resources may be doubled and there may be miscommunication regarding resource allocation.
- Due to the project manager's enormous power, it can be a problem for team members.
- It also has a strict schedule and deadlines, making it a stressful place to work.
- Every structure that the management chooses to implement will have a huge impact on the entire project

4. Matrix organization

- The project team and the various functional departments have the authority to collaborate on the project in a matrix organization. Matrix organizations can be divided into two categories :

a) Matrix project organization with strong project functional management :

- In order to speed the process, the project manager adds functional heads in his team who act as relationships between him and the various functional units. This type may be best suited for a mature company that is used to project management and has a thorough understanding of the overall requirement.

b) Matrix project organization with normal functional management :

- In this form of organization, coordination is expected. The project's requirements are met alongside typical demands in the functional departments. When complex planning and decision - making are necessary and a project plan can be divided down into largely unconnected tasks for the functional departments, this kind is appropriate.
- In this form of structure, the dual tasks would emerge as seen in Figure

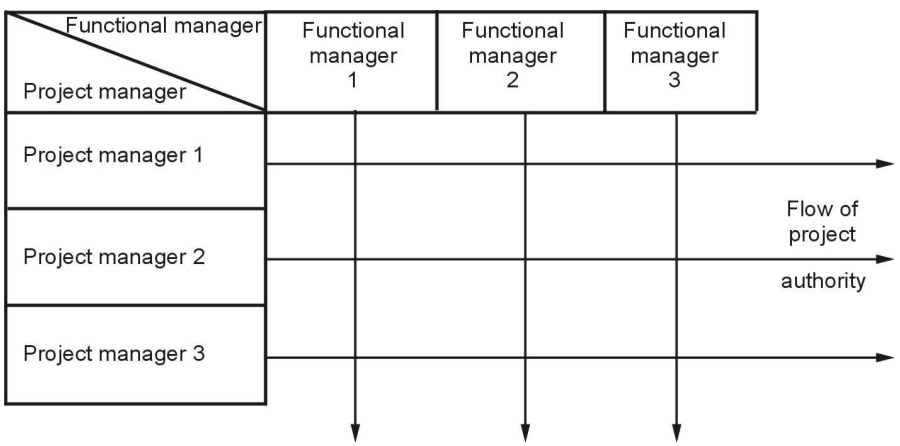


Fig. 3.2.4 Responsibility matrix in matrix organization

Advantages of matrix organization

- Different departments working together.
- Interdepartmental communication is possible.
- Structures for project and functional management are combined.
- Members of the team and management maintain their functional positions.

Disadvantages of matrix organization

- Managerial positions are not at all always well defined.
- It is also possible that team roles aren't properly defined.
- It is possible to slow down the decision - making process.
- Overwork can lead to exhaustion.
- It may become difficult to assess staff performance.

5. Task force organization

- A separate task force is constituted in this sort of organization with the purpose of ensuring that the project is finished effectively. Internal norms and procedures do not apply to the task force. Its primary purpose is to do the task that has been set to it. The project manager is given complete authority and is responsible for all aspects of project execution within the wide limits. The project manager is allocated a group of people or he might hire their services. This style of organization is appropriate when the current organization is traditional, the firm has decided to carry out the project construction on its own and the project size is relatively small.

3.2.2 Comparison between Functional and Divisional Organization Structure

Basis	Functional structure	Divisional structure
Formation	Formation is based on functions.	Product lines promote formation, which is aided by functions.
Specialisation	Functional specialisation.	Product specialization.
Responsibility	Difficult to fix on a department.	Easy to fix responsibility for performance.
Managerial development	Difficult, as each functional manager has to report to the top management.	Duplication of resources in various departments, hence costly.
Cost	Functions are not duplicated hence economical.	Duplication of resources in various departments, hence costly.
Coordination	Difficult for a multiproduct company.	Easy, because all functions related to a particular product are integrated in one department.

3.3 Roles and Responsibilities of Project Leader

3.3.1 Roles of Project Leader

- The project manager functions as the project's leader, having full authority and responsibility for completing the project on schedule and within budget. His job involves bringing together numerous resources in order to achieve the goals.
- The project leader has to play various roles during his tenure. The roles of a project leader are :

Entrepreneur :

- Even though the project leader is not the owner or entrepreneur, he or she must assume the role of an entrepreneur. He is in charge of obtaining funding, facilities and personnel for the project. He is held responsible for failure and receives full credit in the instance of success. Any project's success is mostly determined by this entrepreneur.

Decision maker :

- The project leader is in charge of allocating resources, establishing project scope and managing costs and schedules in accordance with the plans. He is in charge of the project, ensuring that the project's timelines and expenses are met and that the sources of deviations are minimized.

Communicator :

- The project leader is the focal point for all project communications. He functions as a server or a communication centre. He gathers and processes numerous types of data. He is also in charge of informing various members of the project team on the procedures and objectives. He's also in charge of the review sessions.

Change agents :

- The project leader implements the modifications and attempts to mitigate the opposing forces that arise as a result of the change process. Oppositional forces are present in all changes and they are especially strong in projects because they are often targeted towards dramatic changes.

Motivator :

- Without dedicated and motivated team members, no mission can be accomplished effectively. The project leader is responsible for developing and maintaining motivation in his team members through ups and downs. A project may also face times when it appears to be as black as a blue moon, with no hope of success in sight. There are instances when the project leader's primary responsibility is to restore team members' faith in the project. He must keep his team's energy and excitement alive.

Foresighted and fire fighter :

- Any project has a certain amount of risk. The successful project leader anticipates risk or fluctuations and formulates a strategy to deal with them. When the unexpected happens and no one expects it, the project leader leads the team to face the issue like a firefighter.

3.3.2 Responsibilities of Project Leader

Planning :

- A project manager is in charge of creating a strategy for achieving the project's goals while staying within a set budget and deadline. The project will be guided by this plan from initiation to completion. The scope of the project, the resources required, the estimated time and budgetary requirements, the communication strategy, an execution and documentation plan and a proposal for follow - up and maintenance will all be included. If the project hasn't been approved yet, this strategy will be a major part of the pitch to key decision - makers.

Leading :

- Assembling and leading the project team is an important element of any project manager's job. This requires superior communication, people - management and leadership abilities, as well as an acute awareness of others' talents and weaknesses. The project manager assigns tasks, establishes deadlines, provides required resources and interacts with the team members on a regular basis once the team has been formed. It's crucial to be able to communicate honestly and frequently with all parties.

Execution :

- The project manager monitors and participates in the effective completion of each project stage. Again, frequent, open communication with project team members and stakeholders is required.

Time management :

- Staying on time is essential to finishing any project and time management is one of the project manager's primary responsibilities. Project managers are in charge of addressing derailments and successfully interacting with team members and other stakeholders in order to bring the project back on track. To keep going forward even when obstacles arise, project managers need to be specialists in risk management and contingency planning.

Budget :

- Project managers create a budget for a project and make every effort to follow it. Project managers regulate expenditure and re-allocate funds when necessary if certain parts of the project end up costing more (or, in an ideal world, less) than expected.

Documentation :

- A project manager must develop effective methods for measuring and analysing the progress of the project. Data collection and verbal and written progress reports are common methods for documenting a project. A project leadership job also include ensuring that all necessary steps are approved and that these records are archived for future use.

Maintenance :

- Once a project is completed, the work does not end. A plan for continuous maintenance and troubleshooting is required. Even if they are not actively managing the end deliverable's day-to-day operations, the project manager formulates methods for appropriately managing it moving forward.

3.4 Relationship between Project Manager and Line Manager

- The project manager and line manager interface refers to the working relationship between the project manager and the line manager in order to complete project operations within the constraints of schedule, budget and quality performance.
- The project manager is entirely accountable for achieving the project's goals within the time, cost and quality limitations (constraints).
- For the effective completion of a project through the smooth operation of project operations, project managers require a wide range of human and non-human resources, including money, manpower, materials, equipment, information and technology. However, the project manager does not have direct influence over the resources that accept the project budget. Line managers, sometimes known as resource managers, are in charge of gathering resources. They assign resources to projects immediately.
- Only those resources that are temporarily loaned by line managers are under the responsibility of project managers. He reminds the line managers that the project is likewise bound by time and budget constraints. This is where effective resource management begins. As a result, the project manager must engage with all line managers to ensure that the required resources are gathered and delivered on time.

- For the following key purposes, the project manager must always interact with the line managers.
  - To obtain required resources from functional departments in a timely manner.
  - Obtaining good line manager support when engaging with multiple parties in relation to project work.
  - To ensure that project work and line department work are in sync.
  - To obtain technical and management help.
  - To resolve project - related issues.
- The working connection between the project manager and the line manager is critical to good project management and project success. For a healthy working relationship, there must be improved coordination, reporting, communication and negotiation between them. Furthermore, in order to foster positive working relationships, the project manager should assist in the right understanding of;
  - Work planning, scheduling and control using quantitative tools and methodologies.
  - Own job description, organizational structure
  - Open lines of contact with line managers, as well as efficient coordination.
  - Organizational behaviour to address the dual reporting system's issues. Organizational behaviour to address the dual reporting system's issues.

3.5 Leadership Styles for Project Managers

- Project leadership style establishing a project culture and working environment that adds to the project's success and performance. It's all about making decisions, making judgment calls and keeping the team motivated through clear communication.
- Following are the few of leadership styles of project managers adopting based on the situations as shown in Fig. 3.5.1.

Fig. 3.5.1 Leadership styles of project managers

1. Coercive leadership

- Project managers would infrequently utilise this style and it would be more noticeable in crisis situations, such as when a project deadline was approaching and in risk of being missed.
- "Do what I tell you," is how this technique can be summed up in a single statement.

2. Authoritative leadership

- The authoritative leader is a visionary who inspires people by making it apparent how their activity contributes to this vision.
- When the team requires a new vision due to changing circumstances or when clear guidance is not required, the authoritative style works well.
- More use of this style, it is argued, will produce greater results from project teams without causing negative effects, as this style has a generally positive impact in the organization.
- "Come with me," is how this approach could be summed up in a single statement.

3. Affiliative leadership

- This is a very frequent project management method that has a beneficial impact on the project team.
- This leader needs to establish emotional relationships that promote a sense of belonging and bonding inside the organization.
- When colleagues need to heal from a trauma or the team has to reestablish trust, the affiliative method is most effective.
- Because a sole focus on praise and caring might create substandard performance and a lack of direction, this technique should not be employed entirely.
- "People come first," is how this style may be summed up in a single statement.

4. Democratic leadership

- Through collaboration, this leader achieves acceptance. For example, in a Project Management Office (PMO), each team member participates in the definition and measurement of the PMO's objectives.
- When the leader requires the team to buy into or own a choice, plan or goal or when he or she is unsure and needs fresh ideas from qualified teammates, the democratic method is most effective.
- "What do you think ?" is how this approach could be summed up in a single phrase.

5. Pacesetting leadership

- This leader expects and models self - direction and excellence.
- When the team is already motivated and skilled and the leader requires speedy results, the pacesetting method works well.
- This is a popular style, especially when a project approaches major milestones. Although this approach has a detrimental impact on project teams in general, there are times and settings when it can be used to good effect. In any organization facing a serious situation, generating urgency is a great benefit.

6. Coaching leadership

- This approach to project management promotes team members to grow their capacity and capability as project contributors, which benefits the entire project team.
- When a leader wants to help colleagues develop long - term personal strengths that will help them be more successful in the long run, he or she should use the coaching approach.
- When colleagues are adamant about not changing or learning or when the leader is inept, it is the least effective method.
- "Try this," is how this approach could be summed up in a single statement.

3.6 Conflict Resolution

3.6.1 Introduction

- Conflict is defined as a scenario involving at least two interdependent parties that is marked by perceived differences and is viewed negatively by both sides. This frequently leads to negative emotional states and behaviours that are intended to win.
- In our culture and in the nation, conflict is an unavoidable and all - pervasive element. While conflicts can result in destruction and even death, they can also lead to higher effectiveness, improved relationships and increased goal achievement. Conflict is, in fact, one of the "engines of evolution" that allows us to learn, advance and grow as humans. Our goal is not to eliminate conflict, but to effectively manage it so that it can be used to its full potential.
- We shall look at many definitions and perspectives on conflict and conflict resolution document. There is a generic working method for effectively resolving conflicts and disagreements. Specific ways to improve our effectiveness in dealing

with disagreements are also included. Strategies for resolving problems on our own and assisting others in achieving their goals without compromising relationships.

- This is primarily concerned with conflict resolution. A communication method for resolving a problem and reaching an agreement. Defusing any strong emotions engaged in the disagreement and allowing the opposing parties to recognize their differences and similarities are all part of conflict management. Negotiation is the process of allowing conflicting parties to reach an agreement on their differences.

3.6.2 Concept of Conflict Resolution

- The process of managing a problem and reaching a solution is known as conflict resolution. It's best thought of as a working approach with two main components : Dispute resolution and negotiation.
- Conflict management is a communication strategy that involves transforming negative emotional states in a conflict into positive emotional levels that allow for the negotiation of a resolution. Negotiation is a method of communication that allows conflicting parties to reach an agreement on their differences.
- In conflict, a win - win or collaborative strategy necessitates a unique style to negotiating known as interest - based negotiation. Interest - based negotiation is a communication method for reaching an integrated agreement that satisfies the needs of all parties involved.
- Conflict management and negotiation are two independent parts of resolving conflicts to produce positive outcomes. The first component, conflict management, addresses the attitudes and strong negative emotions that are common in conflict situations. It involves calming down the associated emotional energy and coming to an understanding of one another's differences. This component is frequently referred to as a conflict resolution.
- The term "conflict resolution" is frequently used to describe this feature. When damaging behaviour is eliminated and hostile attitudes are reduced, conflict resolution occurs. The reasons of the conflict, on the other hand, have yet to be determined. After the dispute has been decreased, the next stage is to employ negotiation or problem solving to reach a satisfactory outcome for both sides. The conflict, that is, the structure, is resolved at this point.

3.6.3 Principles of Conflict Resolution

The following principles support successful conflict resolution :

- The essence of conflict is the extreme emotional energy that surrounds perceived differences.

- The defusing of strong emotional energy and mutual comprehension of differences are at the heart of conflict resolution.
- To reach a mutually satisfying outcome, negotiation (problem solving) is frequently used in conflict resolution.
- Effective conflict resolution requires the ability to :
  - Listen very carefully to ensure knowledge.
  - Maintain a positive relationship at all times.
  - Distinguish between positions and interests.
  - Work toward a solution using stimulating interests as a guideline.

3.6.4 Conflict Resolution Model

- The working model for conflict resolution consists of four stages : Awareness, self - preparation, conflict reduction and negotiation.

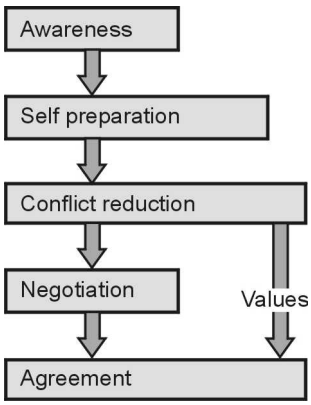


Fig. 3.6.1 Conflict resolution model

Stage 1- Awareness

This is the first stage of the conflict resolution model. It involves becoming aware of the negative emotional states that arise during a fight. It arises from recognition of apparent distinctions, frequently as a result of :

- A claim in which one party tries to convince another party to meet his or her requirements.
- One party adopts a position on a subject that another party or parties oppose.
- One party tries to exert authority or control over the opposing party or parties' activities or conduct.
- Feedback, which occurs when one party provides feedback to another and the feedback is rejected.

- Imposed sanctions, in which one party purposely damages the other in order to obtain what they want.

Stage 2- Self preparation

The second stage of the conflict resolution process involves gaining access to a resourceful state, deciding on an outcome and mapping out the methods to get somewhere. Depending on the circumstances, this stage can be completed fast or take a long period.

This stage involves the following aspects :

- Accessing and maintaining a resourceful state.
- Depend on outcome that achieve in a particular situation.
- Prepare constructive ways of communicating our outcomes and responding to the positions of the other.

Stage 3- Conflict reduction

- Conflict reduction is the third stage of the model and it involves lowering emotional energy and clarifying differences. This enables disputing parties to resolve their differences by agreeing to stop engaging in destructive activity as well as having bad attitudes and feelings toward one another. This agreement may not resolve all of the issues, but it will allow the disputing parties to move on with a better understanding of their differences and mutual respect.
- The method also allows the parties to clear up any misunderstandings and move from a previous to a future - focused mindset.
- When there is a variance in fundamental beliefs, success is attained when there is mutual understanding.
- When negative emotions occur, the ability to listen is employed to reduce them. Both parties have their points of view acknowledged and the similarities and differences between them are explained.

Stage 4 - Negotiation

- Negotiation is a communication process in which each party tries to convince the other to give them what they want or need. Attention negotiation is a type of negotiation in which the goal is to reach an organizational mindset. An integral agreement is one in which the interests of all parties are at least partially met.
- Understanding and clarifying interests is the most important phase in any negotiation. As previously stated, this phase includes distinguishing between position and interests.

- Seeking a mutually satisfactory solution that suits both sides interests is usually the first step in resolving a conflict.
- In most cases, resolving a conflict involves problem solving. In the context of a conflict, problem solving is a collaborative effort to find a mutually accepted solution.
- Problem solving is thus an important step in the negotiation and conflict resolution model.

3.7 Team Management and Diversity Management

3.7.1 Team Management

- Team management refers to the procedures that must be followed in order to make the most use of the project's resources. The project team consists of the project manager and the project staff members that have been assigned to work on the project.
- Managing a project team differs from managing other types of employees , the project team has a beginning and an end in terms of the tasks given to the project. Team members bring a variety of skills and experiences to the project and for many of them, this is their first time working together. Roles and responsibilities change more frequently due to the high level of uncertainty and the team must be flexible enough to react to new difficulties. Working on a project can be stressful due to time restrictions, but it can also be stressful due to the inherent uncertainty of working in new areas, with new sets of stakeholders or on ideas that no one has ever tried before.
- As the project begins, the team is unsure of their duties and the project's strategic direction. Some new employees must adapt to a new organization and its ways of doing things, as well as understand its purpose, vision and values. All of these factors contribute to the stress that comes with starting a new project. Due to the absence of key employees, the rest of the team may be in required to accomplish the task more than was originally planned.
- Team management involves more than recruiting and assigns employees once the project is completed; it also involves careful planning to guarantee that the project has the right people doing the right tasks at the right time.
- People are remains at the centre of project management and they determine whether a project succeeds or fails, despite the recent information and technological revolution in project management. All project operations are planned, organized,

directed, coordinated and monitored by the project team, which is involved in the creation of the project goals. By employing interpersonal and organizational skills such as communication, delegation and collaboration, the team is able to fulfill the project's goals and objectives, decision - making and negotiation.

- People can be seen as either problems and constraints or solutions and opportunities in the challenging environment of development projects.

3.7.2 Diversity Management

- Diversity management refers to organizational efforts that try to promote good inclusion of individuals from various backgrounds into an organization's structure through specialised policies and initiatives. As a result of the increased variety of the workforce around the world, businesses are implementing diversity management techniques.
- Companies may now recruit and manage staff from all over the world and in multiple time zones thanks to technological advancements. Companies are developing particular policies and programmes to improve employee participation, promotion and retention of employees from all origins and cultures. The programmes and policies are intended to create a friendly atmosphere for groups that have previously been denied access to employment and higher - paying occupations.
- In the mid-1980s, North America pioneered the concept of variety, which later extended to other regions of the globe. Ronald Reagan, the then - President of the United States, had promised to repeal the anti - discrimination and affirmative action legislation. Employees from Equality and Affirmative Action presented the case that diversity management should be viewed as a competitive advantage for US businesses rather than a regulatory requirement.
- The discussion generated interest in the concept of diversity and the advantages of diversity management. With the globalisation of the world economy and the expansion of multinational organizations, diversity management has taken on a new meaning, referring not only to the heterogeneity of the workforce in one country, but also to the composition of the workforce across countries.

3.7.2.1 Types of Diversity Management

1. Intranational diversity management

- Intranational diversity management refers to the management of a workforce made

up of citizens or foreigners working in a single country. Employment possibilities for minorities and recent migrants are the subject of diversity programs.

- For example, a French company, might develop policies and initiatives aimed at increasing sensitivity and offering employment to the country's minority ethnic communities.

2. Cross - national diversity management

- The term "cross-national" or "international" diversity management refers to the administration of a workforce made up of citizens from many countries. It could also include immigrants looking for work from various nations.
- The major problem of cross - national diversity management is that, depending on where the employees live, the parent company must consider the legislative and cultural laws of the host countries in which it operates.
- For example, a company located in the United States with offices in Canada, Korea and China. The company will create diversity initiatives and policies that will apply to both its US headquarters and its international branches.

3.8 Change Management

- Projects involve additional or drastic changes, which are difficult for the people involved to digest. Human behaviour is subject to Newton's first law of motion (there is always inertial offered to any change of condition). Any project manager faces a difficult task in bringing about change and ensuring that it is accepted by the stakeholders.
- All significant change efforts only have a 30 % success rate.
- Managers, particularly project managers, are frequently faced with significant challenges presented by a variety of people, including all stakeholders, as a result of change.
- It is important to recognise that perception is a primary source of resistance. Allow the change to take place in a more peaceful environment, where stakeholders' perceptions or expectations of the project's outcomes are good.
- To minimize the negative effects of change, consider the following steps :

Proactive communication :

- People or stakeholders who will be impacted by the project should be informed and treated with respect. It should be communicated in such a way that the project's outcome becomes the stakeholders' goal and they begin to pursue change. They

should be well - informed about the advantages of the changes that have been implemented. Instead of stating the project, stakeholders should create an atmosphere in which the initiative may be implemented.

Encourage middle level management :

- Managers in the middle level can play an important role in reducing opposition to change. They work closely with the other two levels of management and communicate with them on a frequent basis. The results of the projects should be shared to them and they should be asked for assistance.

Avoid over communications :

- Overcommunication can sometimes lead to increased resistance to change. During change management, grapevine communications should not be encouraged because it often leads to increased resistance.

Make the change process gradual :

- To minimise the negative impacts, the transformation process should be moderate and slow. Allow it to be absorbed by those who are concerned. It's always tough to digest a new food too quickly, so take it slowly.

Review Questions

1. *Give the concept of organizational structure.*
2. *Give relationship between project manager and line manager.*
3. *What is organization structure ?*
4. *What are the four basic elements of organization structure ?*
5. *What is organization design ?*
6. *What is conflict ?*
7. *What the consequences of conflict ?*
8. *What the ways to resolve conflict ?*
9. *What are the types of organization structure ?*
10. *Explain leadership styles for project managers.*
11. *Write a notes on change management.*
12. *Write a notes on team management.*
13. *Write a notes on diversity management.*

Multiple Choice Questions

Q.1 Conflict occurrence in projects is _____.

a unavoidable
b depend on type of project
c avoidable
d depends on culture

Q.2 Outsourced projects are susceptible to conflicts as _____.

a People get less pay in these projects and work is more
b More work pressure and less time horizon
c These projects are away from home location
d People are unaccustomed to working together and have different values

Q.3 Who creates the project team ?

a Factory manager
b Operation manager
c Project manager
d Purchase manager

Q.4 The leadership style where focus is on relationships and community rather than exercising of power, is termed as _____.

a laissez - faire
b interactional leadership
c servant leadership
d oligarchy

Q.5 How do you describe a work group that comprises workers with demarcated tasks and distant line managers ?

a Dependent
b Independent
c Interdependent
d Collaborative

Q.6 Organizational Structure reflects in _____.

a organization hierarchy
b organization chart
c departments
d sapan of controls

Q.7 Design of systems are included in the organization chart _____.

a co - ordination
b integration
c communicaton
d all of the Above

Q.8 Organizational structure identifies _____.

a non-departmentalization
b individualism
c grouping
d complexity

Q.9 The view of managing diversity that enables companies to gain access to ethnic and demographic markets is called the :

a differentiation paradigm b integration paradigm

c assimilation paradigm d adaptation paradigm

Q.10 Diversity issues include matters pertaining to _____.

a gender issues b sexual harassment

c both d none

Q.11 _____ should be involved in decision making process.

a Line managers b CEO

c CFO d CMO

Q.12 _____ activities include strategic games, sharing stories, experience and role plays.

a Interaction diversity b Mentors

c Team building d Managing

Q.13 What should be done by the project manager to ensure that all the work in the project is included ?

a Create a contingency plan b Create a risk management plan

c Create a WBS d Create a statement of work

Q.14 The leader who excels as a leader because of his superior knowledge is _____.

a autocratic leader b intellectual leader

c liberal leader d institutional leader

Q.15 When grocery store installed then scanners use to read the product price, this was an example of managing category called _____.

a technology b people

c competitors d structure

Answer Keys for Multiple Choice Questions :

Q.1	a	**Q.2**	d	**Q.3**	c
Q.4	c	**Q.5**	b	**Q.6**	b
Q.7	d	**Q.8**	c	**Q.9**	a
Q.10	c	**Q.11**	a	**Q.12**	c
Q.13	c	**Q.14**	b	**Q.15**	a

❑❑❑

Notes

UNIT IV

4 Project Scheduling

Syllabus

PERT and CPM : *Introduction, Development of Project Network, Time Estimation, Determination of the Critical Path, PERT Model, Measures of variability, CPM Model, Network Cost System*
Resources Considerations in Projects : *Introduction, Resource Allocation, Scheduling, Project Cost Estimate and Budgets, Cost Forecasts*

Contents

4.1 Introduction to PERT and CPM

- PERT and CPM are two well-known network strategies or models that are particularly useful for planning, organizing and executing big time-bound projects that require careful coordination of a wide range of complicated and interrelated activities and resources.
- PERT is the abbreviated form for program evaluation and review techniques and CPM for critical path method.
- Both the techniques were developed in the U.S.A. during the late 1950s. PERT was developed by US Navy Engineers to plan and control the huge Polaris Submarine Program. CPM was developed by E.I. DuPont Nemours & Co.U.S.A. and the Univac Division of Remington Rand Corporation in 1956 in connection with the periodic overhauling and maintenance of chemical plants.
- It resulted in a reduction of the shut-down period from 130 to 90 hours, saving the company hours and $1 million.
- Both techniques have been effectively used to improve the efficiency of large-scale project execution while staying within budget and time constraints. Any new venture, such as the construction of a new plant, bridge, dam, shopping center, or residential complex, the design of a new aircraft, the manufacture of ships, R&D projects, the introduction of a new product, the installation of pipeline, the flotation of a new issue of shares, major repairs and overhaul of plant and machinery units, the organization of a large conference/convention, the management of earthquake relief work and so on, can be considered a project.
- These techniques are all based on the same principle and are network-oriented. PERT and CPM are both time-oriented methodologies in the sense that they both result in the creation of a project schedule. The major distinction between the two systems is that in CPM, time estimates for various activities were thought to be deterministic, whereas in PERT, time estimates are described probabilistically. Project scheduling approaches are the name for these methods.
- In CPM activities are shown as a network of precedence relationships using activity - on - node network construction,
  - Single estimate of activity time
  - Deterministic activity times.

- CPM activities in project management are used for jobs that are repetitive in nature and where activity time estimations can be predicted with a high degree of reliability due to past experience.
- In **PERT** activities are shown as a network of precedence relationships using activity - on - arrow network construction,
  - Multiple time estimates
  - Probabilistic activity times.
- PERT activities in project management used for non-repetitive jobs, where time and cost estimations are difficult to predict. Probabilistic time estimates are used in this strategy.

4.1.1 Benefits of PERT/CPM

- Useful at many stages of project management
- Mathematically simple
- Give critical path and slack time
- Provide project documentation
- Useful in monitoring costs.

4.1.2 Limitations of PERT/CPM

- Clearly defined, independent and stable activities
- Specified precedence relationships
- Over emphasis on critical paths.

4.1.3 Applications of CPM / PERT

- These techniques have been used to solve a wide range of problems in a range of organizations and they have even gained recognition in government agencies. These include the following :
  - Construction of a dam or a canal system in a region
  - Construction of a building or highway
  - Maintenance or overhaul of airplanes or oil refinery
  - Space flight
  - Cost control of a project using PERT / COST
  - Designing a prototype of a machine
  - Development of supersonic planes.

4.2 Development of Project Network

4.2.1 Representation of Project Network

- In a network representation of a project certain definitions are used.

1. Activity

- The term "activity" refers to any single action that uses resources and has a beginning and a finish. An arrow is frequently used to indicate an activity, with the head representing the project's progress. These are divided into four groups.

a) Predecessor activity :

- Predecessor activities are those that must be done immediately before the start of another activity.

b) Successor activity :

- Successor activities are those that cannot begin until one or more of the preceding activities have been completed, but which immediately follow them.

c) Concurrent activity :

- Concurrent activities are activities that can be completed at the same time. It should be remembered that an activity can occur before or after an event, or it might occur concurrently with one or more other activities.

d) Dummy activity :

- A dummy activity is an activity that does not utilize any resources but simply shows technology dependency.
- In the following two situations, a dummy activity is put into the network to clarify the activity

Pattern :

- To identify activities with similar starting and ending positions.
- To establish and maintain proper priority between actions that are not connected by events.
- For example, consider a situation where A and B are concurrent activities. C is dependent on A and D is dependent on A and B both. Such a situation can be handled by using a dummy activity as shown in the Fig. 4.2.1.

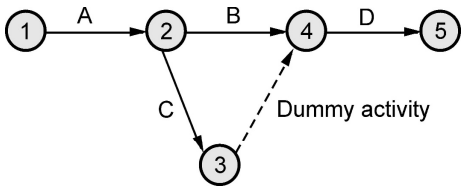


Fig. 4.2.1

2. Event

- An event is a point in time that marks the end of one set of actions and the start of another. In a network, this is commonly represented by a circle, which is also known as a **node** or **connector**.
- The events are classified into three categories :

a) Merge event :

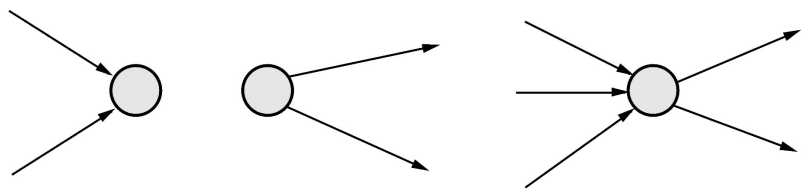
- When more than one activity comes and joins an event such an event is known as a **merge event**.

b) Burst event :

- When more than one activity leaves an event such an event is known as a **burst event**.

c) Merge and burst event :

- An activity can be both a merge and a burst event at the same time, as it can be a merge event for some activities and a burst event for others.



Merge event **Burst event** **Merge and burst event**

Fig. 4.2.2

3. Sequencing

- Maintaining precedence relationships is the first requirement in the development of a network. The following points should be taken into account when creating a network.
  - What job or jobs precede it ?
  - What job or jobs could run concurrently ?
  - What job or jobs follow it ?
  - What controls the start and finish of a job?

- Since all further calculations are based on the network, it is necessary that a network be drawn with full care.

