Chapter – X

PROJECT MANAGEMENT FOR KVKs

'The right technology, at the right place, at the right time, at the right cost and the right methods'

10.1 Management – An Introduction

Management is needed where ever people work together and try to reach a common goal. Management is an art and it can be defined as working with people to determine, interpret and achieve organizational objectives by performing the functions of planning, organizing, staffing, leading and controlling. Researchers work together in an organization because they can accomplish more by cooperating with one another than they can accomplish working alone. An organization is a group of people working together to achieve a common mission, or goal. Management is needed whenever and wherever people work together in an organization. The managerial functions must be performed by anyone who manages any type of organized activity. An understanding of the management activities and techniques will help the KVK scientists to manage their mandated activities effectively and efficiently.

10.2 Levels and Types of KVK Management

Essentially KVK management is more concerned with setting objectives, planning of the mandated activities, organizing the resources, staffing and controlling of the KVK activities in a coordinated manner so that the mandated objectives of the KVK can be achieved. The management skills required at the different levels of management differs very much. In general, people in the lower level of management are expected to possess more technical skill for performing the job and little about human relationship and conceptual skills. The middle level functionaries on the other hand occupy a sandwich position between the top level and bottom level managers. They are expected to possess all such skills like human relationship, technical and conceptual for their smooth functioning. On the other hand the top level functionaries are least worried to technical skills while it is important for them to have a higher conceptual skill. It is also important for them to have a higher conceptual skill. It is also important to note that no management position is exclusively technical or administrative. All levels have elements of both.

In any research organization, the number of people at each level decreases as employees move from non managerial level up through the managerial levels. Technical personnel represent the bulk of the organization membership, and there is a great variation regarding their status and pay. This level includes low skill level positions i.e. the level of a lab technician or laboratory assistant to high skill level positions i.e. a level of a principal scientist or a consultant technologist in the field. Within the managerial ranks, the number of managers at each level decreases as individuals move up from operative to the administrative level. Finally, at the apex of the organization there is normally only one, the chief executive officer, whatever his or her title may be. [Eg. DG, ICAR]

10.3 Management Skills to be Developed

What managerial skills are generally needed to become an effective research manager? They can be summarized as follows:

1. Conceptual skills,
2. Human relations skills,
3. Administrative skills and
4. Technical skills.

The relative importance of any one of these skills to a research manager at a given time depends on the type of research organization, the managerial level, and functions being performed.

10.3.1 Conceptual Skills

It refers to the mental ability to acquire, analyse and interpret information received from various sources. It involves the ability to understand the whole by breaking into parts. It helps the managers to imagine what goes on in their work environment and help them to react appropriately. This is the ability to plan ahead rather than to react. KVK Programme Coordinators need more of these skills.

10.3.2 Human Relations Skills

A network of contacts and human relationships to achieve the organizational goals by using the efforts of other people is needed and considered as important in any organization. Therefore, it is essential for the managers to possess many different behavioural and analytical skills which consist of many abilities required to understand other people and to interact effectively with them. Interpersonal skills are needed to create and maintain a network of contacts with people outside ones' own chain of command. SMS working with farmers need more of these skills.

10.3.3 Administrative Skills

The term refers to the whole range of skills associated with planning, organizing, staffing and controlling. These skills include administrators' abilities to follow policies and procedures, process paperwork in an orderly manner, and manage expenditure within the limits set by the budget. These skills are needed for Programme Coordinators and Host Institute Heads for better management of KVKs.

10.3.4 Technical Skills

Technical skills include the ability to use the knowledge, tools and techniques of a specific discipline, or field. These skills are relatively more important for the first line of managers than for top managers. First line managers are closer to the actual work being performed, often must guide their team how to perform it and must know how it is done properly. Hence, particularly important for SMS.

10.4 Research Project Management Techniques

Research project management can be classified in different ways. Clay gives a broad classification of this technique based on their objectives. He has classified the project management techniques under eight classed according to the purpose for which they are used to achieve. A brief description of the classification is given below:

1. To discover

To find out or to detect or to know something that is going on. The techniques classified under this are input-output analysis, attitude survey, break even analysis, production study etc.

2. Evaluation

For estimating the value or worth of a practice. For example; Job evaluation, Performance appraisal, Cost Benefit analysis and Work measurement fall under this category.

3. Improvement

Performance improvement and attainment of perfection. The techniques such as Management by Objective (MBO), Method Study etc., can be used for this purpose.

4. Specification

For deciding or specifying an expected value or situation or course of action. For example; planning, designing etc.

5. Optimization

Performance optimization can be achieved through the techniques such as linear programming and operations research.

6. Control

Through techniques such as budget control and cost control, we can control the resource utilization in the research programmes.

7. Communication

Report writing, Management Information System (MIS) are useful for the communication flow or information utilization in the research.

8. Demonstration

For learning or to demonstrate something e.g. job instruction, training, programmed learning etc. The management techniques are used to bring about increased

capabilities, efficiency, effectiveness and productivity in an organization. These techniques are employed to manage various resources in an organization such as human, material, time and finance.

The list of few management techniques concerned with the above aspects is given below:

1. Management By Objectives (MBO)
2. Management Information System (MIS)
3. Time and Motion Study
4. Input Out Analysis
5. Break Even Point Analysis (BEP)
6. Production Study
7. Method Study
8. Linear Programming (LP)
9. Critical Path Method (CPM)
10. Programme Evaluation Review Technique (PERT)
11. Activity Bar Charts (ABC)
12. Schedule Bar Charts (SBC)
13. Activity Slack Bar Charts (ASBC)
14. Prudence Diagram (PD)
15. Manpower Utilization (MU)
16. Line of Balance (LOB)
17. Implementation, Planning and Control Technique (IMPACT)
18. Contractual Requirement, Recording, Analysis and Management (CRAM)
19. Least Cost Estimating Schedule (LCES)
20. Computer Operated Management Evaluation Technique (COMET)
21. Activity Balance Line Evaluation (ABLE)
22. Cost Planning and Appraisal (CPA)
23. Integrated Control (IC)

24. Management Planning and Control Technique (MPC)
25. Programme Evaluation Procedure (PEP)
26. Project Audit Report (PAR)
27. Planning Network (PLANNET)
28. Programme Reliability Information System for Management (PRISM)
29. Resources Allocation and Multipurpose Scheduling (RAMPS)
30. Scheduling and Control by Automated Network System (SCANS)
31. Computer Performance Evaluation and Review Technique (COPERT)
32. Computer Programme for Scheduling, Time and Distribution (CPSTD)
33. Trade Off Evaluation System (TOES)
34. Task Reporting and Current Evaluation (TRACE)
35. Weapon Systems Programming and Control System (SPACS)
36. Venture Evaluation Review Technique (VERT)
37. The Operational PERT System (TOPS)
38. Gantt Bar Charts (GBC)
39. Milestone Bar Charts (MBC)
40. Performance Budgeting (BP)

The project management techniques are the recognized methods for analyzing or solving a recognized type of management problem in a detailed systematic way. They are rational, methodological in approach and have direct applicability to the solution. Some depend on mathematical and some on scientific approach. Therefore, the management techniques are considered as scientific way of solving problems. Some of the management techniques that are of frequent use to the research project management are discussed briefly here.

10.5 Performance Budgeting

Budget is a statement of receipt and expenditure which gives an idea to ensure the accountability. Budget consists appropriation of such items like pay, allowances, and contingencies that are evolved in running an organization. Performance budgeting (PB) is a technique of performing present operation in terms of programmes, projects and activities. The activities are identified in the budget in terms of financial and physical terms so that proper relationships between input and output could be established. The performance budgeting is considered as the financial estimates to run the selected programmes effectively, efficiently and economically. Thus, it is the performance of resources in relation to cost.

