Training Programme
on
Project Preparation and Extension Methods

TRAINING MANUAL

Department of Fisheries and Fishermen Welfare

Fisheries Staff Training Institute
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Project Preparation and extension methods

INDEX

1. Introduction to ProjectManagement

Introduction

Realization of these objectives requires systematic planning and careful implementation. To this effect, application of knowledge, skill, tools and techniques in the project environment, refers to project management. Project management in recent years has proliferated, reaching new heights of sophistication. It has emerged as a distinct area of management practices to meet the challenges of new economic environment, globalization process, rapid technological advancement, and quality concerns of thestakeholders.

Project Definition

Project in general refers to a new endeavor with specific objective and varies so widely that it is very difficult to precisely define it. Some of the commonly quoted definitions are as follows. Project is a temporary endeavor undertaken to create a unique product or service or result. (AMERICAN National Standard ANSI/PMI99-001-2004)

Project is a unique process, consist of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective confirming to specific requirements, including the constraints of time cost and resource.

Examples of project include Developing a watershed, Creating irrigation facility, Developing new variety of a crop, Developing new breed of an animal, Developing agro- processing centre, Construction of farm building, sting of a concentrated feed plant etc. It may be noted that each of these projects differ in composition, type, scope, size andtime.

Project Characteristics

Despite above diversities, projects share the following common characteristics.

- Unique innature.
- Have definite objectives (goals) toachieve.
- Requires set ofresources.
- Have a specific time frame for completion with a definite start andfinish.
- Involves risk anduncertainty.
- Requires cross-functional teams and interdisciplinaryapproach

Project Performance Dimensions

Three major dimensions that define the project performance are scope, time, and resource. These parameters are interrelated and interactive. The relationship generally represented as an equilateral triangle. The relationship is shown in figure 1.

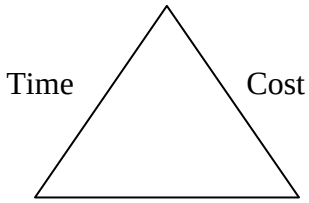

Figure 1. Project performance dimensions

It is evident that any change in any one of dimensions would affect the other. For example, if the scope is enlarged, project would require more time for completion and the cost would also go up. If time is reduced the scope and cost would also be required to be reduced. Similarly any change in cost would be reflected in scope and time. Successful completion of the project would require accomplishment of specified goals within scheduled time and budget. In recent years a forth dimension, stakeholder satisfaction, is added to the project. However, the other school of management argues that this dimension is an inherent

part of the scope of the project that defines the specifications to which the project is required to be implemented. Thus the performance of a project is measured by the degree to which these three parameters (scope, time and cost) areachieved.

Mathematically

Performance = f(Scope, Cost, Time)

In management literature, this equilateral triangle is also referred as the “Quality triangle” of theproject.

ProjectLifeCycle

Every project, from conception to completion, passes through various phases of a life cycle synonym to life cycle of living beings. There is no universal consensus on the number of phases in a project cycle. An understanding of the life cycle is important to successful completion of the project as it facilitates to understand the logical sequence of events in the continuum of progress from start to finish. Typical project consists of four phases- Conceptualization, Planning,Execution and Termination. Each phase is marked by one or more deliverables such as Concept note, Feasibility report, Implementation Plan, HRD plan, Resource allocation plan, Evaluation report etc.

Conceptualization Phase

Conception phase, starting with the seed of an idea, it covers identification of the product / service, Pre-feasibility, Feasibility studies and Appraisal and Approval. The project idea is conceptualized with initial considerations of all possible alternatives for achieving the project objectives. As the idea becomes established a proposal is developed setting out rationale, method, estimated costs, benefits and other details for appraisal of the stakeholders. After reaching a broad consensus on the proposal the feasibility dimensions are analyzed indetail.

Planning Phase

In this phase the project structure is planned based on project appraisal and approvals. Detailed plans for activity, finance, and resources are developed and integrated to the quality parameters. In the process major tasks need to be performed in this phase are

- Identification of activities and theirsequencing
- Time frame forexecution
- Estimation andbudgeting
- Staffing

A Detailed Project Report (DPR) specifying various aspects of the project is finalized to facilitate execution in this phase.

Execution Phase

This phase of the project witnesses the concentrated activity where the plans are put into operation. Each activity is monitored, controlled and coordinated to achieve project objectives. Important activities in this phaseare

- Communicating withstakeholders
- Reviewingprogress
- Monitoring cost andtime
- Controllingquality
- Managingchanges

Termination Phase

This phase marks the completion of the project wherein the agreed deliverables are installed and project is put in to operation with arrangements for follow-up and evaluation.

Life Cycle path

The life cycle of a project from start to completion follows either a "S" shaped path or a "J " shaped path (Figure 2 and 3). In "S" shape path the progress is slow at the starting and terminal phase and is fast in the implementation phase. For example, implementation of watershed project. At the beginning detailed sectoral planning and coordination among various implementing agencies etc. makes progress slow and similarly towards termination, creating institutional arrangement for transfer and maintenance of assets to the stakeholders progresses slowly.

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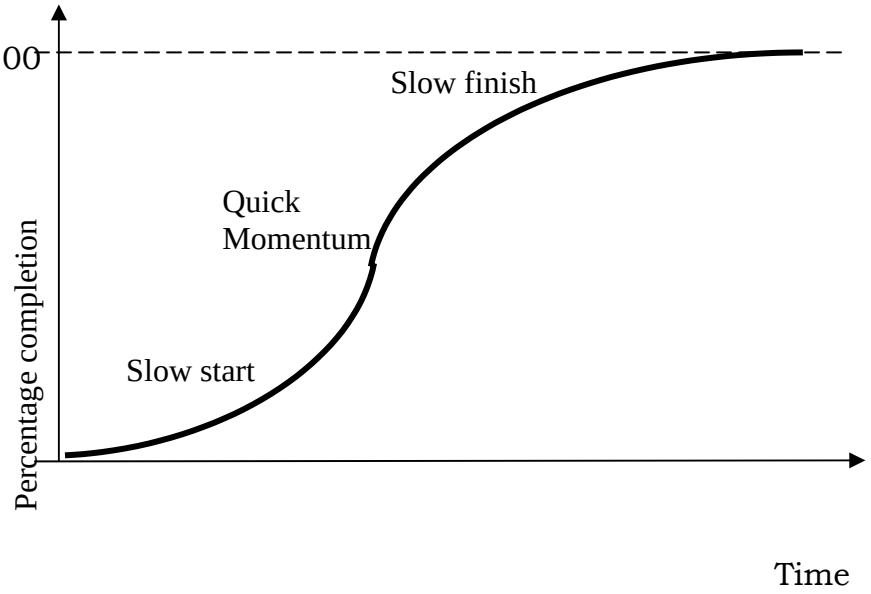

Figure 2. Project life path –"S" shape

In "J" type cycle path the progress in beginning is slow and as the time moves on the progress of the project improves at fast rate. Example, in a developing an energy plantation. In this the land preparation progresses slowly and as soon as the land and seedling are transplantation is under taken. This is shown in figure 3.

