

OPSC

2019

Odisha Public Service Commission
Assistant Engineer Examination

Civil Engineering

Estimation, Construction Planning & Management

Well Illustrated **Theory** *with*
Solved Examples and **Practice Questions**



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Estimation, Construction Planning & Management

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Project Management and Network Theory

1.1 Introduction

Project is a temporary endeavour undertaken to provide a unique product, service or result. A project involves series of activities which consumes resource and time.

Objectives of a Project:

- It should be completed in minimum time with minimum capital investment.
- It should use available manpower and other resources optimally.

1.2 Phases of Project Management

1.2.1 Planning

Planning involves:

1. Defining objectives of the project.
2. Listing of jobs that have to be performed.
3. Determining gross requirements for materials, equipments and man power and preparing estimates of costs and duration for various jobs.
4. To bring about the satisfactory completion of project.

Planning is important because:

1. It provides direction and unifying frame work.
2. It helps to reveal future opportunities and provides performance standards.
3. It minimizes costs by utilizing available resources in best way.

1.2.2 Scheduling

Scheduling is the allocation of resources such as time, material, space, equipment and human and technological effort.

It involves:

1. Finalizing the planned functions mechanically.
2. Assigning starting and completion dates to each activity to proceed in a logical sequence and in a systematic manner.

1.2.3 Controlling

Controlling involves:

1. Determination of deviations from basic plan and their effects on the project.
 2. Replanning and rescheduling of activities to compensate for the deviations which is called “updating”.
- It should be noted that planning and scheduling are accomplished before the actual project starts while controlling is operative during execution of the project.



The method of planning and controlling that was originally developed was called Project Planning and Scheduling (PPS). PPS was later on converted into Critical Path Method (CPM), so the CPM involves the deterministic approach and is used for the repetitive types of projects.

1.3 Techniques Used for Project Management

1.3.1 Bar Chart

Firstly introduced by Henry Gantt around 1900 AD.

Features of bar chart are:

1. It is a pictorial chart
2. It has two coordinate axes, the horizontal coordinate represents the elapsed time and vertical coordinate represents the job or activity to be performed.
3. The beginning and end of each bar represents starting and finishing time of a particular activity respectively.
4. The length of bar shows the time required for completion.

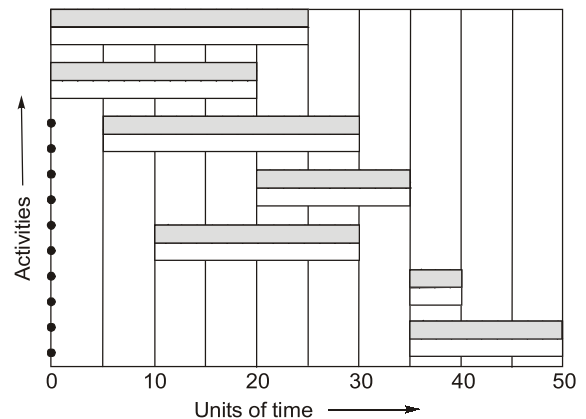


Fig. Bar Chart

Jobs can be concurrent or can be started one after other. So some bars can run parallel or overlap each other or may run serially.

Limitations of bar chart:

1. **Lack of degree of details:** Only major activities are shown in bar chart and sub-activities can not be separated out. Hence effective control over the activities in big projects can not be achieved.
2. A bar chart does not show progress of work and hence it can not be used as a control device.
3. A bar chart is unable to depict interdependencies of various activities clearly.
4. Bar charts are not useful in the projects where there are uncertainties in determination of estimation of time required for completion of various activities such as in R&D projects.
5. Bar chart can not distinguish between critical and noncritical activities and hence resource smoothening and resource levelling can not be done.

Bar chart diagrams are useful for only smaller and simpler conventional projects, especially construction and manufacturing projects, in which time estimates can be made with fair degree of certainty.