4.2.2 Rules for Drawing Network Diagram

Rule 1

- Each activity is represented by one and only one arrow in the network

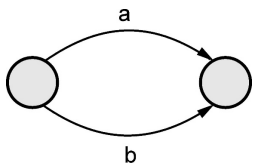


Fig. 4.2.3

Rule 2

- No two activities can be identified by the same end events

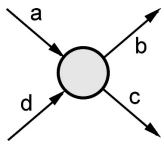


Fig. 4.2.4

Rule 3

- When any activity is introduced to the network, the following questions must be checked to verify the correct precedence relationship in the arrow diagram :
  - What activity must be completed promptly before this activity can begin ?
  - What activities must come after this one ?
  - What other actions must take place at the same time as this one ?
- When drawing a large network, it is essential to follow certain good habits :
  - Try to prevent arrows that cross each other;
  - Use straight arrows;
  - Do not try to represent the time of an activity by its arrow length;
  - Use arrows from left to right. If necessary, utilize vertical and standing arrows to avoid combining two directions.
  - Dummies can be used freely in the rough draught, but there should be no redundant dummies in the final network.
  - There is only one point of entry into the network, known as the **start event** and one point of emergence, known as the **end event**.

4.2.3 Common Errors in Drawing Networks

- When developing network diagrams, the three categories of errors are the most common.

1. Dangling

- Dangling is the act of disconnecting one activity before all other activities in a network diagram have been completed. The activities (5 - 10) and (6 - 7) in the network are not the last ones, as shown in the diagram. As a result, the diagram is incorrect and shows the dangling issue.

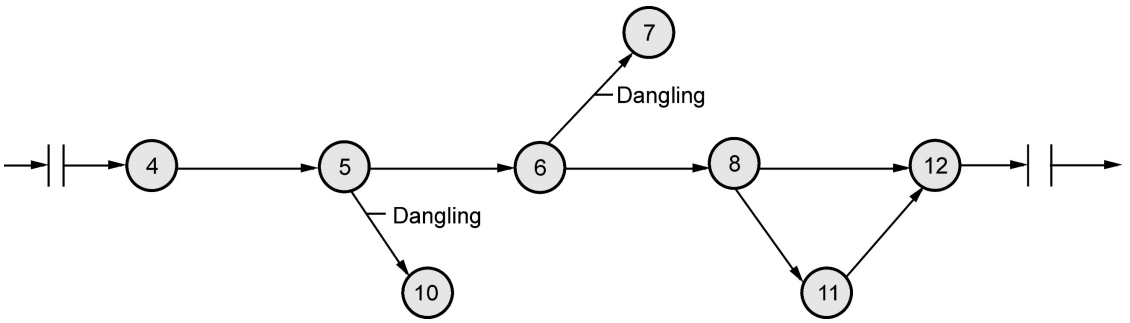


Fig. 4.2.5

2. Looping or Cycling

- In a network diagram, looping error is also known as **cycling error**. As demonstrated in the following diagram, drawing an endless loop in a network is known as a **looping error**.

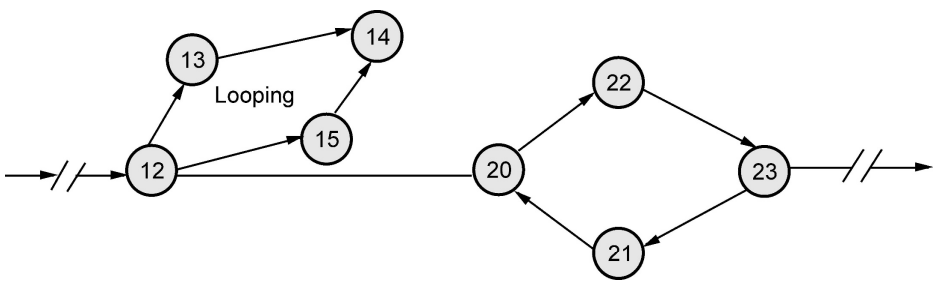


Fig. 4.2.6

3. Redundancy

- The error of redundancy is defined as the unnecessary addition of a dummy activity in network logic, as seen in the diagram below.

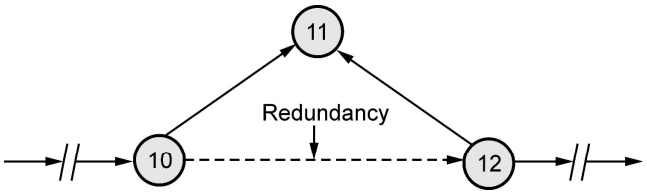


Fig. 4.2.7

Example 4.2.1 *Construct the network diagram for a project with the following activities :*

Event → Event	Activity	Predecessor Activity
1 → 2	A	-
1 → 3	B	-
1 → 4	C	-
2 → 5	D	A
3 → 6	E	B
4 → 6	F	C
5 → 6	G	D

Solution :

- The start event is node 1. The activities A, B, C start from node 1 and none of them has a predecessor activity. A joins nodes 1 and 2; B joins nodes 1 and 3; C joins nodes 1 and 4. So we get the following :

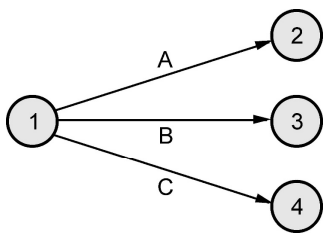


Fig. 4.2.8

- This is a part of the network diagram that is being constructed.
- Next, activity D has A as the predecessor activity. D joins nodes 2 and 5. So we get,

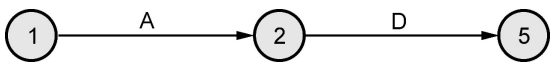


Fig. 4.2.9

- Next, activity E has B as the predecessor activity. E joins nodes 3 and 6. So we get,

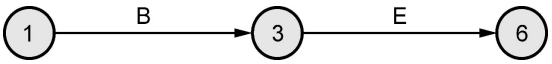


Fig. 4.2.10

- Next, activity G has D as the predecessor activity. G joins nodes 5 and 6. Thus we obtain

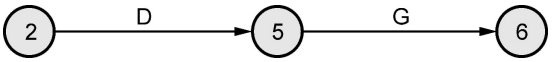


Fig. 4.2.11

- Since activities E, F, G terminate in node 6, we get

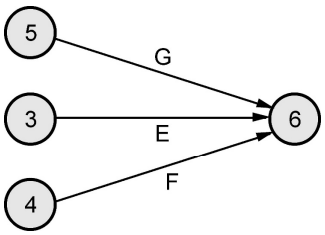


Fig. 4.2.12

6 is the end event.

- Combining all the pieces together, the following network diagram is obtained for the given project :

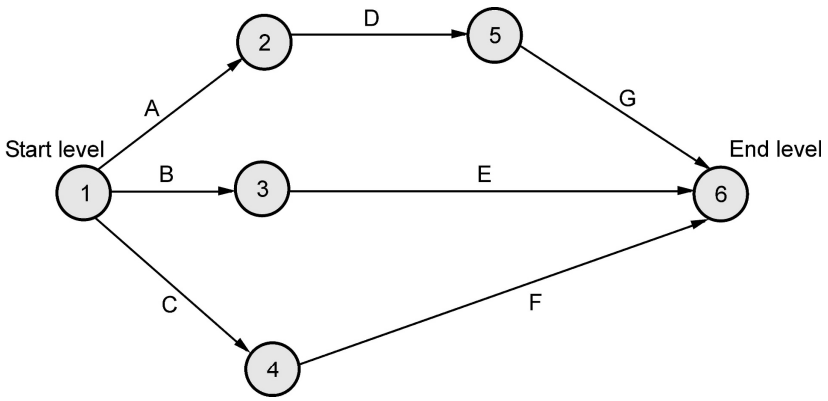


Fig. 4.2.13

4.3 Time Estimation

- For effective project management, accurate time estimation is always a skill. It's important to get time estimations correct for two reasons :
  1. Time estimates affect the project delivery and planning deadlines and hence have an impact on other people's perceptions of your reliability and competency as a project manager.
  2. Time estimations are frequently used to calculate contract pricing and as a result, the contract/commercial project's profitability.
- People frequently estimate the time required to complete projects. This is especially true when the project manager is unfamiliar with the task at hand. Unexpected incidents or high-priority work that's not scheduled may not be taken into account. Project managers frequently fail to account for the whole complexity of a project, as well as the possibility of errors and mistakes.
- Time estimations are important as inputs for other project organization and structure strategies. Using appropriate time estimation techniques, huge projects can be broken down into smaller ones.

Step 1 - Understand the project outcome

- First and important, we must thoroughly understand what we are trying to reach. Examine the project/task thoroughly to ensure that there are no "unknowns." There are a few complex, difficult-to-understand problems that take the most time to solve. The easiest technique to review the job is to make a detailed list of all component jobs.

Step 2 - Estimate time

- We may begin to estimate how long each activity will take place. Once we have a full inventory of all the tasks then we must accomplish the project.
- Make time for project management administration, a detailed project, interfacing with other agencies, resources and authorities, meetings, quality assurance, generating any necessary supporting paperwork or processes and training.
- Also make sure that we have allowed time for :
  1. There are other high-priority activities to be completed that will take priority over this one. Accidents and unusual events. Internal/external meetings.
  2. Absence of key employees/stakeholders due to holidays or illness.
  3. Interaction with other clients, vendors and contractors.

4. Equipment breakdowns.
5. Supplier deliveries that are late.
6. Customer, supplier, contractor, family, pet, coworker and other interruptions. Other priorities and deadlines, such as the planning processes of municipal governments, rejections from quality control etc.
7. Unexpected incidents (e.g., discovering white ants/termites in the walls while renovating the bathroom).

- These issues could greatly increase the amount of time and money required to accomplish a project. If the accuracy of time estimates is crucial, using a systematic way to include these aspects will be beneficial. If at all feasible, use previous experience as a guide. If we don't have any previous experience with the task or project, ask someone who has done it before for advice on what could go wrong, what we should plan for and how long each task took before.
- By estimating the amount of time required to complete a project, we runs the risk of losing a lot of trust and money. We also miss deadlines if we had underestimate time and also put other people of team under unnecessary stress.

Step 3 - Plan for it going wrong

- Finally, budget for all of the expected and unexpected work disruptions and delays that will normally come. Sickness, strikes, materials shortages, low-quality work, administrative errors, etc.

4.4 Determination of the Critical Path

- Computations for basic scheduling
- The notations used are,

(i, j) = Activity with tail event i and head event j
E_i = Earliest occurrence time of event i
L_j = Latest allowable occurrence time of event j
D_{ij} = Estimated completion time of activity (i, j)
$(Es)_{ij}$ = Earliest starting time of activity (i, j)
$(Ef)_{ij}$ = Earliest finishing time of activity (i, j)
$(Ls)_{ij}$ = Latest starting time of activity (i, j)
$(Lf)_{ij}$ = Latest finishing time of activity (i, j)

- The procedure is as follows

A. Determination of earliest time (E_j) : Forward pass computation

Step 1

- The calculation starts at the start node and proceeds to the end node. The forward pass computation begins by assuming that the earliest occurrence time for the initial project event is zero.

Step 2

a. Earliest starting time of activity (i, j) is the earliest event time of the tail end event
   i.e. $(Es)_{ij} = Ei$

b. Earliest finish time of activity (i, j) is the earliest starting time + the activity time
   i.e. $(Ef)_{ij} = (Es)_{ij} + D_{ij}$ or $(Ef)_{ij} = E_i + D_{ij}$

c. Earliest event time for event j is the maximum of the earliest finish times of all activities ending in to that event
   i.e. E_j = max [$(Ef)_{ij}$ for all immediate predecessor of (i, j)] or $E_j = \max [E_i + D_{ij}]$

2. Backward pass computation (for latest allowable time)

Step 1

- For the ending event assume E = L. Remember that all E's have been computed by forward pass computations.

Step 2

- Latest finish time for activity (i, j) is equal to the latest event time of event j
  i.e. $(Lf)_{ij} = L_j$

Step 3

- Latest starting time of activity (i, j) = The latest completion time of (i, j)
  – The activity time or $(Ls)_{ij}$
  $= (Lf)_{ij} - D_{ij}$ or $(Ls)_{ij} = L_j - D_{ij}$

Step 4

- Latest event time for event 'i' is the minimum of the latest start time of all activities originating from that event

i.e. L_i = min [$(Ls)_{ij}$ for all immediate successor of (i, j)] = min [$(Lf)_{ij} - D_{ij}$] = min [$L_j - D_{ij}$]

3. Determination of floats and slack times

- There are three kinds of floats

a) Total float :

- The amount of time by which the completion of an activity could be delayed beyond the earliest expected completion time without affecting the overall project duration time.

- Mathematically,

$(Tf)_{ij}$ = (Latest start – Earliest start) for activity (i – j)

$(Tf)_{ij}$ = $(Ls)_{ij} – (Es)_{ij}$ or $(Tf)_{ij} = (Lj – D_{ij}) – E_i$

b) Free float :

- The time by which the completion of an activity can be delayed beyond the earliest finish time without affecting the earliest start of a subsequent activity
- Mathematically,

$(Ff)_{ij}$ = (Earliest time for event j – Earliest time for event i) – Activity time for (i, j)

$(Ff)_{ij} = (E_j – E_i) – D_{ij}$

c) Independent float :

- The amount of time by which the start of an activity can be delayed without affecting the earliest start time of any immediately following activities, assuming that the preceding activity has finished at its latest finish time.
- Mathematically,

$(If)_{ij}$ = $(E_j – L_i) – D_{ij}$

- The negative independent float is always taken as zero.

d) Event slack :

- It is defined as the difference between the latest event and earliest event times.
- Mathematically,

Head event slack = $L_j – E_j$, Tail event slack = $L_i – E_i$

4. Determination of critical path

a) Critical event :

- The events with zero slack times are called **critical events**. In other words the event i is said to be critical if $E_i = L_i$

b) Critical activity :

- The activities with zero total float are known as critical activities. In other words an activity is said to be critical if a delay in its start will cause a further delay in the completion date of the entire project.

c) Critical path :

- The sequence of critical activities in a network is called **critical path**. The critical path is the longest path in the network from the starting event to ending event and defines the minimum time required to complete the project.

Example 4.4.1 *Determine the early start and late start in respect of all node points and identify critical paths for the following network.*

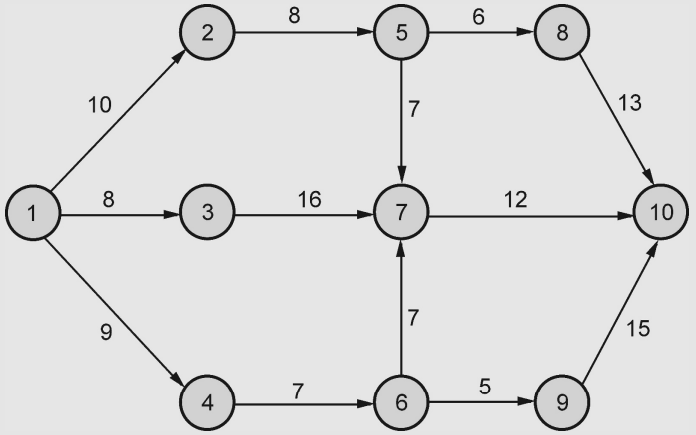


Fig. 4.4.1

Solution : Calculation of E and L for each node is shown in the network :

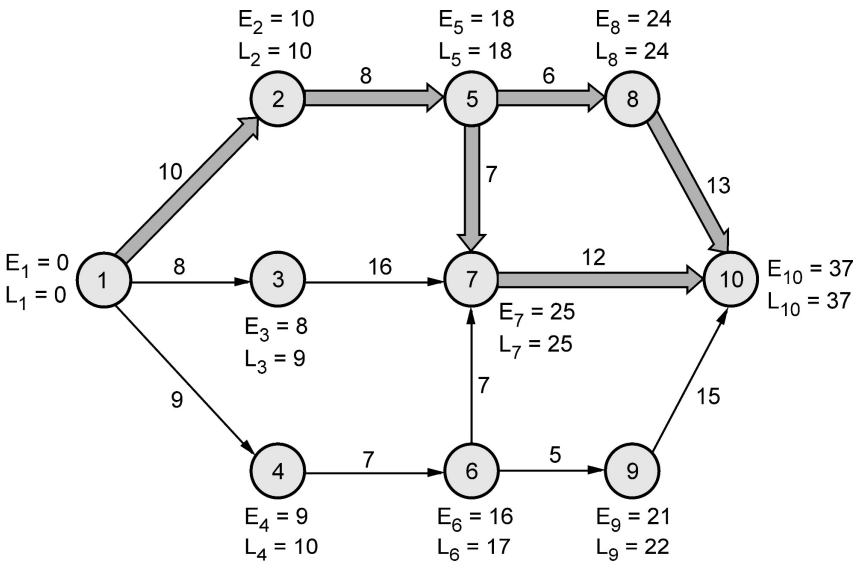


Fig. 4.4.2

Activity(i, j)	Normal Time (D_{ij})	Earliest Time		Latest Time		Float Time $(L_i - D_{ij}) - E_i$
		Start (E_i)	Finish ($E_i + D_{ij}$)	Start ($L_i - D_{ij}$)	Finish (L_i)	
(1, 2)	10	0	10	0	10	0
(1, 3)	8	0	8	1	9	1
(1, 4)	9	0	9	1	10	1
(2, 5)	8	10	18	10	18	0
(4, 6)	7	9	16	10	17	1
(3, 7)	16	8	24	9	25	1
(5, 7)	7	18	25	18	25	0
(6, 7)	7	16	23	18	25	2
(5, 8)	6	18	24	18	24	0
(6, 9)	5	16	21	17	22	1
(7, 10)	12	25	37	25	37	0
(8, 10)	13	24	37	24	37	0
(9, 10)	15	21	36	22	37	1

Network analysis table

From the table, the critical nodes are (1, 2), (2, 5), (5, 7), (5, 8), (7, 10) and (8, 10)

From the table, there are two possible critical paths

i. $1 \rightarrow 2 \rightarrow 5 \rightarrow 8 \rightarrow 10$ **ii.** $1 \rightarrow 2 \rightarrow 5 \rightarrow 7 \rightarrow 10$

Example 4.4.2 *Find the critical path and calculate the slack time for the following network*

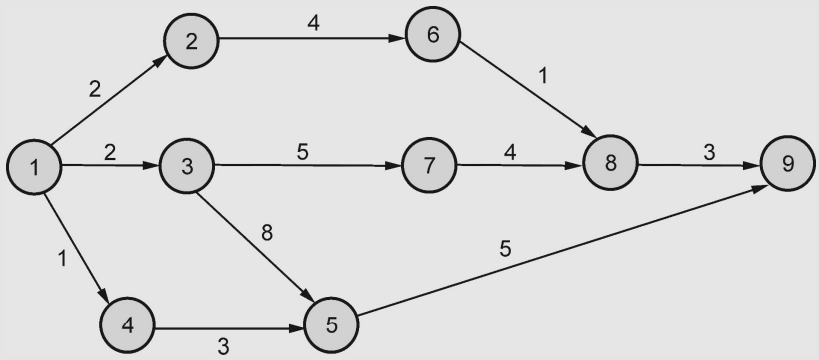


Fig. 4.4.3

Solution : The earliest time and the latest time are obtained below,

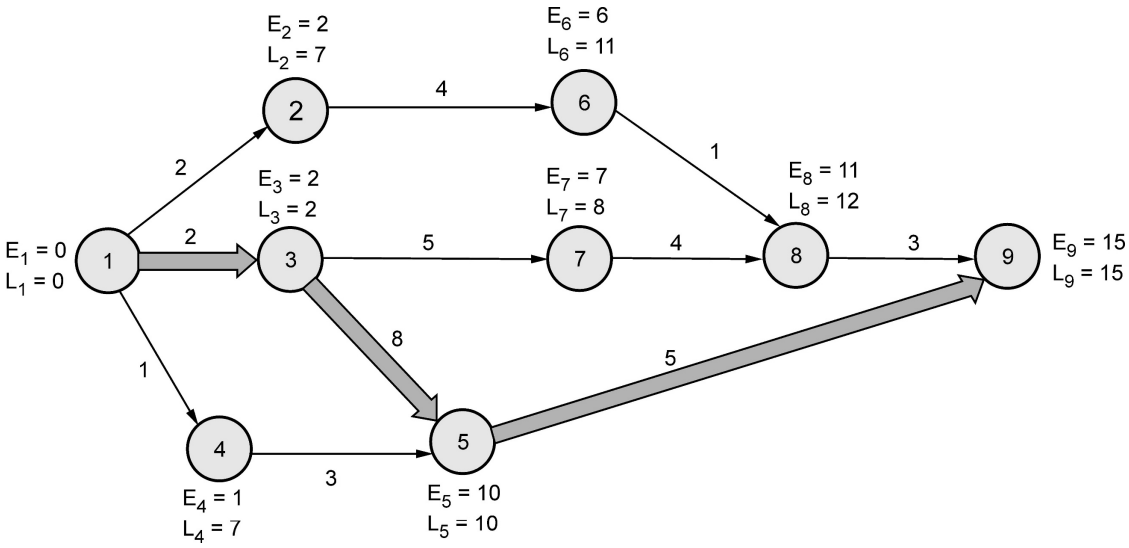


Fig. 4.4.4

Activity(i, j)	Normal Time (D_{ij})	Earliest Time		Latest Time		Float Time
		Start (E_i)	Finish ($E_i + D_{ij}$)	Start ($L_i - D_{ij}$)	Finish (L_i)	$(L_i - D_{ij}) - E_i$
(1, 2)	2	0	2	5	7	5
(1, 3)	2	0	2	0	2	0
(1, 4)	1	0	1	6	7	6
(2, 6)	4	2	6	7	11	5
(3, 7)	5	2	7	3	8	1
(3, 5)	8	2	10	2	10	0
(4, 5)	3	1	4	7	10	6
(5, 9)	5	10	15	10	15	0
(6, 8)	1	6	7	11	12	5
(7, 8)	4	7	11	8	12	1
(8, 9)	3	11	14	12	15	1

Network analysis table

From the above table, the critical nodes are the activities (1, 3), (3, 5) and (5, 9)

The critical path is **1 → 3 → 5 → 9**

4.5 PERT Model

- The PERT model was created for projects with a high level of uncertainty.
- So far, we have discussed projects where the outcome of activities are known with high certainty. In other words, the logic of cause-and-effect is clearly understood. This is especially true in engineering projects.
- However, the start - causing relationship is not well established in R&D projects or in social projects that are described as "process projects," where learning is a key consequence.
- In such cases, the PERT technique is advantageous because it can account for variations in event completion times based on estimates from an expert or an expert committee.
- PERT is also used to calculate the time required for every task independently and to spot the least possible time required for every task independently and to spot the least possible time required to complete the entire project.
- For each activity, three time estimates are taken -
  - The most optimistic
  - The most likely
  - The most pessimistic.
- The duration of an activity is calculated using the following formula :

$$t_e = \frac{t_0 + 4\ t_m + t_p}{6}$$

Where

t_e is the expected time,

t_0 is the optimistic time,

t_m is the most probable activity time

t_p is the pessimistic time.

- It is not required to go into detail about the formula's theory. It is sufficient to understand that the weights are based on a rough approximation of the beta distribution.
- The standard deviation, which is a good measure of the variability of each activity is calculated by the rather simplified formula :

$$s_1 = \frac{t_p - t_0}{6}$$

- The variance is the square of the standard deviation.
- The steps involved in executing PERT method are as follows :

1. Project planning :

- The goal of project planning is to identify all of the significant events that are required for the project's completion and construction. The interconnection of these events is depicted directly as a network.

2. Time estimation :

- Estimates of the time required to complete each network activity are made based on labor and equipment availability, as well as certain assumptions included in the project plan. The project duration and criticality of the activities are estimated by incorporating the time required to complete each of the activities in the network.

3. Scheduling :

- The computations for scheduling provide the earliest and latest permitted start and finish timings for each activity. They identify the critical path through the network as a byproduct and highlight the amount of 'slack' time associated with the non-critical paths.

4. Time-cost trade-off :

- If the project completion time calculated in step 3 is satisfactory, project planning and scheduling may be completed. However, if calculating the cost of reducing project completion time is desired, time-cost trade-offs of activity performance timeframes for those activities on the critical and almost critical paths must be evaluated.

5. Resource allocation :

- Each schedule's feasibility must be evaluated in terms of labor and equipment requirements. Establishing the complete feasibility of a particular timetable may necessitate re-planning and re-scheduling, as well as time-cost trade-offs.

6. Project control :

- Once the network plan and schedule have been established to a sufficient level, they are finalized and ready for usage in the field. Controlling the project includes comparing progress to the timetable, assigning and scheduling workers and equipment and analyzing the effects of delays. When important modifications are made to the schedule, the network is updated and a new schedule is generated. In summary, this stage entails periodic network updates to monitor project progress and making required changes to schedules to achieve project completion as near to the goal time as possible.

4.6 Measures of Variability

- The standard deviation or its square, variance, is used to measure variability in PERT analysis. The variance in the project completion time can be calculated by summing the variances in the completion of the time activities in the critical path.
- Using a normal probability distribution for the critical path with expected time and variance, one can compute the probability that the project will be completed by a specific date. If the number of activities in the path is high enough for the central limit theorem to be applied, the normal distribution assumption also applies.
- To calculate the variance for each activity completion time, if three standard deviation times were selected for the optimistic and pessimistic times, then there are six standard deviations between them, so

$$\text{Variance} = [(\text{Pessimistic} - \text{Optimistic}) / 6]^2$$

$$\text{Standard Deviation} = [(\text{Pessimistic} - \text{Optimistic}) /6]$$

Activity	B	A	Var = [(b – a) /6]2
1 - 2	21	9	4.00
2 - 5	24	10	5.44

Table 4.6.1 Variance of activities

Variance and standard deviation of critical path :

$$\text{Variance} = [(\text{Pessimistic} - \text{Optimistic}) /6]^2$$
$$= 4.00 + 5.44$$
$$= 9.44$$
$$\text{S.D.} = (9.44)^{1/2}$$
$$= \mathbf{3.07}$$

- Now we know that mean and standard deviation of the critical path duration for our project are 28 and 3.07 weeks, respectively. Given this information, we can calculate the probability that the project will be completed by a certain date.

Probability of Completion by a Specified Date

- Convert our specific normal distribution into standard normal distribution (with mean and standard deviation equal to 0 and 1 restrictively) i.e. Find z = (X – mean)/s.d.)
- Obtain cumulative probability up to z looking at the probability distribution of the standard normal variate.

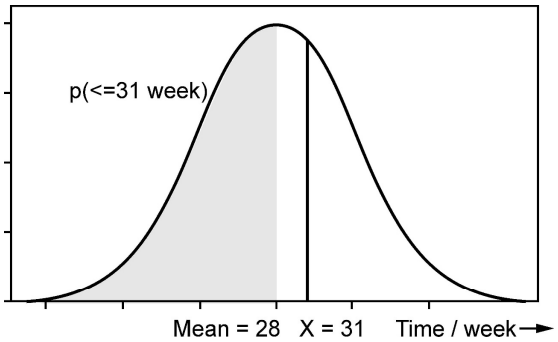


Fig. 4.6.1 Normal distribution of critical path duration

Example 4.6.1 *Find the probability of completing the project by 31 weeks.*

Solution :

$$Z = (31 - 28)/3.07 = 0.97$$

Required probability (P<=31 weeks) = 0.8340

Example 4.6.2 *Find the probability of completing the project by 20 weeks.*

Solution :

$$Z = (20 - 28)/3.07 = -2.6$$

Required probability (P<=20 weeks) = 0.0197

4.7 CPM Model

- The CPM model was created for initiatives with a low level of risk. While both approaches begin with network creation and an emphasis on the critical route, the PERT approach is 'probabilistic' and the CPM approach is 'deterministic.' This does not imply that we only use single time estimates in CPM analysis. In fact, the primary focus of CPM analysis is on fluctuations in activity times caused by changes in resource allocation. These changes are intentional and tied to resource assignments, rather than being generated by random factors beyond management's control, as in the case of PERT analysis. The primary focus of CPM analysis is on time-cost relationships, with the goal of determining the project schedule that minimizes total cost.

Assumptions for CPM Analysis :

- The following are the most common assumptions that support CPM analysis :
  1. A project's costs are separated into two categories : Direct costs and indirect costs. Direct costs are incurred for direct materials and direct labor. Overhead

expenses such as indirect supplies, rent, insurance, management services and so on are examples of indirect costs.

2. Project activities can be increased by crashing, which requires the use of additional resources.
3. Crashing saves time but increases direct expenses due to factors such as overtime payments, extra payments and waste. A downward sloping straight line can be used to represent the relationship between time and direct activity expense.

A typical cost timeline is shown in the Fig. 4.7.1.

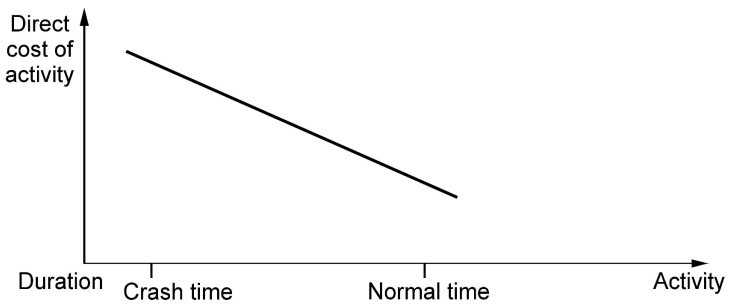


Fig. 4.7.1 A typical cost timeline

4. Project-related indirect expenses rise linearly with project duration. The Fig. 4.7.2 below illustrates a typical line for indirect charges.

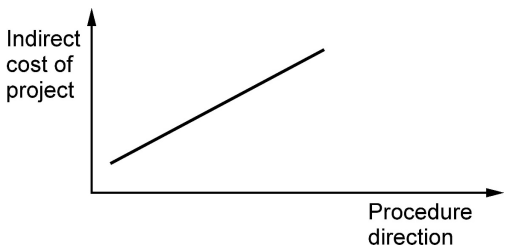


Fig. 4.7.2 Indirect charges

Procedure for CPM Analysis :

- Considering the above - mentioned assumptions, CPM analysis tries to investigate the effects of crashing on total cost (direct cost plus indirect cost). Because the behavior of indirect project costs is well characterized, the majority of CPM analysis focuses on the link between total direct cost and project length. In general, the procedure used in this regard is as follows :
  1. Identify the essential path in the regular network. Determine the length and direct cost of the project.

2. Examine the cost-time slope of activities in the critical path and crash the activity with the lowest slope.
3. Create a new critical path after crashing, as described in step 2. Establish the project's duration and cost.
4. Repetition steps 2 and 3 until all activities on the critical path (which may change each time) fail.

4.8 Network Cost System

- The network cost system was primarily used for vehicle cost planning. The costs are measured, analyzed and compared and the cost is estimated.
- The network system can be explored backward or forward, with events occurring either before or after. The project management should not be repeated.
- Network cost system was developed to provide control of projects.
- For cost projections it is assumed that the expenditure for any activity is incurred evenly over the duration of activity.

Analysis and control of cost

1. **Cost incurred to date :**

   In network cost system, costs are recorded activity wise. Cost incurred to date can be obtained by summing up costs for various activities.

2. **Budgeted cost to date :**

   Budget cost to date is the cost projections made at the beginning.

3. **Value of work done to date :**

   It is the product of budget costs and percentage of work completed.

4. **Cost over run (under run) to date :**

   It is given by,

$$\text{CORD} = \frac{\text{Actual cost} - \text{Value of work completed}}{\text{Value of work completed}} \times 100$$

5. **Time over-run(under run)to date :**

Time over-run is usually defined in terms of months behind or months ahead.

4.9 Introduction - Resources Considerations in Projects

- People, equipment, space, money and whatever else we will need to complete all of the activities we have planned are all considered resources. Resources must be assigned to each action on our activity list. We must first determine the availability

of resources before we can assign them to our project. Information on resource availability comprises what resources we can utilize on your project, when they're available and the conditions under which they're available. Remember that some resources, such as consultants or training rooms, must be planned ahead of time and may only be available at specific periods. Before we can finish designing our project, we will need to know this. Because the wedding halls are all signed up in advance, a June wedding is more difficult to schedule than a december wedding if we start planning in January. Clearly, there is a resource constraint here.