10.5.1 Purpose of Budgeting

1. To aid in financial operation,
2. To clarify the operations of a programme,
3. To promote coordination among different activities,
4. To help in future planning and
5. To measure efficiency.

10.5.2 Advantages

1. It facilitates the rational budgeting based on logic and avoid arbitrary spending.
2. It ensures proper utilization of money and provides coordination between various agencies.
3. It facilitates proper evaluation of the existing programme and thus helps in careful considerations of non policy alternatives and framing of new area.
4. It defines efficiency in terms of the most logical way of allocation of organizational resources.
5. It provides the discipline of constant and interim analysis of programme results in terms of outputs, giving regular feed back on the performance of each programme.

10.6 Training

10.6.1 Definition of Training

The process by which organization helps its employees to acquire knowledge, skills and attitudes required for performing their job effectively are known as training. Training is different from education in the sense that education is for knowing more but training is for doing more.

10.6.2 Objectives of Training

The training programmes are mainly aimed at achieving the following objectives in the development of an individual.

10.6.2.1For new employees

- To develop him to accept more responsibility,
- To develop the ability for cooperation and coordination at all levels,
- To develop ability in the effective utilization of equipment and resources and in their proper upkeep and maintenance and

- To show what the new job comprises of to enable one to adopt his/her knowledge and skills for the specific situation.

10.6.2.2 For deficient employees

- To develop the skill of dealing with people in solving problems and handling grievances to improve the morale and team spirit of the employee,
- To increase the skills, technical ability of those whose performance is lower than the desired standards and
- To make them conscious of the need for higher productivity.

10.6.2.3 For employees going for different jobs

- To develop his overall ability to reduce costs, improve quality and increase production,
- To train people for future jobs who are going for different jobs,
- To train to use modern techniques for the full and optimum utilization of men and materials and
- To develop his/her skill to train others.

10.6.3 Contents of training

1. Factual information,
2. Approaches and techniques for problem solving and decision making,
3. Attitudes,
4. Interpersonal skills and
5. Knowledge of self.

10.6.4 Requirement of a Training Programme

1. Should provide successive glimpses of the job in such dimensions that the skills required for each can be grasped and practiced as and when required.
2. Should provide time and resources.
3. Should make the participants feel safe if he lacks any knowledge.
4. Should make the learning process itself conscious for the participants.
5. Should expose participants to new ideas and method.
6. Should give the trainees the experience of belongingness.
7. Should provide opportunities to step back from day to day tasks to think about one's job as a whole.

10.6.5 Training Process

Training process includes:

1. What does the trainee undergo?
2. What inputs does the user organization provide? and
3. What inputs the training organization is providing?

In general an operative training calls for specific increase in skill and knowledge of individuals according to the organizational goals and objectives.

10.7 Cost- Benefit Analysis (CBA)

Cost Benefit Analysis (CBA) is a technique that helps in making better decisions relating to investment. CBA is a practical way of appraising the project involving public expenditure in terms of net social gain to the society. CBA is carried out based on the cost and its benefits derived from the project. It is a project appraisal technique which test economic feasibility, financial profitability and resource productivity of a project.

According to Dorfman, CBA is closely analogous to the methods of investment project appraisal used by businessmen. The only difference is that estimates of social value are used in place of sales value. In the present century CBA has come in prominence in scientific project evaluations. The basic argument that underline a cost benefit appraisal of a scientific project is that a project can normally be an asset if the total benefits from the project are greater in some sense than total cost. CBA is applied as a method of project appraisal to determine the project feasibilities or to find out the usefulness of a project or programme which is to be implemented.

10.8 Social problems of calculating social cost benefits

10.8.1 Social Price

The prices of various inputs and outputs in terms of their social values are called social prices. The value of inputs and outputs is not calculated in terms of actual market price but in terms of shadow or accounting price. For many benefits which do not have market prices, valuation is often attempted by indirect means. Example, Heavy loss is incurred on a medicine project but it gets a benefit to the society. TB is a wide spread contagious disease in cattle. The estimated loss from morality, morbidity and the total cost is Rs. 220.4 crores per annum. The value of production loss is very large as compared to control programme. The annual direct cost for a cattle population of about 6 million works out to Rs. 0.49 per cattle per annum. Hence the eradication is not only a control activity but an ultimate gain is also aimed at.

10.8.2 Social Rate of Discount (SRD)

It is the marginal rate of substitution between consumption at consecutive points of time and is used to link the costs and benefits occurring in different time periods. The rate of discount in cost benefit analysis is social rate of discount particularly in the developing country. It may be mentioned

that since social rate of discount is less than private rate of discount, a project that private sector R&D may consider unprofitable proposition, is considered profitable by a public sector. Application of cost and benefit analysis in the public sector R&D is limited. It is very difficult to quantify the innumerable variables impinging upon the project. Though the problems of measuring benefits is a serious limitation we cannot leave it as we cannot avoid the cost benefit analysis approach while selecting and administering projects which can raise the standard of people and helps the millions of people suffering from poverty, disease and hunger. Inspite of the inherent limitations we must make use of this technique to ensure effective policy making and planning in research for welfare of masses. The advantage is not in ensuring decision making simpler but in the possibilities for the systematic examination of each part of a problem in hand.

10.8.3 Cost

Cost is of two types:

(a) Fixed cost: are over head costs that must be born by the enterprise regardless of the volume of output. They are long run costs like, building, fences, land use, farm and cattle yard, machinery, herd replacement, general farm expenses and interest charges on fixed capital.

(b) Variable cost: are those charges that have direct function of output and include items which vary with the production. They are short term cost and hence attended by the management. Items of variable cost includes cattle feed, fodder, labour and supervision, seeds and fertilizers, veterinary medicines and detergent, miscellaneous expenses, interest charges on working capital.

10.8.4 Benefit calculation

The benefit of a project is derived from the produce when sold in the market. Benefits derived are of two types.

1. Direct benefit

   By selling product/ product called income.

   For example: sale of milk in dairy project.

2. Indirect Benefit

   Use of produce or product for own purposes otherwise would have been required to be purchased i.e. Biogas plant serves as indirect income in a way that compost is used for field and gas for cooking.

10.8.5 Cost Benefit analysis in scientific projects

Analysis is carried out to judge the profitability and feasibility of a project. On the basis of this a project can be rejected or recommended. The indicators/ parameters and set of tools which are used/ applied for knowing worth of scientific projects are as under:

i) **Net Income (NI)**

Net Income can be worked out as:

Net Income = Gross Receipt – Total cost

ii) **Internal Rate of Return (IRR)**

The IRR is defined in terms of expected profit as a percentage of the investment made. This is rate of return on a project and normally expressed by percentage earned on the amount of capital investment in each year of life of the project.

