**UNIT SIX**

**Net works and Project Management**

**Unit Objectives**

After completing this chapter you should be able to:

* Define what a project is.
* Describe the different types of networks
* Use CPM to evaluate project’s time
* Discuss the use of PERT in solving problems of project
* Describe the concept of crashing

**6.1. Introduction**

It is essential **to identify the various activities** involved in the execution of Projects. The large and complex projects of any organization involve a number of interrelated activities, which might be performed independently, simultaneously, or one after the other. Modern management **has designed a network models approach to solve the problem associated** with the allocation of scarce resources of manpower, material, money and time to these interrelated activities.

A ***project*** can be defined as being a **series of activities designed to achieve a specific objective**, and which has a definite beginning and a definite end. For network analysis to be of use, the project must **be capable of being split into a number of discrete activities**, which relate together in a logical and well-defined manner.

**Network analysis involves the breaking down of a project into its constituent activities**, and the presentation of these activities in diagrammatic form.

 **Networks** are one of the important tools of management science which easily solve problem by presenting in visual formats. The **shortest route problem, minimum spanning tree and maximal flow models** are useful for solving problems associated **with allocation of scarce resources, time, cost, and material consumption.** Moreover, CPM and PERT, which we will discuss later on also contributed a lot for complex projects management under different situations.

**Planning and Scheduling with Gantt chart**

It is a popular tool for planning and scheduling simple projects. It enables a manager to initially **schedule project activities** and, then, to **monitor progress over time** by comparing planned progress to actual progress.

In order to prepare the chart, **first** identify the major activities that would be required. **Next, time estimates** for each activity were made, and the **sequence of activities** was determined.

The obvious advantage of Gantt chart is its simplicity, and this accounts for its popularity.

**6.2 NETWORK DIAGRAMS**

Drawing a logic diagram is a skill requiring practice and ingenuity, and for major projects may require two or three attempts before a satisfactory network or diagram is completed correctly. Computer packages are often used to carry out this process, cutting drastically the time taken.

**6.2.1. Basic Components of Network Diagram**

i)Network

 It is the **graphic representation** of logically and sequentially **connected arrows and nodes** representing **activities and events** of a project. Networks are also called arrow diagram.

ii) Activity

An activity represents some **action** and **time consuming** effort necessary to complete a particular part of the overall project. Thus each and every activity has a point where it ends.

 A

 Here A is called an activity.

The straight lines connecting the circles represent a task that takes time or resources; these lines are called activities. The arrow heads show the direction of the activity.

The beginning and end points of an activity are called **events or nodes**. Event is a point in the line and does not consume any resource. A numbered circle represents it. The head event has always a **number higher than the tail event.**

 Activity

 Tail Head

**Merge and burst events**

It is **not necessary** an event to be the ending event of the **only one activity** but can be the ending **event of two or more activities**. Such event is defined as a **Merge event.**

Merge event

If the event happened to be the **beginning event** of two or more activities, it is defined as a

**burst event.**

**Burst event**

iii) **Preceding, succeeding and concurrent activities**

Activities, which must be **accomplished before** a given event can occur, are termed as **preceding** activities. Activities, which **cannot be accomplished** until any event has occurred, are termed as **succeeding activities**. Activities that can be accomplished concurrently are known as concurrent activities.

**iv) Dummy Activity**

Certain activities, which **neither consume time nor resources but are used simply to represent a connection or a link between the events,** are known as dummies. It is shown in the network by a **dotted (broken) line**.

The purpose of introducing dummy activity is:

* To maintain uniqueness in the numbering system as every activity may have

 distinct set of events by which the activity can be identified.

* To maintain a proper logic in the network.

D

B

A

Dummy

C

v) **Numbering the Events**

After the network is drawn in a logical sequence, **every event is** **assigned a number**. The number sequence must be in such a way that it should reflect the flow of the network. In event numbering, the following rules should be observed:

i. Event numbers should be unique.

ii) Event numbering should be carried out a sequential basis from left to right.

iii) The initial event, which has all outgoing arrows with no incoming arrow, is numbered 0 or 1.

iv) The head of an arrow should always bear a number higher than the one assigned at the tail of the arrow.

v) Gaps should be left in the sequence of event numbering to accommodate subsequent inclusion of activities, if necessary.