- The purpose of activity resource estimation is to allocate resources to each activity on the list. Estimating activity resources may be done using five different methods and techniques.
  i. Expert judgment involves inviting in specialists who have done similar work in the past and asking their input on the resources required.
  ii. Alternative analysis involves analyzing a variety of resource allocation possibilities. This includes varying the number and types of resources we use. Many times, there are multiple ways to complete a task and alternative analysis can help us to choose amongst them.
  iii. Project managers in a variety of industries use published estimating data to help them figure out how many resources they'll require. They depend on information from other people's projects to be collected, analyzed and published in papers, books, journals and periodicals.
  iv. Project management software, such as Microsoft Project, will frequently include capabilities to assist project managers in estimating resource demands and constraints, as well as determining the optimum task combination for the project.
  v. Bottom-up estimating is breaking down complex operations into smaller chunks and determining resource allocations for each one. It's a method of calculating individual activity resource requirements or costs, then adding them up to arrive at a total estimate. Bottom-up estimating is a very accurate method of estimating, assuming that the estimations at the scheduling activity level are correct. Bottom-up estimating, on the other hand, takes a long time since each activity must be assessed and estimated precisely before being included in the bottom-up computation. The greater the accuracy and cost of this technology, the smaller and more detailed the activity.

4.10 Resource Allocation

- The allocation of resources is an important aspect of project management. If we have a task, project, or programme to complete, we will need resources dedicated to it to assist we complete it. To get everything done, we will need qualified people (e.g., creatives, authors, developers, and construction workers), tools (e.g., software, hardware, and conference spaces), and time. Effective resource allocation is important practically for every industry for completing projects on time and on budget.
- The process of assigning and managing assets in a way that supports an organization's strategic goals is known as **resource allocation**.
- Managing real assets like hardware to make the greatest use of softer assets like human capital is part of resource allocation. In order to maximize the effective use of limited resources and achieve the best return on investment, resource allocation involves balancing competing requirements and priorities and identifying the most effective course of action.
- Organizations must first choose their desired end goal, such as higher income, increased productivity, or improved brand awareness, before implementing resource allocation.

Resource Allocation Process :

- Almost every project, product launch, website redesign, and other effort that a business does requires resources. After all, how would anything get done if we didn't have the appropriate resources? Let's start with the most fundamental types of resources you might require or come across when managing a project :

People :

- Writers, editors, user experience (UX) designers, art directors, account managers, traffic managers, freelance or contract resources, developers, testers - these are the people with the abilities we need to complete will project.

Time :

- This is the entire amount of time (days, weeks, months, and years) that we have to complete our project. While the project's completion date may already be set, we can divide that time period into increments to keep our project on track.

Tools and capital :

- If our project team need a separate "war room," or access to specific equipment to build unique features or products, these must be prepared for and distributed effectively during the resource allocation phase of project management.

- A project or program coordinator is in responsibility for resource allocation at the most granular level. Throughout the project's schedule, the project manager must determine what types of people, time and tools will be required. Project managers, on the other hand, rarely have resource personnel reporting to them in most businesses. They'll need to work with department leaders in development, IT, creative and content, as well as those whose direct reports will be asked to help with the project.
- Some companies and corporations appoint a traffic or resource manager who can provide a high-level overview of who is doing what in which department during the time period in issue. To help coordinate the allocation of resources, that person would operate as a go-between with the department head (the person who is actually doing the work's actual manager) and the project manager.
- "How does our workload look next week?" a project manager would ask a possible resource - say, a copywriter - simply in a smaller organization. We were asked to copywrite and edit four web pages for eight to ten hours." If that writer said he or she had time available, the project manager would need to seek formal approval from their boss and enter the resourcing in the company's tracker.
- A creative resource may be requested by name on occasion during the course of a long project where the creative team is working closely with clients or internal stakeholders. If a project requires a short campaign of banner advertising, for example and the client knows that a specific writer is skilled in that area, the client may request that writer be assigned to the project. Whether something can be accommodated is contingent on the other commitments of that resource as well as other commercial considerations. Typically, the project manager has the final word on which resources are assigned to a project.

4.11 Scheduling

- Project scheduling is a method of communicating what activities must be completed and how organizational resources will be assigned to fulfill them within a given timeframe. A project schedule is a document that lists all of the tasks that must be completed in order to complete the project on time.
- When it comes to designing a project timeline, however, few people have extensive experience.
- What and who is being scheduled, and why, and where is this scheduling taking place ?

- A project consists of numerous tasks, each of which has a start and end date (or due date) so that it can be completed on time. Similarly, people have varied schedules, and their availability as well as vacation or leave dates must be noted in order to organise those duties successfully.
- Whereas in the past, workers might have shared spreadsheets via email or printed calendars on a common wall in the water cooler room, most teams now use online project scheduling software. Project scheduling is usually simply one function inside a broader project management software system and it happens in a variety of areas within the platform.
- Most tools, for example, feature task lists that allow a manager to schedule many tasks, their due dates and occasionally the expected effort against each work, as well as assign each task to a person. The programme may also include resource scheduling, which allows our to schedule not only the availability of our team, but also non-human resources such as machines, buildings and meeting spaces.
- Project scheduling software automatically changes tasks that are dependent on one another when one scheduled activity is not done on time, because projects contain so many moving elements and are always changing. It also sends out automated email alerts to remind team members when their scheduled tasks are due or late, as well as to notify the manager when someone's availability changes.
- Project scheduling is relatively simple when done online, especially since the programme performs all the heavy lifting for us.

Schedule a Project

- Let's take a look at the fundamentals of project scheduling before we go any further. Project scheduling takes place throughout the project's planning phase. To begin, we must ask ourself three questions :

  1. What should be done ?
  2. When is it going to be finished ?
  3. Who is going to do it ?

- After we have answered these questions, we may start planning dates, activities, durations, goals and resources. The steps for scheduling a project are as follows :

Identify the activities :

- What are the tasks that we must complete as part of the project ? We may begin to organize these activities by mapping out the actions required to execute them in a logical order using a Work Breakdown Structure (WBS) and a deliverables diagram.

Prepare estimations :

- Once we have defined the activities and broken them down into tasks, we will need to figure out how much time and effort it will take to complete them. This is a necessary component of the equation for calculating the correct timetable.

Establish Dependencies :

- Tasks do not exist in isolation and often one cannot begin until the other has been finished. This is known as a task dependency and our schedule will need to represent these interconnected tasks. One approach to achieve this is to leave some space in our calendar to accommodate these duties.

Allocate Resources :

- The final stage in completing our planned schedule is to determine what resources we will require to complete those tasks on time. We will need to assemble a team, and their time, like the duties, will need to be scheduled.

How to Maintain Schedule Once the Project is initiated

- Once we have put our schedule together then manually input it into a static document like an Excel spreadsheet. Much of the process can be automated with project management software. However, not all project management software is equal.
- There are applications on the market that are excellent for easy scheduling tasks, but when we are in charge of a project, big or small, we need a tool that can adapt to the wide range of scheduling challenges we will face. Tasks, people and projects are the three stages of scheduling, as mentioned previously.

Task Scheduling :

- When it comes to task scheduling, we don't want a simplified to-do list; we want clever software that allows you to handle the diversity of duties associated with each activity in your project.
- It's important to have an interactive Gantt chart. You may use your Gantt chart to visualize the time of each work by adding tasks and dates. Even better, as dates change - as they surely do - we can simply drag and drop those adjustments to instantaneously update the entire Gantt chart.
- There's also the option of automating operations to improve efficiency. When a team member completes a task, email alerts are a wonderful way to know right away. Our programme is online and responding in real-time, so we know when they update.

- Keeping with the automation theme, it's one technique to make task scheduling more efficient. If a project has recurring tasks, they can be scheduled in our project management application so that we don't have to worry about scheduling the same work over and over.

People Scheduling

- Our assignments aren't going to finish themselves. That's why we have put together a team, but if they aren't scheduled in the same manner we have meticulously scheduled our job list, we aren't managing our project.
- Throughout the lifecycle of a project, team members will take time off for holidays, personal days, or vacation. Our timetable will suffer if we aren't prepared for these periods and haven't scheduled other team members to make up the slack in their absence.
- Using a project management software to integrate our calendar is an easy method to keep track of our resources. There's no reason to utilize a standalone calendar that directs us to another programme every time we need to check on the availability of a team member.
- Integrating our task scheduling view on the Gantt chart with resource and workload scheduling tools is another method to keep on top of our scheduling. We can color-code your team's workload so we can see who is behind, ahead, or on schedule with their responsibilities at a glance.

Project Scheduling

- We have progressed from task to resource scheduling and there is no rule that says we can't work on a portfolio of projects. How can we keep track of everything when we are juggling so many balls at once ?
- Whether we are working on one or multiple projects, the project dashboard is our best buddy. The dashboard gathers all of the real-time data gathered by we and our teams, then organizes it based on any number of criteria to give we a picture of where we stand in real-time on a project or many projects.
- And this is just exploring the possibilities of what project scheduling entails. Our continuous series looks into new and important project management terms, concentrating on a single definition and explaining what it signifies for anybody in leadership of a project.
- However, the simplest way to learn about scheduling is to start today with a project tool, our tasks and our team and establish a new project plan.

4.12 Project Cost Estimate and Budgets

- Many individuals believe project cost estimation to be an art because of the complexities involved. To achieve a satisfactory job, one must compile and analyze a large amount of cost data from previous projects completed within the organization and maintain this data up to current by collecting the most recent market price estimations. Market intelligence must be really trustworthy. However, we must never forget that the only thing worse than missing information is receiving incorrect or incomplete information, which must be avoided at all costs.

Cost of Projects

- Even though companies must participate in competitive bidding to secure business prospects, many companies in the project design, engineering, procurement and construction industries use cost data to arrive at the project pricing. Even if it is based on a lot of cost data, project pricing can still be considered an art. At any rate, it is a strategy - **Those who talk, don't know and those who know, don't talk.**

Costing and Princing of Projects

- We may require many types of cost estimates from the concept to the commissioning of projects. Obviously, the type and detail of information and data accessible at that point of the project determines their level of accuracy.

(a) Order-of-magnitude cost estimates

- Without any particular engineering data, this form of cost estimate is made. Within the scope of the project, this cost estimate may be accurate by 25 %. It might be based on previous experience with foreign principals in India or abroad, or it could be based on capacity estimations. Companies that work on foreign projects use a lot of information from their domestic projects and apply wide "scaling factors" to get the cost in the customer's currency. Another common metric is per megawatt of electricity generated by power plants, per kilometre of railway track in the plains, or per kilometer of railway electrification for single, double, triple, or quadruple tracts, or per kilometer of road (to a defined specification) to be built. For preliminary conversations and project formulation, these order-of-magnitude cost estimates are useful.

(b) Approximate cost estimate (PFR estimates)

- It's also known as a top-down estimate because it's done without comprehensive engineering data and can be accurate up to 15 %. At the Preliminary Feasibility Report (PER) stage, this type of estimate is made. We use a variety of costing

strategies here, such as a pro-rata estimate based on previous experience with similar projects and inflation updates. It's also known as analogy estimation or rule-of-thumb estimation. Indexing costs of similar activities is something we do a lot. These have been tweaked to account for capacity and technological advancements. Due to the lack of precise engineering data, the estimator is likely to conclude that because this component is 20 % more complex than a similar one accomplished on another project, it will cost 20 % more overall or in terms of materials, labor, or overhead, as applicable.

(c) Economic feasibility cost estimate (TEFR Estimates)

- We will create an Economic Feasibility Cost Estimate of the project as we proceed through the project formulation. This is utilized to calculate product costs and pricing and as a result, the project's profitability analysis is based on this cost estimate. For the Techno Economic Feasibility Report (TEFR) stage, this is based on a reasonable degree of comprehensive engineering data and should be accurate + 10 %. This activity has been destroyed to include a lot of information. Budget quotations from vendors are also obtained, both in terms of function and for specialized equipment. To produce accurate cost estimates of all primary plant items (within the battery limitations) and all service or utility plants and systems beyond the battery limits, a large amount of cost data accumulated from previous projects is used extensively. It is feasible to generate total cost statistics and the same for each type of equipment used or system deployed.
- This cost estimate was used by corporations when they applied to the Indian government for an industrial license and a capital goods licence for imported plant and machinery. It is only required for industries on the restricted list with regulation.

(d) Detailed project cost estimate (DPR Estimates)

- A number of aspects become defined as the project formulation progresses. Some preliminary drawings are prepared, such as layouts, process flow diagrams, piping and instrument (also known as engineering line) diagrams and the company validates its action plan by preparing a detailed project cost estimate, which corresponds to the Detailed Project Report (DPR) stage and is expected to be accurate to + 5 %. The costing process is highly precise at this point and the costs of all important plant items are backed up by accurate pricing information from the expected vendors. Even at this point, The cost of building and erection labour, as well as the cost of overheads, are factorial estimates.

(e) Control cost estimates

- After making some progress on the fundamental design, such as planning specific schemes, flow diagrams and layouts, a full cost-estimating exercise is carried out. When the above-mentioned basic documents are adequately frozen, we have effectively established the scope of the project at hand. As a result, the goal is to achieve an accuracy of + 2.5 percent, though it may be more precise to say that it is less than + 5 percent, because achieving an accuracy of less than + 5 percent is highly dependent on economic stability price inflationary trends, the balance of payment, currency exchange rate fluctuations and other factors.
- These estimates are used to control costs when plant and equipment are being developed, built and ordered and they serve as a highly effective framework for controlling expenses as they are incurred, as their name implies.
- The prior DPR estimates are utilised for indenting and ordering any key long-delivery items of equipment until the Control Cost Estimates (CCE) are finalized, and the same values are adopted/incorporated into the CCE.

4.13 Cost Forecasts

- The cost forecast is a method for adapting cost planning to continually changing conditions. The system calculates and evaluates the remaining activities based on the network's plan, prediction and actual values for the cost to complete the project.
- During the project's execution phase, there are frequent differences between the initial cost and process planning and the actual project. It only takes a movement in activity dates inside the buffer times to modify project expenses. After the initial actual expenses have been incurred, we must verify and adjust the residual costs. This is the only way for us, as the project manager, to get a fair cost estimate for the project's entire duration.
- The cost forecast enables us to adapt our budgeting to changing circumstances. The system evaluates and values residual activities based on planned, forecasted and actual network values to obtain current residual costs (estimate to completion). The updated total costs (estimate at completion) are calculated by adding the total of the project's already-incurred costs (actual and commitment) and the updated residual costs.

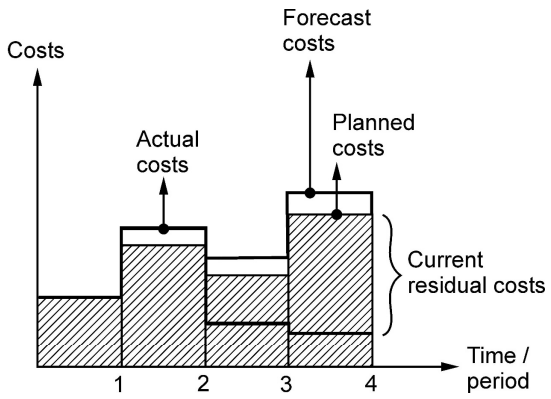


Fig. 4.13.1 Concept of cost forecast

- The obtained figures are estimates that serve as the foundation for our expenses prediction.
- We can run a cost forecast for one or more projects at any time. We can also have multiple forecast versions in the system at the same time if necessary.
- You must first complete the following steps before accessing the cost forecast :

  a. Reschedule :

  The cost forecast does not include any activity scheduling. We must arrange in order to account for schedule variations when calculating the revised residual costs.

  b. Determine overhead based on real and committed values :

  To determine the updated total costs, we must do an overhead calculation on both the actual and committed numbers individually. The system calculates the planned overheads for activities in the cost forecast based on the updated residual costs.

  c. Free our mind :

  Forecast the cost required to complete the project without consideration to budget, leadership expectations, or previous cost forecasts.

  d. Maintain simplicity :

  Simple structure, simple calculation and simple communication.

- Thus, the overall cost forecast should cover all anticipated expenses, incorporate alternatives corresponding with the project's risk level and achieve benefits against opportunities only if opportunity-generating actions are completed.

Review Questions

1. *What is PERT ?*
2. *Explain the concept of PERT.*
3. *What is CPM?*
4. *What are the steps in CPM ?*
5. *Explain the concept of CPM.*
6. *What is scheduling ?*
7. *Describe about PERT.*
8. *Differentiate CPM & PERT.*
9. *Write a notes on measures of variability.*
10. *Describe CPM model.*
11. *Explain the resource allocation in project management.*
12. *Write a notes on project cost and budget.*
13. *Write a notes on cost forecasts.*

Multiple Choice Questions

Q.1 The particular task performance in CPM is known _____.

a dummy b event

c activity d contract.

Q.2 The critical path _____.

a is a path that operates from the starting node to the end node.

b is a mixture of all paths.

c is the longest path.

d is the shortest path.

Q.3 Free float for any activity is defined as the difference between _____.

a its earliest finish time and earliest start time for its successor activity.

b its latest start time and earliest start time.

c its latest finish time and earliest start time for its successor activity.

d its earliest finish time and latest start time for its successor activity.

Q.4 The time with which direct cost does not reduce with the increase in time is known as _____.

a crash time b normal time

c optimistic time d standard time

Q.5 PERT (Project Evaluation and Review Technique) analysis is based on _____.

a Optimistic time, Pessimistic time and Most likely time

b Pessimistic time, Optional time, Maximum time

c Optimistic time, Efficient time, Most likely time

d Minimax time, Optimistic time and harmonic time

Q.6 The PERT in project management means program evaluation and _____ technique.

a resource b reconciliation

c reconsideration d review

Q.7 The statistical tool that depicts a project's tasks and the relationships between those tasks is known as _____.

a milestone b goal

c Gantt chart d PERT chart

Q.8 In PERT (Project Evaluation and Review Technique) method Expected time (Te) is ____.

a (To+Tp+4Tm)/6 b (To+Tp+2Tm)/6

c (To+Tp+Tm)/6 d (Tm+Tp+4To)/6

Q.9 An activity that has more than one dependency arrow flowing into it is termed a(n) _____.

a parallel activity b critical path

c burst activity d merge activity

Q.10 The critical path in a project network is the_____.

a shortest path through the network

b longest path through the network

c network path with the most difficult activities

d network path using the most resources

Q.11 The backward pass in project network calculations determines the_____.

a latest time's activities can begin

b earliest time's activities can be finished

c critical path

d both A and C are correct

Q.12 The resource allocation problem is concerned with determining the best _____ .

a person b manager

c trade-offs d marketing

Q.13 Reserve analysis a technique NOT used in _____.

a estimate costs b determine budget

c control cost d average cost

Q.14 A schedule that has been defined at a degree of resolution that allows progress to be monitored and the project to be controlled, is called, _____.

a project tracking b project scheduling

c project network d project monitoring

Q.15 In order to develop a project schedule, a task set must be distributed on the project time line.

a True b False

Explanation : In order to build a project schedule, it is necessary to distribute a job set across the project's timeline. The tasks assigned to the software team will vary based on the project type and the level of rigor with which the team chooses to complete its work.

Answer Keys for Multiple Choice Questions :

Q.1	c	**Q.2**	c	**Q.3**	a	**Q.4**	b
Q.5	a	**Q.6**	d	**Q.7**	d	**Q.8**	a
Q.9	d	**Q.10**	b	**Q.11**	d	**Q.12**	c
Q.13	c	**Q.14**	b	**Q.15**	a		

❑❑❑

Notes

UNIT V

5 Project Risk & Financial Management

Syllabus

Project Risk Management : *Introduction, Risk, Risk Management, Role of Risk Management in Overall Project Management, Steps in Risk Management, Risk Identification, Risk Analysis, Reducing Risks*

Introduction to Project Management Tools *such as : Trello, JIRA and Asana.*

Financial Management in Projects : *Project Finance structure, Process of Project Financial Management : Conducting Feasibility Studies, Planning the Project Finance, Arranging the Financial Package, Controlling the Financial Package, Controlling Financial Risk, Options Models.*

Contents

5.1 Project Risk Management

5.1.1 Introduction

- All projects are full of uncertainty. Uncertainty is unavoidable since projects are one-of-a-kind and temporary efforts based on assumptions and limits, delivering project outputs to many stakeholders with varying needs. Project management can be viewed as an attempt to govern this uncertain environment by employing structured and disciplined approaches such as estimating, planning, cost control, job allocation, earned value analysis, monitoring and review meetings and so on. Each of these project management factors has a role in defining or controlling the inherent uncertainty in all projects.
- Project Risk Management is a method for understanding, assessing and managing uncertainty within projects. As a result, it is an essential component of project management and effective Project Risk Management is a vital success element for project success.
- However, for project management to be fully effective, project risk management must not be considered as an optional procedure or conducted as an additional overhead work. Because many aspects of project management address inherent uncertainty, the relationship between formal project risk management and other project management processes must be clear. Many of the project management processes should take into account the results of project risk management. They can, for example, have an impact on :
  - Estimating resource requirements, cost or duration;
  - Estimating resource requirements, cost or duration;
  - Evaluating the impact of proposed scope adjustments;
  - Planning or re-planning the project's forward strategy;
  - Allocating resources to tasks;
  - Reporting progress to stakeholders.
- None of these measures can be carried out properly unless there is a clear understanding of the risk involved, as assessed during the project risk management process. In other words, using the information and findings from project risk management improves the effectiveness of the project management process.
- Moreover, successful project risk management requires participation from other project management procedures. Work Breakdown Structure (WBS), estimates,

project timeline, assumptions list and other outputs are all necessary for effective project risk management.

5.1.2 Risk

5.1.2.1 Definition

- A project risk is an unexpected event or condition that, if it occurs, can have a positive or negative impact on the project's objectives.
- The definition of project risk given is as follows :
- A project risk is an unexpected event or condition that, if it occurs, can have a positive or negative impact on the project's objectives.
- This definition of risk contains two fundamental dimensions: uncertainty and impact on project objectives. These two factors must be considered when determining the significance of a project risk. The uncertainty dimension can be represented as "probability" and the effect as "impact" (though other descriptors, such as "likelihood" and "consequence" are possible).
- Risk is defined as both unique events that are uncertain but can be clearly described and more general situations that are less particular but may also give rise to uncertainty. Uncertain occurrences that could have a negative impact on a project's objectives, as well as those that could have a favourable one, are included in the definition of project risk. These two categories of risk are referred to as threats and opportunities, respectively. Within a unified project risk management approach, it is critical to address both threats and opportunities. This enables for synergies and efficiency to be gained, such as addressing both in the same analyses and coordinating responses to both if they overlap or can reinforce each other.
- Risks are unpredictable future occurrences or conditions that may or may not occur, but would be significant if they do. It is critical to differentiate dangers from risk-related characteristics such as cause and effect. Causes are occurrences or circumstances that exist now or are likely to exist in the future and may pose dangers. Effects are conditional future occurrences or conditions that, if the associated risk happens, would have a direct impact on one or more project objectives. To guarantee that each of these three aspects is appropriately documented, the cause - risk-effect chain can be employed in a structured risk statement or risk description.
- When a risk event occurs, the situation no longer becomes uncertain. Risks that arise may be referred to as difficulties or problems, while opportunities that emerge

may be referred to as advantages. Issues / problems and advantages both require project management actions that are outside the scope of the project risk management procedure.

5.1.2.2 Individual Risks and Overall Project Risk

- It is useful to consider project risk at two levels : Individual risks and overall project risk.
- Individual risks are specific events or conditions that may have an impact on project goals. Individual risks can have a positive or negative impact on one or more of the project's objectives, aspects or tasks. Understanding individual hazards can help determine how to use effort and resources to increase the likelihood of project success. The day-to-day management of project risks focuses on these particular hazards in order to improve the chances of a successful project conclusion.
- The effect of uncertainty on the project as a whole is represented by overall project risk. Because it applies to the entire project rather than individual pieces or jobs, overall project risk is greater than the sum of individual hazards on a project. It represents the exposure of stakeholders to the consequences of project outcome variances. It is a critical component of strategic decision - making, programme and portfolio management and project governance where investments are approved or canceled and priorities are established. At these higher levels, it is necessary to set realistic project cost and duration targets, determine the contingency reserve levels required to protect project stakeholders, establish appropriate project priorities and assess whether the risk of overall success is increasing or decreasing as implementation progresses.

5.1.3 Risk Management

- Risk management focuses on identifying and evaluating risks for the project, as well as reducing their chances to reduce the project's impact.
- There are no projects that are risk - free since there are an unlimited amount of events that can go wrong. Risk management does not refer to risk removal, but rather to risk detection, evaluation and management.
- The risk management practices in hundreds of projects in a variety of industries and suggested the following points :
  - Risk management is really not generally practiced.

- Projects that were regarded to be high risk were more likely to include a risk management plan.
- When risk management approaches were implemented to projects, they appeared to be favourable in terms of project success.
- The risk management method had an impact on the project's programmes and objectives, but had a lower impact on the project's product quality.
- Proper risk management raises the chances of a good outcome.

5.1.4 Role of Risk Management in Overall Project Management

- Project risk management is not an optional activity : It is critical to the success of every project. It should be applied to all projects and as a result, should be incorporated in project plans and operational documentation. As a result, it becomes an intrinsic part of every aspect of project management, in every phase and in every process group.
- Many project management processes deal with project planning, from concept to final design and from procurement to daily supervision of execution and close-out. These processes frequently assume an unreasonable level of certainty about the project and as a result, must include treatment of project risks.
- The risk in project estimates and assumptions is addressed through project risk management. As a result, it complements and expands on existing project management procedures. For example, project scheduling, gives dates and critical routes based on activity durations and resource availability that are considered to be known with certainty. Quantitative risk analysis investigates the uncertainty in estimated durations and may provide alternative dates and critical routes that are more realistic in view of the project's risks.
- Project risk management is not intended to be a replacement for the other project management processes. Project risk management, on the other hand, requires that certain project management processes (e.g., scheduling, budgeting and change management) be performed at the level of guidelines available. Project risk management adds the viewpoint of project risk to the results of the other processes, increasing their value by accounting for risk. For example, risk management offers a foundation for estimating the amount of cost and schedule contingency reserves required to support risk response actions with the required level of confidence for achieving project objectives.

- Most projects are affected by a contradiction about project risk. The level of risk exposure is at its peak in the early stages of a project, while information on project hazards is limited. Because little is understood at the time, this does not prevent a project from moving forward. Rather, different approaches to the project may have distinct risk consequences. The more this scenario is recognised, the more realistic project plans and performance expectations will be.
- A risk management technique is relevant throughout the life cycle of a project. The earlier in the project life cycle that risks are identified, the more realistic the project plans and results expectations will be. As project planning advances and more information regarding all aspects and components of the project and its environment, such as stakeholders, scope, time and cost, as well as the accompanying assumptions and limitations, becomes accessible, risk management continues to bring value. The balance between project flexibility and awareness of project risk must be examined and modified on a regular basis as plans develop.
- However, as the project plan becomes more established, with basic decisions, commitments and contracts in place, the alternatives for making significant adjustments to capture opportunities or minimise hazards become more limited. Risk management processes monitor the changes that occur throughout project execution for new risks that may emerge so that suitable solutions may be developed, as well as for current hazards that are no longer feasible. Even when there are few alternatives for changing the future, project risk management plays a role in giving reasonable expectations for project completion dates and costs.
- Finally, risk - related lessons are reviewed throughout the project and during project closure to contribute to organizational learning and enable continuous improvement of project risk management practice.

5.1.5 Steps in Risk Management

- The risk management process is strongly linked to one another. As a result, they cannot be handled in a gradual way. They cannot be handled by a single department of an organization at the same time. Independent roles or departments can help committed procedure with a structured organization and strong communication systems is needed.
- The steps of a risk management process are traditionally as follows :
  1. Establish context
  2. Identify the risks

3. Analyse the risks
4. Evaluate the risks
5. Treat the risks
6. Communication and consult
7. Monitor and review.

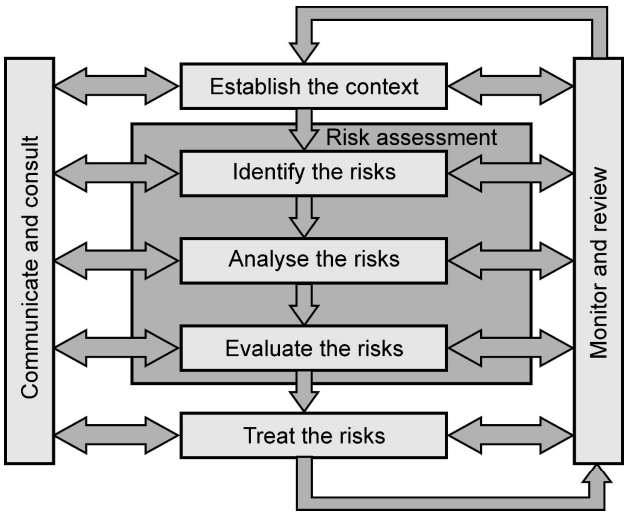


Fig. 5.1.1 Steps in risk management

1. Establish context

- The following are some of the most essential aspects of context definition:
  - The first and most important step is to identify the locations that are at risk. Risks might occur as a result of a particular combination of market, product or service, manufacturing or distribution process and other external variables.
  - The next step is to identify and develop a schedule for assessment activities.
  - It becomes necessary to organize resources as well as establish roles and responsibilities as a result of those activities.

2. Identify the risks

- The risk identification process is the next step in the risk management process; it's critical to identify potential risks and then describe them in depth. As a result, all potential risk management training sources, such as stakeholder positions, market changes, manufacturing failures or work accidents, should be thoroughly investigated. The following steps must be included in the process of detecting possible risks and risk management techniques :
  - The organization's goals have been set.

- Scenarios that the company may experience when conducting business.
- Procedures followed by the organization for managerial and operational objectives.

- Finally, effective risk identification requires the use of acceptable confirmations, which indicate whether the risk analysis was correct or not. These confirmations could include :
  - A confirmation that the event has already taken place. (Confirmation from the source)
  - A confirmation that the incident has occurred previously in a comparable circumstance. (This is an indirect confirmation.)
  - A confirmation that states the cause - and - effect connections while stressing the possibility of the event. (Because of its deductive nature)
- In this manner, a "risk profile" that is unique to each organization.

3. Analyse the risks

- The systematic examination of uncertainties and hazards encountered in business and many other sectors is known as risk analysis. Risk analysts work to detect risks, analyse how and when they occur and calculate the financial and non-financial consequences of negative outcomes.
- This technique also helps in the definition of preventative actions to lower the likelihood of these factors developing and the identification of remedies to successfully deal with these restrictions when they arise in order to avoid potential negative consequences on the company's competitiveness.
- When we estimate project risk, we may avoid future disputes, handle regulatory difficulties, comply with new regulations, reduce our exposure and minimize effect.
- By monitoring project, project planning assists in analysing risk.

4. Evaluate the risk

- When the risks have been identified, they must be assessed based on the following parameters :
  - The possibility that the unfavourable event will occur.
  - The seriousness of the direct or indirect consequences of the event itself.
- In such instances, the decision is based on a number of factors.
  - Criticality of the situation,
  - Relevance, availability of statistical data

- Confirmed analysis procedures.

- The amount of risks must also be assessed at this stage of the risk management process. This stage aids in the creation of an action plan for that specific risk.