Year	Capital Investment	Interest @ 10%	Total
1st	100	10	110
2nd	220	11	221
3rd	121	12.10	133.10
4th	133.10	13.10	146.20
5th	246.20	14.60	160.80

After 5 years of a project, the present value of Rs. 160.80 is of Rs. 100/- invested in the initial year. The rate of interest is reverse and this should be minimum of 15%. However greater IRR value, the project is sound and acceptable.

iii) Present Value of Investment of the Project

In this technique, the Present Value of Investment (PVI) is calculated as:

$$PVI = \frac{R1}{1+r} + \frac{R2}{(1+r)^n} \text{ ---- } \frac{Rn}{(1+r)^n} + Sn$$

Where,

PVI = Present value of Investment

R = Return

R = Value of internal rate of return

(Cost of money available in the market)

n = Life of project

S = Scrap value of project (end of project)

iv) Average Annual Margin of Profit (AAMP)

It is the average profit likely to be generated by the project every year throughout the life span of the project. It is calculated as under:

$$AAMP = \frac{NPV}{1/(1+r)^n}$$

Where,

$$NPV = \frac{M1}{(1+r)} + \frac{M2}{(1+r)^2} + \frac{M3}{(1+r)^3} + \frac{M4}{(1+r)^4} + \frac{M5}{(1+r)^4}$$

Where,

n = indicates the life span of project

M = the margin between the benefit and cost

NPV = Non Projective Value

v) Profitability Index (PI)

It expresses the percentage of increase in the capital sum over the present value of the budget.

$$PI = \frac{NPV}{\text{Original amount investment}}$$

This simply indicates the rate at which the benefit exceeds the cost. This tells us how much benefits can be generated per rupee of investment.

vi) Pay Back Period (PBP)

It is the period just enough for recovering the initial capital cost of any project. It means the cutting point when the benefit equalizes the capital cost of a project. Shorter the Pay Back Period better the investment position and vice versa. It involves calculation of the cash flows which would arise from the investment in each year in the life of the project. The cash flows are accumulated year by year till the time they equal the amount of the original investment made in the project. The length of time it takes to obtain the necessary cash flows equals to the original investment and determines the Pay Back Period (PBP) for the project. It is not a good criterion for project evaluation as it concentrates its attention on the profitability of the project in the beginning and it ignores the returns obtained in the later life of the project.

10.9 Management by Objectives (MBO)

MBO is a process by which superiors and subordinates in a scientific organization jointly identify its common goals, define the areas of responsibilities and plan the ways to achieve the results expected out of them.

MBO is an approach to project management. It is a blending of individual plans and needs towards a large scale accomplishment within a specific period of time.

MBO is designed to determine:

i) What must be done?

ii) How it must be done?

iii) When it must be done?

iv) How much it will cost?

v) What constituents determine satisfactory performance?

vi) How much progress is being achieved?

vii) When and how to take correct action?

10.9.1 Definition

There are various definitions of MBO. One of the comprehensive definition of MBO states "MBO is a result centered, non – specialist, participative and operational managerial process for the effective utilization of all the resources contributing to the integration of the individual with the organization and of the organization with the environment". The aspects comprising this comprehensive definition of MBO are:

i. Result centered

Any act in this world should focus on the result it is going to produce. An organization must have a clear cut result or objective.

ii. Non-specialists

MBO believes in generalist rather than specialists. Specialists fail to visualize the problem in its wider horizons. On the contrary, generalists can better manage the affairs of an organization.

iii. Participative

The philosophy of MBO is that participatory management yields the desired results. With the participation, employee gets a sense of belongingness with the organization and tries hard to achieve organisations' objectives. For an effective execution of operations sense of involvement is essential.

iv. Operational

In an organization three kinds of processes can be visualized:

a) Lower Management – Doer – doing task

b) Middle Management – Supervisor – supervises the men and material

c) Top Management – Manager – managing the whole show.

v. Effective Utilization

MBO is greatly concerned with effective and efficient utilization of resources especially human resources. MBO believes in 'Theory Y' that human beings have the willingness to do work and ability to do things. Depending upon the congenial environment, or work atmosphere, efficiency and effectiveness are achieved.

vi. Goal Congruence

One of the most important aspects of MBO is that individual goals and organizational goals must coincide and both in turn must agree with the environment in which they are existing.

10.9.2 MBO is a five phase process as under

i) Finding Objectives

It is the systematic identification of potential areas where improvement is needed such as improvement in researchers, new facilities, lowering the expenses, work simplification, method improvement possibilities, coordinated research projects, productivity improvement and employees' satisfaction and motivation.

ii) Setting the objectives

This is a formal written statement of objectives supported by the top management. We relate the resources of the organization to the involvement of those expected to deliver the results.

iii) Validation of objectives

This is validation statement of commitments. Commitment is on the part of individual department and on the organization as a whole. Here, the promises, assurances are given to provide resources, materials, methods, people and the management. Some of the objectives can be discarded or eliminated.

iv) Implementing the objectives

At this stage activities are operated upon towards achieving the objectives. Activities pertaining to their objectives are planned and allotted to different components of objectives.

v) Controlling and Reporting

This is the stage of reporting according to the schedule and establishing the target. The activities are measured and reported to different status as well as the progress made in concluding the project. Management team gives its position in relation to their stand where they are going.

10.9.3 Steps of MBO

Following are the steps of MBO

i. Define Roles and Missions

a) Identify organization's roles and missions.

b) Prepare role and mission statement.

c) Get approved by the superior and understanding by others directly concerned.

ii. Forecasting

a) Determining what type of effects is to be forecasted.

b) Determining the critical factors related to research outcome in terms of practical point of view.

c) Determining the primary factors, i.e., human skills, tools and equipments, work space and material requirements.

d) Determining and evaluating all other important factors that might directly and indirectly influence the efforts during the forecast period.

iii. Setting Objectives

a) On the basis of role and mission, identify the type of specific improvement you wish to place in objective form.

b) Determine means of measurement i.e units, percentage, cost and milestones etc.

c) Determine realistic and achievable target for each objective. Establish priorities for identified objectives.

d) Review your objectives against key questions for evaluating them.

Criteria for Good Objectives

a. Should be verifiable.

b. Should state time of their achievement.

c. Should indicate quality.

d. Should state cost of achieving them.

e. Should present challenge.

f. Should indicate priorities.

g. Should promote personnel and professional growth and development.

iv. Programming

Each objective requires further break down as given below:

a) Study situation and select suitable method;

b) Gain agreement and support from the co-workers in the field;

c) Develop plan;

d) Test and review the plan;

e) Implement and

f) Follow up.

v. Scheduling

a) Establish a calendar time block during which each critical programme is to be completed.

b) Confirm or modify target dates, if needed.

vi. Budgeting

a) Estimate the cost, human efforts, materials, facilities needed by each project staff.

b) Confirm or modify the target cost if needed.

c) Determine the availability of necessary resources.

vii. Establishing standards

a) Determining what is to be measured.

b) Determining the point of measurement.

viii. Measuring performance

a) Select the method of measurement.

b) Review the selected method against key question for evaluating control measures.

ix. Taking corrective actions

a) Determine when performance variance requires corrective action.

b) Determine probable causes and their variances.

c) Determine appropriate type of corrective action and it should be applied accordingly.

10.9.4 Advantages of MBO

1. MBO is a process or progress or performance oriented but not procedure oriented. Improvement in the job for managing the things is possible.
2. It is a systematic approach to the research project management.
3. It lets the project manager/KVK P.C to know what is expected of them.
4. It aids in planning and budgeting.
5. It improves communication between P.C and SMS.
6. It makes people more aware of organization's goal.
7. It induces achievement motivation.
8. Evaluation procedure is more suitable.
9. It is development oriented.
10. Its emphasis is on situation management.
11. It is better suited to modern research project management.
12. Improves organizational performance.
13. It has accurate performance appraisal.
14. Goal attainment of the organization is high.
15. It breeds a culture of constant innovation.
16. It leads to better goal congruence.
17. Coordinates team work with organizational clarity. It breeds team spirit.
18. It tries to improve the effectiveness and efficiency of the entire system itself.
19. Leads to better managing. MBO forces the project managers to think of planning for results rather than merely planning activities of work. It also requires the project managers to think of the way to accomplish the given results.

