Project Management : PERT and CPM

Introduction :- A project is a combination of interrelated activities which must be executed in a certain order before the entire task is completed.

The main objective of project management is to schedule the required activities in an efficient manner so as to complete the project on or before a specified time at a minimum cost.

The two well-known techniques of project management are PERT : Project Evaluation and Review Technique.

CPM : Critical Path Method.

Basic difference between PERT and CPM :-

PERT :- (1). In PERT, three estimates are used to form weighted average of completion time optimistic most likely Pessimistic

(2). It is event oriented technique.

(3). It is based on probability distribution of completion times. So it is probabilistic.

(4). It is used for one time projects involving activities of non-repetitive nature.

(5). Time is not related to costs.

CPM :- (1). In CPM, there is only one estimate of completion time of each activity.

(2). It is activity oriented method.

(3). The duration of each activity was known with certainty.

(4). It is used for completion of projects involving activities of repetitive nature.

(5). Time is related to costs.

Significance of using PERT and CPM :-

1). A network diagram translates highly complex project into a set of simple and logical arranged activities.

2). The network diagram helps to get the clarity of thoughts and actions.

3). It helps in timely allocation of resources of various activities to achieve optimal utilization of resources.

4). Corrective action can be taken well in time.

5). Project can be completed with minimum expenditure with the help of PERT and CPM.

6). Difficulties and problems can be resonably expected.

Phases of project Management :-

1). Project planning Phase :- It is helpful to draw a network diagram.

a). Identify various activities (task) (work).

b). Determine requirement of resources such as men, machines, money etc.....

c). Assign responsibility for each work package.

d). Allocate resources to work packages.

e). Estimate cost and time

f). Develop work performance criteria.

g). Establish control channels for project personnel.

2). Scheduling Phase :- It prepares an estimate of the likelihood of the project to be completed on or before the specified time.

a).. Identify all people who will be responsible for each task.

b). Estimate the expected duration of each activity.

c). Specify the interrelationship among various activities.

d). Calculate the total project duration.

e). Identify the critical path and calculate the floats.

3) Project control phase :—

Project control refers to evaluating actual progress against the plan.

If there is a significant difference, then the scheduling and resource allocation decisions are changed, to update (revise) (modify) the allocation of resources and also cost minimization measures are adopted in such cases.

PERT / CPM Network components :—

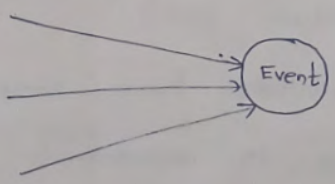
It consists of two major components.

1). Events :— Events represent the project mile stones such as starting and completion of an activity.

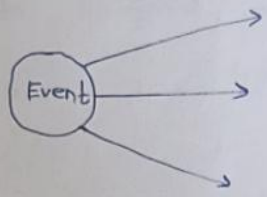
Events are commonly represented by circles (nodes) in the network diagram.

Events are classified into two categories.

(i) Merge event :— An event which represents the joint completion of two or more activities is known as merge event.



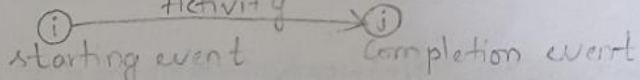
(ii). Burst Event :- An event which represents the initiation (begining) of two or more activities is known as burst event.



Events are represented by numbers.

The numbering of events in the network diagram must ~~start~~ start from left (start of the project) to the right (completion of the project) and top to the bottom.

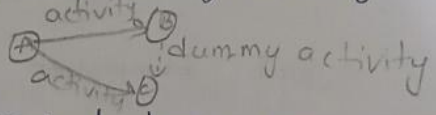
2). Activities :- Activities in the network diagram represent project operations (or tasks) to be conducted. An arrow is commonly used to represent an activity. The activities can be further classified into three categories.



(i). Predecessor Activity:- An activity which must be completed before one or more other activities start is known as predecessor activity.