5. Treat the risk

- The risk control strategies are defined in this step, which includes :
  - Interpreting, delivering or storing incoming data for the control process.
  - Appropriate level and localization for operative procedure and / or practise judgments and activities;
  - Instruments of control.
  - The control process's output data is interpreted, sent or stored.
- The risk management strategies plan contains documentation of the planning activities. The creation of a risk manager job is advised because the treat process is primarily focused on coordinating all operations and their communication.

6. Communication and consult

- Another crucial component in the risk management process is risk communication. The following items must be adequately documented in detail in a risk management report during this step :
  - The profile
  - The matrix
  - The risk treatment
  - The control planning
- All personnel who are involved in any way should be informed of the following. Targeted training courses should be established if necessary, making the risk management training report a useful management tool. The risk management report serves as a reference document throughout the risk management process.

7. Monitor and review

- In the risk management process, a one - time plan is insufficient. It is critical that regular inspections and supervision be carried out. The results of the checking and supervision must be documented, analyzed and recorded at all times.
- The risk management process is a constant process, not a one - time event. For this reason that must be review on a regular basis. It must be based on either direct (inside the company) or indirect (from outside the organization) experience.

- The purpose of such an activity should be :
  - Considering possible changes in any phase of the process.
  - Evaluating the efficiency and effectiveness of the risk management plan
  - Examining and monitoring the results of the assessments.
- If any modifications are introduced, a new risk management process report must be prepared, which is updated to reflect the changes.
- This is all about the risk management process.

5.1.6 Risk Identification

- Using certain techniques, we must detect both project and product risk. Using risk templates, interviewing stakeholders, project compilations and so on are some of the most typical approaches for identifying various hazards.
- We should try to include as many stakeholders as possible in order to discover distinct risks, because the most stakeholders will supply the most risk items linked with the product.
- To identify the risk, several formal methodologies such as Failure Mode and Effect Analysis (FMEA) and Failure Mode Effect and Criticality Analysis (FMECA) are utilised. These strategies identify the impacts of the risk in the event that it occurs. People, society, users, customers and so on may be affected.

Significance of Identifying risks

- Once a risk is managed, the reduction and emergency measures become just another task on a project manager's or better still, someone else's to - do list. However, before we can manage risks, we must first identify them so that they can be assessed, addressed and reduced.
- The capacity to identify hazards should involve the entire project team, but the project manager will usually lead the effort and get things started. There are numerous methods for identifying project risks and the project manager should work through as many of them as are relevant to the project and practical for the project team.

Following are the steps involved in the identifying risks,

1. Previous project :

- The first step in identifying risks is to examine completed projects. If a previous project's nature is comparable to the current one, we can analyse the documentation and information that was gathered about prior initiatives. The risks identified for

previous project might be examined to see if they are likewise risks for the current project.

- Furthermore, the issues that happened will be an excellent resource for detecting dangers that may arise in the current project. We must recognise those difficulties as risks before they exist and figure out how to best minimise them so that they do not become problems. Mitigating these types of risks can provide a significant boost to the project from the start, ensuring that it does not experience the same issues that have hampered earlier initiatives.
- Simultaneously, these sessions should not collapse into forecasting every possible negative outcome. After all, the project team isn't going to reduce the possibility that an impact would reach Earth and end life as we know it. Instead, the project manager should take the lead in the brainstorming session and focus on allowing everyone to speak about the realistic and manageable risks that the project will meet.

2. Paying close attention :

- Another method for identifying risks is to listen carefully. As a project begins its planning and design phases, the project manager should be present in meetings and paying close attention to what is going on. By participating in these sessions, the project manager can begin to develop ideas for risks that need to be reduced and managed by the project team. If we hear people talking about tasks that they are concerned about or scope that is not fully understood, that is a bad sign to sit up, pay attention and begin writing risks relating to the issues they are discussing. To be able to do so, we must be listening and paying attention to what is going on with the project team.

3. Templates :

- In addition to evaluating data and information from past projects, templates can be useful. There are numerous resources accessible about project implementation and common risks that occur in projects depending on the market or type of project. The project manager should conduct study and make use of any resources that are accessible. These resources are available online, in libraries and even through our network of project management peers. When we have a resource available to identify risks for a project, we should use it.

4. Keeping ahead of the competition :

- All of these methods for identifying risks can help we keep ahead of the competition when it comes to project management. The majority of our time and

efforts will be spent developing a schedule and managing work to that schedule. However, risks are an important aspect of the project and should not be worked on in the time that remains after everything else has been completed. Identifying them early in the project and working on them continuously and as soon as possible a good strategy to remain on top of the risks and potential difficulties that may arise. Identifying risks benefits everyone involved in the project.

5. Brainstorming :

- In order to identify risks, the entire project team should participate in the brainstorming process. Key stakeholders might also be asked on the dangers they see on the project. These brainstorming meetings should be open and free of any predefined ideas or small lists of risks that the project manager want to work on. A productive brainstorming session comprises allowing everyone to speak up and listening out the full project team's opinions.

5.1.7 Risk Analysis

- Risk analysis is the process of identifying and analyzing potential issues that could negatively impact key business initiatives or critical projects in order to help organizations avoid or mitigate those risk

Advantages of risk analysis

- To effectively and efficiently secure their information assets, organizations must understand the risks connected with the use of their information systems.
- In a variety of methods, risk analysis can assist an organization in improving its security. Depending on the nature and scope of the risk analysis, companies can utilise the results to :
  - Identify, rate and compare the entire impact of risks on the organization in terms of both financial and organizational consequences;
- Identify security gaps and plan the next measures to eliminate weaknesses and strengthen security.
- Improve information security communication and decision - making procedures.
- Enhance security policies and processes, as well as develop cost - effective means for implementing these information security policies and procedures.
- Implement security controls to mitigate the most significant risks;
- Improve employee awareness of security measures and risks by promoting guidelines during the risk assessment process.
  - Recognize the financial consequences of potential security risks.

Steps in risk analysis process :

The risk analysis process usually follows these basic steps :

1. **Organize a risk assessment survey :**
   - Obtaining feedback from management and department heads is essential to the risk assessment process. The risk assessment survey is a good place to start when it comes to tracking specific risks or threats within each department.
2. **Identify the risks :**
   - The purpose of risk assessment is to review an IT system or another component of the organization and then ask, "What are the dangers to the software, hardware, data and IT employees ?" What are the potential negative events, such as human error, fire, flooding or earthquakes ? What are the chances that the system's integrity will be compromised or that it will not be available ?
3. **Examine the risks :**
   - Once the risks have been identified, the risk analysis process should assess the possibility of each risk occurring, as well as the consequences associated with each risk and how they may affect the project's objectives.
4. **Create a risk management strategy :**
   - Based on an assessment of which assets are valuable and which risks are likely to have a negative impact on those assets, the risk analysis should generate control recommendations that may be utilised to mitigate, transfer, accept or avoid the risk.
5. **Put the risk management plan into action :**
   - The ultimate purpose of risk assessment is to put measures in place to eliminate or reduce risks. Beginning with the highest - priority risk, resolve or at the very least reduce each risk such that it no longer presents a risk.
6. **Monitor the risks :**
   - Any risk analysis process should include a continuous process of identifying, treating and managing risks.

5.1.8 Reducing Risks

- Every organization faces risks. Internal risks include inaccurate sales predictions and inadequate safeguarding of important assets such as inventory. External risks can also exist, such as the risk of a natural disaster or an economic recession. Whatever the source, organizational managers must be aware of potential risks and how to safeguard their organizations from them.

- Mitigating risks refers to the process of protecting an organization from the impact of risk events via the use of various approaches. Mitigation approaches strive to reduce the potential impact of a risk and the possibility that the risk event will occur.
- The TARA framework is made up of four basic mitigation approaches that can be used :
  1. Transference
  2. Avoidance
  3. Reduction / mitigation,
  4. Acceptance

These are the four modes of behaviour.

1. Transference :

- Transference is a risk mitigation technique that involves transferring all or some of the risk to another party. Consider whether we can think of an example of risk transference in our personal life. When do we share or transfer risk with another individual or company ?
- Did we think of insurance, such as car insurance or health insurance ? Consider the benefits of that insurance. Insurance companies will assist us in dealing with the consequences of a risk, such as a car accident or injury, in exchange for a charge. This is exactly what businesses and organizations can do in response to some of the threats they face. Organizations can share their exposure to specific risks with an insurance firm by acquiring insurance.

2. Avoidance :

- Management may decide that the potential impact of a particular risk is not worth tolerating. If management does not want to deal with the risk, it can be avoided. It should be noted, however, that avoiding the danger is not always an option.
- As an example of risk avoidance, consider a large corporation that wishes to extend its operations into a volatile part of the world. While companies may be able to cut costs or enter a new market, they are aware that operating in a volatile location may pose dangers to their business, staff and reputation. After assessing the costs and benefits, the corporation may determine that the risk is not worth the possible gain and as a result, does not expand, thereby avoiding the risk. When something is avoided because of the risk involved, it is said to be avoided.

3. Reduction :

- This involves reducing risk exposure, most likely by performing the activity in a different manner. For example, this method is appropriate when the risk has no major impact but is likely to occur. This is done to reduce the possibility of occurrence by carrying out the action in a different way. However, if reduction is not possible, the company may be forced to accept the risk if it does not have a large impact or avoid it if it does.

4. Accept :

- This involves accepting the risk and doing nothing. This method, for example, is appropriate when the risk has a low impact and a low probability of occurrence. This is due to the fact that even if the risk is realised, it is insignificant.

5.2 Introduction to Project Management Tools

5.2.1 Trello

5.2.1.1 Introduction

- Trello is a kanban-based task management and collaboration tool that works well for any project or team. Content teams, marketing projects, customer support tracking, sales funnels, HR tracking and agile project management all are included in it.
- Trello's most unique feature is its board and card structure, which divides projects into boards, each of which has a card for each task. The cards, on the other hand, has feature tracking lists that prioritise particular assignments and allow us to keep track of the status of our tasks and employees.
- Trello, in general, brings together a variety of project management and collaboration services, giving employees a private channel to interact, track updates and debate projects in real time.
- Trello is a perfect fit for most projects as long as our needs are really not financial in nature, as it doesn't include any budgeting or invoicing capabilities.
- In fact, all team members are aware of system changes with a single click, with an alert appearing on their device as well as to their email account. They may also add additional participants to the chat with a single click. A distinctive aspect is the fast voting mechanism, which allows employees to accept or disapprove of a project and take action in a fraction of a second. In our trello evaluations, we go through the software's features, cost and more.

- Trello is the most user - friendly project management software on the market, given its feature set and the amount of convenience built into its design.
- Trello was one of the first project management tools that is ease to use and wide list of capabilities available in the free version.

5.2.1.2 Trello Features

Trello has following features :

- Detailed and quick overviews of front / back cards
- Easy, drag - and - drop Editing
- In-line editing
- Easy organization with labeling, tags and comments
- Card records archive
- Easy upload (Local devices, Dropbox, Google drive and box)
- File attachment
- Deadline alerts and notifications
- Automated email notifications
- Activity logs
- Individual / group task assignment
- Information backup
- Voting options
- Discussions

5.2.1.3 Benefits of Trello Management tool

1. **Board and card system is well - organized**
   - Trello's developers tried searching for the most simple and user - friendly workflow organization method and they discovered their unique board and card system for detailed progress views. There is less chance of confusion with a board for each project and a card for each work, as all assignments are in sequence and can be tracked with individual performance lists.
2. **Smooth editing**
   - Trello's goal is to keep our project management structured, therefore it ensures that we may edit task lists in order, using the most basic drag - and - drop technique available. Because the lists are totally adjustable, we may track only the metrics that

matter to us, and utilise the automated notifications to stay up to date on all changes and updates.

3. Collaboration

- Many experts would argue that Trello is above all a collaboration system, a claim easily justified by the number of team features available in the system: using it, we can enable our entire team to participate in important discussions (both group meetings and one - to - one chat sessions), send diatribes and notes, share files of all formats, and comment on individual tasks and assignments. We can also upload files directly from our Dropbox, Box, or Google Drive accounts using this system.

3. Timelines that are reasonable

- The power-up calendar in trello can be used to priorities projects with shorter deadlines, assign operations at the last minute and display them according on their status. However, we are not required to use this feature; we can use our current calendar software to activate the iCal feed and import tasks that have already been assigned.

4. Searchable database

- Trello ensures that all essential talks and company data are attractively saved in the system for future use, as well as backed up in the case of a crisis or failure. There are a number of labels and searching filters available to assist us in quickly locating the desired file.

5. Security

- Trello is built to meet with the highest security requirements and uses a bank - level encryption method to ensure that our important data never falls into the wrong hands. As the administrator, we will have the ability to define permissions and decide which boards are private and accessible only to approved users.

6. Integrations

- Trello has public developer APIs, so we may integrate it with almost any third-party programme, system, extension, or plugin.

7. Optimization for mobile devices

- Trello is a mobile - friendly collaboration system that allows users to access data from virtually any device, including Android and iOS devices.

5.2.1.4 Technical Specifications of Trello

- **Devices supported**
  - Web - based
  - iOS
  - Android
  - Desktop
- **Customer types**
  - Small business
  - Medium business
  - Enterprise
- **Support types**
  - Phone
  - Online

5.2.2 JIRA

5.2.2.1 Introduction

- Jira is a highly customisable project management application developed by Atlassian, an Australian company. Jira's primary concept is that all projects are stored in a centralised database and each project contains issues that represent tasks that progress through various stages in team processes. Workflows define the status of our project and the rules that govern how project tasks progress to different statuses.
- Jira is commonly considered as one of the finest project management tools . Jira is an excellent choice if we need a comprehensive solution for handling both traditional and agile projects while also having limited requirements for portfolio level functionality.
- Jira was developed with agile methodologies in mind. Agile is the most widely used software development approach and it follows to the following four principles :
  - Individuals and interactions take priority over processes and tools.
  - Working software is preferred over extensive documentation.
  - Customer participation in contract negotiations
  - Responding to change and maintaining to a plan

- Atlassian applied these concepts to develop a project management system in which flexibility and customization are essential components, allowing companies to adapt the tool to their specific operations.
- Agile project management principles are supplemented by the Jira platform. To get the most out of Jira, use it in conjunction with the agile ceremonies.
- Jira software is part of a package of solutions meant to assist teams of all sizes in managing their workloads. Jira was initially designed as a bug and issue tracker. Jira, on the other hand, has matured into a strong task management tool for all types of use cases, ranging from requirements and test case management to agile software development.

5.2.2.2 JIRA features

JIRA has following features :

- Business project templates
- Issue details:
- Notifications
- Power search
- Product / issue backlog
- Reports and Dashboards
- Email notifications
- Task / Bug linking
- Boards (Cloud only)

5.2.2.3 Benefits of JIRA Management tool

- Jira has advantages for both co - located and remote teams. We may readily anticipate deadline challenges with an efficient working environment and improved visibility into project status. All of the information required by the entire team, including milestones, updates and reminders, is available in one location.
- Jira is still a viable solution for development teams. With the support of the software, businesses of all sizes and across industries can advance their cause, methodology and disciplines.

1. Corresponds with plan requirements

- Jira provides tools for users to sketch out the big picture, communicate plans and relate the larger project roadmap goals to the team's day - to - day work. Teams may

scale their efforts to larger goals, keep track of the big picture, anticipate dependencies and plan with team capacity in mind.

2. Excellent for mobility

- The tool provides a complete view of all user requirements and can generate the necessary serial data, such as burndown charts, sprint velocity and others. Users can also organize tickets into sprints and releases while monitoring the team's effort and task assignments.

3. Available integration

- The problem and project tracking software connects with a wide range of popular third - party applications. Integration with effectively to the needs and slack, for example, makes it simple to communicate issues and reply to notifications. The Atlassian Marketplace has over 3,000 apps available to augment the software's functionalities.

4. For different types of users

- Developers, project managers, engineers, managers and other non - tech business professionals use Jira. Customers from a number of industries use the solution to achieve a variety of aims, including space travel and the development of future technology.

5. Highly adaptable

- Jira users can create any type of issue. They can adapt workflows to meet the specific needs of an organization. Tables, forms, timelines, reports and fields can all be created and adjusted by users.

5.2.2.4 Technical Specifications of JIRA

- **Devices supported**
  - Web-based
  - iOS
  - Android
  - Desktop
- **Customer types**
  - Small business
  - Medium business
  - Enterprise

- **Support Types**
  - Phone
  - Online

5.2.3 Asana

5.2.3.1 Introduction

- Asana is a project management tool that allows we to manage tasks and other projects with a group of people. In more concrete words, Asana keeps track of who is in charge of the task and all associated information, such as all required steps, due dates and so on.
- One of its distinguishing features is its adaptability, which allows us to choose what type of work to track and how to use it (more on that point in a moment). The corporation has offered more options and templates in recent years to provide structure for teams who don't desire unlimited liberty. In other words, subscribers can use Asana in a completely unique and customised way or they can use it in a guided way by using the tools and templates that Asana gives.
- This arrangement differs from standard project management software which is designed for project - based work and can only be utilised in a limited number of ways.
- Asana is capable of handling continuous work (bug fixes, maintenance, etc.) and some sorts of projects, though often more lightweight ones that don't require us to manage dozens of moving parts with other, concurrent projects.
- Project management software, on the other hand, can handle multiple complex projects at once. Let's say a corporation constructs 50 homes per year. A project management tool can map out each stage of construction for all of the houses, ensuring that they are completed in the correct order and that shared equipment and skilled workers are available at the appropriate times for each stage. The project management tool assists us in rearranging the schedules for building all 50 houses, as well as the schedules for all the people working on them, if a piece of machinery or a person is suddenly taken out of action. While Asana can't quite do that, it can assist us in planning a product launch or a marketing campaign,
- Asana is a project and task management platform that automates some of our most time - consuming communication and collaboration processes.

5.2.3.2 Asana features

Asana has following features :

- Customizable dashboards
- Activity feeds
- Focus mode and individual task lists
- Subtasks assignment
- Prioritization
- Email integration
- Notifications and reminders
- Automated updates
- Project / Task creation
- Project permissions
- Searched views
- Tracking
- Customer support
- Multiple workspaces
- Adding followers
- Group discussions
- Tags and comments
- Events and meetings

5.2.3.3 Benefits of Asana Management Tool

- Asana's key advantages are its extensive feature set, customizations and overall usability. Let's go over the details one by one :

1. Prioritization and Segmentation of projects

- Attention option in Asana is intended to allow the firm to concentrate on productive tasks while excluding those that do not support its strategy. Even the simplest assignment is accompanied by a name and deadline once projects are broken down into tasks and subtasks and its progress is tracked thanks to the Harvest integration. The user can upload a file from their local device, Dropbox, Google Drive or Box for each task.

2. Project history and permissions

- Each project, task and subtask will be included in the Activity feed, where we may tag both people and groups who should consume the information. This is a recurring benefit. We can simply discover jobs using the advanced search filter, and we can even mark them as favourites to keep them in sight. When it comes to permissions, the system's administrator will be able to handle them individually for each project.

3. Dashboards that can be customized

- Asana provides fully customisable dashboards that show the status of each participant and track the progress of each task separately. Because it is the first place where modification notifications appear, the dashboard can also be utilised for group conversations. Leads, customer inquiries and job applications can all be tracked using the dashboard.

4. A Communication portal

- We will definitely like Asana's smart inbox, which allows us to transmit all of our corporate communication without the need for third - party apps and services. Large corporations like the fact that crucial project communication is properly preserved and there is no fear of missing updates, as there would be in a packed email inbox. The portal connects all users, allowing them to talk one - on - one or in groups, as well as transfer files from their local devices or Google / Dropbox / Box accounts.

5. Distinctive points of view

- When it comes to views, Asana is one of the best options we receive a priority list with automated notifications, which can be read with a comprehensive search filter to find the relevant files. Needless to say, we will decide which jobs are the most critical and pending, ideally by selecting them from the outstanding Asana calendar.

6. Secure storage

- Asana recognises that our projects and corporate interactions are sensitive company information and follows to the highest security requirements to protect them. At the same time, because it is fully integrated and paired with a variety of services and applications, it blends into our software infrastructure.

5.2.3.4 Technical Specifications of Asana

- **Devices Supported**
  - Web - based
  - iOS
  - Android
  - Desktop
- **Customer Types**
  - Small business
  - Medium business
  - Enterprise
- **Support Types**
  - Phone
  - Online

5.3 Financial Management in Projects

5.3.1 Project Finance Structure

- This Project Finance handbook provides managers of Public - Private Partnership (PPP) projects with a good explanation of the project financing process. Although the private sector participant(s) are responsible for arranging project funding, all stakeholders must understand the process when evaluating the value for money criteria given out in the treasury regulations on PPP projects. Understanding the process will also help department heads manage transaction advisors and negotiate with private - sector partners. Finally, it is critical to recognise that the procedures and structures employed in project financing are dynamic and evolving. As a result, all stakeholders will need to be adaptable.
- Project funding can be obtained from various sources. The Fig. 5.3.1, Fig. 5.3.2 and Fig. 5.3.3 below demonstrate the difference between public, corporate and project funding, using an example of a water treatment project.

A. Public finance

- For many years, many governments, including the South African government, funded projects using existing surplus funds or by issuing debt (government bonds) to be returned over a set period of time. However, governments have become less interested in this investment because it strains their own bank sheets and hence

limits their ability to undertake other projects. This issue has prompted a quest for alternate financing sources.

- Lenders assess the government's overall ability to raise funds through taxation and general public enterprise income, including new tariff revenue generated by the project.
- On the government's list of financial commitments, the sovereign guarantee appears as a liability.

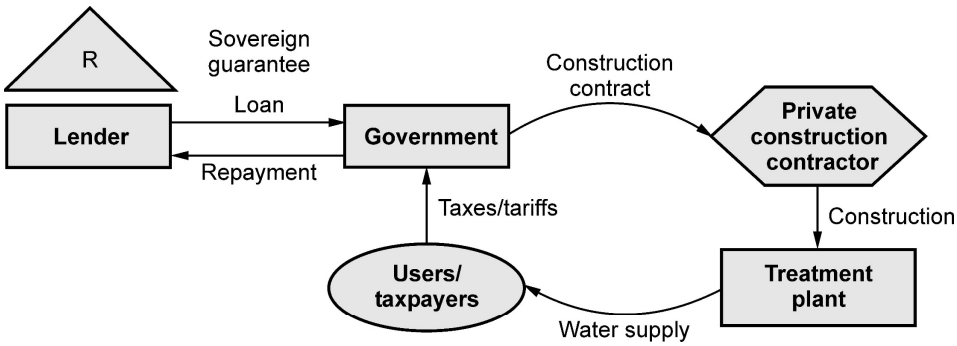


Fig. 5.3.1 Public finance structure

B. Corporate finance

- The figure below illustrates the structure of a water treatment project in which the private sector participant utilises its own credit to raise funds due to its capability and the project's limited size and nature. This method is frequently utilised for smaller, less capital-intensive projects that do not require outside funding. However, private corporations, like governments, reject this choice since it strains their balance sheets and capabilities and limits their potential participation in future projects.
- A private corporation borrows funds to build a new treatment centre and guarantees repayment to lenders using its available operating income and asset base.
- The corporation may also choose to donate its own equity.
- Lenders do credit research by examining the company's overall income from operations, stock of assets and current liabilities.
- On the company's balance sheet, the loan appears as a liability ("Mining the Corporate Balance Sheet").

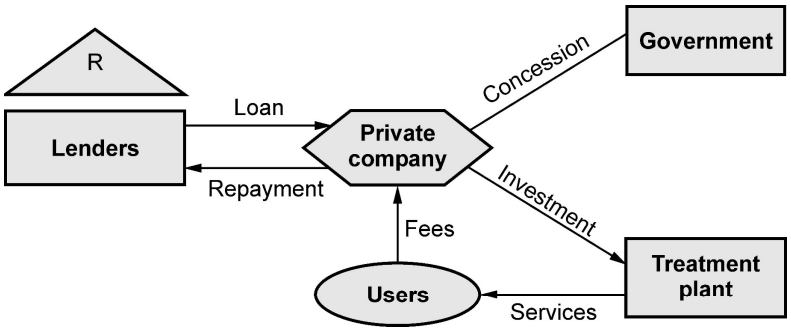


Fig. 5.3.2 The corporate finance structure

C. Project finance

- The assets and/or future income of the project are used as the basis for raising finance in project financing. In most cases, the sponsors establish a special purpose, legally independent business in which they are the primary shareholders. The newly formed business normally has the bare minimum of equity required to issue debt at a fair cost, with equity often ranging between 10 % and 30 % of the total capital required for the project. Individual sponsors frequently own a tiny enough percentage of the new company's equity to prevent it from being considered a subsidiary for legal and accounting purposes.
- Each independent project's final legal framework is unique. The diagram below shows a simple project finance example. It demonstrates that the legal vehicle (company) generally has more than one sponsor, due to :
- The project exceeds one sponsor's financial or technical capabilities.
- The risks associated with the project must be communicated.
- A larger project achieves economies of scale that a number of smaller initiatives will achieve.
- In terms of capability, the sponsors complement one another.
- The procedure necessitates or encourages the formation of a joint venture with specific interests (e.g. local participation or empowerment)
- The legal and accounting standards specify a maximum equity holding for a sponsor, above which the project company is considered a subsidiary.

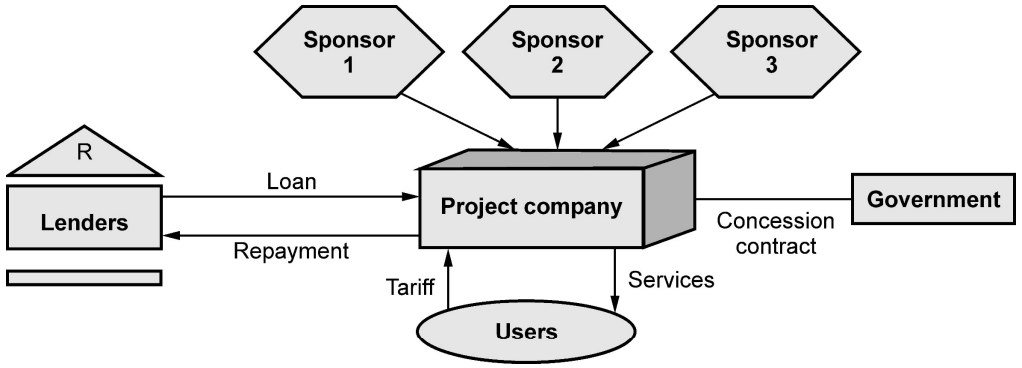


Fig. 5.3.3 Project finance

- A group of private companies forms a new project company to build, own and run a specific infrastructure project. Each of the sponsors has made an equity commitment to the new project firm.
- Lenders lend money to the project company. To repay all debts, lenders look to the project's estimated future revenue stream and the assets of the project firm.
- The government of the host country does not give financial assurances to lenders; instead, sponsoring corporations provide limited guarantees. Financing on the "Off-Balance-Sheet."

5.3.2 Process of Project Financial Management

1. Introduction

- The purpose of financial management process is to obtain actual financials (or expenses) that accumulate during the course of a project's life cycle. Project financials are formally documented through the completion of the project expense form.
- The figure below illustrates an overview of the project financial management process, including the roles processes, and procedures involved.

2. Budget planning

- Budget planning includes documenting projected financial project information that is expected to occur during the course of the project. To correctly build a sound project budget, the project manager and project sponsor should list the known project activities that will need to occur and estimate their cost, keeping time restrictions and other dependencies in mind. The project sponsor creates and approves an initial financial expense form.

3. Document expenses

- Once the financial expense form has been authorised and the project has initiated, the project manager and / or project administrator should begin tracking all expenses on a regular, ideally weekly, basis.

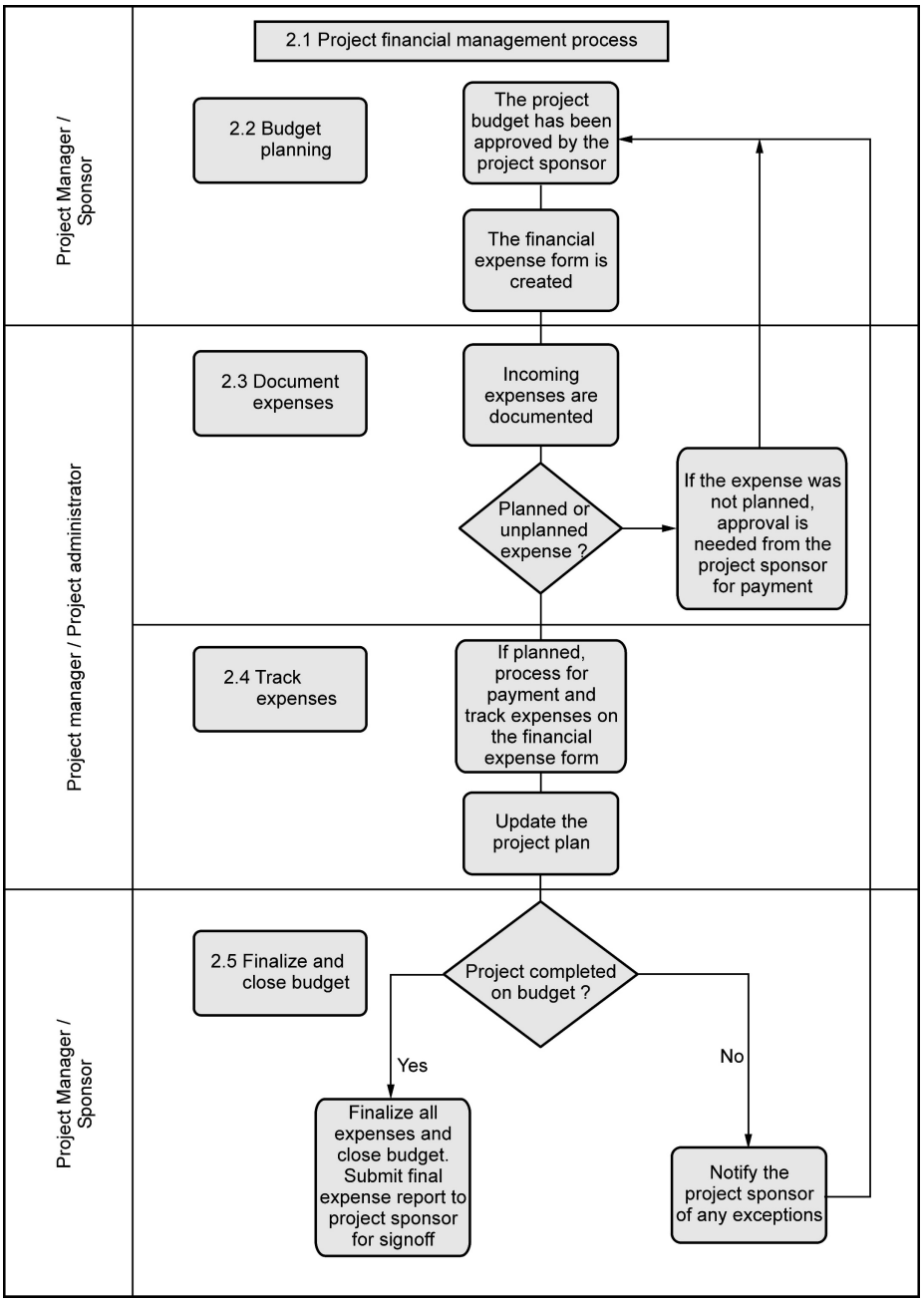


Fig. 5.3.4 The financial management process

- The project manager must confirm the following during this process :
  - The activities for which the expense was committed are reasonable (as per the project plan)
  - The expense was originally budgeted (as defined in the approved budget)
  - Before presenting any unexpected expenditure to the project sponsor for approval, ensure that it is fair and reasonable (if above a certain agreed upon limit)
- Only budgeted expenditures may be approved by the project manager. Unbudgeted expenses in excess of a particular limit may require the permission of the project sponsor or project board.
- Based on the information provided above, the project manager will :
  - Approve the expense and process it for payment or reimbursement.
  - Obtain further information from the person submitting the expense
  - Decline the expense and register a complaint with the person who submitted it.
- Payment will be planned after the project manager has given formal approval of the expenditure. It is standard procedure to pay expenses in 'batches' to save administrative workload and more effectively manage project cash - flow.