1.3.2 Mile-Stone Chart

- It is a modification over original Gantt chart. Milestones are key events of main activities represented by bar. Therefore they give idea about completion of sub-activities.

1.3.3. Linked Bar Chart

- It is an important our original bar chart or mile stone chart.
- In linked bar chart, auticities are linked with arrows and liners, indicating require and order of auticities.

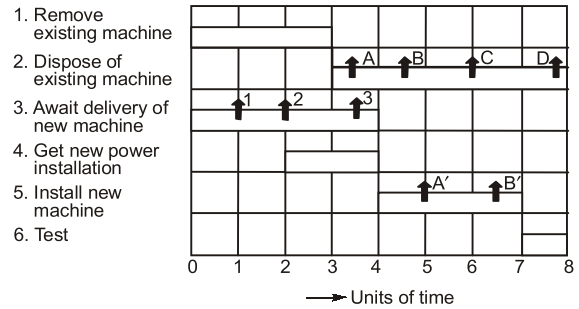


Fig. Mile-stone chart

Do you know? Controlling can be better achieved with the help of milestone charts, but still activity interrelationship and accountability of time uncertainty can not be depicted which can be overcome in network technique.

1.3.4 Network Methods

- It is an outcome of the improvements in the milestone charts.
- They are called by various names such as PERT, CPM, UNETICS, LESS, TOPS and SCANS.
- However all these have emerged from the two major network systems viz.:
 1. PERT
 2. CPM

1.4 Network Techniques

Advantages of network method over bar chart and milestone chart:

1. Interrelationships between activities and events of a project are clearly shown.
2. The project can be treated as an integrated whole with all its sub-activities clearly related with each other. It helps in controlling the project.
3. Network method is useful for very complicated projects having large number of activities.
4. It indicates the time required in between two activities in which rescheduling of a project is possible.
5. Time uncertainty is accounted for and so it is also useful for research and development projects.

1.5 Elements of a Network

1.5.1 Event

- An event is either start or completion of an activity.
- Events are significant points in a project which act as control points of the project.
- An event is an instant of time and it does not require time or resources.

Following are examples of an event:

1. All parts assembled
2. A budget prepared
3. Construction completed

Following can not be events:

1. Prepare budget
 2. Assemble parts
 3. Excavate trench
- Events are represented by nodes in a network. It may have any of the following shapes.

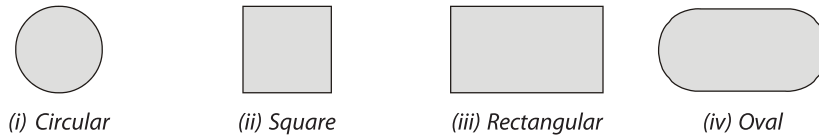


Fig. Different Shapes for Events

Most commonly adopted shape for events is circular shape.

- **A tail event or a start event of a project:** It has only outgoing arrows.

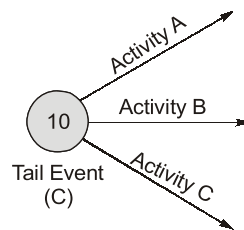


Fig. Tail Event

Event 10 is a tail event. Arrows represent job or activity of a project.

- **Head event or final event:** It is finish of a project having only incoming arrows.

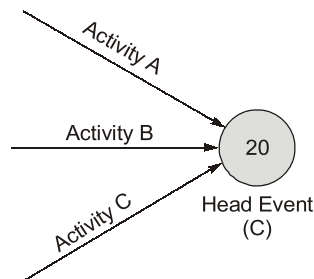


Fig. Head Event

Event 20 is a head event

- **Dual role events:** All events except the first and the last event of a project are dual role events. They have both incoming and outgoing arrows.

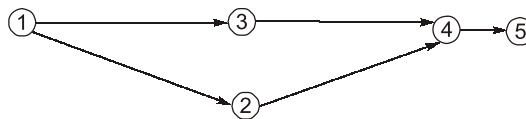


Fig. Dual Role Events

e.g.: Events 2, 3 and 4, are dual role events.