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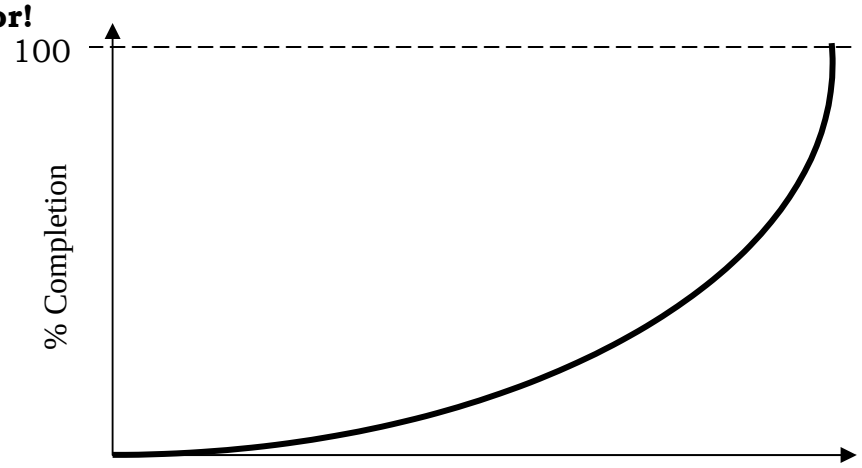


Figure 3. Project life cycle path - "J" Shape

Project Classification

There is no standard classification of the projects. However considering project goals, these can be classified into two broad groups, industrial and developmental. Each of these groups can be further classified considering nature of work (repetitive, non-repetitive), completion time (long term, shot term etc), cost (large, small, etc.), level of risk (high, low, no-risk), mode of operation (build, build-operate-transferetc).

Industrial projects also referred as commercial projects, which are undertaken to provide goods or services for meeting the growing needs of the customers and providing attractive returns to the investors/stake holders. Following the background, these projects are further grouped into two categories i.e., demand based and resource / supply based. The demand based projects are designed to satisfy the customers' felt as well the latent needs such as complex fertilizers, agro-processing infrastructure etc. The resource/ supply based projects are those which

take advantage of the available resources like land, water, agricultural produce, raw material, minerals and even human resource. Projects triggered by successful R&D are also considered as supply based. Examples of resource based projects include food product units, metallurgical industries, oil refineries etc. Examples of projects based on human resource (skilled) availability include projects in IT sector, Clinical Research projects in bio services andothers.

Development projects are undertaken to facilitate the promotion and acceleration of overall economic development. These projects act as catalysts for economic development providing a cascading effect. Development projects cover sectors like irrigation, agriculture, infrastructure health and education.

The essential differences between Industrial projects and Developmental project aresumerised in the following table1.

Table 1. Difference between Industrial and Developmental Projects

Dimension	Industrial Project	Developmental Project
Scale of Project	Limited	Large
Promoters	Entrepreneurs or corporates	Government, Public Sectors, NGOs
Investment	---	High
Gestation Period	---	High
Profitabilty	High, Considered on IRR(Internal Rate of Return)	Modest, Considered onERR (Economic Rate of Return)
Finance	Stringent debt equity norms	Operates on higher debt- equity norms
Source of fund	National stock markets and from domestic financial institutions	International organizations like World Bank,

		IMF,ADB,DFID and others mostly as loan ,yettimes providing for some grants.
Interest rates and repayment period:	Market rate and the repayment period is generally 7 to 10 years	Very low for borrowed funds and the repayment period extends up to 25 years and even beyond.

Project management

Project management is a distinct area of management that helps in handling projects. It has three key features to distinguish it from other forms of management and they include: a project manager, the project team and the project management system. The project management system comprises organization structure, information processing and decision-makingandtheproceduresthatfacilitateintegrationofhorizontalandverticalelementsofthe project organization. The project management system focuses on integrated planning and control.

Benefits of Project Management Approach

The rationale for following project management approach is as follows.

- Project management approach will help in handling complex, costly and risky assignments by providing interdisciplinary approach in handling the assignments. Example: R&Dorganizations.
- Project management approaches help in handling assignments in a specified time frame with definite start and completion points .Example handling customer orders by

Industries involved in production of capitalgoods.

- Project management approaches provide task orientation to personnel in an Organization in handling assignments. Example: Organizations in IT sector handling software development assignments forclients.

2. Project Identification andFormulation

Introduction

A project in the economic sense directly or indirectly adds to the economy of the Nation. However an introspection of the project performance clearly indicates that the situation is far from satisfactory. Most of the major and critical projects in public sector that too in crucial sectors like irrigation, agriculture, and infrastructure are plagued by tremendous time and cost overruns. Even in the private sector the performance is not all that satisfactory as is evident from the growing sickness in industry and rapid increase in non-performing assets (NPAS) of Banks and Financial Institutions. The reasons for time and cost over runs are several and they can be broadly classified under-technical, financial, procedural and managerial. Most of these problems mainly stem from inadequate project formulation and haphazardimplementation.

Project Identification

Project identification is an important step in project formulation. These are conceived with the objective of meeting the market demand, exploiting natural resources or creating wealth. The project ideas for developmental projects come mainly from the national planning process, where as industrial projects usually stem from identification of commercial prospects and profitpotential.

As projects are a means to achieving certain objectives, there may be several alternative projects that will meat these objectives. It is important to indicate all the other alternatives considered with justification in favour of the specific project proposed for consideration.

Sectoral studies, opportunity studies, support studies, project identification essentially focuses on screening the number of project ideas that come up based on information and data available and based on expert opinions and to come up with a limited number of project

options which are promising.

Project Formulation

Project Formulation Concept

"Project Formulation" is the processes of presenting a project idea in a form in which it can be subjected to comparative appraisals for the purpose of determining in definitive terms the priority that should be attached to a project under severresourceconstraints. Project Formulation involves the following steps (Figure1).