(ii). Successor activity:- An activity which started immediately after one or more of other activities are completed is known as successor activity.

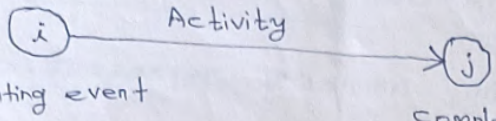
(iii). Dummy activity:- An activity which does not consume either any resource or time is known as dummy activity. A dummy activity is needed when



a). Two or more parallel activities in a project have same head and tail events. (or)

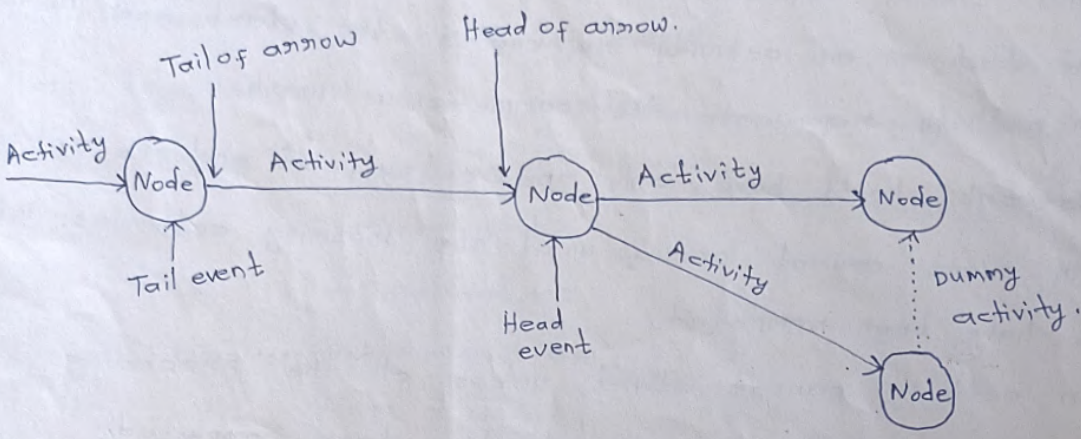
b). two or more activities have some of their immediate predecessor activities in common.

A dummy activity is denoted by dotted line. in the network diagram.



starting event

completion event.



Network Models :-

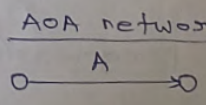
Activity-on-Node (AON) Network :- In this network activities are placed within the nodes, and the arrows are used to indicate sequencing requirements.

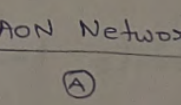
Activity-on-Arrow (AOA) Network :- In this network activities are indicated by arrows. The nodes indicates the points in time, when an activity is starting or ending.

In general, AOA diagrams are better for project management.

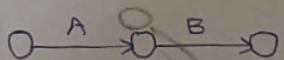
Some of the network diagrams are as follows,

1). Activity A

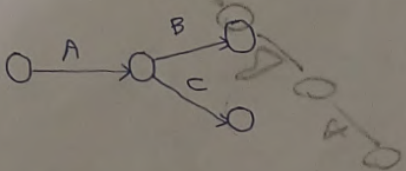


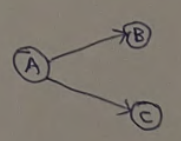


2). B must follow A

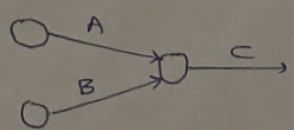


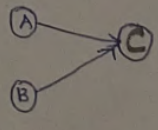
3). B and C must follow A



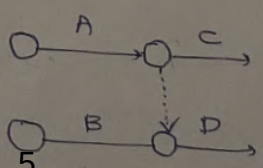


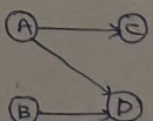
4). C must follow A and B





5). C must follow A, D must follow A and B





Rules for Network (drawing)

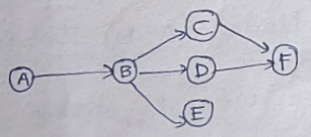
1). In the Network diagram, arrows represent activities and circles represent events.
The tail of an activity represents the start, and head of an activity represents the completion of work.