**6.2.2. Rules for drawing a network**

* A complete network **should have only one point of entry -the start event**, and one point of exit -the finish event.
* Every activity must have one preceding event -the tail, and one following event - each activity has one head.
* Several activities may use the same tail event, and the same head event, but no two activities may share the same head and tail events.
* Time flows from left to right.
* An activity must be completed in order to reach the end-event.
* Dummy activities should only be introduced if absolutely necessary.
	+ 1. **Convention for Drawing Networks**

In addition to the rules described above, certain conventions are followed for the sake of clarity and uniformity. There are two slightly different conventions for constructing the net work diagrams. Under one convention, the **arrows**are used to designate **activities**, where as under the other convention, the **nodes**are used to **designate activities**. These conventions are referred to as activity- on-arrow (A-O-A) and activity – on- node (A-O-N) respectively. In order to avoid confusion, the discussion here focuses primarily on activity- on- arrow convention. When we use this convention:

* Networks proceed from left to right -the start event is at the left hand side of the diagram and the end event at the right hand side
* Networks are not drawn to scale.
* Arrows representing activities should have their head to the right of their tail unless it is impossible to draw the network in that way.
* Events or nodes should be numbered so that an activity always moves from a lower numbered event to a higher one. This convention is relatively easy to accomplish in a simple network but in a complex network it may be necessary to number in tens to allow for extra activities to be added without the need for a complete renumbering of the whole diagram
* Lines that cross should be avoided if possible
* The start event may be represented as a line instead of a circle, particularly when several activities may begin at the start point.

**6.2.4. Common Errors in Drawing Networks**

There are **three types of errors**, which are most common in network construction. These are:

a) **Formation of a loop**: If an activity were represented as **going back in time**, **a closed loop would occur.** In a network diagram looping error is also known as **cycling error.** Cycling (looping) in a network can result through a simple error or while developing the activity plans, one tries to show the repetition of an activity before beginning the next activity.

 A closed loop would produce an endless cycle in computer programmers with a built- in routine for detection or identification of the cycle. Thus one property of a correctly constructed network diagram is that it is non-cyclic.

A

B

C

**Dangling**: No activity should end without being joined to the end event. If it is not so, a dummy activity is introduced in order to maintain the continuity of the system. Such end-events other than the end of the project as a whole are called dangling events. All activities must contribute to the progression of the network or be discarded as irrelevant.

DB

CB

F

Dangling

c) **Redundancy**: If a dummy activity is the only activity emanating from an event, it can be eliminated.

F

D

Dummy

A

B

E

C

* 1. **TYPES OF NETWORK MODELS**

**Section objective:**

Up on completion of this section, the learner will be able to:

* Identify the three models of network
* Explain their importances
* Distinguish among the three models of network

 **6.3.1. The Shortest Route Problem**

The objective of this network model is **to obtain the shortest path in which one can minimize distance, time or costs** involved form the origin to destination.

If we have **“n” location** in the network, the total steps required to solve the shortest route problem will be **n-1.**

The determination of shortest route involves labeling procedure in which each node is assigned with two numbers where by the 1st label represent distance from the original (source) node and the 2nd number refers the node that immediately precede the labeled node. The labeling procedure begins with the original node where the label will be (O, S) to indicate the distance is zero and it is starting point.

In the shortest route algorithm nodes are labeled either permanently to indicate the final labeling or temporary labeling to indicate that the labeling might be revised. Labels remain temporary until it can be ascertained that no shorter route to a node exists.

 **The Shortest Route Algorithm**

**Step 1**: Start at node 1 and find the distance from node 1 to other nodes that can be directly reached form node 1. Temporarily label each of these nodes with their distance from node 1

followed by a comma and a number 1. Then select the node that has smallest distance from node 1, and make its label permanent. This can be done by shading the node.

**Step 2**: Find the distance from the new permanent node to each non permanent nodes that can reached directly form this node. Temporarily label each of these nodes with the cumulative distance from node 1 if a node has no label. Or, change the earlier assigned temporary label of a node if its cumulative distance from node 1 through the new permanent node is less than the previous temporary label. Then permanently label (shade) the node that has the smallest cumulative distance form node 1.

**Step 3**: Repeat the preceding steps until all nodes have permanent labels.

**Step 4**: Identify the shortest route to each node from node 1 by working backward through the tree according to the nodes label specified on the node.

Example :

Find the shortest route of the following network starting form node one. Travel between nodes can be in either direction. The table should show the distance from node 1.

13

5

2

(O, S)

4

(

8

7

1

6

5

3

1

7

***1st Step***

16

6

4

Select the node, which has the **smallest distance from node 1**, and label it permanent and shade.

Shade node 1 and temporarily label node 2, 3 and 4, which can be directly reached from node 1. The label should show the distance from node 1.

(5.1)

13

5

2

(8, 1)

(O, S)

4

(

8

7

6

1

5

3

1

7

(7, 1)

16

6

4

***2nd Step***

**Select** the node, which has **the smallest distance from node 1**, and label it **permanent and shade** the node (i.e. node 2), then temporarily label nodes that can be directly reached from node 2. Therefore node 5 is labeled as (18, 2.)