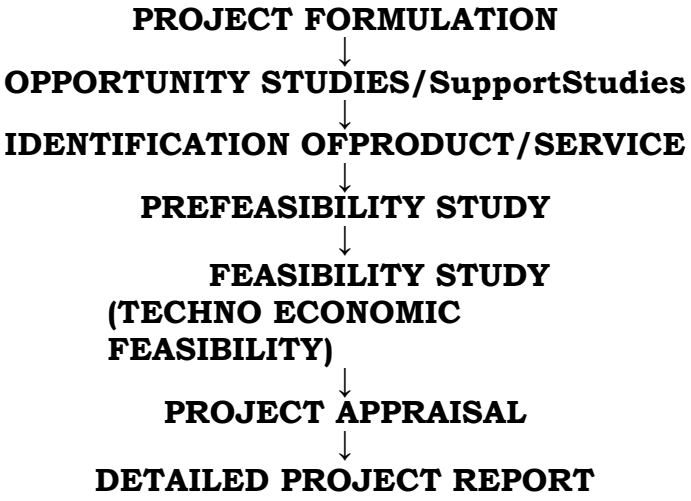


Figure 1. Project Formulation –Schematic view

Opportunity Studies

An opportunity study identifies investment opportunities and is normally undertaken at macro level by agencies involved in economic planning and development. In general opportunity studies there are three types of study – Area Study, sectoral and Sub-sectoral Studies and Resource Based Studies. Opportunity Studies and Support studies provide sound basis for project identification.

Pre feasibility Studies / Opportunity Studies

A pre-feasibility study should be viewed as an intermediate stage between a project opportunity study and a detailed feasibility study, the difference being primarily the extent of details of the information obtained. It is the process of gathering facts and opinions pertaining to the project. This information is then vetted for the purpose of tentatively determining whether the project idea is worth pursuing furthering. Pre feasibility study lays stress on assessing market potential, magnitude of investment, , technical feasibility, financial analysis, risk analysis etc. The breadth and depth of pre-feasibility depend upon the time available and the confidence of the decision maker. Pre-feasibility studies help in preparing a project profile for presentation to various stakeholders including funding agencies to solicit their support to the project. It also throws light on aspects of the project that are critical in nature and necessitate further investigation through functional supportstudies.Support studies are carried out before commissioning pre-feasibility or a feasibility study of projects requiring large-scale investments. These studies also form an integral part of the feasibility studies. They cover one or more critical aspects of project in detail. The contents of the Support Study vary depending on the nature of the study and the project contemplated. Since it relates to a vital aspect of the project the conclusions should be clear enough to give a direction to the subsequent stage of project preparation.

Feasibility Study

Feasibility Study forms the backbone of Project Formulation and presents a balanced picture incorporating all aspects of possible concern. The study investigates practicalities, ways of achieving objectives, strategy options, methodology, and predict likely outcome, risk and the consequences of each course of action. It becomes the foundation on which project definition and rationale will be based so that the quality is reflected in subsequent project activity. A well conducted study provides

a sound base for decisions, clarifications of objectives, logical planning, minimal risk, and a successful cost effective project. Assessing feasibility of a proposal requires understanding of the STEEP factors. These are as under Social, Technological, Ecological, Economic, andPolitical.

A feasibility study is not an end in itself but only a means to arrive at an investment decision. The preparation of a feasibility study report is often made difficulty by the number of alternatives (regarding the choice of technology, plant capacity, location, financing etc.) and assumptions on which the decisions are made. The project feasibility studies focus on

- Economic and MarketAnalysis
- TechnicalAnalysis
- MarketAnalysis
- FinancialAnalysis
- EconomicBenefits
- Project Risk andUncertainty
- ManagementAspects

Economic and Market Analysis

In the recent years the market analysis has undergone a paradigm shift. The demand forecast and projection of demand supply gap for products / services can no longer be based on extrapolation of past trends using statistical tools and techniques. One has to look at multiple parameters that influence the market. Demand projections are to be made keeping in view all possible developments. Review of the projects executed over the years suggests that many projects have failed not because of technological and financial problems but mainly because of the fact that the projects ignored customer requirements and marketforces.

In market analysis a number of factors need to be considered covering – product specifications, pricing, channels of distribution, trade practices, threat of substitutes, domestic and international competition,

opportunities for exports etc. It should aim at providing analysis of future market scenario so that the decision on project investment can be taken in an objective manner keeping in view the market risk anduncertainty.

Technical Analysis

Technical analysis is based on the description of the product and specifications and also the requirements of quality standards. The analysis encompasses available alternative technologies, selection of the most appropriate technology in terms of optimum combination of project components, implications of the acquisition of technology, and contractual aspects of licensing. Special attention is given to technical dimensions such as in project selection. The technology chosen should also keep in view the requirements of raw materials and other inputs in terms of quality and should ensure that the cost of production would be competitive. In brief the technical analysis included the followingaspects.

Technology	-Availability	
	-	Alternatives
	-	Latest /state-of-art
	-	Otherimplications
Plantcapacity	-	Market demand
	-	Technologicalparameters
Inputs	-	Rawmaterials
	-	Components
	-	Power
	-	Water
	-	Fuel
	-	Others

Availability skilled man power
\Location
Logistics
Environmental consideration –
pollution, etc., Requirement
buildings/ foundation
Other relevant details

Environmental Impact Studies:

All most all projects have some impact on environment. Current concern of environmental quality requires the environmental clearance for all projects. Therefore environ impact analysis needs to be undertaken before commencement of feasibilitystudy.

Objectives of Environmental Impact Studies:

- To identify and describe the environmental resources/values (ER/Vs) or the environmental attributes (EA) which will be affected by the project (in a quantified manner as far aspossible).
- To describe, measure and assess the environmental effects that the proposed project will have on theER/Vs.
- To describe the alternatives to the proposed project which could accomplish the same results but with a different set of environmentaleffects

The environmental impact studies would facilitate providing necessary remedial measures in terms of the equipments and facilities to be provided in the project to comply with the environmental regulation specifications.

Financial Analysis

The Financial Analysis, examines the viability of the project from financial or commercial considerations and indicates the return on the investments. Some of the commonly used techniques for financial

analysis are as follows.

- Pay-backperiod.
- Return on Investment(ROI)
- Net Present Value(NPV)
- Profitability Index(PI)/Benefit CostRatio
- Internal Rate of Return(IRR)

Pay-back Period

This is the simplest of all methods and calculates the time required to recover the initial project investment out of the subsequent cash flow. It is computed by dividing the investment amount by the sum of the annual returns (income – expenditure) until it is equal to the capital cost.

Example1. (Uniform annual return)

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

Example 2.(Varying annual return)

In a project Rs.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 drawback in this method is that it ignores any return received after the payback period and assumes equal value for the income and expenditure irrespective of the time.

It is also possible that projects with high return on investments

beyond the pay-back period may not get the deserved importance i.e., two projects having same pay-back period – one giving no return and the other providing large return after pay-back period will be treated equally, which is logically notcorrect.

Return on Investment(ROI):

The ROI is the annual return as percentage of the initial investment and is computed by dividing the annual return with investment. It is calculation is simple when the return is uniform. For example the ROI of the fish ponds is (5000/ 10000) X 100 = 50%. When the return is not uniform the average of annual returns over a period is used. For horticultural orchard average return is (1,30,000/3) = 43333. ROI = (43333/100000) X 100 = 43.3 %.