4. Track expenses

- This procedure include updating the financial expense form and project plan with new information and notifying the project sponsor of any budget vs. actual expense variations. The following procedures are carried out :

A. Financial expense form should be updated

- After the payment is scheduled, the financial expense form should be updated to ensure that an accurate record of the approval and payment is maintained. Although the form must be altered when the expense is approved, it should also be updated throughout the process to ensure that the project manager gets up - to - date expense information at all stages of the project's lifespan.

B. Project plan revision

- The project plan is updated on a regular basis (usually weekly), with the total spending documented against each project activity as specified in the financial expense form. As a result, the project manager or administrator can :
  - Create an overview of the project's overall financial status to date.
  - Identify any exceptions (for example, cases when the actual expenditure exceeds the planned expenditure)

- Determine whether the time frame of a work will be impacted while waiting for expenditure approval or payment

C. Inform the project sponsor of the exception

Any expenditure variations to date should be identified by the project manager. depending on the variation from the plan, the project manager may :

- Change the person or amount of resources assigned to a work;
- Allocate additional cash to finish a task;
- Request assistance from an external provider to complete a task;
- Change the person or amount of resources assigned to a work;
- Allocate additional cash to finish a task;
- Request assistance from an external provider to complete a task;

D. Mark the task as completed

- Once a work gets complete, it is indicated as 100 percent complete in the project plan and no further money may be assigned to the task for the life of the project.

5. Finalize and close budget

- After ensuring that all project expenses have been paid for and no more tasks / expenses are outstanding, the project manager or administrator should submit a final financial expense form for approval to the project sponsor. This material, once authorised, should be included in the project closure report for project historical purposes.

5.3.2.1 Conducting Feasibility Studies (Refer Section 2.5)

5.3.2.2 Planning the Project Finance

- The following are the sources that are common to projects in all three sectors :

a) Equity and Preference share capital

- Equity is one of the most important kinds of capital available to promoters and shareholders and it has the following characteristics :

i) Promoter groups contribution :

Promoters are expected to bring in 25 % of the total issuance of equity capital for projects up to Rs 100 crores, and just 20 % if the cost exceeds Rs 100 crores, or as laid out by the Securities and Exchange Board of India (SEBI) from time to time. Promoters' shares are locked in (unable to be transferred or withdrawn) for a defined amount of years from the start of production or the date of allotment of shares, whichever comes first.

ii) State governments contributions

State governments may subscribe to the capital issue through State Financial Corporation's (SFCs) up to a particular maximum limit; they may not accept stock in enterprises with a net worth more than a certain amount.

iii) Public subscriptions :

Public subscriptions to a company's equity are controlled by SEBI standards and certain provisions of the Companies Act of 1956, and must be considered. There is also an over - the - counter (OTC) facility that handles equity capital offerings ranging from ₹ 30 lacs to ₹ 25 crores.

iv) Seed capital assistance

Controlled by IDBI, this financial assistance scheme is available for medium - scale units that are set up and run on a full - time basis by technically and / or professionally qualified and experienced entrepreneurs. It is offered through SFCs and SIDCs and details can be obtained from the concerned units.

v) Venture capital assurance :

Risk Capital & Technology Finance Corporation Ltd. (RCTFC), a subsidiary of Industrial Finance Corporation of India (IFCI) and Technology Development and Information Company of India (TDICI), a subsidiary of Industrial Credit and Investment Corporation of India (ICICI), may be approached for "venture capital assistance" in accordance with their rules.

vi) Financial institutions and mutual funds take up equity in companies :

Financial Institutions and mutual funds take up some equity in companies in the early stages to build investor confidence and then sell it to the public or promoters as appropriate at a profit, providing a useful basis for ensuring the success of equity share issues.

vii) Non-Resident Indians (NRIs) subscribing to stocks

The government of India and the Reserve Bank of India are allowing NRIs to engage in equity with or without repatriation privileges, which can be a valuable source of funds to address the country's needs.

viii) Employee stock options :

Public businesses are required to set aside 5 % of their public offering for employee stock options. Unsubscribed shares, on the other hand, can be sold to the general public.

ix) Preference shares (Preferred stock) :

This kind of shares takes precedence over regular shares, as the name implies. Unlike ordinary shares, they have a set dividend rate that is not affected by earnings. They may only be able to cast a restricted number of votes. There are several varieties.

- Cumulative preference shares
- Non - redeemable preference shares
- Convertible preference shares
- Non - convertible preference shares
- Cumulative convertible preference share

x) Government subsidies :

State governments in India provide incentives that may include :

- Housing programmes for employees and other industrial workers in their colonies.
- Raw material supply.
- Purchases by the government.
- Subsidy for State Capital Investment.
- Loans for develop
- Combining the unit's Net Foreign Exchange (NFE) with the parent / associate company's NFE for the purpose of granting "Export House" designation based on export profits.
- International Price Reimbursement Scheme (IPRS) on iron and steel purchases to assist units in setting competitive export prices.
- Tax relief in the form of a sales tax refund, octroi or entrance fax.
- Land at reserved pricing for new units and expansions of existing units.
- Financial assistance with the feasibility and project report costs.
- Electricity subsidy
- Exemption from paying water rates in the states developed growth centres through financial aid such as term loans, underwriting shares, share subscription, working capital loans and so on.
- Purchase / installation of captive power generating units are eligible for a subsidy.
- Improvements to the terms and circumstances of sales tax loans.
- A five - year tax breaks for corporation tax payments throughout the first eight years of operation.

- Ad hoc project implementation subsidies may have to be returned if the project does not enter commercial production within an acceptable time frame.

b) Internal funding sources

- It is not applicable to new businesses. Due to business strategy that profits are kept after dividends are paid and depreciation allowances are made.

c) Financing for leases

- Vast number of private financing businesses, All India Financial Institutions, and banks provide capital equipment lease finance; they pay the whole price of the essential equipment to the lessee.
- Lease financing of capital equipment is done by a large number of private financing companies, All India Financial Institutions and banks; they pay the full price of the tools required to the vendor and then lease it to the buyer under an agreement to pay back the principal and interest in monthly/quarterly installments.
- The asset is transferred to you at a minimal recoverable amount at the conclusion of the leasing period.
- Debt-equity is not the primary determinant of credit worthiness now, and the lease charges interest rates that are slightly higher than bank lending rates.

d) Debentures

- These are debt instruments issued by firms to borrow money from the public at a fixed rate of interest with different redemption periods after which the company will either buy them back or convert them into ordinary equity shares at predetermined conversion premium rates.
- Debentures are a sort of project financing that is growing in popularity.
- Debentures are a sort of project financing that is growing in popularity. There are four types of debentures :

  Fully Convertible Debentures (FCDs)

  Partially Convertible Debentures (PCDs)

  Non - Convertible Debentures (NCDs)

  Optionally Convertible Debentures (OCDs)

5.3.2.3 Arranging the Financial Package

- "Financial Package" refers to the financing package that includes all financial assistance specified in the Financing Agreements and Subordinated Debt, if any, as

well as the total capital cost of the project and the means of financing it, as set forth in the financial model and approved by the senior lenders.

- Some projects have a large budget and require careful planning and tracking. Some projects do not have a budget part. Consider the following simple measures for arranging project finances :

1. Estimate costs

- Predicting costs is the first step in handling our project's budget. This is not as easy as it appears. We will need to figure out how many people, equipment, materials, and other assets we will need to finish the task.
- The next step is to calculate the costs of these resources and when they will be consumed.

2. Set the budget

- Estimating expenses is not the same as setting a budget. According to our company's financial standards, the budget shows how capital is allocated.
- The budget reveals when funds are assigned to our project, provides spending reports, allocates capital vs. expense money and so on. We must keep track of project costs in accordance with the budget.

3. Decide if we can get contingency funding

- Estimates for projects are not always correct. A contingency is a term that describes an estimation that is irregular. This estimation uncertainty is represented by a contingency budget.
- For example, if we estimate our project to be worth ₹ 10,00,000 with a 90 % confidence level, we could request ₹ 1,00,000 lac in contingency funding to account for the uncertainty. This ₹ 1,00,000 are not used risk or different target appeals, but they could be if it turns out that we miscalculated the amount of work on our project.
- Emergency budgets are not permitted in all organisations. If we don't have this kind of budget flexibility, we can include the uncertainty in our baseline estimate through contingency funding.

4. Track weekly

- The next stage is to start keeping track of our design expenses. Every expense – both human and physical resources - must be tracked. This may be a typical procedure, but it should be reviewed by our accounting system on a regular basis. Request that

our staff create expenditure forms and send them to us. When they pay money on account of the project, they may ask for our permission.

- We must approve the large sum of money before they are discovered so that we may better control project expenses.
- The term "cash flow control" refers to the process of managing the funds required to complete our design. Make that our Sponsor has budgeted for the following 1 - 2 months of work and has made the necessary reserves available to handle the project. Then keep track of how those money are spent each week.

5. Manage expectations

- Communicate the current situation of our spending as well as our budgeted spending. If we are on the verge of going over or under budget, make sure you keep expectations realistic so there are no unexpected consequences.
- Cost control for a project might be difficult. If the project manager does not keep track of the cash, it becomes even more difficult. So, manager should periodically observed the expectations in accordance to the expenses.
- Thus, a financial packages are the total calculated costs that are needed to fulfill a project within a limited period of time. So it is used to arrange and monitor the estimate costs of the work for every stage of the project

5.3.2.4 Controlling the Financial Package

- The systems, policies and methods through which an organization monitors and regulates the direction, allocation and use of its financial resources are known as controlling of financial packages. Controlling of financial packages are the heart of any resource management organization and improves operational efficiency.
- After a careful examination of a company's current policies and future prospects, efficient financial packages control procedures should be implemented.
- Before implementing financial management in a corporation, it's also essential to make sure the following four stages are completed:

1. Detecting irregularities and overlaps

- Financial budgets, financial reports, profit and loss statements, balance sheets and other financial documents shows a performance of the company and operational overview. As a result, detecting any overlaps and irregularities resulting from the data available is important when creating financial control measures. It aids in the detection and elimination of any existing gaps in the current management system.

2. Timely updating

- Financial packages control is the basis of resource management and as a result, of a company's overall operational efficiency and profitability. The importance of timely updating of all relevant data cannot be overstated. It's also crucial to keep all management practises and policies up to date when it comes to existing financial control procedures.

3. Investigating all potential operational scenarios

- It is critical to properly assess all possible operational scenarios before establishing a set financial packages control approach in a business. Assessing policies through the perspective of various operational scenarios - such as profitability, expenditures, safety and size of production or volume - can give the necessary data. It also aids in the establishment of an effective financial control policy that includes all parts of the organization's operations.

4. Making projections and forecasting

- Forecasting and developing projections are critical aspects in executing a financial packages control policy. They give insight into the company's long - term aims and aspirations. They can also assist in the development of a financial control policy that is aligned with the company's objectives and act as a catalyst for achieving those objectives.
- Cash flow maintenance, operational efficiency, profitability, resource management and fraud prevention are the important parameter managed with controlling financial packages of any organization.

5.3.2.5 Controlling Financial Risk

- A financial risk is anything that has to do with money flowing in and out of the business.
- Controlling of financial risk is the process of identifying and addressing financial hazards that our company may face now or in the future. It’s not about avoiding risks because few organizations can afford to be completely risk - free. It’s more about putting a distinct line. The goal is to figure out what risks we are willing to face, which dangers we need to avoid and how you will design a action to protect.
- The plan of action is the most important aspect of any financial risk control strategy. These are the methods, rules and practice that our company will follow to guarantee that it does not take on more risk than it can handle. In other words, the

strategy will make it plain to employees what they can and cannot do, what choices need to be escalated and who is ultimately responsible for any risk that arises.

- Financial risk is control in a variety of ways by businesses. This procedure is dependent on the type of business, the market it serves and the level of risk it is willing to take. In this view, it is the responsibility of the firm's owner and directors to identify and analyze risk and determine how the company will manage it.

The following are some of the steps involved in controlling the financial risk :

a) Identifying the exposure of risk :

- Identifying financial hazards, as well as their sources or causes, is the first step in controlling of financial risk .The balance sheet of the company is an excellent place to start. This gives an overview of the company's debt, liquidity, foreign exchange exposure, interest rate risk, and commodity price sensitivity. We should also look at the income statement and the cash flow statement to observe how income and cash flows change over time and how it affects the risk profile of the company.

b) Calculating the exposure :

- The next stage is to quantify or assign a monetary value to the hazards we've identified. Of course, risk is unpredictably unpredictable and placing a precise number on risk exposure will never be possible. Analysts frequently employ statistical models such as the standard deviation and regression approach to assess a company's risk exposure. These tools calculate the difference between our data points and the average or mean.
- Excel, a spreadsheet programme, may assist small firms in doing simple analyses in a quick and precise manner. The bigger the standard deviation, the greater the risk associated with the data point or cash flow being quantified.

C) Choosing a "hedging" strategy :

- Once we have examined the risk sources, we will need to select how we will use the knowledge. Are we willing to take the risk ? Is there anything we can do to reduce or hedge against it ? This decision is based on a number of criteria, including the company's goals, its business environment, its risk appetite and whether the cost of risk mitigation justifies the risk reduction.
- Apart from these above steps, the following action steps also essential to control the financial risk :
  1. Lowering the volatility of cash flow.
  2. Fixing interest rates on loans so that our financing costs are more predictable.

3. Keeping track of running costs.
4. Keeping track of our payment terms.
5. Establishing strict billing and credit control procedures.
6. Saying goodbye to consumers that consistently violate our credit restrictions.
7. Recognize our commodity price exposure, or how vulnerable we are to changes in the price of raw materials. For example, a rise in oil prices, might increase costs and diminish profitability in the haulage industry.
8. To limit the risk of fraud, ensure that the correct personnel are assigned to the proper jobs with the appropriate level of supervision.
9. Conducting due diligence on projects, such as analysing the risks of joining a partnership or joint venture.

- Thus, Controlling Financial Risk is a tedious task to the entrepreneur accomplished by the project manager

5.3.2.6 Options Models

- "Options are derivative contracts that allow the holder the right but not the obligation to purchase or sell the underlying instrument at a predetermined price on or before a specified future date," according to the definition.
- To determine a current theoretical value, option traders typically use a variety of option price models. To compute the theoretical value for a certain option at a given moment in time, Option price models use some fixed knowns in the present (elements such as underlying price, strike and days till expiration) as well as forecasts (or assumptions) for factors such as implied volatility. Variables will change over the course of the option's life and the theoretical value of the option position will adjust to reflect these changes.
- Option pricing models are mathematical models that compute the potential value of an option based on a set of variables. An option's theoretical value is an estimate of what it should be worth based on all known inputs. To put it another way, option pricing models tell us how much an option is worth. Finance experts could change their trading strategies and portfolios based on an estimate of an option's fair value. As a result, option pricing models are effective tools for finance professionals who trade options.
- An option, according to its formal definition, is a sort of contract between two parties that gives one party the right but not the duty to buy or sell the underlying

asset at a fixed price before or on the expiration date. Calls and puts are the two main forms of options.

1. A call option offers we the right, but not the responsibility, to purchase the underlying asset at a fixed price before or on the expiration date.
2. A put option gives us the right but not the responsibility to sell the underlying asset at a fixed price before or on the expiration date.

- Options can also be categorised based on how long they take to exercise :
  - A. European style options can only be used until they expire.
  - B. American - style options can be used at any time between the time of purchase and the date of expiration.
- The above - mentioned option classification is critical because the option pricing model we choose will be influenced by whether we choose European - style or American - style options.

Binomial option pricing model

- A binomial option pricing model is the simplest way to price the options. The assumption of fully efficient markets is used in this model. The model may price the option at each point in a specified time period based on this assumption.
- The binomial model assumes that the price of the underlying asset will either rise or fall over time. We may compute the payout of an option under these scenarios using the underlying asset's various prices and the strike price of an option, then discount these payoffs to obtain the option's current value.

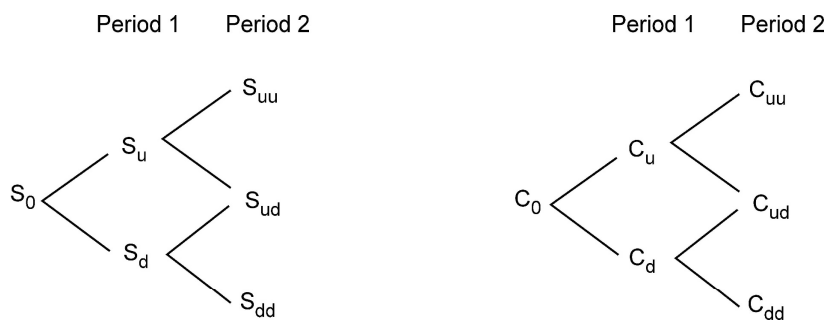


Fig. 5.3.5 Binomial tree for two period

Review Questions

1. *What is risk management ?*
2. *Explain the process of risk management.*
3. *Explain the role of risk management in overall project management.*

4. *Write a note s on risk analysis.*
5. *Write a notes on project management tools :*
   1. *Trello*
   2. *JIRA*
   3. *Asana.*
6. *Explain the process of project financial management.*
7. *Discuss on planning the project finance.*
8. *Explain the controlling of financial pakage.*
9. *Comment on conducting feasibility studies.*
10. *Write a notes on option model.*

Multiple Choice Questions

Q.1 Risk in project management is defined as _____.

a an uncertain event that, if it occurs, has a positive effect on project objectives

b an uncertain event that, if it occurs, has a negative effect on project objectives

c an uncertain event that, if it occurs, has a positive or negative effect on project objectives

d an uncertain event that do not have any effect on project objectives

Q.2 Risk Event Graph is having following on X axis :

a Gantt Chart b Work Break Down Structure

c Project Life Cycle d Splitting

Q.3 Which risk is connected to the circumstance outside the project that may influence the scope of work and the performance of the organization ?

a Operational risk b Financial risk

c Strategic risk d Contextual risk

Q.4 Which of the following is not the part of Risk Control ?

a Execution of the risk response strategy

b Monitoring of triggering events

c Initiating contingency plans d Not watching for new risks

Q.5 Which of the following is the goal of financial management ?

a Maximise the wealth of Equity shareholders

b Maximise the wealth of Preference Shareholders

c Maximise the wealth of Debenture holders

d All of the above

Q.6 Financial management mainly focuses on _____.

a efficient management of every business

b brand dimension

c arrangement of funds

d all elements of acquiring and using means of financial resources for financial activities

Q.7 Which of the following is not considered as a risk in project management?

a Specification delays

b Product competition

c Testing

d Staff turnover

Q.8 Which of the following tools is used for project management ?

a JIRA

b Trello

c Asana

d All of the Above

Q.9 The concept of financial management is _____.

a profit maximization

b all features of obtaining and using financial resources for company operations

c organization of funds

d effective management of every company

Q.10 The finance manager is accountable for _____.

a earning capital assets of the company

b effective management of a fund

c arrangement of financial resources

d proper utilisation of funds

Q.11 _____ is a specific risk factor.

a Market risk.

b Inflation risk.

c Interest rate risk.

d Financial risk.

Q.12 Which of the following factors affect financial decision ?

a Cost

b Risk

c Cash flow position

d All of the above

Q.13 According to Black Scholes Model, the stocks with call option pays the _____.

a dividend

b no dividends

c current price

d past Price

Q.14 According to Black Scholes Model, the purchaser can borrow fraction of security at risk free interest rate which is _____.

a short term b long term

c transaction cost d no transaction cost

Q.15 Finance function comprises _____.

a safe custody of funds only b expenditure of funds only

c procurement of finance only d procurement and effective use of funds

Answer Keys for Multiple Choice Questions :

Q.1	c	**Q.2**	c	**Q.3**	d
Q.4	d	**Q.5**	a	**Q.6**	d
Q.7	c	**Q.8**	d	**Q.9**	b
Q.10	c	**Q.11**	d	**Q.12**	d
Q.13	b	**Q.14**	a	**Q.15**	d

❑❑❑

UNIT VI

6 Product Development and Entrepreneurship

Syllabus

Product Development : *Introduction, Development Process and organizations, product planning, identifying customer needs, Product Significations, concept generation, selection, testing, Design for Manufacturing, Prototyping, Robust Design.*

Entrepreneurship : *Concept, knowledge and skills requirement; characteristic of successful entrepreneurs; entrepreneurship process; factors impacting emergence of entrepreneurship.*

Legal issues related to Product development and Entrepreneurship : *Intellectual property rights-patents, trademarks, copyrights, trade secrets, licensing, franchising.*

Contents

6.1 Introduction

- A product is something that a company sells to its clients. Product development is the set of actions that begins with the identification of a market opportunity and ends with the manufacture, sale and delivery of a product.
- Most organization's economic success is dependent on their ability to identify customer needs and rapidly generate products that meet these needs while being cost effective. Achieving these objectives is not just a marketing challenge, or a design problem, or a manufacturing problem; it is a product development problem that involves all of these tasks.
- The ability of the company to interrelate its own skills and expertise with the challenging environment associated with the company leads to successful product development. Organizations adopt that they lack essential entire technology knowledge and the resources to discover this knowledge, then they must be careful in the knowledge they collect and still ensuring that decision making uses the total technology. The knowledge chosen includes both learnings held by people within the firm and new knowledge obtained from outside the company and via research.
- Product development incorporates all levels of the organization, from top management to the field engineer on the line and it can only be successful if there is integration throughout the organization as well as strong leadership from top management.
- The cultures of the organization and its employees have a significant impact on the product development programme.
- It is useful in the company to evaluate the degree of product development attained in the last few years and then correlate this to some of the elements essential to effective product development on a regular basis.
    - Make sense of collective objectives and methodologies;
    - The profitability of the projects;
    - Top management engagement in product development;
    - 'Go/no-go' judgements by top management at critical important moments;
    - Top management leadership;
    - Resources for product development.
- Product enhancement, product line extension, product relaunch and product innovation are all part of the product development programme.

6.1.1 Characteristics of Successful Product Development

- Successful product development results in products that may be manufactured and sold financially from the perspective of investors in a for-profit organization, although profitability is sometimes difficult to assess quickly and directly. Five additional factors, all of which ultimately relate to profit, are routinely used to evaluate the success of a product development project. Those factors are as given below :

A) Quality of the product :

- How good is the end outcome of the development effort ? Does it meet the needs of the customers ? Is it durable and dependable ? Product quality is eventually reflected in market share and customer willingness to pay.

B) Cost of the product :

- What is the product's manufacturing cost ? This cost comprises capital equipment and tooling expenditures, as well as the incremental cost of producing each unit of the product. Product cost influences how much revenue the firm makes for a given total sales and sales price.

C) Time required for development :

- How promptly did the team finish the product development process? The project duration of a firm defines how sensitive it can be to industry competition and technical developments, as well as how fast the firm receives financial benefit from the team's work.

D) Cost of development :

- How much money did the company have to invest in order to develop the product ? The development cost is typically a large portion of the investment necessary to generate profits.

E) Capability for development :

- Is the team and the firm better suited to produce future products as a result of their product development project experience ? Development capability is a resource that the company can utilize in the future to develop products more effectively and economically.

6.2 Development Process and Organizations

- A process is the sequence of steps that converts one set of inputs into another set of outputs. Most individuals understand the concept of physical processes, such as those used to make a cake or assemble a vehicle. A product development process is the series of stages or procedures used to create a product. operations carried out by a company to develop, design and commercialize a product. Many of these steps and activities are more intellectual and organizational in nature than physical in nature. Some firms establish and follow a specific and precise growth process, whereas others do not. Others may be unable to define their process at all. In addition, every organization adopts a method that is at least marginally distinct from that of any other organization. Actually, The same company may use various techniques for each of numerous different types of projects for development.
- For the following reasons, a well-defined development process is beneficial.

Assurance of quality :

- A development process defines the phases of a development project as well as the stages along the way. Following the development process is one technique to ensure the quality of the end product when these phases and stages are appropriately chosen.

Coordination :

- A fully described development process serves as a master plan that outlines the roles of all development team members. This plan reminds team members when their efforts will be expected and with whom they will need to interchange information and materials.

Planning :

- A development process comprises goals that represent the completion of each phase. The timing of these goals establishes the schedule of the overall development project.

Management :

- A development process acts as a standard for evaluating the success of a continuous development activity. A manager can discover potential trouble areas by comparing actual events to the specified process.

Improvement :

- Careful documentation and continuing evaluation of an organization's development process and results may aid in identifying areas for improvement.

- The general product development process and organization is divided into six stages, as shown in Fig. 6.2.1.

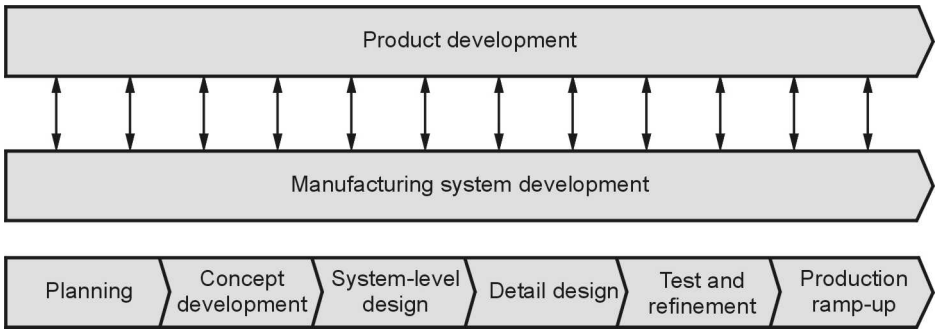


Fig. 6.2.1 Product development process and organizations

1. Planning

- As planning comes before project approval and the start of the actual product development process, the planning activity is commonly referred to as "phase zero." This phase begins with the selection of opportunities driven by business strategy and includes an assessment of technological changes and market objectives. The project mission statement, which defines the product's target market, business goals, important assumptions and restrictions, is the result of the planning process. Product planning covers the new products planning process.

2. Concept development

- The requirements of the targeted audience are recognized during the concept development phase, different product ideas are produced and analyzed and one or more concepts are chosen for future testing and development. A concept is a description of a product's form, function and features that is usually supported by a set of specifications, a competitive product analysis, and an economic justification for the project.

3. System-level design :

- The defining of the product architecture, decomposition of the product into components of the system, concept generation of important components and distribution of design stage authority to both internal and external resources all seem to be part of the system-level design phase. During this phase, initial designs for the manufacturing systems and final assembly are frequently defined as well. This phase's result typically includes a physical layout of the product, functional requirements for each of the product's systems and a preliminary process flow diagram for the final assembly process.

4. Detail design :

- The detail design phase comprises the entire specification of all unique item's shape, materials and specifications, as well as the identification of any standard parts to be obtained from vendors. A process plan is formulated, and equipment for each part to be fabricated inside the production system is designed.
- The control documentation for the product-the drawings or computer files detailing the geometry of each part and its production equipment, the specifications of the purchased parts and the process plans for the fabrication and assembly of the product-is the output of this phase. Materials selection, production cost, and strong performance are three essential aspects that should be considered throughout the product development process but are resolved in the detail design phase.

5. Testing and refinement :

- During the testing and refining phase, various concept design models of the product are built and tested. Early (alpha) prototypes are typically built with production-intent parts-parts having the same geometry and material qualities as intended for the production version of the device but not necessarily fabricated using the production techniques.
- Alpha prototypes are evaluated to determine whether the product will function as intended and whether it meets the major client needs. Later (beta) prototypes are often made with parts supplied by the intended production procedures, however they may or may not be assembled using the intended final assembly process. Internally, beta prototypes are thoroughly assessed and consumers often test them in their own use environment. The purpose of beta prototypes is often to address performance and reliability problems in order to identify essential technical adjustments for the final product.

6. Production ramp-up :

- During the ramp-up phase, the product is manufactured utilizing the intended production system. The ramp-up period is intended to train the workers and smooth out any remaining issues in the manufacturing processes. Products created throughout the ramp-up process are occasionally delivered to favored customers and thoroughly reviewed to identify any remaining problems.
- The transition from ramp-up to continuous production is usually slow. At some point during this transition, the product is released and made widely available. A post launch project evaluation may take place soon after the launch. This review comprises an evaluation of the project from both a commercial and technical

standpoint, with the goal of identifying methods to enhance the development process for future initiatives.

6.3 Product Planning

- The product plan specifies the portfolio of products to be developed by the organization as well as the timing of their market introduction. The planning process takes into account product development opportunities recognized by a variety of sources, including marketing, research, customers, current product development teams and competitor benchmarking.
- The product plan is updated on a regular basis to represent changes in the competitive environment, technological advancements and information on the achievement of existing products. Product plans are created with the goals, capabilities, constraints, and competitive environment of the company in mind. Product planning decisions are typically made by the organization's senior management and may occur only once or twice a year. This process is managed by a director of planning in some organizations.

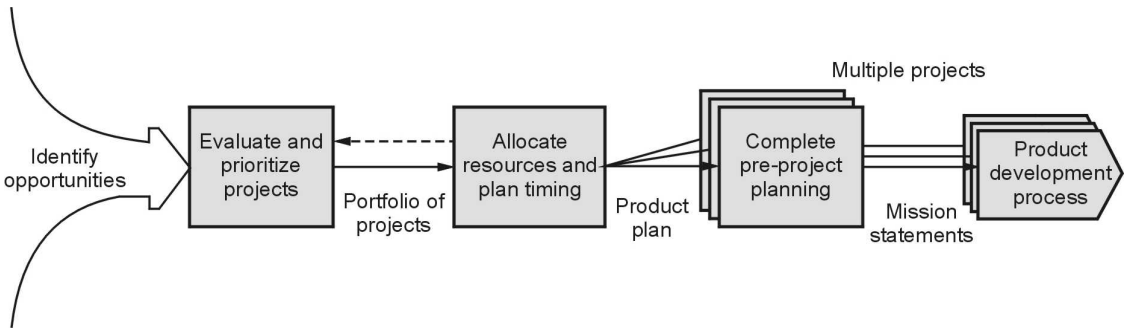


Fig. 6.3.1 Product planning process

- The steps in the product planning process are shown in above Fig. 6.3.1.
- A five-step process for developing a product plan and project mission statements follows :
  1. Identify opportunities.
  2. Evaluate and prioritize projects.
  3. Allocate resources and plan timing.
  4. Complete pre-project planning.
  5. Reflect on the results and the process.

1. Identify opportunities

- The process of planning begins with the identification of product development opportunities. Such opportunities could involve any of the project types. Because it gathers inputs from across the organization, this step is known as the **opportunity funnel**. Opportunities can be collected inactively, but we also suggest that the firm actively seeks out opportunities.
- When it is used actively, the opportunity funnel continuously collects ideas and new product opportunities can arise at any time. It is recommended that each promising opportunity be described in a short, logical statement and that this information be collected in a database as a way of tracking, sorting and refining these opportunities. For collecting and storing information on opportunities, several Web-based idea management systems are available, though a simple list in a worksheet may be fulfilled.