(5, 1)

2

13

(18,2)

4

5

(O, S)

(8,1)

8

5

3

7

(7, 1)

7

6

1

16

6

4

**3rd Step**

Identify the smallest distance from node 1 i.e. from node 3, 4, and 5, which have values of (8, 1), (7,1) and (18,2) respectively. **Permanently label and shade node 4,** which has the **smallest** distance of 7. Identify non-permanent labels; directly reached from this node and temporarily label it by the distance from node 1.

(5,1)

13

13

2

(O, S)

(18, 2)

4

5

(8, 1)

73

5

8

3

63

1

7

(7,1)

(23, 4)

13

16

6

4

**4th Step**

The node with the smallest temporary label is node 3. Thus, its label becomes permanent and the node is shaded. Node 3 can be reached directly from node 1 through node 4 with the same distance of 8 (i.e. tie exists). Next, find each non-Permanent label that can be reached directly from node 3. Node 5 is the only node with a value of (18, 2). However, the cumulative distance of node 5 from node 1 through node 3 is 15 (i.e. 8+7=15). Because the route through node 3 is shorter, we update the temporary label of node 5 to reflect this shorter route.

(5,1)

(15, 3)

13

5

2

(O, S)

(18,2)

(8,1)

tie

8

7

5

1

3

7

6

(7, 1)

1

(23,4)

16

4

6

**5th Step**

Identify the node, which have smallest label from the un-shaded nodes or temporary labels. Node 5 with a distance of 15,3 is selected and becomes permanent label.

(5,1)

2

(15,3)

~~18,2~~

13

4

5

(8,1)

(O,S)

tie

5

7

8

3

6

1

(23,4)

(7,1)

1

7

16

6

4

**6th Step**

The only node which is not shaded and can be reached directly from the new permanent node is node 6. Using this route, its cumulative distance from node 1 would be 15+6=21. Because this is less than its current table update label to 21, 5 and make permanent & shade it.

2

(15, 3)

~~18,2~~

13

5

4

(O,S)

8, 1 tie

7

5

8

(21,5)

~~(23,4)~~

3

1

6

7

(7,1)

1

16

6

4

 Permanent label of the final network indicates the shortest distance of each node from node 1 (the starting node). In order to identify the route that yields the shortest distance to a particular node, it is necessary to work backtracking. The shortest route of the nodes from node 1 to each node is summarized below.

|  |  |  |  |
| --- | --- | --- | --- |
| Node | Distance | Shortest Route | Alternative Route |
| 2 | 5 | 1-2 | - |
| 3 | 8 | 1-3 | 1-4-3 |
| 4 | 7 | 1-4 | - |
| 5 | 15 | 1-3-5 | 1-4-3-5 |
| 6 | 21 | 1-3-5-6 | 1-4-3-5-6 |

* + 1. **Minimum Spanning Tree Model**

The minimum spanning tree problem involves in **connecting all of the nodes of a network using as little of the connecting material as possible**. For example, the nodes might represent oil storage tanks, and lines represent pipeline that are used to carry the oil between tanks. The cost of the pipeline would be proportional to the length of the pipeline used. Hence, the objective would be to connect all of the tanks using as little pipeline as possible. Similar activities include designing communication systems by using minimum amount of wiring, designing highway networks by using minimal amounts of materials etc.

**Algorithm of Minimum Spanning Tree**

Step 1. Start at any node, (usually, node 1 is used as the starting point), identify the node that has **shortest distance from node 1** and connect it to the node 1 using a line. If a tie occurs, break it arbitrarily

Step 2. Find the shortest distance form the existing portion of the tree (i.e. the connected nodes) to a node that is not yet connected. Make the connecting line from previously connected tree to the new node which has shortest distance.

Step 3. Continue until all nodes have been connected to the tree.

Step 4. To find the total (minimal) length of the connecting distance, sum up their values.

**Example:**

Consider the following network where the nodes represent fuel storage tanks and the connecting lines represent possible pipeline connections. The numbers on the lines represent the **distance** in meters for a particular pipeline connection. Determine the spanning tree for the network storage tanks and the amount of pipe that will be needed to make the connections.

26

22

6

2

4

13

24

18

27

33

5

1

20

30

32

18

49

7

3

Arbitrarily choose node 1 as a starting node consider all branches incident on it. They are 1-2 and 1-3 with distance of 13 and 18 respectively. Since 1-2 is the **shortest, select this line and connect it.** Now node 1 and 2 are connected.