20. Clarifies organization. MBO tends to force clarification of organisational roles and structures.

21. Elicits commitment.

22. Helps to develop effective controls.

10.9.5 Disadvantages/ Weaknesses of MBO

1. Failure to teach philosophy.

2. Failure to give goal setters guidelines.

3. Goals are difficult to set.

4. Goals tend to be short run.

5. It may create tension, insecurity and all other discomforts among people since it is progress oriented.

6. It may crate rat race among SMS/scientists for achieving progress, where each rat wants to become a cat in the progress.

7. It may spoil interpersonal relation.

8. It may require more paper work and time.

9. Subjectivity still may creep in.

10. All accomplishments may not be quantifiable.

11. After some time it may become a routine approach.

12. Setting arbitrary goals may lead to failures.

13. There is over insistence on number.

14. Makes use of inapplicable standards.

10.10 Work study/ Work measurement

It is productivity technique which helps to think beyond what you are doing. It would help in establishing wastages in labour, efforts, drudgery and fatigue. It would assist in:

a. Work simplification;

b. Job evaluation;

c. Man power planning;

d. Production planning and control;

e. Setting time standards and

f. Designing incentive schemes.

Work measurement assists to carry out the job under defined standard.

10.10.1 Purpose of work study/ work measurement

1. Calculation of initial time an individual requires handling the job. Different job requires different time. Time may be standard time, optimum time, minimum time etc.
2. There is effective planning and scheduling of operations.
3. It forms as a scientific tool for controlling the workers.
4. Workers' cost control and
5. Rational basis of incentives scheme; Work appreciation incentives can be determined.

10.10.2 Procedure of work study/ work measurement

1. Analysis

Analysis occurs when the work is broken down into elements, e.g. harvesting, cutting, serving and feeding etc.

2. Measurement

Ascertain the basic task.

3. Synthesis

This is the stage when available methods gathered and put into suitable forms according to the purpose for which they are planned.

4. The cost of work measurement

There are two components of cost of work measurement.

(i) The cost of installing the work, and

(ii) The cost of maintaining the work.

Mostly the cost of installation is higher than the maintenance.

10.11 Time Study

Time study is a technique of recording the time and rate of working for the element of specific operations carried out under specific conditions for analyzing the data so as to obtain the time necessary for carrying out the job and define the level of performance. The sole objective is to determine the allowed time, normal time and standard time.

10.12 Management Information System (MIS)

Management Information System can be easily understood by explaining the three terms:

1. Management,
2. Information and
3. System.

10.12.1 Management

Which means planning, organizing and controlling.

10.12.2 Information

Information consists of classified and interpreted data that are being used for decision making. Information is important to the life of the research system as the flow of blood to the life and health of an individual.

10.12.3 System

A system is a set of two or more elements such as peoples' things and concepts which are joined together to attain common objectives. A system is a complex whole which consists of structurally and functionally interacting subsystems.

MIS can be defined as an organized structural complex of (i) individuals (ii) materials and (iii) procedures, for providing pertinent information from both external and internal resources. The planning, controlling and operational functions of an organization by providing uniform information for use are the basis for decision making. MIS facilitates administrative action. This is meant to focus on these explicit record keeping activities that most administration see as directly related to decision making or project management. In other words MIS is an approach of furnishing adequate and accurate information in time to right person in the hierarchy to assist him/her in decision making, pertaining to the organizational goals. It also provides him/ her information regarding important constraint which could be analyzed and put before the policy maker for introducing timely change and initiating corrective measures.

Management Information System is thus more or less a conceptual system so designed to provide information for management. It is based on the premise that measurement needs information in order to be effective. MIS is something like a machine which takes in some inputs from the environment, processes it and gives out a product in the form of a desired result.

The feedback constitutes the monitoring process which is used to maintain the systems output within the desired limits of control. Information flow is very vital for the successful function of a system, but very difficult to visualize because of its intangibility. The need for a MIS becomes necessary which imparts structure and procedures for the flow of information such that any turbulence becomes discernible before it is too late.

10.12.4 How MIS functions?

MIS provides the necessary information for management. Each aspect of management namely, planning, organizing, controlling and initiating requires decision making and hence MIS in other words produces the necessary information for decision making. In any situation that requires decision making, a good manager has to think of all the alternative actions that he can take in the situation.

10.12.5 MIS Design

In designing a MIS, therefore, one has to identify various levels of hierarchy, determine the decision making process at each stage, the kind of information that it requires and the network that can satisfy this requirement. Good MIS requires a very careful study of the above type and very creative but pragmatic attitude by the designer. One must note that a very common misunderstanding exists about MIS is that it is a computerization of office records. In designing a MIS considerable data has to be processed in order to provide information, and it may become extremely difficult to do it manually. That is why computers have become a tool which is used extensively by MIS. MIS has nothing to do with computers. So MIS is a concept by itself which has to be conceived of with or without the presence of a computer which happens to be most sophisticated tool for the purpose. Thus MIS is neither mechanization nor it is gathering of “statistics”. It is a profound concept which has been found to be very powerful for the successful functioning of any system. MIS and formal system together, integrate, compare, analyze and disperse information internal and external to the enterprise in a timely, effective and efficient manner. MIS has to be tailored to specific needs and may include routine information such as monthly reports, information that points our ‘expectations’ especially at critical points and information necessary to ‘predict’ the future.

10.13 Record Management

Record management is a programme that involves the functions of creating, administering, retaining, submitting and destroying of records. Records are the memory of the internal and external transactions of an organisation. The proper maintenance of records in right quality and quantity is the essence of record management. The source of this record keeping would be reflected in the timely availability of all the records. Some of the important points that are to be kept in mind are comprehensiveness, proper planning, economy, accuracy, and timeliness. The records should:

1. Serve specific costs.
2. Have specific objectives and purposes.
3. Be kept to a minimum with respect to number, scope and content.
4. Be designed for less expensive handling.
5. Be upto date.
6. Be worth their cost.
7. Be related directly to tabulations and reports that will stem from them.

8. Be available when needed and

9. Be considered valuable by supervisions and top management.

10.13.1 Types of Records

The types of records differ from organization to organization. General classifications of records that are available in a research organization are:

1. Personnel;

2. Accounts;

3. Purchases and receipts;

4. Stock;

5. Activities and

6. Beneficiaries/ clients/ consultancies, etc.

10.13.2 Aspects of Records Retention Management

The steps involved in preservation or arranging of records are given below:

1. Classification

   The records must be classified and numbered according to their contents, nature and period of maintenance. However, it would be useful to classify them into the following four types of classification such as vital records (preserved for long time), important records (not in current use but are of high value), useful records (in current use), and transit records (short period).

2. Retention Period

   The decision regarding the retention period should be taken on the basis of their usefulness, requirements and objectives.

3. Transfer of Records

   Dating of unimportant records for destruction and moving the records from active to inactive files and to stores are to be done. Microfilming of records can be kept to minimize storage space and easy handling.

4. Storage of Records

   Storage should be done at a proper place where proper conditions of temperature, circulation of air and humidity are provided. Dust and dirt accumulation should be avoided by proper sealing and shelving. The protective measures should be adopted for the preservation of valuable records for the use of future generation. The activity and accuracy ratio of a record storage system is calculated by the following means.

1. Activity ratio = $\frac{\text{Number of reference found}}{\text{Number of documents filed}}$

2. Accuracy ratio= $\frac{\text{Number of references not found}}{\text{Number of reference found}}$

If the activity ratio is below ten percent, it represents that there is too much inactive material. More than 20 percent activity ratio shows that the records are in bad shape. If the accuracy ratio is half or one percent, it is considered as excellent and more than one percent is not desirable.