2). Network should have only one entry point and one exit point.

3). An event cannot occur until the incoming activities into it have been completed.

4). An activity cannot start unless all the preceding activities on which it depends have been completed.

5). Events left untied to the overall network are called "danglers".



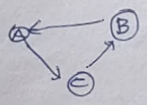
E - dangler.

To avoid this dangler, connect it to the end event F.

6). Crossing of arrows should be avoided.

7). An arrow should always be straight, but not curved.

8). Loop network should be avoided.



9). Use dummy activities when it is required and it is to be minimised.

10). Events have to be progressively numbered from left to right.

CRITICAL PATH METHOD

The critical path analysis is used to estimate the total project duration and to assign starting and finishing time of all activities involved in the project.

The duration of individual activities may be uniquely determined in the case of CPM.

Notations:- E = Earliest occurance time of an event.

L = Latest allowable time of an event.

ES = early starting time of an activity.

LS = Late starting time of an activity.

EF = Early finishing time of an activity.

LF = Late finishing time of an activity.

t = duration of an activity.

Earliest occurance time:- (Forward Pass Method):-

1). set the earliest occurance time of initial event 1 to zero.

i.e $E_1 = 0$ for $i = 1$.

2). Earliest starting time $ES_{ij} = E_i$ for activity (i,j) starting at event i

3). Earliest finishing time $EF_{ij} = ES_{ij} + t_{ij}$

4). Proceed to next event as above.

5). Earliest occurance time $E_j = \text{Max}\{EF_{ij}\}$, for all predecessor activities.

6). If $j = N$ is the final event

$E_N = \text{Max}\{EF_{ij}\}$ for all terminal activities.

Latest Allowable time :- (Backword Pass Method).

1). set the latest occurance time of last event N equal to its earliest occurance time.

$L_N = E_N$ for $j = N$.

2). Latest finishing time

$LF_{ij} = L_j$ for all activities (i,j) ending with the event j.

3). Latest starting time

$LS_{ij} = LF_{ij} - t_{ij}$ for all activities (i,j) ending at event j.

4). Proceed backward to the event in the sequence.

5). Latest occurance time of event i is

$L_i = \text{Min}\{LS_{ij}\}$ for all immediate succesor activities.

6). For $j = 1$ (initial event),

Latest occurance time

$L_1 = \text{Min}\{LS_{ij}\}$ which becomes zero.

Float (slack) (free time) of an Activity and Event :-

It is the length of time to which an event can be delayed without delaying the total project completion time.

Floats occur in non-critical activities.

Slack on Events :- Event Float $= L_i - E_i$

If $L = E$, then such events are critical events.

If $L \neq E$, then slack on such events can be negative $(L < E)$ or positive $(L > E)$.

Slack or Activities:- It is the length of free time available within the estimated times of non-critical activities. There are three types of floats on non-critical activities.

Total Float $TF_{ij} = LS_{ij} - ES_{ij} = LF_{ij} - EF_{ij}$.

Free Float $FF = (E_j - E_i) - t_{ij}$

Independent float $= (ES_{ij} - LS_{ij}) - t_{ij} = (E_j - L_i) - t_{ij}$.

The negative value of independent float is considered as zero.

Critical Path:-

The activities having zero total float value are identified as critical activities.

Critical path is the sequence of critical activities that form a continuous path between the start of a project and its completion.

If any activity in this sequence is delayed, the completion of entire project will be delayed.

The critical path is shown by a thick line or double line in the network diagram.

The Longest time to complete the project

= Length of the critical path

= sum of the individual times of all the critical activities.

The critical path on a network diagram can be identified as (i). For all activities (i, j). $E_j = L_j$ and $E_i = L_i$

(ii). On critical path. $E_j - E_i = L_j - L_i = t_{ij}$