Next consider all arcs incident either on node 1 or node 2 that connect to other nodes. Such lines are **1-3, 2-3 and 2-4** with a distance of **18, 20 and 22** respectively. **Node 1-3** with a distance of **18** of selected. Now the connected nodes are 1, 2, and 3.

Next consider all braches incident to Node 1, 2 and 3. These are **2-4, 3-4, 3-5 and 3-7** with distance of **22**, 27, 30 and 49. The **shortest distance is 22 i.e. 2-4**. Make 2-4 part of the network

|  |  |
| --- | --- |
| 6425173A | 2213218213B2 |
| 2213426153718C | 221364218171853D  |
| 22213641812451873E | 2242131862415327183F |

The next step will be to identify the shortest line that is incident to node 3 and 4. These are 3-5, 3-7, **4-5** and 4-6 with a distance of 30, 49, **18** and 26. Since **4-5 is the shortest** distance, include it in the network.

Continue in this manner until all nodes are connected with their shortest distance. The network solution for the above problem is shown on the following figure

The length of pipe that will be needed for this system can be found by summing the line lengths (distance): i.e. 18+13+22+18+24+32= 127 meters.

* 1. **PROJECT MANAGEMTN AN OVERVIEW**

**Section objectives:**

Up on completion of this section, the learner will be able to:

* Define project management and related concepts
* Explain elements of project management
* Describe phases in project management and tools used
* Identify techniques used in project management

Being able to create an effective specification, supported by the **analysis, design and implementation stages of the project development,** and to deliver a system to the required standards and within the **time and cost constraints** imposed depends on the effective management of the entire development process.

**Effectiveness and Efficiency**

The primary objectives underlying any process of project management -whether related to investments in information systems or to some other capital expenditure project -may be encapsulated under two headings:

 **Effectiveness**: ensuring that the project:

* Meets the required needs of the users or the other objectives that have been established
* Is produced to specified quality standards to satisfy user needs
* Can be integrated within existing organizational information systems, structures and processes
* Is sufficiently flexible to respond to changes in the environment in which the system will operate,
* Provides appropriate support to decision makers at all levels: operational, tactical and strategic.

**Efficiency**: ensuring that the development of the project -including development, delivery, installation and final implementation -is

* Undertaken within the manpower resources, costs and time targets or constraints specified at the outset
* Efficient in exploiting the resources of the project team members' and the users' time as fully as possible, avoiding unnecessary idle time, delays or time wasted in undertaking unnecessary tasks or activities
* Capable of delivering the resources on time -neither too late nor too early to cause problems of storage, loss of value due to deterioration, unexpected fluctuations in planned cash flows
	+ 1. **Project Management Elements**

The terms effectiveness and efficiency, as defined above, may be expressed in terms of the key elements of any project, namely:

* ***Time***
* ***Resources***
* ***Costs***
* ***Quality.***

The term '**efficiency**' relates primarily to the **elements of time, resource utilization and costs** (measuring the value of the output produced against the costs and time taken to produce the system).

'**Effectiveness**' is concerned more with the **quality of the system** in terms of the required performance standards and objectives. Let us look at these project elements in detail.

**6.4.1.1. Time**

 Typically, the objectives of the project will stipulate **either a target time for completing the development of the project, or the date by which the system should be fully operational.** **Failure** to meet these prescribed target completion dates may have both direct and indirect consequences if the organization, some of which may be highly significant. For example:

* Losses of potential financial returns reduced operational efficiency and lost competitive advantage from the system operation itself.
* Reduced benefits and potential opportunities if other organizational development is tied to the project -for example, the launch of a new product involving (expensive promotional campaign).
* Resources remaining idle: specific staff recruited and not utilized, and environment facilities all arriving ahead of requirement and increasing the organization’s risk of loss, damage or deterioration.
* Delays that may require either the extension of contracts negotiated with specific programmers or analysts hired only for the duration of the project (possibly increased rates), or the use of overtime working to recover lost time (at higher rates)
* The retention of existing computing equipment beyond the anticipated time necessitating the extension of maintenance contracts and often incurring high maintenance costs than the new equipment.
* Unplanned cash flow effects from either early or delayed purchasing or delivery).
	+ - 1. **Resources**

For these purposes, the term resources relates to both **materia**l and **human** resources. Material resources will include consumable materials and support services. Although the acquisition and management of material resources improve demanding, the management of human resources is usually the key element. Generally, the management of resources involves:

* evaluating alternative suppliers of tangible products and services; negotiating prices (economy), quality standards and delivery times; and progressing orders placed
* recruiting and training the staff for the project
* Planning workloads for individual staff, scheduling and co-coordinating the work, the project team, establishing performance targets, and regular monitoring and appraisal of individual staff performance.
	+ - 1. **Costs**