Events 2, 3, 4, are dual role events

- **Successor events :** The event or events that follow another event are called successor events to that event.

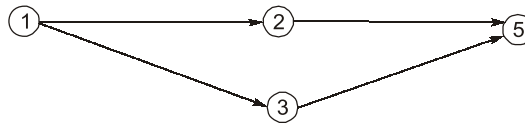


Fig. Successor Events

e.g.: Event 2 and 3 are successor events of event 1.

Event 2, 3 are successor events of 1

- **Predecessor events** : The event or events that occur before another event are called predecessor event to that event.

In above figure, events 2, 3 are predecessor to event 5.

Do you know? It should be noted there can be only one tail event and one head event in a project.

1.5.2 Activity

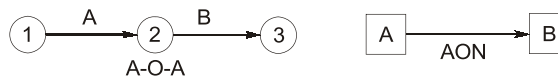
Activity is actual performance of a job. It requires time and resources for its completion.

Following are examples of an activity:

1. Excavate trench
2. Mix concrete
3. Prepare budget



In A-O-A system (Activity On Arrow network system), activity is represented by arrows between events while in A-O-N (Activity On Node system), activities are represented by nodes. In A-O-N system, events have no places.

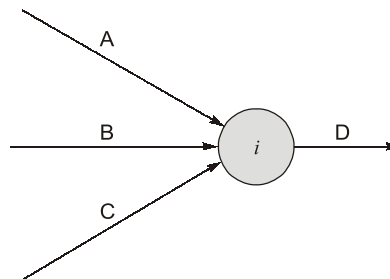


Here *A* and *B* activities are represented in two different systems.

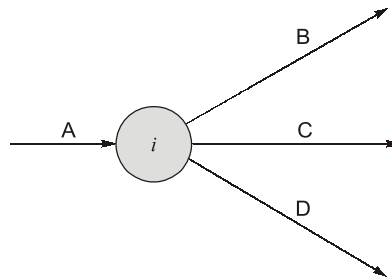
1.5.2.1 Type of Activity

1. **Parallel activities**: Parallel activities are those which can exist simultaneously or concurrently and are independent of each other.

Ex:

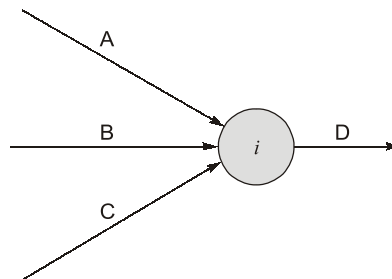


A, *B*, *C* are concurrent activities and terminates at same node '*i*' such activities are independent of each other.



As soon as event 'i' reached, activity B, C and D can be simultaneously started. Such activities (B, C, D) are also parallel activities.

2. **Serial activities:** The activities which can be started one after another and are dependent on each other are called as serial activities.



The set of activities A, B and C are in series with activity D.

3. **Successor and predecessor activity:** The activity which exist after the occurrence of other activity is referred as successor activity. If this activity exist immediately after the occurrence of other activities it is referred as immediate successor activity.

The activity which exist before the occurrence of other activity is referred as predecessor activity. If this activity exist immediately before the occurrence of the other activities is referred as immediate predecessor activity.

1.5.3 Dummy

- A dummy is a type of operation which neither requires time nor any resource, but it denotes dependency among the activities.
- It is represented by dashed arrow.

In the figure shown below, a dummy activity is shown.

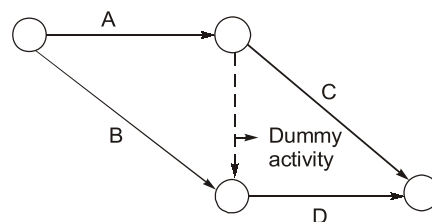


Fig. Dummy Activity