2. Evaluate and prioritize projects

- The opportunity funnel, if aggressively handled, might accumulate hundreds or even thousands of opportunities in a year. Some of these chances don't make sense in the context of the company's other activities and in most circumstances, the company can't explore all of them at once. The selection of the most promising initiatives to pursue is the second step in the product planning process. Competitive strategy, market segmentation, technical trajectories and product platforms are four key views that can help you evaluate and prioritize new product prospects in existing product categories. After going through these four points, we'll talk about identifying chances for fundamentally new products and how to strike a balance in the project portfolio.
- Following are four useful perspectives to prioritize :

  a) Competitive strategy

  b) Market segmentation

  c) Technological trajectories

  d) Product platforms.

a) Competitive strategy

- A company's competitive strategy establishes a fundamental approach to markets and products in relation to competitors.

- The possible competitive strategies are :
  - **Technology leadership :**
    - It Emphasis on research and development
  - **Cost leadership :**
    - Focus on production efficiency (economies of scale, manufacturing methods, low-cost labor, better management
  - **Customer focus :**
    - Follows closely customer's needs and preferences
    - May result in a broad product line with high product variety
  - **Imitative strategy :**
    - Allows competitors to explore the products
    - If their products are successful, the firm quickly launches its limitations

b) Market Segmentation

- Market segmentation is the process of breaking a large target market into smaller groups of clients.
- The firm can examine which product prospects best address deficiencies in its own product line and which exploit gaps in competitor's offerings by mapping competitor's products and the firm's own products onto segments.
- In distinct segments :
  - Distinct needs and priorities
  - Distinct strategies to target them.

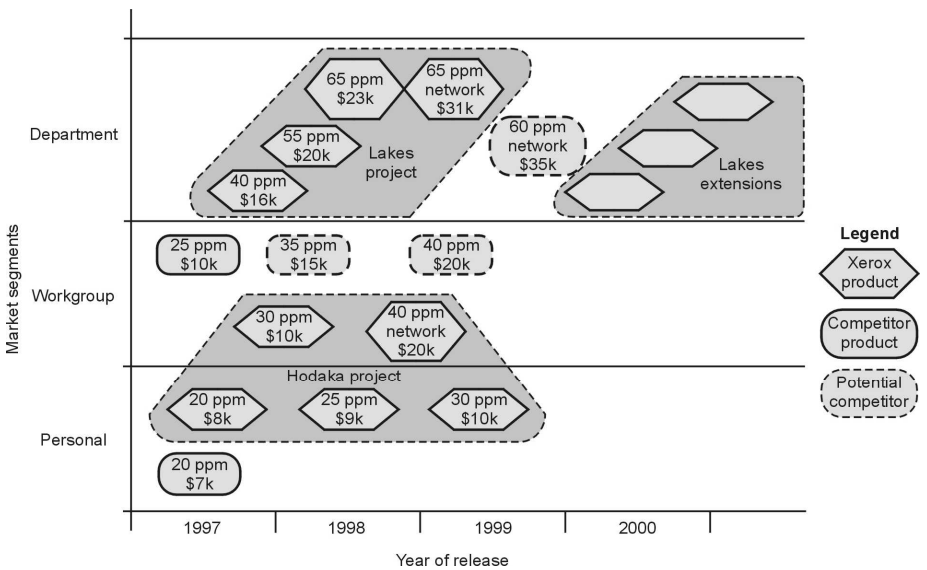


Fig. 6.3.2 Product segment map for Xerox machine

C) Technological Trajectories

- When it comes to technology-intensive enterprises, one of the most important product decisions is when to introduce a new technology into a product line.
- Technology S-curve displays the performance of the product over time
- Usually single performance measure is used (speed, resolution)

Example - Xerox

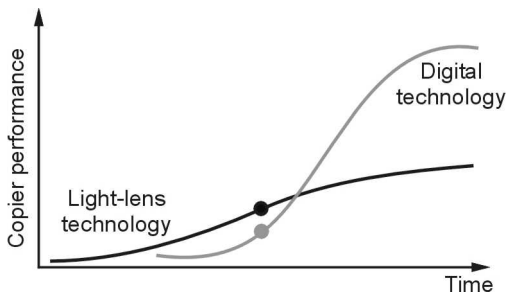


Fig. 6.3.3 Xerox Digital copier Technology

- The Fig. 6.3.3 shows the S-curve of the Xerox machine in which Xerox predicted that digital copier technologies would be in the early stages of development and that it would be able to develop a full-featured digital copier in the near future.
- The horizontal axis may be overall R&D effort or time, while the vertical axis may be a performance/cost ratio or any other key performance metric. While S-curves accurately represent technological advancement in a wide range of industries, predicting the future direction of the performance curve (how close or distant is the ultimate performance limit) can be tricky.

d) Product Platforms

A platform development project,

- Creates the architecture for a family of products
- Involves major development effort
- Later we may extend an existing product platform to better address familiar markets.

Derivative Products

- The platform enables the creation of a wide range of derivative products quickly and efficiently.
- It is really possible that they will be included in the first platform development effort, or that they will be developed later.

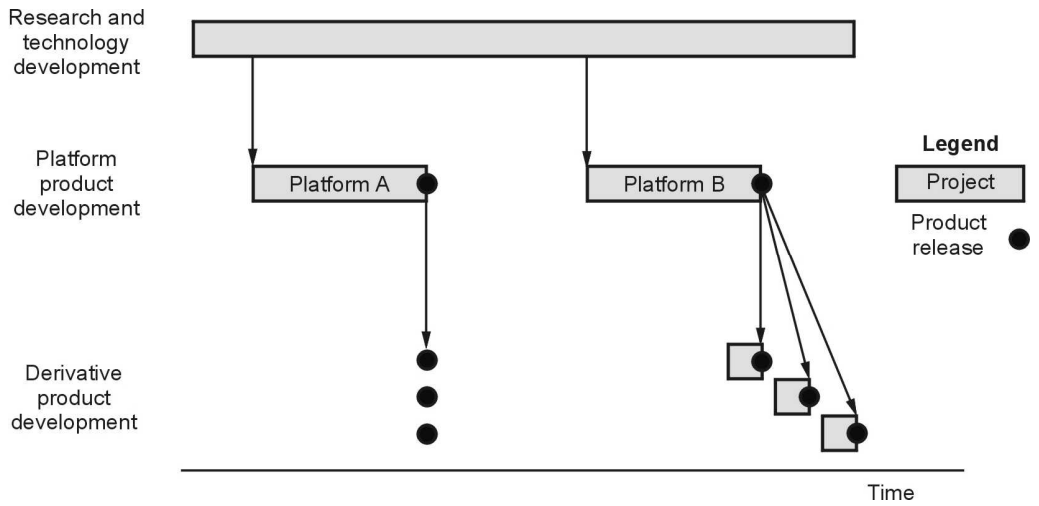


Fig. 6.3.4 The initial platform development effort (Platform A) or derivative products may follow thereafter (Platform B)

3. Allocate resources and plan timing

Allocate resources

- The company is unable to fund every product development opportunity in its planned balanced portfolio of projects. When it comes to determining the timing and resource allocation for the most promising projects, there will always be too many competing for too few resources.
- As a result, attempting to assign resources and schedules nearly invariably leads to a return to the preceding evaluation and prioritizing stage to trim the list of projects to pursue.
- Many organizations concentrate on too many projects, ignoring the limited resources available for development. As a result, talented engineers and managers are assigned to an increasing number of projects, productivity falls, projects take longer to finish, products arrive late and earnings plummet. Aggregate planning assists an organization in making the most efficient use of its resources by focusing on initiatives that can be executed within the specified budget.

Project Timing

- A variety of criteria must be considered when determining the timing and sequencing of initiatives, often known as pipeline management.
  - **Introduction of new products at the right time :**
    - In general, the earlier a product is released to the market, the better; however, releasing a product before it is of sufficient quality might harm the company's reputation.

- **Ready for technology :**
  - In the planning process, the robustness of the underlying technologies is essential. A known, reliable technology can be easily and reliably integrated into products.
- **Ready for the market :**
  - Early investors buy the low-end product and may trade up, or they buy the high-end product supplied at a high initial price, depending on the order in which products are introduced. Customers who wish to stay current may become frustrated if upgrades are released too quickly; on the other hand, delivering new items too slowly risks falling behind competition.
- **Competition :**
  - The expected arrival of competitive products may cause development projects to move more quickly.

4. Complete pre-project planning

- A pre-project planning activity occurs after the project has been approved but before significant resources are applied. A small, cross-functional team of persons, referred to as the core team, is involved in this work.
- Project staffing and leadership are also addressed in the pre-project planning phase.
- This could entail persuading key members of the development team to "sign up" for a new project, i.e., agreeing to lead the development of the product or a significant component of the product. Budgets are usually developed as part of the pre-project planning process.
- Budgets and staffing plans for fundamentally new items will only be for the concept development phase of development. This is because the project's details are largely unknown until the new product's main concept is determined. When and if the concept is further developed, more extensive planning will take place.

5. Reflect on the results and the process

- The team should ask various questions in this final step of the planning and strategy process to assess the quality of both the process and the results. The following are some questions to consider :
- Is there a wide and compelling collection of product opportunities in the opportunity funnel ?
- Does the product strategy align with the company's competitive strategy ?
- Does the product strategy address the company's most pressing current opportunities ?

- Is the entire amount of money set aside for product development sufficient to carry out the company's competitive strategy ?
- Have innovative approaches to leverage finite resources, such as product platforms, joint ventures and supplier relationships, been considered ?
- Is the core team willing to take on the challenges presented by the mission statement that results ?
- Is the mission statement's content consistent ?
- Are the mission statement's assumptions truly necessary, or is the project overburdened ? Will the development team be free to create the greatest product possible ?
- What can be done to improve the product planning process ?
- The product planning technique is presented as a step-by-step process for ease of presenting; nevertheless, continuous reflection and critique of consistency and fit is required. Steps in the process can and should be completed at the same time to ensure that all of the plans and decisions are in sync with one another as well as the firm's goals, capabilities and limits.

6.4 Identifying Customer Needs

- Customer needs identification is an important aspect of the whole product development process, since it is linked to opportunity discovery, product planning, concept generation, concept selection, competitive benchmarking and the creation of product specifications.
- Needs are essentially independent of any specific product we may build; they are not limited to the notion we ultimately pursue. A team should be able to recognise consumer demands without knowing whether or not it will be able to meet those needs in the future. Specifications, on the other hand, are dependent on the design we establish.
- The requirements for the product we finally design will be determined by what is technically and economically viable, as well as what our competitors have to offer in the marketplace and customer needs.
- Customer qualities and customer requirements are two more terms used in industry to refer to customer needs.
- Customer needs identification is a process in and of itself, for which we provide a five-step strategy.

- We feel that a little structure goes a long way toward enabling good product development methods and we hope and expect that individuals who use it will see it as a starting point for continuous improvement and refinement rather than a rigid procedure.

The five steps are :

1. Collect raw information from customers.
2. Analyze the raw data in terms of the customer's requirements.
3. Arrange the requirements into a hierarchy of primary, secondary and tertiary requirements (if applicable).
4. Determine the relative importance of the various requirements.
5. Consider the outcomes and the process.

1. Collect raw information from customers

- **Interview :**
  - 1~ 2 hour/person one-on-one interviews with key customers.
- **Focus Group :**
  - A moderator facilitates a two-hour discussion with a group of 8 - 12 customers. Usually with fees. 2 hour/group.
- **Observing the product in use :**
  - Watching customers use an existing product or perform a task for which a new product is intended.

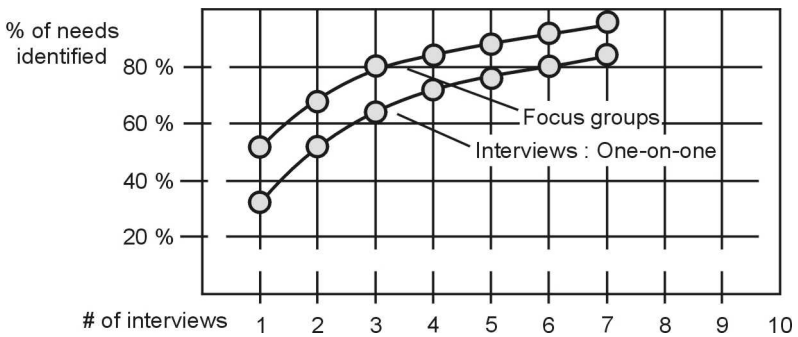


Fig. 6.4.1 Comparison of the percentages of customer needs that are revealed for focus groups and interviews as a function of the number of sessions

2. Analyze the raw data in terms of the customers requirements

- Customer needs are represented as written statements as a result of interpreting the need that lies somewhere under the raw data obtained from clients. Each statement or observation (as specified in the data template's second column) can be transformed into any number of ways.

- Customer requirements Griffin and Hauser discovered that many analysts can interpret the same data.
- Because various needs require different translations, having more than one team member conduct the process is beneficial. We'll provide five writing tips later in this section.
- The superset of all the needs obtained from all the interviewed customers in the target market is the list of customer needs. Some requirements may not be technologically feasible.

Analysis of the raw data in terms of the customer's requirements is formulated with an example as mentioned below :

Writing Good Need Statements

Category	Customer Statement	Need Statement-Right	Need Statement-Wrong
"what" not "how"	"Put protective shields around battery contacts".	Battery protected from accidental shorting.	Unit contacts covered by sliding plastic door.
Specific	"I always drop it."	Operates after dropping.	Unit is rugged.
Positive not negative	"I need to work outside in the rain."	Unit operates normally in the rain	Unit not disabled by rain
Product attribute	"I want to recharge it with the cigarette lighter"	Battery can be charged from cigarette lighter	Cigarette lighter adaptor can recharge unit.
Avoid "must	"I want to see how much juice is left in the battery".	Unit provides indication of battery level	Unit should provide indication of battery level.

3. Arrange the requirements into a hierarchy of primary, secondary and tertiary requirements

- Steps 1 and 2 usually result in a list of 50 to 300 needs statements. It's tough to deal with such a large number of precise needs and it's even more difficult to summarize them for use in following development operations. Step 3 purpose is to compile an usable hierarchical list of these requirements. The list will normally include a number of primary needs, each of which will be followed by a number of secondary needs. Secondary needs may be split down further into tertiary needs in the case of highly complex products. Primary needs are the most basic, whereas intermediate and tertiary requirements reflect more specific wants.
- The process for collecting the demands into a hierarchical list is simple and many teams can execute the task successfully without extensive guidance.

- It included a step-by-step approach for convenience as given below :
  - Print or write each needs statement on a separate card or self-stick note
  - Eliminate redundant statements
  - Group the cards according to the similarity of the needs they express
  - For each group, choose a label
  - Consider creating supergroups consisting of two to five groups
  - Review and edit the organized needs statements.
- When the team tries to reflect the needs of two or more unique market segments, the process becomes more challenging.

4. Determine the relative importance of the various requirements

- The hierarchical list by itself does not reveal the relative significance that customers place on various needs. However, when creating the product, the development team will have to make trade-offs and allocate resources. Making these trade-offs correctly requires an understanding of the relative importance of the various needs. The relative importance of the customer needs discovered in steps 1 through 3 is determined in step 4 of the needs process.
- A numerical relevance ranking for a subset of the demands is the result of this stage.
- The work can be approached in two ways :
  1) Depending on team members' consensus based on their customer experience, or
  2) Basing the importance assessment on additional customer surveys.
- The obvious cost and speed versus accuracy trade-off between the two approaches is that the team can make an educated judgment of the relative importance of the demands in one meeting, but a customer survey can take a week or more.
- We believe that, in most circumstances, the customer survey is relevant and worth the time it takes to complete. Before the relative importance surveys are completed, other development processes, such as concept formulation and competitor product analysis, may start.

5. Consider the outcomes and the process

- The procedure concludes with a review of the outcomes and the process. While it is possible to structure the process of discovering client wants, it is not an exact science. The team must test its findings to ensure that they are compatible with the knowledge and intuition that the team has built over many hours of client interaction. The following are some questions to consider :

- Have we interacted with all of our target market's main sorts of customers ?
- Are we able to go beyond needs that are exclusively tied to existing items in order to grasp our target customer's latent needs ?

Is there anything we should look into further in follow-up interviews or surveys ?

- Which of the customers with whom we spoke might make suitable collaborators in our ongoing development efforts ?
- What have we learned since the beginning that we didn't know before? Are any of the requirements surprising to us ?
- Have we enlisted the help of everyone in our business who requires a thorough understanding of consumer requirements ?
- How can we make the process better in the future ?
- A good method to describe the system's findings is to make a list of the most significant and latent demands. The most important needs identified, for example, are :
  - The thermostat is simple to operate.
  - During the day, the thermostat can adjust the temperature based on the user's preferences.
  - My existing heating and/or cooling system is compatible with the thermostat.
  - The thermostat helps to save energy.
  - The thermostat can be programmed from a comfortable position, which is one of the hidden demands.
  - The thermostat works perfectly right out of the box and requires no additional setup.
  - The thermostat adjusts to the presence of people.
  - The outside surfaces of the thermostat do not fade or discolour over time.
  - In the winter, the thermostat keeps pipes from freezing.
- The essential few requirements that must be met for a great product are reminded by the important needs, while the latent needs supply insights that can drive the creative process of developing product integration.

6.5 Product Significations

- A product specifications is well elaborated in the product specification document. A product specification, often known as a product spec, is an important product document that lays out the primary requirements for developing a new feature, functionality, or product. A product spec, like a blueprint, comprises vital

information (such as target users, business needs, goals and other important aspects) to assist the product team in developing a successful product.

- A product spec is an important first step in product development since it necessitates critical thinking in the early phases of developing a new concept. It clearly communicates what we are building, to whom we are building it and what should be the end product. It also provides crucial background information for those who will be working on the project. It also acts as a roadmap for product teams to follow during the development process. A solid product spec also gives clarity, which helps to speed up development, keep teams on track and avoid costly misunderstandings.
- Every product specification is based on technical specifications, engineering specifications and other features unique to the product. However, the following should be included in our product specification document in general :

1. Summary :

- This is a broad overview of the product. It starts with a summary of the product concept and then moves on to a brief description of the product and its overall concept. It also explains why the product is being developed in the first place. The product overview describes how the final product will look, what features it will have and how long it will take to produce.

2. Functional Specification :

- This is a document that defines how we see the next product's appearance and capabilities. It should also include information about how users will engage with it. It serves as a point of reference for the product development team as they get started. We could also want to include a paper with a flexible technical specification for our team.

3. Business Case

- The business case for the product's development should be the next item on our spec sheet. It explains the advantages or benefits that the product provides to the company in the market. It also considers the budget and other resources needed to accomplish the project.

4. User Personas

- This specifies to whom this product is intended for and who is the target audience. It goes into the specifics of the target demographic and their problems that the solution will answer. Knowing who the product is meant for ensures that our efforts are focused on the customer.

5. User Stories

- These are short messages from the point of view of the product's end-users. They describe the features that people would want to see in the new product. Acceptance criteria - These are the factors that indicate if a user story has been completed by the product, such as whether a desired feature has been incorporated - should also be included with user stories.

6.6 Concept Generation, Selection, Testing

6.6.1 Concept Generation

- A product concept is a rough description of the product's technology, functioning principles and form. It is a brief summary of how the product will meet the needs of the consumer. A concept is frequently expressed as a crude three-dimensional model or a sketch.
- It's frequently accompanied by a short textual description. The extent to which a product satisfies a customer's needs depends in major part on whether or not it satisfies buyers and can be successfully sold.
- The foundational concept's quality When an excellent idea is badly implemented, it can be dangerous. However, a bad design can rarely be adjusted to attain success in subsequent development phases
- Furthermore, in comparison to the rest of the development process, concept generation is quite inexpensive and can be completed quickly.
- The common steps in concept generation process of a design product follow the following five steps :

  1. Clarify the problem
  2. Search externally
  3. Search internally
  4. Explore systematically
  5. Reflect on the solution and the process

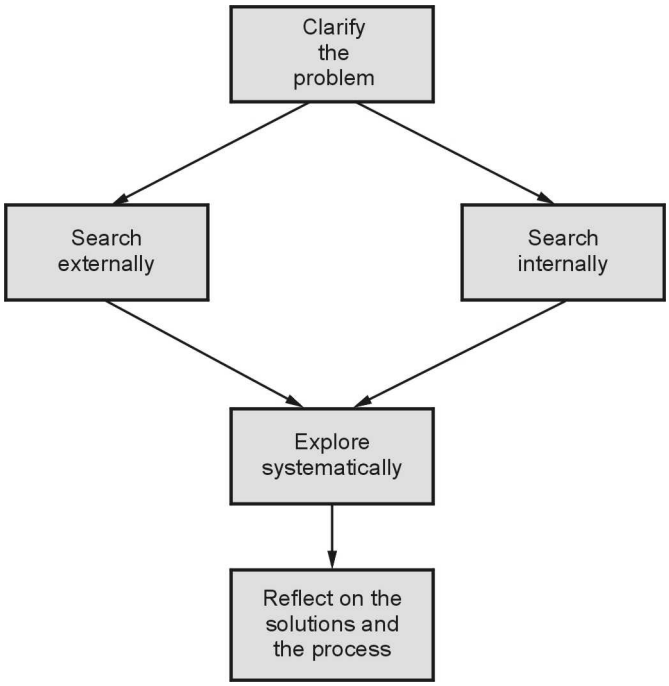


Fig. 6.6.1 Process of concept generation

1. Clarify the problem

- Clarifying the problem involves acquiring a broad knowledge and if necessary, breaking it down into sub problems. Although these pieces of information are typically still being revised when the concept generation phase begins, the project's mission statement, customer needs list and early product specification are suitable inputs to the concept development process. In an ideal world, the team would have been involved in both identifying client demands and defining the target product specifications. Before beginning concept generating activities, those members of the team who were not participating in the prior steps should become familiar with the processes employed and their outcomes.

2. Search externally

- The goal of external search is to uncover existing solutions to the overall problem as well as the subproblems identified during the problem clarification process. External search is stated as the second step in the concept generation approach, although this sequential labeling is misleading; external search happens all the time during the development process.
- It is frequently faster and less expensive to implement an existing solution than to design a new one. The team can focus its creative attention on the essential

subproblems for which there are no adequate prior answers by liberally using existing solutions.

- In addition, a traditional solution to one subproblem can sometimes be paired with an innovative solution to another subproblem to produce a superior overall design. As a result, external search comprises a thorough assessment of not just directly competing items, but also technology employed in products with similar sub functions.
- The external search for solutions is primarily a data collection procedure. Using an expand-and-focus technique, available time and resources can be maximized by first broadening the scope of the search by gathering information that could be related to the problem and then narrowing the scope of the search by studying promising directions in greater depth. The external search will become inefficient if we use too much of either strategy.
- Lead user interviews, expert consultation, patent searches, literature searches and competition benchmarking are at least five good approaches to obtain knowledge from external sources.

3. Search internally

- Internal search is the process of generating solution concepts through the use of personal and team knowledge and creativity. This type of search, also known as **brainstorming**, is internal in the sense that all of the ideas that emerge from it are derived from knowledge that the team already possesses.
- This task in product development may be the most open-ended and creative of any. Internal search can be thought of as the process of retrieving potentially useful information from one's memory and then adapting that information to the problem at hand. Individuals working alone or in groups can carry out this process.
- Both individual and group sessions are essential for internal search.

4. Explore systematically

- The team will have gathered tens or hundreds of concept fragments-solutions to the subproblems-as a result of its external and internal search activities. By organizing and synthesizing these solution fragments, systematic exploration aims to navigate the space of possibilities.

5. Reflect on the solution and the process

- Although the reflection phase is placed at the end for ease of presenting, reflection should actually be done throughout the process. Among the questions to ask are :

- Is there a growing sense among the team that the solution space has been well explored ?
- Are there any other function diagrams available ?
- Are there any other methods to break down the problem ?
- Have all external sources been exhausted ?
- Have all ideas been accepted and incorporated into the process ?

6.6.2 Concept Selection

- The process of analyzing concepts in terms of consumer needs and other criteria, comparing their relative strengths and shortcomings and selecting one or more concepts for future inquiry or development is known as **concept selection**.
- Every team has an implicit or explicit process for selecting concepts. The decision-making techniques used to select concepts range from intuitive to formal methodologies.
- Structured concept selection helps in successful design. A two-stage method is recommended : Concept screening and concept scoring.
- Concept screening compares concept variants to selection criteria using a reference concept. Different reference points may be used for each criterion when scoring concepts.
- To reduce the range of concepts under evaluation, concept screening employs a crude comparison mechanism.
- Concept scoring employs a finer rating scale and weighted selection criteria. If concept screening yields a dominating notion, scoring may be skipped.
- A matrix serves as the foundation for both screening and scoring in a six-step selection procedure.
- The six steps are follows in concept selection process,
  1. Make the selection matrix first.
  2. Give each concept a score.
  3. Sort the ideas into categories.
  4. Put the ideas together and improve them.
  5. Pick one or more concepts to work with.
  6. Consider the outcomes and the process.
- Idea selection is used throughout the design and development process, not just during concept development.

- Concept selection is a group method that helps in the selection of a winning concept, assists in team finding common ground and keeps track of the decision-making process.

1. Make the selection matrix first

- To prepare the matrix, the team selects a physical medium appropriate to the problem at hand. Individuals and small groups with a short list of criteria may use matrices on paper.

2. Give each concept a score

- Each column in the matrix is assigned a relative score of "better than" (+), "same as" (0), or "worse than" (–) to represent how each concept compares to the reference concept in terms of the criterion. Before going on to the next criterion, it is normally recommended to rate each concept on one criterion. When there are a lot of concepts, though, it's faster to use the opposite strategy and rate each one entirely before going on to the next.
- Some people find it difficult to work with the coarse nature of the relative ratings. However, at this stage in the design process, each concept is only a broad idea of the final product and more specific ratings are largely meaningless. Indeed, given the lack of precision of the concept descriptions at this point, it is extremely difficult to consistently compare concepts to one another unless one concept (the reference) is used as a basis for comparison on a consistent basis.

3. Sort the ideas into categories

- After rating all of the concepts, the team adds up the number of "better than," "same as," and "worse than" scores for each category and enters the total in the matrix's lower rows. The number of "worse than" ratings can then be subtracted from the number of "better than" ratings to yield a net score.

4. Put the ideas together and improve them

- After rating and ranking the concepts, the team should check to see if the results make sense and then consider how to combine and improve certain concepts. There are two issues to consider.
- Is there a generally good concept that is harmed by a single flaw ? Can a minor change improve the overall concept while still distinguishing it from the other concepts ?
- Are there two concepts that can be combined in order to keep the "better than" qualities while eliminating the "worse than" qualities ?

- Concepts that have been combined and improved are then added to the matrix, rated by the team and ranked alongside the original concepts.

5. Pick one or more concepts to work with

- Once the team members are satisfied with their understanding of each concept and its relative quality, they decide which concepts will be refined and analyzed further. Based on previous steps, the team will most likely have a good idea of which ideas are the most promising.

6. Consider the outcomes and the process

- The outcome should be acceptable to all team members. If an individual disagrees with the team's decision, it is possible that one or more important criteria are missing from the screening matrix, or that a particular rating is incorrect or unclear. An explicit consideration of whether the results make sense to everyone reduces the likelihood of error and increases the likelihood that the entire team will be fully committed to the subsequent development activities.

6.6.3 Concept Testing

- A concept test invites a direct response from potential customers in the target market to a description of the product concept. Concept testing differs from concept selection in that it is based on data gathered directly from potential customers and relies on decision taken by the development team to a lesser extent.
- Concept testing can be used to ensure that the product concept meets the demands of customers, estimate the sales potential of a product concept, and/or acquire user feedback for the purpose of developing the product concept.
- Concept testing is useful at several stages of the development process, including identifying the original product opportunity, deciding which of two or more concepts to pursue, evaluating a product concept's sales potential and/or deciding whether to continue product development and commercialization.
- A seven-step process follows for testing product concepts :

  1. Define the purpose of the concept test.
  2. Select a sample population for your survey.
  3. Decide on the survey format.
  4. Explain the concept.
  5. Track consumer feedback.
  6. Analyze the outcomes.
  7. Think about the outcomes and the process.

1. Define the purpose of the concept test

- As a first step in concept testing, it is recommended that the team write down the questions that they want the test to answer. Concept testing is essentially an experiment and defining the aim of the experiment, as with any experiment, is critical to devising an effective experimental procedure. This step is similar to prototyping's "definition of purpose."

The following are the most common questions that are addressed during concept testing :

- Should one of several different concepts be pursued ?
- What can be done to improve the concept so that it better meets the demands of the customers ?
- What is the chance of selling a certain number of units ?
- Is it necessary to continue development ?

2. Select a sample population for our survey

- The concept test is based on the idea that the population of potential customers questioned is representative of the product's target market. Inferences based on the concept test will be biased if the survey population is either more or less enthusiastic about the product than the product's eventual target audience.
- As a result, the team should select a survey population that is as representative of the target market as possible. The first few questions in a survey are known as screener questions and they are intended to ensure that the responder fits the definition of the product's target market.
- In such instances, the team may decide to survey only the largest segment of potential clients. When only one group is sampled, however, assumptions about the overall market's response are likely to be inaccurate.

3. Decide on the survey format

The following formats are commonly used in concept testing :

- **Face-to-face interaction :**
  - An interviewer communicates directly with the respondent in this format. Intercepts are a type of face-to-face interaction.
- **Telephone :**
  - Telephone interviews can be scheduled in advance and targeted at certain individuals.

- **Postal mail :**
  - Concept-testing materials are given out through mail surveys and respondents are requested to return a completed form.
- **Electronic mail :**
  - Electronic mail surveys are quite similar to postal mail surveys, with the exception that (as of this writing), respondents appear to be significantly more likely to respond to electronic mail surveys than to postal mail surveys.
- **Internet :**
  - A team might use the Internet to establish a virtual concept-testing site where survey participants can look at concepts and respond. Typically, an electronic mail message is used to invite respondents to the test site.

4. Explain the concept

- The survey format chosen is heavily linked to how the concept will be delivered.

5. Track consumer feedback

- The format of the survey is heavily linked to the manner the subject is presented. Most concept test surveys begin by communicating the product concept and end with a measurement of client reaction. Customer reaction is commonly measured by asking the responder to pick between two or more alternative concepts when a concept test is conducted early in the concept development phase. Additional inquiries explore why people behave the way they do and how product concepts might be enhanced. In general, concept tests are used to assess purchasing intent. Five response categories will be provided on the most generally used purchase-intent scale. Concepts can be communicated in any of the ways described below, in order of increasing descriptive richness.
  - Definitely would buy.
  - Probably would buy.
  - Might or might not buy.
  - Probably would not buy.
  - Definitely would not buy
- This scale can be modified by providing seven or more response categories or by asking respondents to specify a numerical probability of purchase.

6. Analyze the outcomes

- If the group is only interested in comparing two or more concepts, the results are simple to interpret. If one concept outperforms the others and the team is certain that the respondents comprehended the major differences between the concepts, the team can simply choose the preferred notion. If the results are inconclusive, the team may opt to go with an idea based on cost or other factors, or provide numerous versions of the product.

7. Think about the outcomes and the process

- The concept test's main advantage is that it allows us to collect input from real potential clients. The qualitative insights gained from open-ended dialogues with respondents about suggested concepts may be the most valuable outcome of concept testing, especially early in the development process. This data, as well as the numerical outcome of the forecast, should be considered by the team.
- The forecasting approach assists the team by considering the influence of three major variables :
  1) The total size of the market,
  2) Product availability and awareness, and
  3) The fraction of customers who are likely to purchase.
- Considering alternative markets for the product can sometimes increase the first factor. The second factor can be increased through distribution arrangements and promotion plans. The third factor can be increased through changes to the product design .
- Finally, note that the experience with a new product is likely to be transferable to comparable products in the future. By documenting the findings of its idea testing and seeking to reconcile these results with later observations of product success, the team can gain from its experience.