Management priorities for both the time and resource elements will be reflected in the project costs. A key performance indicator used by senior management to assess the project during its development phase is the level of expenditure incurred relative to the budgeted expenditure. Managing the costs of a project involves the following:

* **Forecasting** and **estimating** the costs of the project in total so that the level of anticipated expenditure can be established for each month or quarter. These costs will normally be subdivided into a variety of sub-headings relating to capital and revenue expenditures, and costs associated with staff, materials and overheads. (Total expenditure approach )—**Engineers estimates**.
* **Monitoring** the actual expenditure in total and under each of the sub-headings within the budget. This will allow the project team to assess the degree to which actual expenditure matches budgeted expenditure. In cases where there are significant variances, the project team will be required to establish the **cause and the consequences** for the total project costs.-- **Variance Analysis**
* Significant overspending on a project may require the project manager and the organization to review either the subsequent stages of the development process or the initial system objectives and performance standards, with the intention of modifying the more expendable elements to meet budget limits.—**Feedback and feed forward decisions**.
	+ - 1. **Quality**

 Quality management is primarily focused on the **output of the development process as an operational system.** It may be more difficult to measure quality than the three other elements, because it may be assessed against more subjective criteria. While different perceptions of quality exist, the important assessment of quality relates to the project’s ability to meet the users' requirements and expectations. Generally, the management of quality Incorporates

* Establishing quality and performance standards for the project at the outset and developing methods for measuring these less tangible elements
* Establishing procedures and methods of working which will assist in assuring the achievement of the standards in the final system
* Monitoring the project regularly against the desired standards and ensuring that the necessary procedures are being observed.
	+ 1. **Project Initiation Document**

The Project Initiation Document (PID), sometimes called a ***'statement of work'*** or ‘project ***charter'***, is a formal document listing the goals, constraints and success criteria for the project -the rules of the game. The PID, once written, is subject to negotiation and modification by the various stakeholders of the project. According to Eric Verzuh, a PID should contain at least the following sections:

* **Purpose statement:** This **explains why the project** is being undertaken.
* **Scope statement**: This puts **boundaries to the project** by outlining the major activities of the project.
* **Deliverables:** What are the **main outcomes expected from the project?** The focus on what makes the success of the project easier to measure. Deliverables tend to be tangible *elements* of the project, such as reports, assets and other *outputs*.
* **Cost and time estimates:** Even at this early stage, it is a good idea for the project team to have some feel for the organization’s expectations in terms of the project budget.
* **Objectives:** A clear statement of the mission, critical success factors and milestones of the project
* **Stakeholders:** A list of the major stakeholders in the project and their interest in the project.
* **Chain of command**: A statement (and diagram) of the project organization structure
	+ 1. **Duties of Project manager**

The project manager may be required to interface with all three levels (strategic, tactical and operational) at different times, although, in the larger projects, the team or group leaders would be responsible for the operational level management of the activities and personnel within their team.

1) **Strategic:**  At this level, the manager should:

* evaluate and analyze strategic impact of each proposed system on the organization’s operations, in promoting competitive advantage, and on the other existing or proposed information systems within the organization
* report to senior management on the results of the strategic evaluation and quantify the potential costs and benefits that may be derived from each system development
* contribute to the strategic decision-making process of the organization in terms of the information resource
* review and evaluate the strategic consequences of the progress achieved in developing the system at regular intervals.

**2) Tactical:** At this level, the manager's responsibility is to

* **convert** the objectives, targets and performance standards agreed for the project into **operational plans**
* develop the outline and detailed plans for the project, identifying the time, resource and cost parameters, and producing a schedule of activities for the project staff
* monitor the performance of the project against the agreed plans, budgets and quality performance standards, and report progress to both the steering committee and the management sponsor
* liaise with management and staff in the user departments, to ensure an effective interface in terms of integration and co-operation between the users and the project development staff
* facilitate a similar level of co-operation with project staff and outside agencies - either with suppliers or distributors for the company's main business, or with the specialist agencies supporting the system development project itself
* analyze deviations from planned performance, evaluating alternative solutions and recommending appropriate control changes to future plans or targets
* develop appropriate information systems to provide the necessary Information to monitor and control the project.

**3) Operational:** At this level, the manager should:

* manage and control the daily activities of the project team members
* conduct regular progress meetings with the project staff and team leaders to identify and resolve existing and potential difficulties
* appraise the performance of individual members of the project development staff and seek to assure the achievement of the required quality standards throughout the project development.
	+ 1. **Problem Areas and Project slippage**

All projects include some risk: cost overrun, missed deadlines, poor outcome, disappointed customers, and business disruption.