Computation of ROI also suffers from similar limitation as of pay-back period. It does not differentiate between two projects one yielding immediate return (lift irrigation project) and another project where return is received after some gestation period say about 2-3 years (developing new variety of crop).

Both the pay-back period and ROI are simple ones and more suited for quick analysis of the projects and sometimes provide inadequate measures of project viability. It is desirable to use these methods in conjunction with other discounted cash flow methods such as Net Present Value (NPV), Internal Rate of Return (IRR) and Benefit-Costratio.

Discounted Cash Flow Analysis:

The principle of discounting is the reverse of compounding and takes the value of money over time. To understand his let us take an example of compounding first. Assuming return of 10
%, Rs 100 would grow to Rs110/- in the first year and Rs 121 in the second year. In a reverse statement, at a discount rate of 10% the return of Rs.110 in the next year is equivalent to Rs100 at present. In other

words the present worth of next years return at a discount rate 10 % is only Rs.90.91 i.e., (100/110) Similarly Rs121 in the second year worth Rs 100/- at present or the present value of a return after two years is Rs. 82.64 (100/121). These values Rs.90.91 and rs.82.64 are known as present value of of future annual return of Rs.100 in first and second year respectively. Mathematically, the formula for computing present value (PV) of a cash flow "C_n" in "nth" year at a discount rate of "d" is asfollows;

$PV= C_n / (1+d)^n$

The computed discount factor tables are also available for ready reference. In the financial analysis the present value is computed for both investment and returns. The results are presented in three different measures ie. NPV, B-C Ratio, and IRR.

Net Present Value (NPV)

Net Present Value is considered as one of the important measure for deciding the financial viability of a project. The sum of discounted values of the stream of investments in different years of project implementation gives present value of the cost (say C). Similarly sum of discounted returns yields the present value of benefits (say B). The net present value (NPV) of the project is the difference between these two values (B- C). Higher the value of NPV is always desirable for a project.

Benefit-Cost Ratio (B-C Ratio) or Profitability Index (PI):

The B-C Ratio also referred as Profitability Index (PI), reflect the profitability of a project and computed as the ratio of total present value of the returns to the total present value of the investments (B/C). Higher the ratio better is the return.

Internal Rate of Return (IRR):

Internal Rate of Return (IRR) indicates the limit or the rate of discount at which the project total present value of return (B) equals to total present value of investments (C) i.e. B-C
= Zero. In other words it is the discount rate at which the NPV of the project is zero. The IRR is computed by iteration i.e. Computing NPV at different discount rate till the value is nearly zero. It is desirable to have projects with higherIRR.

Risk andUncertainty:

Risk and Uncertainty are associated with every project. Risk is related to occurrence of adverse consequences and is quantifiable. It is analysed through probability of occurrences. Where as uncertainty refers to inherently unpredictable dimensions and is assessed through sensitivity analysis. It is therefore necessary to analyse these dimensions during formulation and appraisal phase of the programme. Factors attributing to risk and uncertainties of a project are grouped under thefollowing;

- Technical –relates to project scope, change in technology, quality and quantity of inputs, activity times, estimation errorsetc.
- Economical- pertains to market, cost, competitive environment, change in policy, exchange rateetc.
- Socio-political- includes dimensions such as labour, stakeholdersetc.
- Environmental – factors could be level of pollution, environmental degradationetc.

Economic Benefits:

Apart from the financial benefits (in terms of Return on Investment) the economic benefits of the project are also analyzed in the feasibility study. The economic benefits include employment generation,

economic development of the area where the project is located, foreign exchange savings in case of import substitutes or earning of foreign exchange in case of export oriented projects and others.

Management Aspects:

Management aspects are becoming very important in project feasibility studies. The management aspects cover the background of promoters, management philosophy, the organization set up and staffing for project implementation phase as well as operational phase, the aspects of decentralization and delegation, systems and procedures, the method of execution and finally the accountability.

Time Frame for Project Implementation:

The feasibility study also presents a broad time frame for project implementation. The time frame influences preoperative expenses and cost escalations which will impact the profitability and viability of the project.

Feasibility Report:

Based on the feasibility studies the Techno economic feasibility report or the project report is prepared to facilitate project evaluation and appraisal and investment decisions.

Project Appraisal

The project appraisal is the process of critical examination and analysis of the proposal in totality. The appraisal goes beyond the analysis presented in the feasibility report. At this stage, ifrequiredcompilationofadditionalinformationandfurtheranalysisofproject dimensionsareundertaken. At the end of the process an appraisal note is prepared for facilitating decision on the projectimplementation.

The appraisal process generally concentrates on the following aspects.

- **Market Appraisal**: Focusing on demand projections, adequacy ofmarketing infrastructure and competence of the key marketingpersonnel.
- **Technical Appraisal:** Covering product mix, Capacity, Process of manufacture engineering know-how and technical collaboration, Raw materials and consumables, Location and site, Building, Plant and equipments, Manpower requirements and Break- evenpoint.
- **Environmental Appraisal:** Impact on land use and micro-environment, commitment of natural resources, and Government policy.

. **Financial Appraisal:** Capital, rate of return, specifications, contingencies,cost projection, capacity utilization, and financingpattern.

- **Economic Appraisal:** Considered as a supportive appraisal it reviews economic rateof return, effective rate of protection and domestic resourcecost.
- **Managerial Appraisal:** Focuses on promoters, organization structure, managerial personnel, and HRmanagement.
- **Social Cost Benefit Analysis (SCBA):** Social Cost Benefit Analysis is a methodology for evaluating projects from the social point of view and focuses on social cost and benefits of a project. There often tend to differ from the costs incurred in monetary terms and benefits earned in monetary terms by the project SCBA may be based on UNIDO method or the Little-Mirriles (L-M) approach. Under UNIDO method the net benefits of the project are considered in terms of economic (efficiency) prices also referred to as shadow prices. As per the L-M approach the outputs and inputs of a project are classified into (1) traded goods and services (2) Non traded goods and services; and(3) Labor. All over the world including India currently the focus is on Economic Rate of Return

(ERR) based on SCBA assume importance in project formulation and investmentdecisions.

Detailed Project Report(DPR)

Once the projects are appraised and the investment decisions are made a Detailed Project Report (DPR) is prepared. It provides all the relevant details including design drawings, specifications, detailed cost estimates etc. and this would act as a blue print for project implementation.

Project Management Techniques

Introduction

Project management involves decision making for the planning, organizing, coordination, monitoring and control of a number of interrelated time bound activities. Project Manager therefore, often depends on tools and techniques that are effective enough not only for drawing- up the best possible initial plan but also capable of projecting instantaneously the impact of deviations so as to initiate necessary corrective measures. The search for an effective tool has resulted in development of a variety of techniques. These project management techniques can be classified under two broad categories i.e., Bar Charts and Networks.