10.14 Filing of records

Filing is the process of classifying, arranging and storing records in a systematic manner so that these can be easily retrieved. Filling is the systematic arrangement for keeping the records so that these may be found and delivered quickly when needed for references in future. It is the process by which the documents are placed in proper carriers according to some predetermined arrangements so that any of these when required may be located quickly and conveniently. The common filing arrangements are based on alphabetical, numerical, geographical, chronological and subject wise orders. Recently, many achievements in the filing procedures have been arrived and it is according to convenience and necessity, the design of the filing system is selected and put in use.

10.14.1 Advantages

1. Easy retrieval;
2. Records are protected from damage or loss;
3. Eliminates the need of duplication;
4. Enhances the economy of operation;
5. Serves as a reference in a future date and
6. Ensures uniformity and standardization in record maintenance.

10.15 Network Analysis - PERT and CPM

Project management involves several tasks such as decision making, planning, organizing, staffing, directing, coordinating and controlling. It is the art of getting the best out of available resources-men and materials. It demands meticulous planning and systematic execution. Planning is one of the basic functions of management. It involves selecting a course of action from various alternatives available to a project manager to achieve certain objectives. It is deciding in advance what to do, how to do, when to do and who to do it? It bridges the gap from where we are to where we want to be in a desired future. The task of planning is therefore to minimize the risk factor. Network analysis techniques are used to aid the project management in planning and to control the implementation of the same. The most important network analysis techniques are known as Programme Evaluation and Review Technique (PERT) and Critical Path Method (CPM).

PERT, a part breaking introduction to project management systems was originally developed by the U.S. Navy special project office during the course of a research project started in January, 1958. The objective of this project was to design a management control system for the development of the Polaris missile system; a programme whose activities were subject to a considerable degree of uncertainty in performance time, as well as being widely spaced geographically and also involved several thousand agencies and contractors. Since time was of the essence, the research team concentrated on planning and controlling this element of the programme. One of the principal features of PERT is the statistical treatment of the uncertainty in activity performance time. It includes an estimate of the probability of meeting specified scheduled dates at various stages in the project. PERT also emphasizes the control phase of project management by various forms of project status reports.

Using the logic of mathematics, the DuPont Company and the Univac Division of Sperry Rand jointly developed a similar technique in 1957 for scheduling problems associated with building construction. This technique was designed independent of the work of the Navy Special projects office and became known as the Critical Path Method (CPM).

The PERT technique was somewhat revolutionary in the sense that it did away with the traditional bar charts for showing schedules and substituted a network showing graphically the inter-relationship between specific accomplishments and the work that needed to be done to achieve each goal. It involves the basic concepts of statistical probability to complete the programme.

10.15.1 What is PERT?

Programme Evaluation and Review Technique (PERT) is the technique evolved for planning, scheduling and controlling the execution of a project which is usually large in size and complex in its ramifications. It is known to be of special value when the job/ project consists of a group of inter related activities which are performed by several units. It is basically a programme planning technique and can be applied to project(s) that need careful planning and scheduling of activities for smooth execution. It can be successfully applied where the project involves more persons, institutions and agencies. It is basically a “look ahead” process for the planning and execution of projects. In view of the fact that task of technology assessment, refinement, demonstration and integration by KVKs is a stupendous one and a host of departments, agencies and organisations are involved in it, PERT is a sophisticated and highly dependable tool which can be used for planning and controlling of KVK projects.

10.15.2 Similarities and differences of PERT and CPM

1. Normally PERT is used for variable activities while CPM is used for deterministic activities. Variable activities mean the activities which may have never occurred before and/ or which contain a considerable number of chance elements. Deterministic activities are those for which we have considerable experience and whose mean value is accurately known and whose variance in performance time is negligible.

2. PERT is used where the emphasis is on shortening and monitoring project execution time without too much concern for cost implication, while CPM is used where the emphasis is on optimizing resource allocation and minimizing overall cost for a given project execution time.

3. In CPM no allowance is made for uncertainty in the estimates of their durations.

4. In CPM therefore, is based on single time estimation while in PERT, control of time is vital for programme performance.

5. CPM takes account of costs whereas PERT is concerned with time.

6. PERT is event oriented while CPM is activity oriented.

10.15.3 Basic terminologies in PERT

A PERT Network diagram is known as Arrow Diagram. A network consists of arrows and circles. Arrows represent activities while circles represent events. Any project can be broken up into a number of activities. The start and end of each activity can be recognized and are known as 'Events' in PERT terminology. The following are the operational definition of terms used in any PERT.

10.15.3.1 Activity

An activity is also known as job, task, assignment, work etc. An activity consumes either time or resource or both which have definite start and finish. It is denoted by arrows. The length and direction of the arrow has no relation to activity time, except that the tail of the arrow denotes the beginning and the head denotes the completion of an activity. The head of arrow represents the direction of flow of work.

10.15.3.2 Dummy Activity

Some activities which do not consume time or resources are known as Dummy activities. This is denoted by a dotted arrow. This activity is only for indicating interdependency of activities. It is used solely to illustrate precedence relationship when the use of actual jobs would lead to the complications.

10.15.3.3 Event

The beginning and ending points of activities are called events. An event is also known as function, stage, milestone etc. Unlike an activity, an event does not consume time or resource. An event is a clearly definable movement in time, which is the beginning or end of an activity for a number of activities. Event is nothing but an instantaneous point in time. Events are of activities. Events are denoted by circles or rectangles. An activity is always bounded by two events.

i) Merge Event

If an event represents the joint completion of more than one activity is called a merge event.

ii) Burst Event

If an event represents the joint initiation of more than one activity, it is called as burst event.

iii) Successive Events

This is the event that immediately follows a particular event.

iv) Predecessor Event

That comes immediately before a particular event.

10.15.3.4 Network

When all activities and events in a project are connected logically and sequentially they form a network. It is a graphical representation of a project plan with various activities. In a network, activity is represented by an arrow and an event by a circle.

10.15.3.5 Project

A project is any task which has a definable beginning and a definable end, and requires the expenditure of one or more resources in each of the separate but interrelated and inter-dependent activities which must be completed to achieve the objectives for which the task was initiated.

10.15.3.6 Activity duration/Span(Te)

In PERT, the activities duration or time is calculated by using three time estimates such as optimistic, pessimistic and most likely time. The activity duration (Te) is calculated from the following formula.

$$Te = \frac{a + 4m + b}{6}$$

Where,

a = the optimistic performance time estimate. This is the estimate of the shortest possible time in which an activity can be completed under ideal conditions. In arriving at this estimate no provisions are made for delays or setbacks.

b = the pessimistic performance time estimate. This is the maximum possible time it could take to accomplish the job, if everything went wrong and abnormal situations prevailed.

m = the most likely performance time estimate. This is the time estimate which lies between the optimistic and pessimistic performance time estimates.

Te = mean activity performance time based on the three time estimates.

10.15.3.7 Critical Path

It is the path which takes the longest duration of time to reach the objective event. If it is required to complete the project in less time, the duration of the activities lying in the critical path will have to be shortened. Time for an activity can be reduced by employing more resources or by using improved technology.

10.15.3.8 Float/ Slacks (S)

Since the critical path is defined as the longest path in time from the starting event to the objective event, all other events and activities in the network must lie on paths which are shorter. This means that along these paths there is a slack, or time to spare. These paths are referred to as slack paths and are the areas where surplus resources of men, facilities, or time are to be found. The difference between the earliest expected and the latest allowable time is called slack or floats.

10.15.3.9 Early Start (ES)

The early start of a job in a project is the earliest possible time that the job can begin.

10.15.3.10 Early Finish (EF)

The early finish of a job is its early start time plus the time needed to complete the job.