**Risk management**

Risk management consists of the following steps:

1. Identification of the risks.

2. Estimate of their downside effects i.e., the implications of what could go wrong.

3. Estimation of the probabilities of the events occurring.

4. Decide how the risks will be handled. Risks can be handled as follows:

* *Do nothing.* This is appropriate where the effect is small or the chance of occurrence very remote
* ***Insure against the risk***
* *Off-load the risk*, for example by arranging for third parties to complete part of the project
* *Investigate the risk further and try to protect against it*. For example arrange to have additional staff available in case of project overrun.

**Threat Identification and slippage reduction**

**a) Possible threats:**

The following can threaten the success of a project. Suggestions are included as to how minimize the slippage involved with those threats.

***Poor management***

Many project leaders will be from technical backgrounds and they may not have the proper management skills for controlling large projects.

Project leaders should be properly trained so that they have managerial skills as well as technical skills. They should not be given large critically important projects until they have proved themselves on smaller exercises.

***Poor planning***

Managers have not made use of the various planning methods available: network analysis, Gantt charts. They have not broken the project down into its various activities and estimated a time and cost for each.

***Lack of control mechanisms***

It is essential to be able to monitor the progress of projects otherwise it is impossible to decide whether they will meet cost and time budgets. Reporting mechanisms and review dates should be set out in advance.

***Unrealistic deadlines***

There is often pressure from users for projects to be completed quickly. Project teams, particularly if they have had to win the job competitively, may have suggested times that are unrealistic. Project managers must look critically at the deadlines. They should identify the critical activities of the project and ensure that these do not slip.

***Insufficient budget***

Too few people are employed on the project, inadequate materials is bought, the cheapest (not the best) solutions are always sought. Of course, organizations cannot ignore costs and should try to get good value for money. However, it is important to be objective about what a given cost budget can produce by way of project outcomes. If money is tight, it might be better to do a smaller project thoroughly than a larger one poorly.

***Moving targets***

The project specification keeps changing as the project progresses. This will certainly add costs and delay to the project. User’s requirements should be thoroughly examined and the analyst should check understanding before the project is started. Techniques such as structured walkthroughs and prototyping will help here.

**b) Project change procedure**

One of the most effective methods of dealing with the need to amend projects is to have a project change procedure. Although this procedure will not remove some of the risks discussed above, It will enable some changes to be made to the project with minimal disruption and slippage occurring.

The main issue to be aware of in changing a project is that the later into a project that a change is made, then the more difficult it will be to accommodate that change and the greater will be the expense of that change. A change management procedure for a project will normally involve the following activities:

***Identifying the need for change***

This may arise from many sources including user input, technical difficulties with implementing part of the project, time or cost efficiencies identified by the project team etc. Any change will be discussed with the Project Manager initially.

**Make change, *Change recommendation***

A more formal explanation of the change is produced, stating clearly the need for the change, what the change will be and the costs and benefits associated with the change.

***Feasibility of change***

The project manager and senior members of the project team will check that the change is actually possible in terms of technical and social feasibility

***Steering committee approval***

When the case for a change has been checked, the change document will be placed before the Steering committee for discussion, and approval if the change is accepted

***Project sponsor approval***

Major changes will also require the authorization of the project sponsor and possibly the Board or similar decision-making body of the organization

***Amending project plan***

The project plan will be amended to take account of the change. Deadlines and costs will be revised.

***Make change***

The change is actually carried out and, where necessary, tested to ensure that there are no conflicts with other sections of the project.

* + 1. **PROJECT MANAGEMENT TOOLS**

The key elements of project management are *planning* and *control*. Deciding and specifying what to do is the function of a project *plan.* Making sure it is done right is the function of project *control*.

Planning is vital if control is required later. Planning is necessary to avoid wasting **time**, **resources** and **effort**. It should also be flexible to take into consideration any change that may occur through unforeseen circumstances during the development of the project.

**The main steps in planning a project are**:

* Identify purpose of project
* Set objectives -define deliverables
* Gather information on resources, timescales
* Construct a plan -list tasks, timescales and dependencies, allocate tasks, decide on the tools to be used and identify control systems.

Control systems must be capable of **measuring progress, reporting deviations and taking corrective action.**

**The criterion for a good control system includes the following:**

* The plan and its control should be *viable*
* Good control relies on *good monitoring* -keep it simple (KIS)
* Control depends on having **measurable objectives** and milestones or benchmarks.