Bar Charts

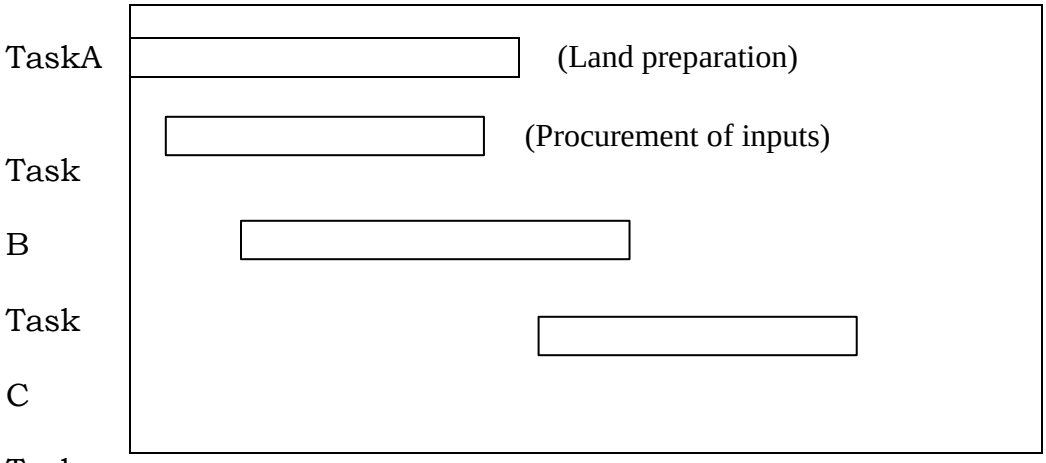
Bar charts are the pictorial representation of various tasks required to be performed for accomplishment of the project objectives. These charts have formed the basis of development of many other project management techniques.

Gantt Chart

Henry L Gantt (1861 – 1919) around 1917 developed a system of bar charts for scheduling and reporting progress of a project. These charts latter were known as Gantt Charts. It is a pictorial representation specifying the start and finish time for various tasks to be performed in a project on a horizontal time-scale. Each project is broken down to physically identifiable and controllable units, called the Tasks. These tasks are indicated by means of a bar, preferably at equi-distance in the vertical axis and time is plotted in the horizontal axis (Figure 1). In this figure "Task A" is land preparation, "Task B" is procurement of inputs etc. Land preparation (Task A) takes five days starting from day one. However in practice the time scale is superimposed on a calendar i.e., if land preparation starts on 1st June it would be completed by 5thJune.

Length of the bar indicates required time for the task whereas the width has no significance. Though the bar chart is comprehensive, convenient, and very effective, it has the following limitations:

- Like many other graphical techniques are often difficult to handle large number of tasks in other words a complexproject.
- Does not indicate the inter relationship between the tasks i.e., if one activity overruns time what would be the impact on projectcompletion.



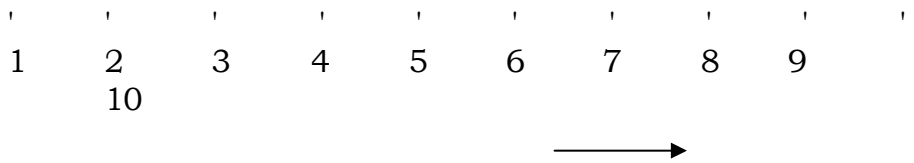


Figure 1: Bar Chart

Milestone Chart

Milestone chart is an improvement over the bar chart (Gantt chart) by introducing the concept of milestone. The milestone, represented by a circle over a task in the bar chart indicates completion of a specific phase of the task (Figure 2). For example land preparation (Task A) includes ploughing and leveling. From the simple bar chart it is difficult to monitor progress of the ploughing. Introduction of a milestone on day 3 would specify that the ploughing would be completed by day 3 of the project i.e. 3rd June. In a milestone chart a task is broken down in to specific phases (activities) and after accomplishment of each of the specific activity a milestone is reached or in other words an event occurs. The chart also shows the sequential relationship among the milestones or events within the same task but not the relationship among milestones contained in different tasks. For example in figure 2, the milestone 2 of task A cannot be reached until the milestone 1 is crossed and the activity between milestone 1 and 2 is over. Similarly, in task B the milestone 4 can begin only after completion of milestone 3. But the relationship between the milestone of task A and task B is not indicated in the milestone chart. Other weaknesses of this chart are as follows:

- Does not show interdependence betweentasks.
- Does not indicate criticalactivities.

- Does not consider the concept of uncertainty in accomplishing thetask.
- Very cumbersome to draw the chart for large projects.

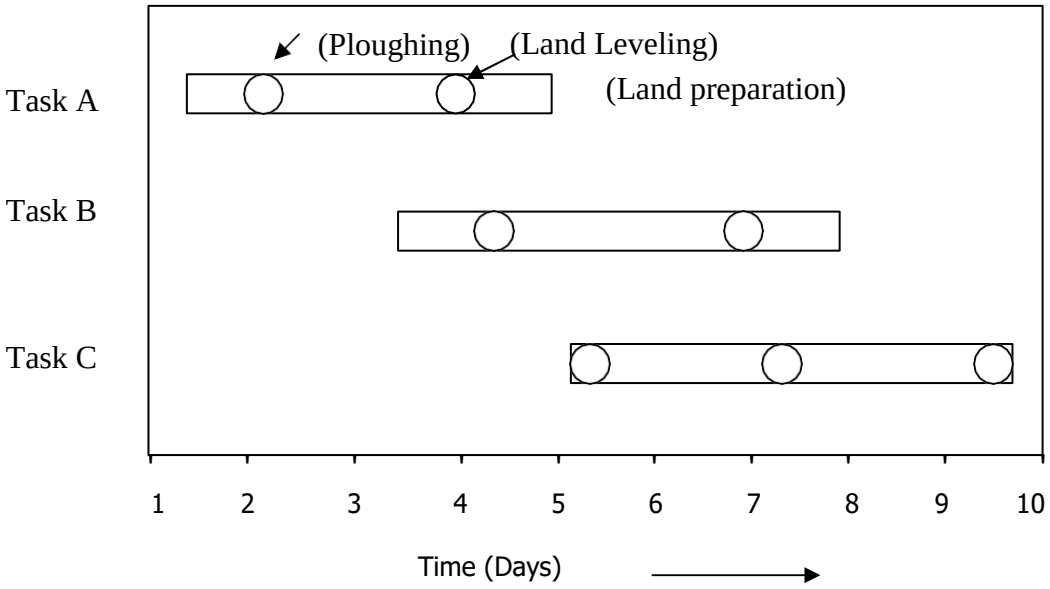


Figure 2: Milestone Chart

Networks

The network is a logical extension of Gantt's milestone chart incorporating the modifications so as to illustrate interrelationship between and among all the milestones in an entire project. The two best-known techniques for network analysis are Programme Evaluation and review Technique (PERT) and Critical Path Method (CPM). These two techniques were developed almost simultaneously during 1956-1958. PERT was developed for US navy for scheduling the research and development activities for Polaris missiles programme. CPM was developed by E.I. du Pont de Nemours & Company as an application to construction project. Though these two methods were developed simultaneously they have striking similarity and the significant difference is that the time estimates for activities is assumed deterministic in CPM and probabilistic in PERT. There is also little distinction in terms of application of these concepts.