6.7 Designs for Manufacturing

- Design For Manufacturing (DFM) aims to reduce manufacturing costs while simultaneously improving (or at the very least not jeopardizing) product quality, development time and development expenses.
- DFM starts with the concept development phase and the system-level design phase; critical decisions must be made in these phases while keeping production costs in mind.

- DFM uses manufacturing cost estimations to guide and prioritize cost-cutting actions. Cost estimate necessitates knowledge of the key manufacturing processes. This approach must include suppliers and manufacturing specialists.
- Because exact cost assessment is difficult, most DFM practice entails making informed decisions without detailed cost data.
- By knowing what drives component costs can be decreased. Novel component design concepts or gradual improvements to current designs through simplicity and standardization may be used as solutions.
- By adopting well-established design-for-assembly (DFA) criteria, assembly costs can be lowered. Components can be modified to make assembly easier, or their functions can be integrated into other components to eliminate them entirely.
- Understanding the reasons for complexity in the manufacturing process is the first step toward lowering manufacturing support expenses. Design decisions have a significant impact on the costs of manufacturing support. Even though overhead cost estimates are generally insensitive to such changes, decisions should be made with these implications in mind.
- DFM is an integrative method that occurs throughout the development process and requires input from all members of the development team.
- DFM decisions can have an impact on product development lead time, cost and quality. Manufacturing costs and these equally essential broader challenges will almost always have to be traded off.
- Design for manufacturing process follows the following steps :

  1. Estimate the manufacturing costs.
  2. Reduce the costs of components.
  3. Reduce the costs of assembly.
  4. Reduce the costs of supporting production.
  5. Consider the impact of DFM decisions on other factors.

1. Estimate the manufacturing costs

- The manufacturing cost is the total of all expenditures for the system's inputs and waste disposal.
- Firms typically use unit manufacturing cost as a cost measure for a product, which is calculated by dividing overall manufacturing expenses for a period (usually a quarter or a year) by the number of units of the product manufactured during that period.

- A manufacturer's unit production cost is made up of three types of cost :

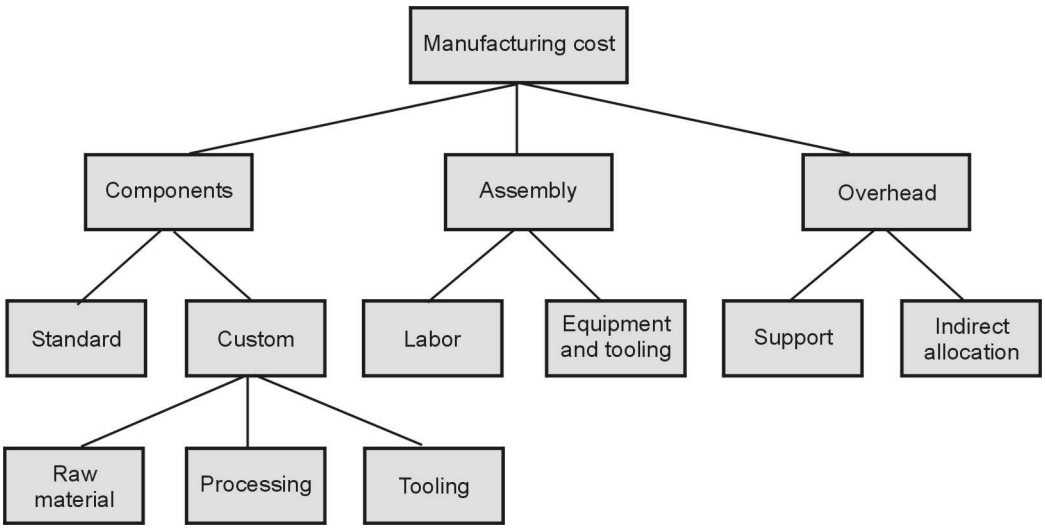


Fig. 6.7.1 Elements of manufacturing cost

i. Component costs :

- Standard parts acquired from suppliers may be included in a product's components (sometimes referred to as pieces of the product). Custom parts are created from raw materials such as sheet steel, plastic pellets, or aluminium bars. Some custom components are manufactured in the manufacturer's own facility, while others may be made by third-party vendors.

ii. Assembly costs :

- Discrete goods are typically put together from parts. Assembling involves labour costs almost usually, as well as costs for equipment and tooling.

iii. Overhead costs :

- The term "overhead" is used to describe all of the other costs. Support costs and other indirect allocations are two types of overhead.
- Materials handling, quality assurance, purchasing, shipping, receiving, facilities, and equipment/tooling maintenance are all examples of support costs (among others). These are the support systems needed to create the product and the cost of these systems is heavily influenced by the product design. However, because these costs are sometimes shared by multiple product lines, they are grouped together as overhead.
- Indirect allocations are manufacturing expenditures that cannot be explicitly connected to a specific product but must be paid in order to stay in business.

2. Reduce the costs of components

To reduce the cost of component in the design for manufacturing some strategies need to follow as under :

Understand the Process Constraints and Cost Driver

- Some component parts could be expensive merely because the designers were unaware of the manufacturing process's capabilities, cost drivers and limits.
- Some component parts could be expensive merely because the designers were unaware of the manufacturing process's capabilities, cost drivers and limits. For example, a designer may, request a small internal corner radius on a machined product without realizing that physically achieving such a feature necessitates an expensive electro-discharge machining (EDM) operation.
- In some cases, the constraints of a process can be concisely communicated to designers in the form of design rules. For example, the capabilities of an automatic laser cutting machine for sheet metal can be concisely communicated in terms of allowable material types, material thicknesses, maximum part dimensions, minimum slot widths and cutting accuracy.

Redesign Components to Eliminate Processing Step

- After a full assessment of the proposed design, suggestions for change may be made, resulting in the production process being simplified. Reduced costs are usually achieved by reducing the number of steps in the part fabrication process. Some phases in the procedure may not be required.

Choose the Appropriate Economic Scale for the Part Process

- As a manufacturer's production volume grows, its manufacturing cost normally decreases. Economies of scale is the term for this occurrence. For a fabricated component, economies of scale exist for two reasons :
  1. Fixed costs are shared over more units, and
  2. Variable costs are reduced.
- Because the firm can justify the use of larger and more efficient processes and equipment.

Standardize Components and Processes

- The concept of economies of scale can also be used to component and process selection. The unit cost of a component decreases as the production volume of the component increases. Quality and performance often improve as production volumes increase and so does the manufacturer's investment in learning and improving the process.

3. Reduce the costs of assembly

- Assembly makes for a small portion of the total cost for most products. Focusing on assembly costs has significant indirect benefits. Along with the assembly cost, the part count, manufacturing complexity and support expenses are all decreased.
- This concept is useful in developing an intuition for what drives the cost of assembly. The expression for the DFA index is,

$$\text{DFA} = \frac{(\text{Theoretical minimum number of parts}) \times (3 \text{ seconds})}{\text{Estimated total aseembly time}}$$

Assembly cost considered with the following :

a) Integrate Part

- It is not necessary to assemble integrated parts. The part fabrication process executes the "assembly" of the geometric features of the part.
- Integrated parts are often less expensive to fabricated.
- The part fabrication process can control the relationships between essential physical aspects with integrated parts.

b) Maximize Ease of Assembly

- Even if two products have the same amount of parts, the assembly time may differ by a factor of two or three.

c) Consider Customer Assembly

- Designing a product that can be assembled quickly and correctly by even the most unskilled clients is a significant task in and of itself. Customers may be willing to complete some product assembly themselves if it gives additional benefits, such as making the purchase and handling of the packaged product easier.

4. Reduce the costs of supporting production

- Working to reduce the costs of components and assembly, the team may be able to reduce the demands placed on the production support functions. for example, a reduction in the number of parts, reduces the demands on inventory management. Reduced assembly content reduces the number of workers needed for production, decreasing the cost of supervision and human resource management.

5. Consider the impact of DFM decisions on other factors

- The primary objective of the product development process is not to reduce manufacturing costs. The economic success of a product is also determined by the product's quality, the timeliness with which it is introduced and the cost of developing the product. There may also be instances where the economic success of a project is compromised in order to maximize the overall economic success of the enterprise.

6.8 Prototyping

- Prototypes are virtually always required in the creation of new products. A prototype is a model of a product that approximates it in one or more aspects of interest.
- Prototypes can be usefully classified along two dimensions :

  (1) The degree to which they are physical as opposed to analytical, and

  (2) The degree to which they are comprehensive as opposed to targeted.
- Physical prototypes are usually preferable for communication and thorough prototypes, while all sorts of prototypes can be utilized for both of these reasons.
- For learning, communication, integration, and milestones, prototypes are employed. Physical prototypes are excellent for communication, while full prototypes are best for integration and milestones.
- Several concepts can help guide prototype decisions throughout product development.
- Analytical prototypes are more adaptable than physical prototypes in general.
- To discover unforeseen events, physical prototypes are required.
- Using a prototype can help us to avoid costly iterations.
- A prototype can help speed up further stages of development.
- Task dependencies may be restructured by a prototype.
- The relative cost and time necessary to produce and assess prototypes have been decreased due to 3D CAD modeling and free-form fabrication technologies.
- A four-step process for prototyping is as follows :
  1. Determine the prototype's objective.
  2. Determine the prototype's level of approximation.
  3. Make a rough outline for your experiment.
  4. Make a procurement, construction and testing schedule.

1. Determine the prototype's objective

- Remember that prototypes serve four purposes : Learning, communication, integration, and achievements. The team lists its specific learning and communication goals while determining the objective of a prototype. Members of the team also discuss potential integration requirements and whether the prototype is meant to be one of the project's major milestones.

2. Determine the prototype's level of approximation

- The degree to which the final product is to be approached must be defined before a prototype can be planned. The team should think about whether a physical prototype is required or if an analytical prototype will suffice. In most circumstances, the best prototype is the simplest one that accomplishes the goals set forth in step 1. In certain circumstances, an older model is used as a testbed and is changed for the prototype's needs. In some circumstances, an existing prototype or one that is being created for a different purpose can be used.

3. Make a rough outline for our experiment

- In most circumstances, using a prototype in the development of a product might be considered an experiment. Experimentation best practices can help ensure that the prototyping effort yields the most value. The experimental plan identifies the experiment's variables (if any), the test protocol, a description of the measurements to be taken and a strategy for interpreting the findings. When there are a lot of variables to investigate, having a good experiment design helps a lot.

4. Make a procurement, construction and testing schedule

- Because prototyping is considered a subproject within the broader development project, the team benefits from having a timeline for the prototyping activity. When it comes to identifying a prototyping endevour, three dates are very significant. The team first determines when the components will be ready to assemble. (This day is also known as the "bucket of parts".) Second, the team determines when the prototype will be tested for the first time. (This date is frequently referred to as the "smoke test" date because it is when the team will first provide electricity to a product with an electrical system and "check for smoke.").
- Third, the team establishes a deadline for completing testing and producing final results.

6.9 Robust Design

- The term "robust design" refers to a collection of engineering design methodologies for creating durable goods and processes.
- A robust product (or process) performs well even when subjected to noise effects. Noises are caused by a variety of uncontrolled variations that can have an impact.
- A robust product (or process) performs well even when subjected to noise effects. Noises are caused by a variety of uncontrolled variations that can have an impact on performance, including manufacturing variations, operating conditions and product degradation.

- We propose a design-of-experiments (DOE) - Based approach to the development of robust products.
- This robust design process consists of seven steps :
  1. Identify control factors, noise factors and performance metrics.
  2. Formulate an objective function.
  3. Develop the experimental plan.
  4. Run the experiment.
  5. Conduct the analysis.
  6. Select and confirm factor setpoints.
  7. Reflect and repeat.

1. Identify control factors, noise factors and performance metrics :

- **Control factors**
  - Experiments are typically conducted with two or three discrete levels (setpoint values) of each factor. These parameters are known as **control factors** because they are among the variables that can be defined for the product's production and/or operation.
- **Noise factors**
  - Noise factors are variables that cannot be explicitly controlled during the product's manufacturing and operation. Manufacturing variations, changes in material properties, multiple user scenarios or operating conditions and even product degradation or misuse can all be noise factors.
- **Performance metrics**
  - An experiment is an analysis of the performance of a set of products and their associated metrics in order to find control factor setpoints to optimize this performance. The metrics may be derived directly from key specifications where robustness is of critical concern. These are the product specifications of interest in the experimental environment.

2. Formulate an objective function

- Several objective functions are useful in robust design for different types of performance concerns and they can be formulated either to maximize or minimize performance concerns.

- **Maximizing**
  - This function is used in performance dimensions where larger values are preferred, such as maximum deceleration before belt slippage. This objective function is commonly expressed as $\eta = \mu$ or $\eta = \mu^2$, where μ^2 is the mean of the experimental observations under a given test condition.
- **Minimizing**
  - This function is used for performance dimensions where smaller values are preferable, such as back angle at maximum deceleration. This objective function is commonly expressed as $\eta = \mu$ or $\eta = \sigma^2$, where σ^2 is the variance of the experimental observations under a given test condition. Alternatively, such minimization goals can be expressed as maximized functions, such as $\eta = 1/\mu$ or $\eta = 1/\sigma^2$
- **Target value :**
  - For performance dimensions where values closest to a desired setpoint or objective are best, such as the amount of belt slackening before constraint, this sort of function is used. $\eta = 1/(\mu - t)^2$, where t is the target value, is a frequent maximizing form of this objective function.
- **Signal-to-noise ratio :**
  - This type of function is used particularly to measure robustness
  - A common maximizing form of this objective function is $\eta = 10 \log(\mu^2 / \sigma^2)$.

3. Develop the experimental plan

- Some develop the experimental plans are better at defining specific types of systems, while others offer more comprehensive analysis as follows :
- **Experimental Designs :**
  - A critical concern in designing experiments is the cost of setting up and running the experimental trials. In some cases, efficient plans can be used that simultaneously change several factors at once.
- **Testing Noise Factors :**
  - If some noise factors can be controlled for the purposes of an experiment, the influence of these noise elements may be directly assessed. If the noise elements cannot be controlled during the experiment, we simply measure the product's performance in the presence of noise by allowing it to vary naturally.

4. Run the experiment

- The product is tested under the various treatment conditions stated by each row in the experimental plan to carry out the experiment. The randomization of the experimental runs assures that any systematic trend over the course of the experiment is unrelated to systematic changes in the factors used for testing.

5. Conduct the analysis

- The data from the experiment can be analyzed in a number of ways. But the most basic analyses engaging with a design of experiment specialist provides team benefits.

6. Select and confirm factor setpoints

- Analysis of means and factor effect graphs help to determine which elements are most effective in reducing product variance (robustness factors) and which factors might be used to improve performance (performance factors). The team should be able to improve the overall robustness of the product by selecting setpoints based on these insights.

7. Reflect and repeat

- One round of testing may be sufficient to identify robustness, but further experimentation is needed to optimize the product for future use.
- The team may choose to do the following in subsequent experimentation and testing :
  - Rethink the setpoints for parameters that have a performance versus robustness trade-off.
  - Investigate relationships between some of the parameters in order to increase performance even more.
  - Use values between the levels tested or outside this range to fine-tune the parameter setpoints.
  - Look into other noise and/or control factors that were not considered in the first trial.

6.9.1 Concept of Entrepreneurship

- The term "entrepreneur" comes from the French verb entreprendre, which means "to embark on." This refers to those who "undertake" the risk of starting new businesses. An entrepreneur establishes a business. Entrepreneurship refers to the process of creating something new.

- Entrepreneurship is a set of actions taken by an entrepreneur, who is always on the lookout for new ideas and turns them into profitable opportunities by accepting risk and uncertainty with the enterprise. Entrepreneurship is derived from entrepreneurship.
- Entrepreneurship involves problem solving, innovation, implementation, future forecasting, independence and success.
- It is the systematic analysis of opportunities in the environment that leads to a purposeful and organized search for change.
- Entrepreneurship equally applies to large and small businesses, as well as economic and non-economic activities. It is a dynamic and risky process.
- It is the ability to create and build something out of almost nothing.
- Entrepreneurship is a mindset that seeks out opportunities, takes calculated risks, and reaps the rewards of starting a business.
- It also involves land, labor, natural resources and capital that can generate a profit in economics.
- It is made up of activities that are involved in the conception, creation and operation of a business.
- Thus, “entrepreneurship is a constant process of vision, change and creation." It necessitates the investment of time, effort and passion in the development and implementation of new ideas and creative solutions. The ability to form an effective venture team, creative skill to organize needed resources, the fundamental skill of building a solid business plan and above all, the vision to recognize opportunity where others see chaos, contradiction and confusion are all necessary factors."

6.9.2 Knowledge and Skills Requirement

- Entrepreneurial knowledge and skills should be integrated into the educational system because they enable young students to participate in the country's economic development.
- Young people can gain the confidence to see value in their own ideas by incorporating entrepreneurship into the educational system. They can then make company decisions that they can apply in the workplace.
- Entrepreneurship requires technical, managerial, and entrepreneurial knowledge and skills.

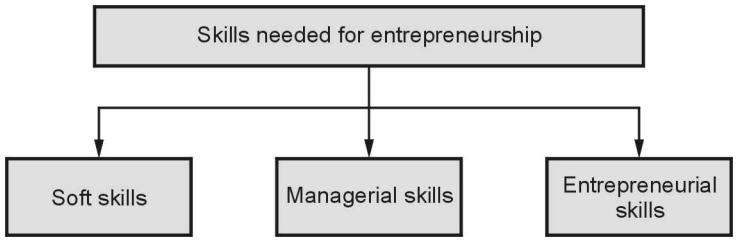


Fig. 6.9.1

1. Soft skills

- It contains the following items :
  - Communication
  - Interpersonal relations
  - Environmental observation
  - Coordination
  - Specific operation technology
- **Communication**
  - It is the process of people exchanging information. It requires effective language, presentation skills and a conducive environment, among other things. The diagram below illustrates how to effectively communicate.

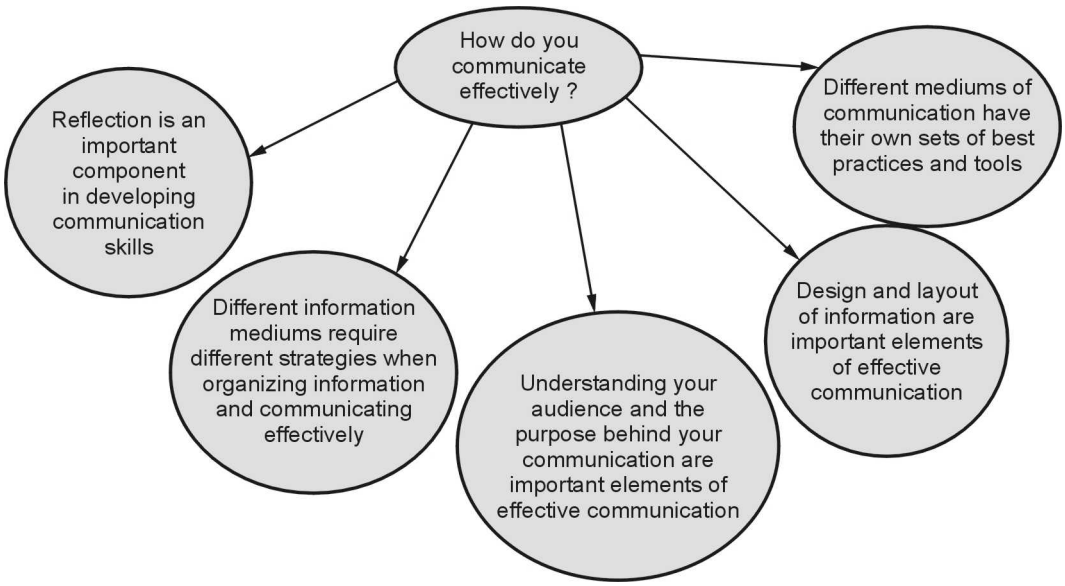


Fig. 6.9.2 Communication

- **Interpersonal relations**
  - Communicating with one another is a skill. It is used in our daily social lives as well as in office. Confident, calm, and charismatic people are viewed as having good interpersonal skills.

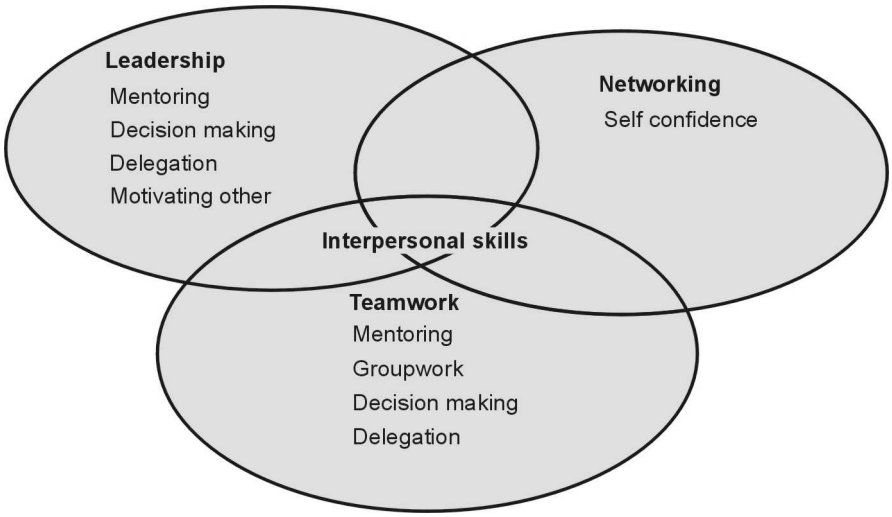


Fig. 6.9.3 Interpersonal relations

- **Environmental observation**
  - One of the technical skills is environmental observation. This ability helps in the understanding of job objectives and the current societal situation in relation to the business that one wishes to start.
- **Coordination**
  - One of the technical skills is environmental observation. This ability helps in the understanding of job objectives and the current societal situation in relation to the business that one wishes to start.
- **Specific operation technology**
  - Specific technology is sometimes required to achieve a specific goal. For example, if we want to create software for web design, we need to be familiar with technologies such as HTML, CSS, and JAVA SCRIPT.

2. Managerial skills

- It contains the following items :
  - Planning
  - Motivation

- Marketing
- Accounting
- Negotiating.

- **Planning**
  - It is a fundamental management method that involves the creation of one or more detailed plans in order to achieve the best possible outcome. The planning process consists of identifying the goal, developing a strategy and deciding on the process to be used to achieve the goal using the same strategy.
- **Motivation**
  - Goal-oriented behavior is defined as **motivation**. It is frequently used to explain why a person is interested in doing a specific job.
- The following points assist us in remaining motivated :
  - Surround ourself with positive people.
  - Make a vision board.
  - Set sensible objectives.
  - Take care of ourself.
  - Have faith in ourself.
  - Recognize our positive qualities.
  - Recognize our achievements.
  - Visualize ourself achieving our objectives
  - Be gentle with ourself.
  - Don't compare ourself against others.
- **Marketing**
  - Marketing is an art form that tries to satisfy the needs of clients. It includes the coordination of product, price, place and promotional strategy. We have to follow the points mentioned below to ensure maximum sale of our product/service. These are known as 4 P's of marketing - Product, price, place and promotional strategy.
    - Determine the product
    - Determine its cost
    - Contact the customer
    - Execute the promotional strategy.

- **Accounting**
  - It is the process of keeping or preparing financial records. It entails record analysis, verification and reporting.
- **Negotiating**
  - It is a process by which people resolve all problems that arise between two or more parties. Negotiation is used by parties to reach a mutually beneficial outcome. The following stages are included in the negotiation process :
    - Preparation
    - Discussion
    - Clarification of objectives
    - Reaching mutually beneficial conclusions
    - Strategy implementation
    - Agreement.

3. Entrepreneurial skills

- It contains the following items :
  - Innovation
  - Persistency
  - Visionary
  - Flexibility.
- **Innovation and Risk Taking Ability**
  - Risk-taking is synonymous with innovation. An organisation that develops a new idea takes a significant risk in launching a new market. An idea must be replicable at a low cost while also meeting the needs of the customer. It is the process of transforming new ideas into valuable services.
- **Persistency**
  - In this skill, we remain to do something even if it is difficult or if others oppose it. This skill necessitates a great deal of dedicated effort.
- **Visionary**
  - They are someone who can see the future and take action based on their vision, rather than just theorizing about how things should be.
- **Flexibility**
  - Flexibility is the intention to change in response to changing situations in order to improve one's situation. One should not be too strict in his or her working methods; rather, one should be able to easily adapt to new ones.

6.9.3 Characteristic of Successful Entrepreneurs

The characteristic of successful entrepreneurs are as follows :

1. Positivity of thought

- We will be successful if we maintain our confidence, persevere and remain positive. If, on the other hand, we allow doubt and uncertainty to prevail, we will almost certainly fail. The one thing we can be certain of is that we will face difficulties. During these times, our success or failure will be determined.

2. Resourceful

- Most start-ups have limited resources such as money, information and time. Successful entrepreneurs understand how to make the most of these resources. They are experts at stretching a dollar and making a limited amount of resources go a long way.

3. Have a desire to succeed

- Successful entrepreneurs are goal-oriented. They place a high value on achievement and the integral benefits that come with achieving difficult goals. It is a powerful motivator for the majority of business owners.

4. Objective

- When making business decisions, we must be objective and dispassionate because emotion, bias and sentiment can lead to poor decisions. It is difficult to be objective about our business because we are invested in its success.

5. Committed

- Building a successful business requires complete dedication. It takes a lot of effort, and we will get discouraged at times. During these times, we must remain steadfast, faithful and dedicated to our vision.

6. Dependable

- This should be self-evident, but I'll say it anyway. Our perceived level of dependability and the success of y\our business have a strong positive relationship. Customers expect us to be dependable irrespective of the nature of business operated by us.

7. Technical abilities and knowledge are required

- Every business necessitates specialized technical skills and knowledge on the part of the owner. To be successful in business, we must be skilled at what we do. This frequently entails ongoing education and training for the purpose of obtaining specific credentials (e.g., certifications, licenses).

8. Excellent communication skills

- We must be able to exchange information accurately in a fast-paced world using a variety of communication methods (e.g., interpersonal, electronic). The ability to listen and truly understand where another person is coming from is especially important when we are starting out in the real world.

9. Enjoy being around people

- Customers, potential customers, colleagues, competitors, suppliers, lawyers, accountants and coaches are just some of the individuals we will engage with as a successful entrepreneur. It is quite beneficial if we enjoy being among these individuals.

10. Dependable

- The success of our business is strongly linked to our perceived level of dependability. Customers want we to be dependable regardless of what type of business we run. Although this should be self-evident, we will state it anyhow in the spirit of this article.

6.9.4 Entrepreneurship Process

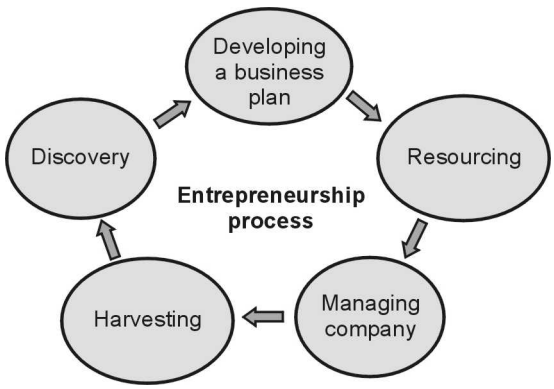


Fig. 6.9.4 Entrepreneurship process

1. Discovery

- The entrepreneur identifies and evaluates business opportunities. The next step after deciding on an opportunity is to evaluate it. In order to find the best business opportunity, an entrepreneur invites feedback from everyone, including employees, customers and channel partners. It is difficult to identify and evaluate opportunities.

- An entrepreneur can evaluate the efficiency of a business opportunity by constantly asking himself questions such as whether the opportunity is worth investing in and what the risks are. Above all, an entrepreneur must determine whether their personal skills and interests are compatible with their business objectives.

2. Developing a Business Plan :

- Once an opportunity has been identified, an entrepreneur must develop a comprehensive business plan. A business plan is critical to the success of any new venture. It serves as a benchmark and evaluation criteria to determine whether an organization is on track to meet its objectives.
- The major components of a business plan are mission and vision statements, goals and objectives, capital requirements, a description of products and services and so on.

3. Resourcing :

- The third step in the entrepreneurial process is resourcing, in which the entrepreneur identifies the sources of finance and human resources. Here, the entrepreneur finds investors for its new venture as well as personnel to carry out business operations.

4. Managing the company :

- Once the funds have been raised and the employees have been hired, the next step is to begin business operations in order to meet the objectives. First and foremost, an entrepreneur must determine the management structure or hierarchy that will be required to solve operational problems as they arise.

5. Harvesting :

- Harvesting is the final stage of the entrepreneurial process in which an entrepreneur decides on the future prospects of business. In this case, the actual growth is compared to the planned growth and an entrepreneur makes a decision about the stability or expansion of business operations.

6.9.5 Factors Impacting Emergence of Entrepreneurship

- The lack of entrepreneurs in developing countries is partly due to a number of factors, including economic and social factors, as well as the socio-cultural and institutional background that exists in these countries. Various researchers from around the world have identified the characteristics that influence the growth of entrepreneurship.

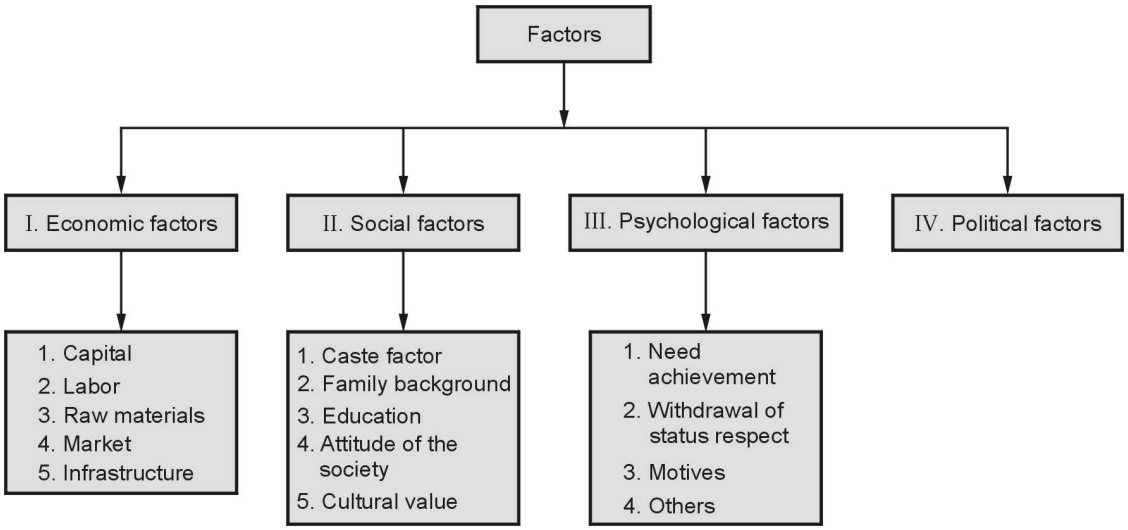


Fig. 6.9.5 Factors impacting emergence of entrepreneurship

I. Economic Factors

- The most direct and immediate impact on entrepreneurship is the economic environment.
- The following are some of the economic factors that influence entrepreneurship growth :

1. Capital

- As capital is viewed as a lubricant for the industrial process, our experience suggests that when capital investment increases, the capital-output ratio tends to rise as well. This leads to a rise in profit, which is then used to boost capital formation, and entrepreneurship.