**In conclusion, three things occur in the planning and control process:**

* A plan is prepared specifying the project requirements, work tasks, responsibilities, schedules and budgets.
* The plan is compared to actual project performance, time and cost.
* Corrective action taken if there are any discrepancies and the requirements, schedules and budgets are updated.
	+ - 1. **Advantage of project management tools**

The following are the main advantages afforded by using critical path methods:

1. **Easier visualization of relationships**. The network diagram that is produced shows how the different tasks and activities relate together, making it easier to understand a project intuitively.

2. **More effective planning.** CPM forces management to think a project through thoroughly.

3. **Better focusing on problem areas**. The technique enables the manager to pinpoint likely bottlenecks and problem areas before they occur

4. **Improved resource allocations.** Manpower and other resources can be directed to those parts of the project where they will have the most effect in reducing cost and speeding up the completion of the project. Overtime can be eliminated, or confined to those jobs where it will do the most good.

**5. Studying alternative options**. Management can simulate the effect of alternative courses of action.

**6. Management by exception**. CPM identifies those actions whose timely completion is critical to the overall timetable, and enables the leeway on other actions to be calculated.

**7. Improved project monitoring**. By comparing the actual performance of each task with the schedule, a manager can immediately recognize when problems are occurring, can identify when those problems are important and can take the appropriate action in time to rescue the project.

* + - 1. **Types of Project management tools**

A project manager has a range of project management tools available to assist with the planning and control of individual systems projects.

**The project management tools available include:**

* Work Breakdown Structure
* Gantt chart
* Critical path analysis
* Resource Histogram
* Budget.
	+ - * 1. **Work Breakdown Structure (WBS)**

A Work Breakdown Structure is a **results-oriented family tree that captures all the work** of a project in an organized way.  It is often portrayed graphically as a **hierarchical tree;** however, it can also be a tabular list of "element" categories and tasks or the indented task list that appears in the Gantt chart schedule. One of the main methods of breaking down work into manageable units, and then allocating those units to members of the project team, is to use a work breakdown structure.

Illustrative example of a practical work break down structure (WBS) is given

 **PRACTICAL APPLICATION OF WBS**

Example one:

**Work Breakdown Structure: THE Case of CBE’s BPR Upgrading Project**

The CBE has started a project to upgrade the BPR performed on its functional units. To manage this project, the Bank has **established three teams each team consisting of four members.** The project was expected to be finalized by the end of July, 2007. In this case, the Bank can apply the concept of Work Breakdown Structure as follows.

1. **Top-level WBS**

This breaks the project down into stages, often using the project life cycle stages as major sub-divisions of the project. Mostly, BPR has five stages:

 BPR

Documentation

Analysis

Problem

Identification

Recommendation

Implementation

1. **Second level WBS**

This breaks each stage down into groups of tasks.

* 1. **Documentation**

 **Documentation**

**AS IS (existing) workflow of the core functions**

**AS IS (existing) workflow of the support functions**

* 1. **2.2 Analysis**

 **Analysis**

Collect Stakeholders opinions through designing a questionnaire

Collect customers’ opinions

Search for best practices (benchmarking)

* 1. **2.3 Problem Identification**

**Compare what is with what should be**

**Identify the causes, effects and impact of the problem**

 **Problem Identification**

**2.4. Recommendation**

 **Recommendation**

**Specific Recommendations**

**General Recommendations**

**2.5. Implementation**

 **Implementation**

**Change Management**

**Implementation Plan**

**6.4.6.2.2. Gantt chart**

The **Gantt** chart is a timeline chart. It clearly shows when each task is to begin, the time it will take to complete each task, and which tasks will be going on simultaneously. You may want to use more than one level of Gantt chart.

A Gantt chart, named after its inventor, shows the activities of a project, the same as CPA. However, these activities are presented as a bar chart with the start and finishing times clearly identified.

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**6.4.6.2.3. Critical Path Method**

This is a diagrammatic representation which shows the various activities in a project. The aim of the CPA is to identify how those activities link together and to show the critical path or the sequence of activities where a delay will result in the overall project being delayed. An activity is said to be critical if a delay in its start will cause a further delay in the completion of the entire project.

The sequence of critical activities in a network is called the critical path. It is the **longest path in the network from the starting event to the ending event** and defines the **minimum time required to complete the project.** In the network it is denoted by double line. This path identifies **all the critical activities of the project**. Hence, for the activity (i,j) to lie on the critical path, following condition **must be satisfied.**

 a) ESi= LSi

 b) EFi = LFj

 c) ESj- ESi = LFj- LFi = tij.

ES i, EF j, are the earliest start, and finish time of the event j and i. LS i, LF j, are the latest start, finish time of the event j and i.