PERTisusedwhereemphasisisonschedulingandmonitoringtheprojectandC PMisused where emphasis is on optimizing resource allocation. However, now-a-days the two techniques are used synonymously in network analysis and the differences are considered to be historical.

Both CPM and PERT describe the work plan of project where arrows and circles respectively indicate the activities and events in the project. This arrow or network diagram includes all the activities and events that should be completed to reach the project objectives. The activities and events are laid in a planned sequence of their accomplishments. However, there are two types of notations used in the network diagram. They are asunder,

1. Activity-on-Arrow (AOA),and
2. 2. Activity-on-Node(AON).

In AOA notation, the arrow represents the work to be done and the circle represents an event – either the beginning 0f another activity or completion of previous one. This is shown in figure 3.

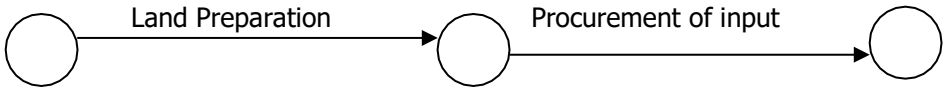


Figure 3. Activity on Arrow

For AON notation, a box (or node) is used to show the task itself and the arrow simply show the sequence in which work is done. This is shown in figure 4.

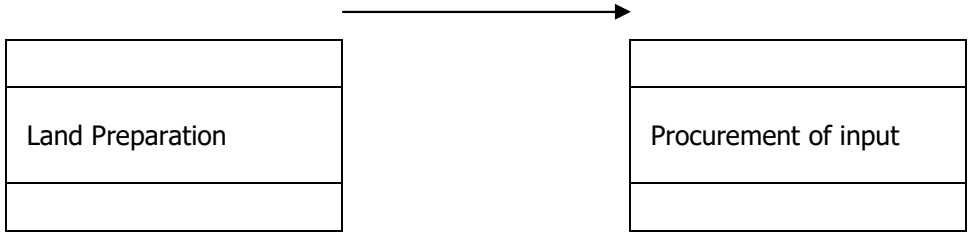


Figure 4. AON Diagram

Most project management software usually uses AON diagram. AOA network diagram are usually associated with the PERT diagram. This would be used in the following sections.

1.3.1 Programme Evaluation and Review Technique (PERT)

The PERT technique is a method of minimizing trouble spots, programme bottlenecks, delays and interruptions by determining critical activities before they occur so that various activities in the project can be coordinated.

PERT terminology

Some of the terms frequently used in PERT are as follows.

Activity : A recognizable work item of a project requiring time and resource for its completion.

Dummy Activity: An activity that indicates precedence relationship and requires no time nor resource.

Critical Activity: Activities on the critical path having zero slack / floattime.

Critical Path: The longest time path connecting the critical activities in the project network. The total time on this path is the shortest duration of the project.

Event: An instantaneous point in time signifying completion or

beginning of an activity. Burst Event: An event which gives rise to

more than one activity.

Merge Event: The event which occurs only when more than one activity are accomplished.

Expected Time: The weighted average of the estimated optimistic, most likely and pessimistic time duration of a project activity:

$$\text{Expected Time } (T_E) = \frac{T_o + 4\,T_M + T_P}{6}$$

where T_o is theOptimistictime, T_M is the Most

P

likely time T is the Pessimistictime

Earliest Start Time (EST): The earliest possible time at which the event can occur. The EST also denotes the Earliest Start Time (EST) of an activity as activities emanate from events. The EST of an activity is the time before which it can not commence without affecting the immediate preceding activity.

Latest Start Time (LST): The latest time at which the event can take place. Also referred as the

Latest Start Time (LST) indicating the latest time at which an activity can begin without

delaying the project completion time.

Slack: The amount of spare time available between completion of an activity and

beginning of next activity.

Steps For Network Analysis

The six steps of network analysis are as follows.

1. Prepare the list ofactivities
2. Define the inter relationship among theactivities.
3. Estimate the activityduration
4. Assemble the activities in the form of a flowdiagram
5. Draw the network
6. Analyze the network i.e. compute EST and LST; identify critical events, critical path and criticalactivities.

Step1: Prepare the list ofactivities

An activity in a project is the lowest level of resource consuming, time-bound work having a specified beginning and endpoint. It should be

quantifiable, measurable, costable, and discrete. The total project is subdivided into activities and each activity is given an alphabetical symbol / code. When the number of activities is more than 26, alphanumeric or multi -alphabet codes can be used. This involves a detailed delineation of the activities to be performed to complete the project. There is no limit to the number of activities to which the project should be splitted. However, it is advisable to limit the number to the minimum required from managerial consideration for avoiding unnecessary complexity. In a simple project it may be easier to identify the activity. In complex projects project activities are identified by splitting it into different hierarchical levels (sub-projects). For example in the activities of a watershed project could be broken down in to sub-projects such as agricultural sub-projects, Soil & water conservation sub-projects, Aforestation sub-project etc. For each of these subprojects the activities could be identified. Depending on the size and nature of the project sub-projects could be further divided into sub-subproject.

For illustration of the process, a simple example of creating facility for lift irrigation in a farm would be used in the following text. Some of the assumptions are as under.

1. It is assumed that the competent authority has approved the project and the project scheduling starts with the activity of "Siteselection".
2. Irrigation would be provided from a newly dugwell.
3. Field channels from the well would be laid after itsdigging.
4. Suitable pump would be procured and installed for liftingwater.
5. Specification for the pump is finalized based on the groundwater prospecting data beforedigging.
6. Pump and other inputs would not be procured until the site isselected.
7. Pump would be installed after digging thewell.

With above assumptions, the activities of the project are listed in Table 1. It may be noted the list is not exhaustive. The list would be different with different set of assumption or the perception of the project manager. More activities could be added to the list or some of the activities could be further subdivided. The number of activities in this example has been delineated and limited to only six numbers with objective of simplicity and to demonstrate the process of networking.

Table 1. List of activity

Sr. No	Activity	Symbol / Code
1.	Site selection	A
2.	Digging well	B
3.	Laying field channels	C
4.	Procurement of Pump	D
5.	Installation of pump	E
6.	Test run	F

Step 2: Define the inter relationship among the activities

The relationship among the activities could be defined by specifying the preceding and succeeding activity. Preceding activity for an activity is its immediate predecessor, i.e. the activity that needs to be completed before the start of the new activity. In the given example, selection of the site precedes digging of well. In other words the site needs to be selected before digging of the well. Thus the activity "Selection of site" becomes proceeding activity to the activity of "Digging the well" Succeeding activity is the one that immediately starts after completion of the activity. "Digging well" is the succeeding activity to "Selection ofsite".