2. Labor

- Entrepreneurship thrives in an environment where workers are mobile and adaptable, unlike in labor-rich countries such as Japan. The disadvantage of high-cost labor can be mitigated by introducing labor-saving technology, as was done in the United States.

3. Raw Materials

- The availability of raw materials is essential to the start-up of any industrial enterprise. Without raw resources, no firm can be founded and no entrepreneur can develop.

4. Market

- The most important criteria of the market for entrepreneurial emergence are whether or not it is expanding and at what rate it is increasing. The disadvantages of a competitive market, on the other hand, can be mitigated by improvements in transportation systems and increased demand for producer goods.

5. Infrastructure

- Entrepreneurial growth is reliant on a well-developed communication and transportation infrastructure. Consider the establishment of India's postal and telegraph systems, as well as the development of roads and highways in the 1850s. Trade/business groups, business schools, libraries and others play an important role in supporting entrepreneurship.

II. Social factors

- Social factors can play an important role in promoting entrepreneurship. In truth, it was Europe's extremely cooperative society that made the industrial revolution a huge success.
- The following are the primary elements of the social environment :

1. Caste factor

- The dominance of specific ethnic groups in business is a worldwide phenomena. Western protestant principles, Japanese Samurai, American trade classes and French family business interests have all distinguished themselves as entrepreneurs. We define social mobility as the ability to migrate from one caste to another.

2. Family background

- The Zamindar family aided in the acquisition of political authority and the demonstration of a better level of financial acumen. Mobility was influenced by the family's occupational and social status. A family with a manufacturing background can serve as a springboard for a career in industry. Only a few people are necessary to take risks in certain circumstances.

3. Education

- Education allows a person to understand the outside world and provides him with the necessary knowledge and abilities to deal with day-to-day issues.
- In any community, the educational system plays a critical role in developing entrepreneurial values. Prior to the twentieth century, India's educational system was founded on religion. Later, when the British arrived in our country, they established an educational system solely for the purpose of producing clerks and

accountants for the East India Company. As we can see, the foundation of such a system is anti-entrepreneurial. The terrible effect is that our country's young men and women have developed a taste for solely serving others.

- The emphasis was on getting them ready for regular employment rather than assessing their ability to stand on their own. Their strengths and talents have not been fully utilized but squandered on the mundane tasks of everyday life.

4. Attitude of the society

- Some civilizations value innovation and novelty and entrepreneur's efforts and rewards, such as money, are lauded. Others will not tolerate change and entrepreneurship will not be able to take root in such an environment. Some communities have a natural aversion to any form of profit-making, and this can hinder the growth of entrepreneurship.

5. Cultural Value

- Entrepreneurship would be celebrated and rewarded if the society was economically or monetarily oriented; money accumulation as a way of life would be admired. People in less developed countries are not driven by money. Non-economic endeavors provide many opportunities for people to achieve social distinction. Agrarian civilizations are characterized by a lack of suitable economic motives.

III. Psychological Factors

- Many entrepreneurial theorists have proposed theories of entrepreneurship that emphasize psychological issues in general.
- The following are some of them :

1. Need Achievement

- 'Need achievement is a social drive to succeed that tends to characterize successful entrepreneurs, especially when reinforced by cultural variables. David McClelland proposed one of the most influential psychological theories of entrepreneurship in the early 1960s. According to Paul Wilken, "entrepreneurship becomes the link between demand fulfillment and economic growth".
- The theory states that people with high needs-achievement are distinctive in several ways. The theory identifies the factors that produce such people. Initially, McClelland attributed the role of parents to mustering their son or daughter to be masterful and self-reliant.

2. Withdrawal of Status Respect

- The emergence of entrepreneurship is the loss of a group's standing respect, according to Everett Hagen. According to Hagen, Japan progressed faster than any other non-western society save Russia. The repeated long-term withdrawal of expected status from major sections in society led to technical advancement through entrepreneurial roles.
- The loss of status by a group, according to Hage, is the primary stage that leads to future entrepreneurial conduct.
- He claims that four types of events might cause status withdrawal :
  a) The group may be internally displaced;
  b) The group's valued symbols may be demonized;
  c) The group may drift into a state of status inconsistency; and
  d) The expected status of migration in a new community may not be accepted.
- He further postulates that withdrawal of status respect would give rise to four possible reactions and create four different personality types :
  a) **Retreatist :** A person who continues to labor in society but is dissatisfied with his or her job or position;
  b) **Ritualist :** A person who adopts a defensive posture and acts in ways that are accepted and approved in his culture, but has little chance of improving his situation;
  c) **Reformist :** He is a person who foments a rebellion and strives to establish a new society; and
  d) **Innovator :** He is a person who foments a rebellion and attempts to establish a new society.

3. Motives

- Other entrepreneurial psychological theories focus on the entrepreneur's motivations or objectives. Entrepreneurs, according to Cole, seek power, status, security and societal service in addition to riches. On-monetary characteristics such as independence, self-esteem, power and societal regard are highlighted by Stepanek.

Similarly,

He distinguishes three types of entrepreneurs based on their motivation :

a) Managing entrepreneurs whose primary motivation is security.
b) Controlling entrepreneurs who seek power and authority above all else.

- Finally, Rostow looked at intergradational changes in entrepreneur families. The first generation, he argues, desires wealth, the second, prestige and the third, art and beauty.

4. Others

- Thomas Begley and David P. Boyd studied in detail the psychological roots of entrepreneurship in the mid 1980s. They came to the conclusion that entrepreneurial attitudes based on psychological considerations have five dimensions :

  i) First, there was 'need-achievement,' as McClelland defined it. A high achievement-orientation is consistently found in all studies of successful entrepreneurs.

  ii) The 'locus of control,' as Begley and Boyd put it, is the second dimension. This implies that the entrepreneur believes that he has complete control over his life and is unaffected by elements such as luck, fate, and so forth. Need-satisfaction suggests that people have control over their lives and are not affected by outside circumstances.

  iii) The willingness to take risks is the third dimension. According to these two academics, entrepreneurs who take moderate risks get higher returns on their assets than those who take no chances at all or take excessive risks.

  iv) The study's next dimension is tolerance. Only a small percentage of decisions are made with all of the facts. As a result, all company executives must have a certain level of ambiguity tolerance.

  v) Finally, here is an example of what psychologists refer to as "Type A" behavior. This is nothing more than "a never-ending fight to achieve more and more in less and less of time. "The presence of 'Type A' behavior in all of an entrepreneur's efforts defines them.

IV. Political Factors

- Government policies affecting numerous economic characteristics such as prices, availability of capital, labor and other inputs, demand structure, taxation and income distribution have a significant impact on entrepreneurship growth.
- Try to learn about the government's role and influence on business, such as taxation, finance, and labor, and inquire about a company's opportunities and growth prospects. Above all, a politically stable and united government can have a substantial impact on business operations in India.

- In the last few decades, a number of factors have changed in favor of ambitious men and women in India, including access to finance, economic factors such as access to knowledge and access to capital and the development of entrepreneurial mindsets and business knowledge are increasingly more relevant.
- Infrastructure development shifts government policy in favor of business and industry, and vice versa. Other factors that have prompted Indian entrepreneurs to seek for new business prospects includes an increase in demand for produced goods.

6.10 Legal Issues Related to Product Development and Entrepreneurhip

6.10.1 Introduction - Intellectual Property Rights

- Intellectual property rights are the rights granted to individuals over their mental works. For a set amount of time, they usually grant the creator exclusive rights to use his or her creation.
- Traditionally, intellectual property rights are divided into two categories :
  i) Copyright and rights related to copyright.
  ii) Industrial property.

(i) Copyright and rights related to copyright

- Copyright protects the rights of creators of literary and artistic works (such as books and other publications, musical compositions, paintings, sculpture, computer programmes and films) for at least 50 years after their death.
- The rights of performers (e.g. actors, singers, and musicians), creators of phonograms (sound recordings), and broadcasting companies are also protected by copyright and associated (often referred to as "neighboring") rights. The primary social goal of copyright and related rights protection is to stimulate and reward creative work.

(ii) Industrial property

Industrial property can usefully be classified into two areas :

A) One area can be defined as the protection of distinguishing indicators, such as trademarks (which distinguish one company's goods or services from those of another) and geographical indications (which identify a good as originating in a place where a given characteristic of the good is essentially attributable to its geographical origin).

The goal of trademark protection is to encourage and ensure fair competition, as well as to safeguard customers by allowing them to make educated decisions about diverse goods and services.

If the symbol in question remains distinctive, the protection may extend eternally.

B) Other sorts of industrial property are protected largely to encourage technological innovation, design and development. Patented inventions, industrial designs and trade secrets all come into this category.

The social goal is to protect the outcomes of investments in new technology development, hence providing an incentive and means to fund research and development operations.

A well-functioning intellectual property policy should also make it easier to transfer technology through FDI, joint ventures, and licensing

The protection is usually granted for a set period of time (typically 20 years in the case of patents).

6.10.2 Patents

- A patent describes how things work, what they do, how they do it, what they're made of and how they're manufactured to protect new inventions. The owner of a patent has the legal right to prevent anyone from creating, using, importing, or selling the innovation without their permission.
- A patent is a property right granted to an inventor by a sovereign body.
- Patents encourage businesses and people to keep developing innovative products and services without fear of infringement. For example, large pharmaceutical corporations can invest billions of dollars in research and development. Their medications and medicines may be copied and sold by corporations who did not conduct research or devote the necessary cash in R&D if they did not have patents.
- Patents, on the other hand, can be used to demonstrate a company's innovativeness as well as to protect its intellectual property. In other words, patents help businesses safeguard their intellectual property and increase their profits - and they are also more cost-effective.

To be patentable an invention must be :

- New
- Innovative
- Better or cheaper or different to anything that has been done before.

Patents are divided into three categories :

- **Design patents**
  - A design patent can be applied by anyone who creates a novel design for a product. Beverage bottles (consider the form of a Coca-Cola container) and furnishings (such as the kneeling chair) are two examples.
- **Plant patents**
  - Plant patents are available to botanists who are involved in grafting and developing new hybrid plant types. The smooth angel rose and drought-tolerant corn are two examples.
- **Utility patents**
  - a utility patent can be applied for by anybody who invents or discovers "any useful new process, machine, article of manufacture, or composite of matter, or any new and useful improvement thereof." The little green drink stopper that starbucks gives out with its cups, or the hoverboard kind of skateboard, are two examples.

Procedure for Patent :

- **Conceptualization :**
  - When generating an idea, most innovation teams attempt to solve a common problem faced by their company, industry, or the world at large. They will put up plans and acquire the resources needed to make their solution or vision a reality once they've come up with one. To provide a more exact description of the final product or process, prototypes or drawings can be made.
- **Disclosure of an Invention :**
  - Every invention is subjected to an internal review process. Internal lawyers and an invention review panel from various disciplines make up the innovation team. The reviewers rate, rank, score and point out apparent problems in the invention's supporting documents and descriptions, which the inventor thereafter addresses. For a single idea, these assessments can frequently occur several times.
- **Application for a Patent :**
  - Some organizations create their own provisional or nonprovisional patent applications which are then submitted to the proper patent office. The prosecution step is the back and forth with the government patent office and involves consulting with a professional patent lawyer for advice on how best to proceed.

- **Maintenance :**
  - You might not want to renew a technology or other patented asset that is accumulating dust, so we might instead try to sell, license, or donate it. A patent has a limited lifespan after it is granted, so consider innovating ahead to keep up with the competition.
- **Costs :**
  - Costs will vary depending on the nation or countries we file an application in and can range from tens of thousands of dollars to tens of thousands of dollars, plus legal expenses, depending on the intricacy of the invention.
  - Maintenance fees can add up to thousands of dollars per patent, per nation where patent rights have been awarded, over the course of the patent's existence.

The following cannot be patented :

- Theory, method, or scientific or mathematical discovery
- Work in the literary, theatrical, musical, or artistic fields
- A technique for carrying out a mental act, playing a game, or conducting business
- The way information is presented, or some computer programmes
- A type of animal or plant
- Medical treatment or diagnosis methods
- Anything that is not in accordance with public policy or morality.

6.10.3 Trademarks

- Trademarks are essentially business identifiers and are commonly referred to as brand names, logos, or trade names. A trade mark is connected to the goods or services as a business identity, or they are sold in the market under the indicated trade mark. For example, Xerox is a brand name for photocopiers and Apple is a company name for computers.
- Trademarks may include names of persons owning the business, numerals, invented words and shapes, horizontal or vertical lines in any color. Trade marks indicate source of origin and help in building a brand name and brand value to which the ordinary consumer associates with.
- Name of company owners, numerals, invented words, shapes, horizontal or vertical lines in any color, are all examples of trademarks. Trademarks serve to identify the origins of a product and aid in the development of a brand name and brand value that the average customer can recognize.

- In India, registration of a trade mark is required for the enforcement of trade mark rights. There is a Madrid Protocol of international registration, but India is not a party to it as of yet. A Bill has been proposed in Parliament in this regard and India may adopt this system in the future.
- Markets are made up of words and symbols that can be represented graphically. The Trademark Act stipulates that trademarks must have certain additional qualities. Any person who intends to register a mark as a trade mark in India can do so.
- This mark is required to fulfill the following mentioned criteria as prescribed by act to be categorized as a trade mark .The mark is required to be :
  - The mark must be distinctive and unique in character in order to be recognized.
  - Indicates no quality or describes the goods for which the mark is used.
  - It doesn't contain any words that are regularly used in everyday conversation.
  - It does not resemble a well-known trademark.
  - Doesn't resemble a recognized trademark
  - Not confusing and deceiving regular consumers about the source of origin.
  - To include any sign or phrase forbidden by the Emblem and Names (Prevention of Improper Use) Act 1950.
  - The mark should not include a shape of products, a form that is inherent in goods, a shape that is required to achieve a technical result, or a shape that adds substantial value to goods.

If the mark meets the above requirements, it will be registered as a trademark.

Procedure for Trademarks :

- Trademarks do not always require government approval to be effective; they might be effective simply by being used often in interstate trade. However, trademark registration provides significantly superior protection and is obtained by filing an application with the appropriate government entity.
- A trademark application involves a detailed description and representation of the mark and its usage in association with related products or services from the firm or user.
- It's a good idea to work with outside counsel who specializes in trademark applications and/or search services, just as it is with patents, to ensure that our desired mark has a clear path.

- **Costs :**
  - The cost of obtaining a trademark is usually relatively low, but can vary from company to company depending on who owns the rights to the name and also vary with trademark registration authority.

6.10.4 Copyrights

- Copyrights protect the way ideas are expressed ("original works of authorship"), including written works, art, music, architectural plans and even software programming code (most evident nowadays in video game entertainment). Copyrights provide the owner of the protected materials authority over reproduction, performance, new versions or adaptations, public performance and distribution of the works, with some limitations.
- Copyright provides the owner of copyright with the exclusive right to,
  - Make copies or multiple copies of the work.
  - Construct other works based on the original work.
  - Make copies or multiple copies of the work available to the public through a sale or other transfer of ownership, as well as through rental, lease, or loan.
  - If the work is a literary, musical, dramatic, or artistic production, a play or a motion picture or other multimedia work, perform it in front of an audience.
  - If the work is a sound recording, make it public by using a digital audio transmission.
- When two or more writers collaborate on a single work, they are referred to as joint authors and have an indivisible interest in the finished product. When numerous writers contribute to a collective work, each author's individual contribution is separate and distinct from the collective work's copyright ownership.
- Publication, according to copyright law, is the sale or other transfer of ownership of copies or multiple copies of a work to the public, as well as the rental, lease, or lending of such copies or multiple copies. Publication also includes offering to give copies or multiple copies to a group of individuals for the purpose of further distribution, public performance, or public display.

Procedure for Copyright

- The Copyright Office invites people to apply online for copyright registration - The process of applying for a work to be protected by law. Copies of books, movies, music and other works of art should be registered with the government for the best protection against copyright infringement.

Costs

- Depending on the type of work being protected, currently fees vary between $25-$100. The most frequent copyright registration sought is for one work by one author and costs about $35.
- Under copyright law, the publication of the distribution of copies or work records to publicly by sale or by other transfer of ownership or by lease, lease, or loan. Provides distribution copies or multiple copies of a group of people for the purpose of further distribution, community service, or public distribution.

6.10.5 Trade Secrets

- Trade secrets are proprietary processes, programs, resources, formulas, strategies or other confidential and special information for the company that uses them. They serve as a competitive advantage for the business.
- Confidential information about the process, method or design a manufacturer or retailer uses to design, market, or develop a product.
- Trade secrets are secret practices and processes that give a company a competitive advantage over its competitors.
- Trade secrets may differ across jurisdictions but have three common traits : not being public, offering some economic benefit and being actively protected.
- Trade secrets may take a variety of forms, such as a proprietary process, instrument, pattern, design, formula, recipe, method, or practice that is not evident to others and may be used as a means to create an enterprise that offers an advantage over competitors or provides value to customers.
- When people who may benefit from the knowledge gain access to it, it loses its value to the original owner. When such parties obtain access to information in an unlawful and unjust manner, our first instinct is to stop them from benefiting from the concept. The value of a trade secret is determined by its confidentiality.
- The following documents must be signed in order to protect trade secrets :

  1. Agreement on non-competition and employee secrecy
  2. Application of a post-employment contract
  3. Agreement of non-disclosure
  4. Authorized disclosure by the company's board of directors
  5. Agreement and declaration termination
  6. Agreement on invention assignment and its application
  7. Agreement for injuctive relief.

- Trade secrets, on the other hand, must be protected in India under the country's Intellectual Property laws. Trade secrets are protected by Indian courts under contract law. There are a few papers that are linked with trade secret protection. We should keep these contracts in tact and follow the law.

6.10.6 Licensing

- Licensing is a strong and adaptable tool for establishing collaborations and bringing invention out of the darkness of an inventor's workspace and into the light of the marketplace.
- Simply described, a license is similar to a "lease" arrangement between an owner (licensor) and a lessee (licensee), in which the owner (licensor) grants rights to use property in return for a fee.
- Licenses apply to intellectual capital (i.e., IP), which are mental creations such as formulae, drawings, procedures, software, or literary and creative works that are protected by patents, trademarks, copyrights, know-how, or trade secrets, rather than leasing something "physical" like a vehicle or a home.
- IP, unlike real asset can be licensed to numerous users in various locations at the same time. The lease/license, on the other hand, is only valid for a limited time and is subject to the terms and conditions of a mutually agreed-upon licensing agreement.
- These agreements also include restrictions on how IP may be used, ensuring that licensees only pay for the value of their usage and that licensors receive their "fair share" for each use. Inventors are able to fund and perform more research and development (R&D) as a result of this compensation and the innovation cycle is sustained.

The followings things can be licensed :

- Almost everything may be licensed as long as it has a property right that can be protected. Patents, trademarks, copyrights, know-how, and trade secrets can all be used to legally protect IP rights. Licensing permits a person to utilize another's legally protected intellectual property within the terms and conditions of a licensing agreement.
- There are several different forms of IP rights that may be licensed. Technology is usually associated with products, materials, machinery, processes, or procedures. New technology can be legally protected by a government-issued patent. It is also possible to license technology in the form of a trade secret.

Only the parties involved are aware of the terms and conditions of license agreements, the majority of agreements include the following :

1. A clear statement of the licensed subject matter and the scope of rights being granted to the licensee by the owner/licensor;
2. Specific terms and conditions regarding the scope of the license (e.g., exclusive or non-exclusive), the field in which the licensed activities may be conducted, and the duration of the agreement;
3. A description of the license's compensation for the use of the licensor's intellectual property rights;
4. Other terms and conditions, such as when, when, and how payments are to be made.

- Thus, licensing is a common, flexible, and quick method of commercializing intellectual property. It's a strong approach to create profitable, win-win partnerships between parties with distinct skills.

6.10.7 Franchising

- A franchise is an agreement or license between two legally separate persons that grants them the right to operate a business as follows :
  1. An individual or group of individuals (franchisee) who promote a product or service using the trademark or brand name of another business (franchisor)
  2. The franchisee used to promote a product or service using the operating methods of the franchisor
  3. The franchisee need to pay the franchisor fees for these rights
  4. The franchisor has to provide rights and support to franchisee.

Types of Franchises

There are two main types of franchises :

A) Product distribution franchises

B) Business format franchises.

A) Product distribution franchises

- Product distribution franchises are supplier-dealer arrangements that merely sell the franchisor's products. The franchisor often licenses its brand and logo to franchisees but does not supply them with a comprehensive system for running their firm in product distribution franchising. Beverage distributors, vehicle dealers, and petrol stations are among the industries where this sort of franchising is most common.

- Some well-known product distribution franchises are Chrysler, Texaco, John Deere, Goodyear Tires, Ford, Exxon, other automobile producers etc.
- Despite the fact that product distribution franchises account for the majority of total retail sales, the majority of franchises available today are business type possibilities.

B) Business format franchises

- Business format franchises, on the other hand, employ not just the franchisor's product, service and trademark, but also the whole business model, including marketing plans and operations manuals. The most frequent sort of franchise is a business format franchise.
- Some well-known Business Format Franchise are KFC, McDonalds, Starbucks Coffee, Dunkin' Donuts, Famous Amos, etc.

Legal Issues of Franchising

- Franchising establishes a long-term business engagement and understanding the franchise programme is essential. A potential franchisee should seek the advice of an experienced franchise attorney to help them understand the legal issues. The success of both the franchisor and the franchisee is dependent on a healthy relationship between them.
- Federal and state regulations control franchising, requiring franchisors to give prospective franchisees with information about the franchisor-franchisee relationship.
- The two main franchising legal documents are as follows :
  1. The Disclosure Document, which might be in the UFOC format - The UFOC is to provide information to prospective franchisees about the franchisor, the system and the agreements they will be required to sign.
  2. Franchise agreement

The Franchise Agreement

- The terms of the connection between the franchisor and franchisee are more precise in the franchise agreement than in the UFOC. A typical franchise agreement can include information on :
  1. The franchise system, which includes things like trademarks and products
  2. Geographical area
  3. Partie's rights and obligations : Standards, processes, training, help, advertising and so forth.
  4. The franchise's term (duration)

5. The franchisee's payments to the franchisor
6. The right to terminate and/or transfer the franchise.

- The franchise agreement is a legal, written contract that controls the connection and details the franchise acquisition conditions. Before signing, prospective franchisees are entitled to have the completed franchise agreement for at least five business days. This allows them to evaluate and analyze the terms and conditions of the agreement.

Review Questions

1. *Describe the project development process.*
2. *Discuss on identifying the customer needs.*
3. *Write short notes on concept Generation.*
4. *Write short notes on Testing.*
5. *Write short notes on selection of concept.*
6. *Write a notes on Prototyping.*
7. *Discuss on robust design.*
8. *Explain the concept of entrepreneurship.*
9. *Enlist the characteristic of successful entrepreneurs.*
10. *Describe in details about entrepreneurship process.*
11. *Define the factors impacting emergence of entrepreneurship*
12. *Define Intellectual property rights.*
13. *Write short notes : 1. copyrights 2 Trade secrets*
14. *Write in brief about franchising.*
15. *Discuss on Patent.*

Multiple Choice Questions

Q.1 Which from the following is NOT a tangible element ?

a Fixtures b Trademarks

c Monetary assets d Stockholder equity

Q.2 Product cost can be reduced by considering the following aspect(s) at the design stage :

a Minimum number of operations

b Unnecessary tight tolerance should not be provided

c Design should consist of standard parts

d All of the above

Q.3 The following is the preliminary stage of production planning :

a Capacity planning

b Material requirements planning

c Scheduling

d Product development and design

Q.4 New-product development starts with _____.

a idea screening

b idea generation

c concept development and testing

d marketing strategy development

Q.5 _____ calls for testing new-product concepts with groups of target consumers.

a Concept development b Concept testing

c Idea generation d Idea screening

Q.6 If a product concept passes the _____, it moves into _____.

a business analysis test; product development

b concept development stage; product development

c concept testing stage; product development

d idea generation stage; product development

Q.7 Introducing a new product into the market is called _____.

a test marketing b new product development

c experimenting d commercialization

Q.8 Which of the following is correct ?

a Prototyping comes before evaluation and improvement

b Evaluation and improvement comes after preliminary design and final design

c Preliminary design comes after concept generation, but before screening

d Screening comes before preliminary design, but after concept generation

Q.9 The life cycle of a product includes _____.

a extraction of natural resources

b processing of raw materials

c manufacturing of products

d all of the mentioned

Q.10 In a prototype model, working ___ of a system built until an acceptable prototype is achieved.

a system b prototype

c engineering d none of the mentioned above

Q.11 A prototyping model starts with ___ analysis.

a data b requirement

c dummy system d none of the mentioned above

Q.12 Which of these is not a type of entrepreneurship?

a Small business entrepreneurship

b Scalable entrepreneurship

c Large scale entrepreneurship

d Intrapreneurship

Q.13 An entrepreneur who is the owner of more than one business is called :

a Portfolio entrepreneur b Intrapreneur

c Corporate entrepreneur d None of the above

Q.14 What protects the intellectual property created by inventors ?

a Copyright b Patents

c Registered designs d Trademarks

Q.15 In most countries, how long does copyright last for ?

a 10 years after the creation of the work

b 50 years after the creation of the work

c 10 years after the death of the person who created that work

d 50 years after the death of the person who created that work

Answer keys of Multiple Choice Questions :

Q.1	b	**Q.2**	d	**Q.3**	d	**Q.4**	b
Q.5	b	**Q.6**	a	**Q.7**	d	**Q.8**	d
Q.9	d	**Q.10**	b	**Q.11**	b	**Q.12**	d
Q.13	a	**Q.14**	b	**Q.15**	d		

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Solved Model Question Paper (In Sem)

Project Management

T.E. [E&Tc] Semester - VI (As Per 2019 Pattern)

Time : 1 Hour] **[Maximum Marks : 30**

N.B : ***i) Attempt Q.1 or Q.2, Q.3 or Q.4.***
ii) Neat diagrams must be drawn wherever necessary.
iii) Figures to the right side indicate full marks.
iv) Assume suitable data, if necessary.

Q.1 **a)** *What is need of project management ?* **(Refer section 1.4)** **[4]**

b) *Define project. Explain the term project management.* **(Refer sections 1.1 and 1.3)** **[3]**

c) *Explain the phases of project management life cycle.* **(Refer section 1.7)** **[8]**

OR

Q.2 **a)** *Explain project management processes.* **(Refer section 1.8)** **[5]**

b) *Explain project management principle.* **(Refer section 1.11)** **[4]**

c) *Explain the responsibilities of a project manager in detail.* **(Refer section 1.6)** **[6]**

Q.3 **a)** *Explain concept of BEP.* **(Refer section 2.6.2)** **[3]**

b) *Explain the project selection criteria.* **(Refer section 2.1.1)** **[4]**

c) *Write a note on feasibility studies.* **(Refer section 2.5)** **[8]**

OR

Q.4 **a)** *What is project planning and need of project planning.* **(Refer section 2.7)** **[5]**

b) *Write a note on project identification process.* **(Refer section 2.2)** **[3]**

c) *Explain the Work Breakdown Structure (WBS) in detail.* **(Refer section 2.8.3)** **[7]**

Solved Model Question Paper (End Sem)

Project Management

T.E. [E&Tc] Semester - VI (As Per 2019 Pattern)

Time : 2 $\frac{1}{2}$ Hours] **[Maximum Marks : 70**

N.B : ***i) Attempt Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, Q.7 or Q.8.***

ii) Neat diagrams must be drawn wherever necessary.

iii) Figures to the right side indicate full marks.

iv) Assume suitable data, if necessary.

Q.1 **a)** *Explain role and responsibilities of project leader ?* **(Refer sections 3.3.1 and 3.3.2)** **[8]**

b) *What is organization structure and explain its types.* **(Refer sections 3.2 and 3.2.1)** **[10]**

OR

Q.2 **a)** *Explain leadership styles for project managers.* **(Refer section 3.5)** **[10]**

b) *Explain the principle of conflict resolution and its model.* **(Refer sections 3.6.3 and 3.6.4)** **[8]**

Q.3 **a)** *Enlist the rules for drawing network diagram.* **(Refer section 4.2.2)** **[5]**

b) *Determine the early start and late start in respect of all node points and identify critical paths for the following network.* **(Refer example 4.4.1)** **[12]**

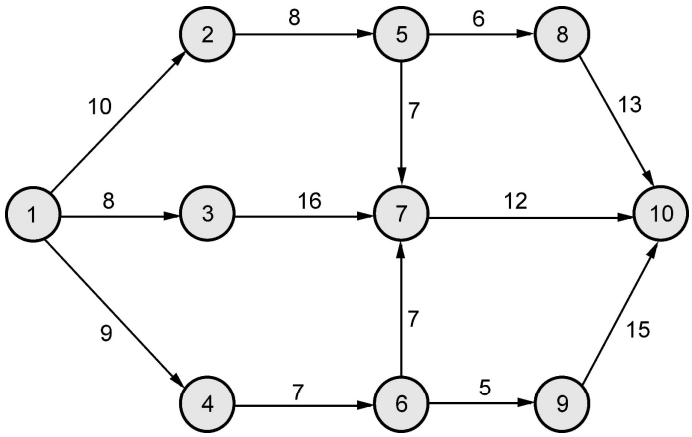

Fig. 1

OR

Q.4 **a)** *Enlist limitation and application of CPM/PERT.* **(Refer sections 4.1.2 and 4.1.3)** **[3]**

b) *Explain the representation of project network in details.* **(Refer section 4.2.1)** **[8]**

c) *Explain the process of determination of the critical path.* **(Refer section 4.4)** **[6]**

Q.5 **a)** *Write a note on risk.* **(Refer section 5.1.2)** **[4]**

b) *Explain the role of risk management in overall project management.* **(Refer section 5.1.4)** **[8]**

c) *Define risk analysis and enlist its advantages.* **(Refer section 5.1.7)** **[6]**

OR

Q.6 **a)** *Explain the process in risk management.* **(Refer section 5.1.5)** **[8]**

b) *Write a note on JIRA.* **(Refer section 5.2.2)** **[6]**

c) *What is risk management.* **(Refer section 5.1.3)** **[4]**

Q.7 **a)** *Write a note on identify the customer needs.* **(Refer section 6.4)** **[6]**

b) *What are factors impacting emergence of entrepreneurship.* **(Refer section 6.9.5)** **[6]**

c) *Write a note on prototyping.* **(Refer section 6.8)** **[5]**

OR

Q.8 **a)** *Enlist the characteristics of successful product development.* **(Refer section 6.1.1)** **[6]**

b) *Discuss on knowledge and skills requirement for a entrepreneur.* **(Refer section 6.9.2)** **[8]**

c) *Explain the process of concept generation.* **(Refer section 6.6.1)** **[3]**

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TEXT BOOKS FOR T.E. (E&TC) SEM VI

Compulsory Subjects

1. Cellular Networks *(V. S. Bagad)*
2. Project Management *(Rana S. Mahajan, Dr. Dipak P. Patil, Dr. Manoj V. Bhalerao)*
3. Power Devices & Circuits *(Dr. J. S. Chitode, Dr. Shamsundar M. Kulkarni)*

Elective Subjects

4. Digital Image Processing
5. Sensors in Automation
6. Advanced JAVA Programming *(A. A. Puntambekar, Santosh Dhekale)*
7. Embedded Processors
8. Network Security *(V. S. Bagad, I. A. Dhotre)*