 ***The procedure of determining the critical path***

*Step 1*. List all the jobs and then draw arrow (network) diagrams. Each job indicated by an arrow with the direction of the arrow showing the sequence of jobs. The arrows are placed based on the **predecessor, successor, and concurrent** relation within the job.

*Step2.* Indicate the normal time ( tij) for each activity ( i,j) above the arrow which is deterministic.

*Step 3*. Calculate the earliest start time and the earliest finish time for each event and write the earliest time Ei for each event i. Also calculate the latest finish and latest start times.

*Step 4*. Indurate the various times namely normal time, earliest time and latest time on the arrow

 diagram.

*Step 5*. Determine the total float for each activity by taking the difference between the earliest start and the latest start time.

*Step 6*. Identify the critical activities and connect them with the beginning event and the ending

 event in the network diagram by double line arrows. This gives the critical path.

*Step 7*. Calculate the project duration.

***Example:***

A small maintenance project consists of the following jobs whose precedence relationship is given below.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Job*** | ***1-2*** | ***1-3*** | ***2-3*** | ***2-5*** | ***3-4*** | ***3-6*** | ***4-5*** | ***4-6*** | ***5-6*** | ***6-7*** |
| Duration ( days)  | 15 | 15 | 3 | 5 | 8 | 12 | 1 | 14 | 3 | 14 |

**Required:**

a) Draw an arrow diagram representing the project.

b) Find the total float for each activity.

c) Find the critical path and the total project duration.

**Solution:**

The network diagram that represents the project is as follows

14

15

15

5

1

14

12

8

3

1

3

7

6

4

5

2

3

ii) The total float for each activity

To determine the **total float first the earliest start and finish**; **late start and finish** are computed.

***Forward pass calculation***

In this we estimate the earliest start and the earliest finish time.

ESj given by:

 ESj= Max (ESj, tij)

 Where Esi is the earliest time and tij is the normal time for the activity (i,j).

 ES1=0

 ES2= ES1 + t1-2= 0 + 15=15

 ES3= Max ( ES 2 + t2-3, Es1 + t1-3)

 = Max (15 +3, 0+15) = 18 =ES2+t2-3

 ES4= ES3+ t3-4 = 18+8 = 26

 ES5 = Max ( ES 2 + 2-5, ES4 + t4-5)

 = Max ( 15 +5, 26+1) = 27

 ES6 = Max ( ES3+t3-6, ES4+ t4-6, ES5+t5-6)

 = Max ( 18+12, 26+14, 27+3)

 = 40

 ES7 = ES6 + t6-7 = 40 +14 = 54

***Backward pass Calculation***

In this we calculate the earliest finish and latest start time Lfi, given by LFi = Min ( LFj-tij) where LFj is the latest finish time for the event j.

 LF7 = 54

 LF6= LF7 - t6-7 = 54-14 = 40

 LF5= LF 6-t5-6= 40-3 = 37

 LF4 = Min ( LF5-t4-5, LF6-t4-6)

 = Min ( 37-1, 40-14) = 26

 LF3 = Min ( LF4-t3-4, LF6-t3-6)

 = Min ( 26-8, 40-12) = 18

 LF2 = Min ( LF5 - t2-5, LF3-t2-3)

 = Min ( 37-5, 18-3) = 15

 LF 1 = Min ( LF3-t1-3, LF2-t1-2)

 = Min ( 18-15, 15-15)=0

The following table given the calculation for critical path and total float.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Activity*** | ***Normal time*** | ***Earliest*** | ***Latest*** | ***Total float LFj-ESj or LFi-ESi*** |
| ***Start*** | ***Finisgh*** | ***Start*** | ***Finish*** |
| ***ESi*** | ***ESj*** | ***LFi*** | ***LFj*** |
| 1-2 | 15 | 0 | 15 | 0 | 15 | 0 |
| 1-3 | 15 | 0 | 15 | 3 | 18 | 3 |
| 2-3 | 3 | 15 | 18 | 15 | 18 | 0 |
| 2-5 | 5 | 15 | 20 | 32 | 37 | 17 |
| 3-4 | 8 | 18 | 26 | 18 | 26 | 0 |
| 3-6 | 12 | 18 | 30 | 28 | 40 | 10 |
| 4-5 | 1 | 26 | 27 | 36 | 37 | 10 |
| 4-6 | 14 | 26 | 40 | 26 | 40 | 0 |
| 5-6 | 3 | 27 | 30 | 37 | 40 | 10 |
| 6-7 | 14 | 40 | 54 | 40 | 54 | 0 |

iii)The critical path

From the above table we observe that the activities 1-2, 2-3, 3-4, 4-6, 6-7 are the critical activities.

The critical path is given by, 1-2-3-4-6-7

The total projection is given by 54 days.