10.15.3.11 Late Start (LS)

Late start of an activity is the latest time it can take to begin without pushing the finish date of the project further into the future.

10.15.3.12 Late Finish (LF)

The latest finish of an activity is its late start time plus its duration.

10.15.3.13 Predecessor Activity

Is the activity which precedes another activity. Without the completion of the predecessor activity the work on successor activity cannot be started.

10.15.3.14 Basic steps for application/steps for 'PERT'ing a project

Once it has been decided that a project is to be planned, scheduled and controlled with the help of PERT, certain procedures are followed for its implementation. The main steps in using the PERT system are as under:

1. Determine (Decide) the objectives and project structure.
2. List out (prepare) the list of key events, determine sequences of events and departmental responsibilities (individual job/ activities).
3. List out activities and their inter-relationship.
4. Construct net work.
5. Obtain time estimates for each activity and compute estimated time.
6. Enter the time estimated in the network.
7. Calculate ES, EF, LS and LF.

8. Calculate critical path and floats.

9. Prepare a table of ES, EF, LS and Floats for each activity.

A detail explanation of the above basic steps of PERT network is given under:

1. Determine (DECIDE) the objectives and the project structure

A project with clear and correct objectives can be better planned. Before providing for PERT application, it is desirable to state whether planning aims at minimizing the duration of project or also aims at resource scheduling and cost optimization.

2. List out (PREPARE) the key events and determine individual responsibilities

This step consists of analyzing the total work into the individual tasks or activities which must be carried out in order to complete the project. While preparing the list of activities, one is faced with the difficulty of deciding upon appropriate size of the individual activities. The level of details that should be shown depends to a large extent upon how the final network is to be used. The temptation to add more detailed information should be avoided. In considering any particular activity or group of activities with regard to expanding, condensing, or eliminating it, designer can ask himself the following questions to guide his decision:

i) Who will use the network, and what are their interests and span of control?

ii) Is it feasible to expand the activity into more detail?

iii) Are there separate skills, facilities, or areas of responsibilities involved into the activity, which demands more details?

iv) Will the accuracy of the logic or the time estimates be affected by more or less detail?

Clearly, these questions are only guidelines to the subjective decision that must be made in each case. There are no firm rules that may be followed in determining the level of detail.

3. List out activities and their inter-relationship and construction of network

Establishing activity inter-relationship consists of specifying the sequence in which the activities will be performed. The basic factor which governs the inter-relationship of activities is the logical sequence which exists between activities. A systematic questioning procedure is followed to throw light on the sequence in which a project is to be completed. The questions are:

i) What other activities must be completed before (precede) an activity can be started?

ii) What other activities can start (succeed) as soon as an activity is completed?

iii) What other activities can be performed at the same time (concurrently)?

With the help of this procedure, an activity dependency list may be prepared and used in the network planning. However, it is not necessary to analyse and prepare an activity dependency list,

as after working with one or two networks, one person can draw network straight from list of activities. After establishing activity inter-relationship, the next step is construction of network. Network, as already stated, is a pictorial representation of a project plan showing the inter-relationships of the various activities and to exhibit their inter-relationships, a precise plan of work depicted in the form of a network is prepared. While constructing networks, certain rules and conventions are usually followed. They are:

i) No activity can be shown twice in the network unless it occurs twice in the project in which case it should bear a different activity identification;

ii) Before an activity may begin, all activities preceding it must be completed;

iii) An event cannot occur until all activities leading to it are completed.

iv) No activity can begin until its immediate preceding event has occurred.

v) Arrows imply logical precedence only. Neither the length of the arrow nor its compass direction has any significance.

vi) Any two events may be directly connected by not more than one activity.

vii) Event numbers must not be duplicated in a network; and

viii) Network may have only one initial event and only one terminal event.

The last three rules hold good only when computation is to be done with computer. In case of hand calculation they are not considered essential. It is extremely difficult to draw a neat network at the very first attempt, when the number of activities becomes fairly large. Practice helps one to develop an eye for constructing networks. As an aid to identify the activities in a network, it is a common practice to allot codes to different activities or to reduce the activity details into two to three words to accommodate it in the network.

4. Event numbering

In some cases instead of allocating code to activities, the events are numbered in numerical numbers to facilitate easy identification of an event and activity in a network. In such cases event is referred by its number and activity is referred by its preceding and succeeding event numbers.

5. Obtain time estimates and computer estimated time

Once the first draft of the project network has been developed, it is desired to refine the network and add time estimates to obtain a practical, working draft ready for the scheduling and computations. In practice, the process of time estimation and network refinement are closely inter-related and are usually accomplished at that time. For example, as one begins to make time estimates, it is found that certain activities need to be redefined, in order to represent the project accurately and at the desired level of detail. Time estimates are important as they form the basis of the work schedule, and the work schedule can be no better than the basic data from which it is derived. It is therefore, important to obtain the most accurate estimates as far as possible. The estimating of time for activities is perhaps the facet of PERT system.

There are occasions when the duration of an individual activity is liable to deviate considerably from its average, because of the effects of random disturbances. So to accommodate such random disturbances in PERT, we make three time estimates as under:

a) Optimistic time

The time which would be required if everything worked out or proceeded ideally. Such estimate is unrealistic and occurs very rarely.

b) Pessimistic time

This is just opposite of the optimistic estimate, barring totally uncontrollable situation such as fire, floods etc. It tells us what would be required if everything which could logically go wrong does go wrong. This estimate is also unrealistic and occurs very rarely.

c) Most likely time

The time which, in terms of the estimate's own experience, is most likely to take under the circumstances expected to exist. The most likely time need not to be midway between the other two time estimates.

These three time estimates are reduced to one, statistically by making use of the formula:

$$\text{Activity expected time (Te)} = \frac{a + 4m + b}{6}$$

Where,

a = Optimistic time; **4m** = Most likely time and **b** = Pessimistic time.

The activity expected time is used in network analysis and for preparing schedules for the project. However, it is not always imperative to make three time estimates. In a network, single time estimation may also be used if the person responsible for carrying out a project or an individual activity feels that this one time estimate will be valid and practicable.

Guidelines for getting better time estimates

i) As far as possible, the time estimate should be obtained from the personnel who will have the ultimate responsibility for executing the work; and

ii) It is necessary to consider the possible tendency of setting high estimates for self protection.

6. Enter time estimates or scheduling the network

At this stage, in the application of PERT, the project plan has been computed and the mean performance time has been estimated for each activity. It is not appropriate to begin scheduling the activities and to determine the network, critical paths, and the duration of the project.

The basic scheduling computation is to value a forward and a backward pass through the network. Based on a specified occurrence time for the initial network event, the forward pass computations give the earliest expected start and finish time for each activity, and indirectly the earliest expected occurrence time of each event. By the specification of the latest allowable occurrence time for the terminal network event, the backward pass computations will give the latest allowable start and finish time for each activity and indirectly the latest allowable occurrence time for each event. After the forward and backward pass computations are completed, the slack (float) can be computed for each activity and the critical and sub-critical path(s) of the network is determined. The conversion of these computational results to calendar dates merely requires the modification of calendar dates wherein the working days are numbered consecutively from a prescribed calendar date for the start of the project.

Computation Nomenclature

The following nomenclature is usually used in the schedule computations:

t = Single estimate of mean activity duration time;

TE = Earliest event occurrence time;

TL = Latest allowable event occurrence time;

ES = Earliest (activity) start time;

EF = Earliest (activity) finish time;

LS = Latest allowable (activity) start time;

LF = Latest allowable (activity) finish time;

S = Total slack of activity (float) and

SF = Activity free slack (or float).