In PERT the interrelationship is generally defined using the preceding activity. Only the terminating activities will not have any preceding activity. And all other activities must appear at least once as a preceding activity in the table. The inter relationship among the activities

listed in the example is as in Table 2.

Table 2. Interrelationship of activities

Sr. No	Activity	Symbol	Preceding activity
1.	Site selection	A	----
2.	Digging well	B	A
3.	Laying field channels	C	B
4.	Procurement of Pump	D	A
5.	Installation of pump	E	B, D
6.	Test run	F	C, E

Step 3: Estimation of activity time

The activity time is the time, which is actually expected to be expended in carrying out the activity. In deterministic cases as in CPM one time estimate is used. In probabilistic cases as in PERT, the activity time has some kind of probabilistic distribution and is the weighted average of three time estimates (Optimistic time, Pessimistic time and Most likely time) for each activity. The expected time for each activity is computed asfollowing:

$$\text{Expected Time } (T_E) = \frac{T_o + 4\,T_M + T_P}{6}$$

where T_o is the Optimistic time,(minimum time assuming every thing goes well)

T_M is the Most likely time, (modal time required under normal circumstances) T is the Pessimistic time, (maximum time assuming every thing goes wrong)

Example: Estimation of estimated time for the activity “Site selection”

For this activity the tree time estimates i.e., Optimistic, Most likely and Pessimistic times are 4, 6 and 14 daysrespectively.

i.e. $T_O = 4$, $T_M = 6$, and $T_P = 14$.

$T_E = \frac{4 + 4*6 + 14}{6} = \frac{4+24+14}{6} = \frac{42}{6} = 7 \text{days}$

Three time estimates, optimistic, pessimistic and most likely, could the decided on past experiences in execution of similar activities or from the feedback from individuals with relevance experience. The three time estimates and computed estimated time for the project activities are given in Table 3.

Table 3. Activity time estimates

Sr.No	Activity	Symbol	Preceding activity	Time (Days)			
				Optimistic Time T_O	Most likely time T_M	Pessimistic time T_P	Estimated time T_E
1.	Site selection	A	----	4	6	14	7
2.	Digging well	B	A	2	3	4	3
3.	Laying field channels	C	B	7	16	19	15
4.	Procurement of Pump	D	A	4	7	10	7
5.	Installation of pump	E	D, B	3	4	11	3
6.	Test run	F	C, E	1	2	3	2

Network Diagram

Having decided on activities, their relationship and duration (estimated time of the activity), next step is to draw the network diagram of the project. PERT network is a schematic model that depicts the sequential relationship among the activities that must be completed to accomplish the project.

Step 4: Assemble the activities in the form of a flow chart:

In a flow chart the activity and its duration is shown in a box. The boxes are connected with lines according to the preceding and succeeding activity relationship. The flow charts do not give details like start and completion time of each activity until unless it is super imposed on a calendar. It also does not facilitate computation of various slacks. However, the critical path for the project can be identified by comparing the various path lengths (sum of activity time, from start to finish, on any path). The longest path in the chart is the critical path. The flow diagram for the project considered for illustration is as in Figure 5 .

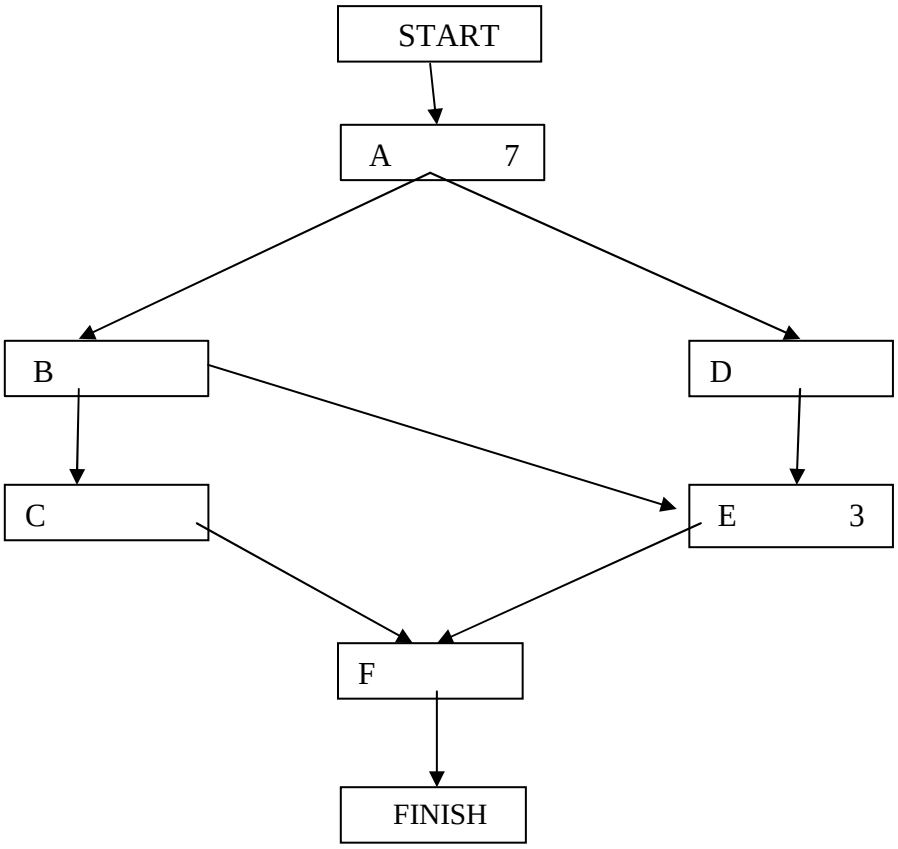


Figure 5. The flow

diagram PathI A-B-E-F 7+3+3+2 = 15

PathIIA-B-C-F 7+3+15+2 = 27

PathIIIA-D-E-F 7+7+3+2 = 19

PathIIi.e.,A-B-C-Fbeingthelongestpath(27days)istheCriticalpath.

Step 5: Draw thenetwork

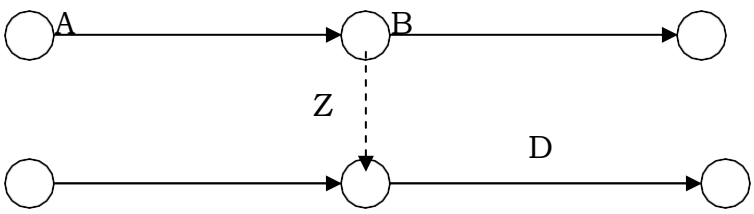
This graphical representation of the project shows the precedence relationship among the activities. An arrow generally represents activities in the diagram while a circle represents event. Each activity starts with an event and end in an event. Activities in a project are performed either sequentially i.e. one after another or they are undertaken concurrently i.e. simultaneously. To draw the network it requires the knowledge of specifying which activities must be completed before other activities can be started, which activities can be performed in parallel, and which activities immediately succeed other activities.