7. (i) Calculation of forward pass computation (ES & EF)

As stated above, the purpose of the forward pass is to compute the earliest start and finish time for each activity in the project on working days basis. To accomplish this, the forward pass computation arbitrarily starts with an earliest occurrence event, and they assume that each activity starts as soon as possible, when its predecessor event occurs. According to network logic, an event occurs when all of its predecessor activities are completed. Hence, the earliest event occurrence time is equal to the largest of the earliest finish times of the activities merging to the event in question. Regardless of how many activities merge to a given event, the earliest merge event time is the largest of the earliest finish times of the merging activities. These rules or assumptions are summarized below.

	Forward Pass Rules	Formulae
1.	The Earliest occurrence time of the (single) initial event of the network is taken as zero	TE = 0(For initial event)
2.	Each activity begins as soon as the predecess or event occurs	ES = TE (for predecessor event)
3.	The earliest event occurrence time is the largest of the earliest finish times of the activities merging to the event in question	EF = ES + t = TE + t where TE = largest of (EF_1., EF_2., EF_n) for an event with n merging activities

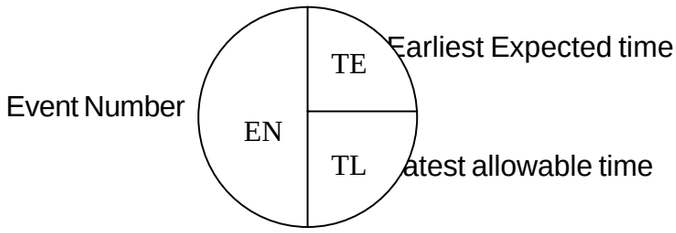
These assumptions/rules have been applied to the network.

7. (ii) Calculation of backward pass computation (LS& LF)

The purpose of the backward pass is to compute the largest allowable start and finish times for each activity, which will permit the terminal event to occur at its earliest expected time as computed in the forward pass. To accomplish this, the backward pass computation starts with the project terminal event and arbitrarily assigning to it a latest allowable occurrence time equal to its earliest occurrence time. When TL= TE, the latest allowable activity start time is computed by subtracting the activity duration time from the latest allowable finish time. According to network rules, an event must occur before any succeeding activity commences. Hence, the latest allowable occurrence time for an event is equal to the smallest of the latest allowable start times of the activities bursting from the event in question. These assumptions or rules are summarized below:

	Backward Pass Rules	Formulae
1.	The latest allowable occurrence time of the (single) terminal event of the network is set equal to the earliest occurrence time computed in the forward pass.	TL = TE (for terminal event)
2.	The latest allowable start time for an activity is its successor event (latest allowable time minus the duration of activity in question).	LF = TL (for successor event)
3.	The latest allowable time for an event is the smallest of the latest allowable start times of the activities bursting from the event in question.	TL = Smallest of (LS_1, LS_2, LS_3 … LS_n) for an event with bursting activities

In the network, the earliest expected time of occurrence of an event or an activity pending, it is denoted in upper portion of an event circle and the latest allowable occurrence time is denoted in lower portion of an event circle as shown below:



8. Calculation of critical path (s) and floats(s)

i) Determining the critical Path

It is the longest path through the network and it determines the shortest time in which the project can be completed. The critical path in a network passes through all the critical events and critical activities. If any activity on the critical path is delayed, the whole duration of completion of project is delayed. Determination of critical activities and critical path helps management to concentrate on critical activities at the time of executing the project to obviate delays. A tabular procedure for critical path computation such as earliest occurrence time, earliest finish time, latest occurrence time, latest finish time, free slack, total slack, and critical activities have been mentioned. However, it cannot be that efficient as hand computations made directly on the network. This is only one aspect of the PERT technique which aims at controlling the overall duration for completion of the project. But this technique is equally applicable for resource allocation and cost control. This relates to four factors such as time, cost, resource and performance. Being out of the domain of the KVK work, other aspects of PERT have not been dealt with in this book.

ii) Slack/ Float

Two types of slacks in a network are of most value that they are called total activity slack/ float or simply total slack and activity free slack/ float or simply free slack/float.

iii) Total Slack

Total activity slack is equal to the latest allowable time of the activity's successor event minus the earliest finish time of the activity in question; S = TL – EF. It is equal to the amount of time that the activity completion time can be delayed without affecting the earliest start of occurrence time of any activity or event on the network critical path. In general, we can say that the total slack is the time by which the actual activity completion time can exceed its earliest expected time of any event on the critical path. Any activity for which the total slack is zero is said to have exercised a critical control over the overall duration of the project. They have no flexibility in time with them and a delay in any one of them will delay the completion of the project and vice versa.

iv) Free Slack

Merge point activities which lie along slack paths has what is called free slack. Activity free slack is equal to earliest expected time to the activity's successor event minus the earliest finish time for the activity in question, SF = TE- EF. It is equal to the amount of time that the activity or event in the network, may be critical or non critical. The free slack measures the amount of time by which an activity can be delayed without of the earliest start time of any other activity in the network whether critical or non critical.

9. Scheduling computation

With the network already drawn and duration of activities known following information can be obtained:

ES = Earliest activity start time;

EF = Earliest activity finish time;

LS = Latest activity start time and

LF = Latest activity finish time.

As we have already discussed, the calculations of ES and EF are known as "Forward pass" and calculations of LS and LF are known as "Backward pass".

10.15.4 Merits/Advantages of PERT

The majority of PERT applications contain the phases like the preparation of the network diagram, the estimation of expected time to perform each activity, the computation of the critical path schedule, and the proper interpretation of the results.

Experiences with these applications under a broad range of project types have shown that the PERT:

1. Encouraged a logical discipline in the planning, scheduling and controlling of the project.
2. Encourages more long range and detailed planning of projects. It develops in advance a plan of action required to produce a project.
3. Provides a standard method of documentation and communicating project plans, schedule, time and cost performance. Enables project manager to predict with some degree of certainty the probable time and rupees it will take to achieve desired objectives.
4. Identify the most critical elements in the plan focusing the managers' attention on the most constraining part of the project.
5. Illustrates the effects of technical and procedural changes on the overall schedule.

6. Provides a ready made standard against which performance can be measured as the plan is placed into action.

7. Enables management to better manage the resources available on the project.

8. With continuous reporting of progress it affords project manager a great deal in the way of control.

9. Enables project manager to determine when delay begins to develop, precisely where they are and what can be done to correct them.

Network analysis techniques (PERT/ CPM) are useful for eliminating delays and reducing costs. They are simple to apply and a high degree of saving is possible. Network analysis is one of the most effective and successful tools in the planning and control of any research project.

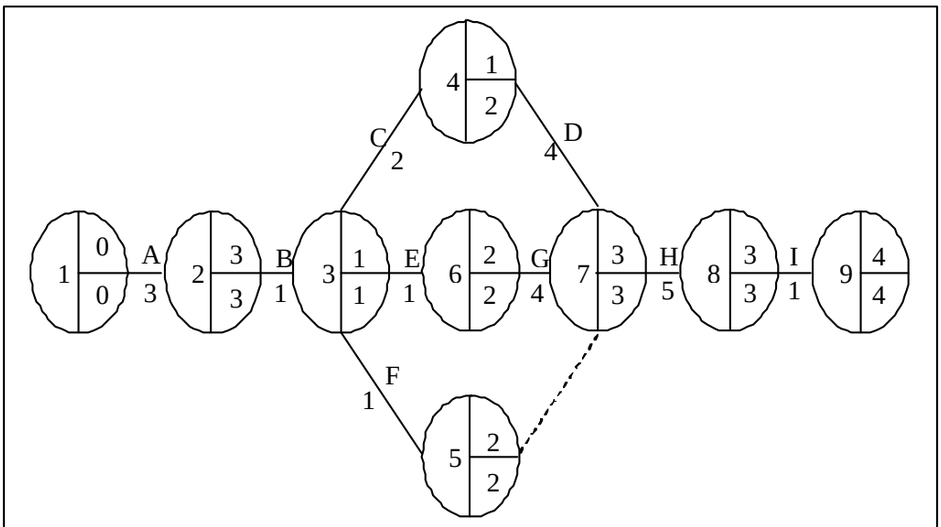
Example 1: Suppose the following are the activities, draw PERT diagram

Sl. No.	Activity	Activity symbol (S)	Preceding activity (PA)	Time Duration (Months)
1.	Aerial photograph	A	-	3
2.	Soil survey	B	A	12
3.	Photo analytical transfer	C	B	2
4.	Soil preparation	D	C	4
5.	Soil physical analysis	E	B	12
6.	Soil chemical analysis	F	B	12
7.	Interpretation of data	G	EF	4
8.	Final report preparation	H	GD	5
9.	Field demonstration	I	H	12

Pert Diagram

10.16 How to draw the CPM network

Draw the largest activity path horizontally on a paper indicating the events by circles and connecting the event by activity arrows. Label them with numbers and letters respectively. Thereafter look at the precedence relationship between the activities and draw the activity arrows with events appropriately connecting the events on the length path. When two or more activities emerging from same event circle and all of them becoming precedent to a succeeding activity a broken arrow is introduced. Connecting the events depict the continuity of the network. These broken arrows are



PERT DIAGRAM

called 'dummy' activities and do not consume any resources. In this way all the activities are to be shown in the CPM network and then write the time estimate for each activity below the activity arrow.

10.17 CPM analysis

After the network is drawn each event circle is divided into 3 segments as shown below:

Left semi circle carries the event number. Right top segment contains earliest starting time (EST). Right bottom segment contains the latest starting time (LST) for an event. The network is first solved from start to finish or forward pass. The rules are as follows:

1. EST for the start event is assumed to be zero.
2. Each activity starts as soon as the event at which its start is realized. The earlier finishing time for an activity is equal to EST to the event from which it starts plus the duration of that activity.
3. EST of an event is equal to the largest of the earliest finishing times of the activity merging on the event.

Network is analyzed in the same way working backward from finish to start or backward pass. The rules are as follows.

1. LST of the finish event is equated to its EST.
2. The latest finishing time for an activity is equal to the LST of its successor event. The latest starting time for an activity is its latest finishing time minus duration.
3. LST for an event is smallest of the latest starting time for the activities emerging from the event.

With these rules the network is analyzed and the EST and LST are noted on the event circles. We find that the EST and LST are equal to the event of the largest path. The difference between LST and EST is called the 'Event slack' which gives the margin of time by which the commencement of an activity can be delayed without dislocating the total duration of the project. Thus, events with zero slack trace the critical path which is also the longest path.

The slack time for an activity is obtained as follows:

Activity slack is equal to LST of event minus EST of start event minus duration of reference activity.

These slacks indicate that the activities concerned can be performed at the slow phase twice by releasing some of the resources for use of critical activity. From the analysis we can draw the project in the form of network as given in PERT.

Advantages:

1. A comprehensive view of the entire project is available for the project management.
2. Because of current and sequential relationships, time duration becomes effective, thereby monitoring the progress of the project becomes easier.
3. Identifying the critical activities keeps the project leader alert and well prepared for alternate plans if needed.
4. Breaking down the project into smaller components permit better closer control of the project. Thus CPM is a dynamic tool of project management.

10.18 Bar Charts

Bar charts are the pictorial representation of various activities of a project with the help of bars against time scale. The important bar charts considered for detailed description are Gantt Bar Charts, Milestone Bar Charts, Modified Gantt Bar Charts and Activity Slack Bar Chart.

10.19 Gantt Bar Charts

These bar charts were developed by H.L.Gantt, who was contemporary of "the father of the scientific management", F.W. Taylor. Gantt used the bar charts first on production officers. Bar chart is a pictorial representation of various tasks of a project to be done. It is made up of two coordinate axes-one represents for tasks to be undertaken and the other for time elapsed. The tasks are denoted by bars and the length of bar indicates the time requirement for accomplishing particular task.

For example, there is a project consisting of five tasks i.e. A, B, C, D and E. These tasks are represented by means of bars. The bar chart with the bars representing the tasks clearly indicates the independent nature of tasks. Usually, for many projects some job may start at a time and would go simultaneously and some will have to be accomplished prior to others can begin with and thus the dependency between the tasks exists.

10.19.1 Limitation

In bar charts dependency between the tasks is not there. Critical activities cannot be ascertained for project completion.

10.20 Activity – Slack Bar Chart (ASBC)

In this technique each activity is shown by means of a bar. The broken bar is divided into two parts – one is with parallel lines and the other with broken parallel lines. If the activity has the inbuilt slack which means that the activity cannot be commenced upto a certain stage (growth of crop or animal), though it needs 2 or 3 days (few days) for accomplishing. The continuous parallel lines in the bar represent the exact time requirement for completing the work activity. In other words the former is for the critical period and the later is for inbuilt slack. The normal slack of any activity can be easily understood by the graph itself. All the bars are shown against time scale of horizontal axis (X-axis). The vertical axis (Y-axis) is meant for naming/ symbolizing the activities. The relationship between the activities is indicated by arrows. The head of arrow indicates the succeeding activity. The arrow may be upward or downward direction. The length of arrow and direction do not have any significance. The ASBC was developed at NAARM, Hyderabad in the year 1986.

10.20.1 Intrinsic Merits of ASBC

1. Unlike PERT or CPM networks, ASBC clearly indicates the slacks of the activities.
2. The technique is highly relevant and completely applicable for biological projects related to plants, animals, birds and fisheries, whereas PERT and CPM networks are not suitable for many cases.
3. It is more effective for short duration projects, which consist of sequential activities with three to four concurrent activities.
4. ASBC represents all aspects i.e. time requirement for each activity, inbuilt slack period, critical activity period, activity relationships and duration of project.
5. Identification of inbuilt-slacks facilitates for taking up more projects.
6. It is easy to draw the ASBC chart by using a graph sheet unlike PERT and CPM network, wherein complicated procedures and analysis are involved.

10.20.2 Limitation

1. ASBC may not help when activities of more than 50 are involved in the project.
2. It is cumbersome to draw the bars, if the project has many concurrent activities.

10.21 Six – Sigma Concept

Six Sigma aims at continuous quality improvement and it is a step by step problem solving frame work and work breakdown structure, which can be remembered by using the acronym **DMAIC**

First the problem is

1. **D**efined to determine what needs to be improved.
2. **M**easures the current status against the desired status.
3. **A**nalyses the root causes of the production gap.
4. **I**mplements improved solution (after brainstorming and selecting).
5. **C**ontrols the long term sustainability of the improvements by establishing monitoring mechanisms, accountabilities and work tools.

10.22 5 – S Principles

5-S principles are followed to attain a better quality standard in an organization. This involves five steps as detailed below.

1. Seiri: Sorting out and disposal of unwanted things
2. Seitdn: Set right all required things
3. Seiso: Cleaning all areas and equipments
4. Seiketsu: Standardization
5. Suitsuke: Training and discipline at all levels

Above this the KVKs have to continuously aim for improvement and maintenance of standards and performance. At the zonal level, Zonal Project Directorates also have to follow the same. The 5-S model followed by Zonal Project Directorate, Zone - III, is given below.