Dummy Activity:

For example in a project Crop 2 is to be raised in same plot of land after harvesting of Crop 1. The activities and there inter relation could be as under

Sl No	Activity	Code	Preceding activity
1	Harvesting of Crop-1	A	-
2	Sale of Crop – 1	B	A
3	Raising nursery of Crop-2	C	-
4	Transplanting Crop-2	D	A, C

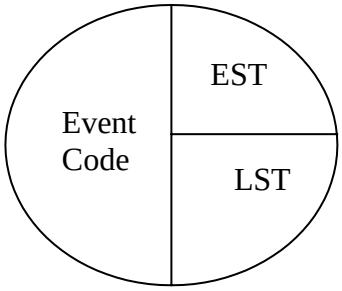
The network diagram of the above project would be as follows



The activity "Z", represented by dashed arrow in the diagram, is a dummy activity. This does not consume any resource i.e. have zero time and zero cost. This only represents the logical relation among the activities.

Rules for Drawing the Network:

1. Each activity is represented by one and only one arrow in thenetwork
2. All the arrows must run from left toright.
3. Dotted line arrows represent dummyactivities.
4. A circle represents anevent.
5. Every activity starts and ends with anevent.
6. No two activities can be identified by the same head and tailevent.
7. Do not use dummy activity unless required to reflect thelogic.
8. Avoid Looping and crossing of activity arrows byrepositioning.
9. Every Activity, except the first and the last, must have at least one preceding and one succeedingactivity.
10. Danglers, isolated activities must beavoided.
11. For coding use alphabets for all activities including the dummy activity and numbers for events.
12. Standard representation of the event:



The network diagram for the project detailed in Table 4 is as follows (Figure 6)..

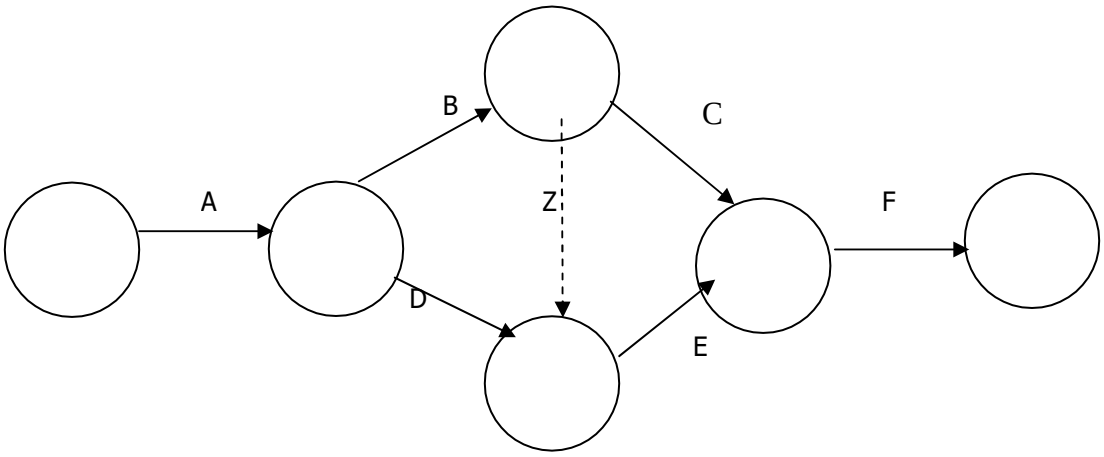


Figure 6. Activity inter-relationship

Project Control

Steps in Project Control

Fixing up the Review Period

Obtaining Progress Information

Comparing Actual Progress with the Schedule Taking Appropriate Corrective Correction

Reporting to Higher Management Updating

Conventions for Updating Frequency of Updating

Redrawing Network

So far the discussions were on the use of PERT/CPM in planning andschedulingaproject. This unit considers the third aspect, viz. the use of this method duringprojectexecution.No management technique, however elegant and sophisticated, can takeawaytheresponsibility of management to exercise control through making decisions.Managementtechniques will, however, by providing the relevant information, enable managementtotakebetter-informeddecisionsandtherebyexerciseafinerdegreeofcontrolthanwouldbepossibleotherwise.

A project being a dynamic entity must respond to changing conditions if it is to be completed successfully. Further projects are always executed in an environment of endless change, and there is therefore the need for continuous reassessment and reappraisal of the project. The original plan and schedule cannot therefore be executed to the last detail because of a host of influencing factors, of which the following are afew.

- Changes in the date for completion
- Changes in activitydurations
- Changes in resourceavailability
- Changes in activityrelationship
- Failure of suppliers to deliver ontime
- Unexpected environmental conditions (strikes, weather,etc.)

It is, therefore, necessary to have some procedure whereby the progress of work is checked at regular intervals against the plan, discrepancies highlighted and thenecessary

corrective active action taken to ensure that objectives are achieved. This is the function of project control.

Measurement of the actual achievement and comparison with the original plan is therefore an essential feature of an effective control system. The sequence of instruction,execution, measurement, feedback and. correction is fundamental to control theory.

The management of the project is therefore a continuous process involving both planning and control. While the planning can be done at leisure, the control phase is carried out under continuous pressure.

The continuous recycling of information helps comparing with the original. Plan and in cases of deviation (in majority of the cases deviations do, occur as it is very rare that plan targets are fulfilled exactly) it becomes necessary to reschedule the plan. This involves considerable work even in smaller projects. In the case of large projects involving several activities, a computer becomes an invaluable tool.

Project control in action: The steps involved in project control are:

1. Fixing up the reviewperiod
2. Obtaining progressinformation
3. Comparing actual progress with theschedule
4. Taking appropriate corrective action whenrequired.

Fixing up the review period **:** How often the project is to be reviewed depends upon a large number of factors and there can be no standard rule or practice about this. The frequency of reviewing however will depend upon the type of project, its overall duration and the degree of uncertainty involved.

For the average project, a fortnightly review should be sufficient in the normal course but in the case of rapidly changing projects, higher frequency of reviewing is necessary to have close control. Projects of the same overall duration using 3

time estimates (PERT system) for activities require greater frequency of reviewing than those using single time estimates (CPM system) for activities. The interval between reviews may change depending on the management needs.

Obtaining progress information:For obtaining progress, a form shown below is normally used. The basic information required refers to activities just started, activities completed, and progress on current activities. While the information regarding first two can be given precisely, the last may best be quantified by estimating the comp1etiondate.