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School of Mechanical Engineering

Module 6

Project Scheduling

By

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Project

- A project is a combination of interrelated activities with well defined objectives to be completed in a specific time period. Project is something special which is different from routine and regular activities.
- Project is a non routine, non repetitive, one-off undertaking, with well defined time, financial and technical performance goal.
- According to Project Management Institute (PMI), “Project can be defined as a temporary endeavor undertaken to accomplish a unique objective at goal.”

EXAMPLES OF PROJECT

- Construction of a house.
- Writing a book.
- Building a dam.
- Introducing a new product in the market.
- Construction of a new bridge over a river.
- A Politician contesting an election.
- Organizing a seminar.

Project Management

- PM is the application of knowledge, skills, tools and techniques to a broad range of activities in order to meet the requirements of the particular project.
- Project Management knowledge and practices are best described in terms of their component processes.
- These processes can be placed into five Process Groups: Initiating, Planning, Executing, Controlling and Closing.

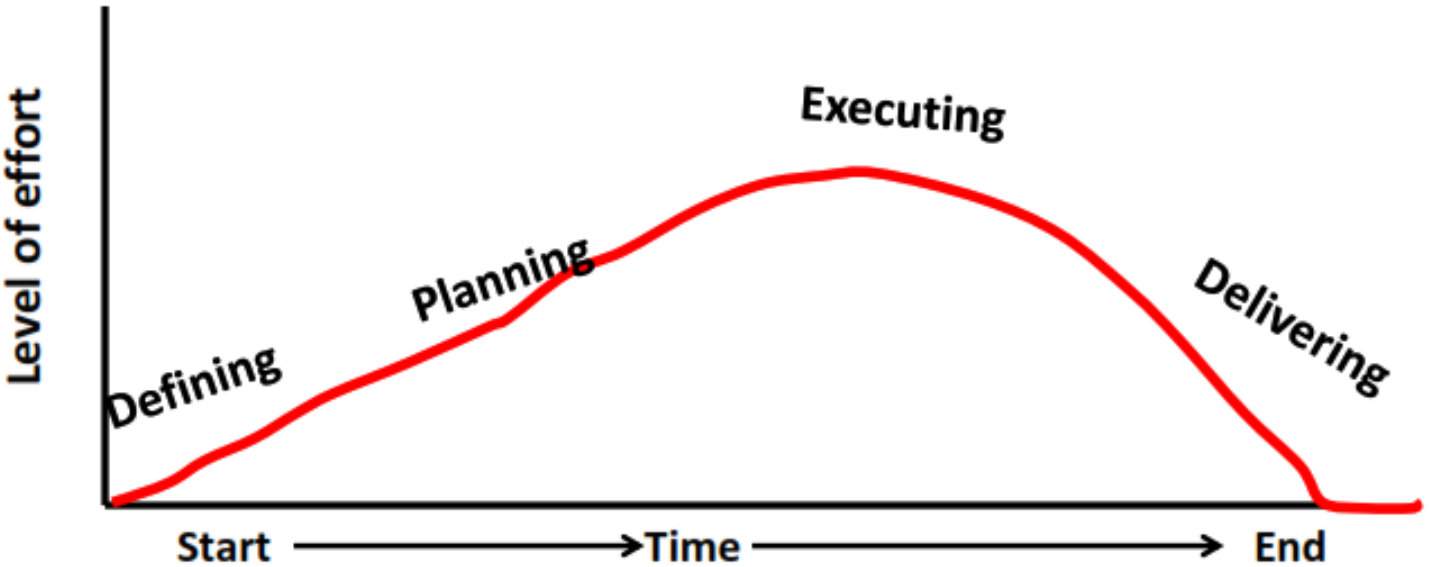
Why do companies use PM?

- To handle projects effectively in an organization.
- To define the project and agree with the customer
- To plan and assess resource needs for the project
- To estimate project cost and make proposals
- To plan & schedule activities in a project.
- To allocate the right resource at the right time.
- To assess risk and failure points and make backup plans.
- To lead a project team effectively and communicate well among
- To explore the latest concepts and techniques of project management.
- To learn a new thought process that helps organized thinking and structured approach.

Project Management Activities

- Planning the work
- Assessing and justifying risk
- Estimating resources
- Organizing the work
- Acquiring human and material resources
- Assigning tasks
- Directing activities
- Controlling project execution
- Reporting progress
- Analyzing the results based on the facts achieved

Project Management Process



Defining	Planning	Executing	Delivering
1.Goal	1.Schedules	1.Status reports	1.Train Customer
2.Specifications	2.Budgets	2.Changes	2.Transfer documents
3.Tasks	3.Resources	3.Quality	3.Release Resources
4.Responsibilities	4.Risks	4.Forecasts	4.Lessons learned
	5.Staffing		

PM Phases


PROJECT
MANAGEMENT
STAGES
PLANNING
SCHEDULING
CONTROLLING
CLOSING
Most important phase of the project management.
Planning is an art and science of converting a set of objectives to realization through a series of steps executed in an organized and predicted way so that there will be less requirement of changes in the plan later on.
The old saying "Plan the work, Work the plan"

- PLANNING
- SCHEDULING
- CONTROLLING
- CLOSING

Scheduling Phase is the process of formalizing the planned activities, assigning the durations, resources and sequence of occurrence in consultation with the team members.

Planning and Scheduling phases are under taken before the actual project starts.

PLANNING

SCHEDULING

CONTROLLING

CLOSING

Controlling phase is undertaken during the actual project implementation.

Project controlling is a mechanism established to determine deviations from the project base schedule, to re-plan & reschedule during implementation to compensate the deviations on the basis of commissioning minima, flow of resources like finance, manpower, equipment & application techniques.

PLANNING

SCHEDULING

CONTROLLING

CLOSING

Closing phase is the last phase of the project which brings close out of the complete project. Whatever the project requirements are pre-defined, during this phase the total delivery is made and it is accepted by the customer.

Maximum conflicts can arise in the project during this phase between those who have worked to deliver the outcome (contractor) and those who are accepting the results of the work (customer).

Techniques of PM

- Bar charts, Milestones charts,
- Network techniques

(a) Programme Evaluation and Review Technique (PERT)

(b) Critical Path Method (CPM)

Bar charts are the two-dimensional pictorial representation of a project. In a bar chart, the activities of the project are shown on one axis and their durations are represented on the other axis. A bar chart helps to review the project progress, allows for rescheduling the project and highlights the critical activities and other bottlenecks in the completion of the project. A bar chart, however, is normally suited to small projects. It cannot take into account the uncertainties in activity duration nor represent the interrelationships between the various activities of the project.

Milestone charts are the modified and improved versions of bar charts. However, whereas bar charts represent activities, milestone charts represent the events which mark either the beginning or the end of an activity. Though milestone charts are more detailed and offer better control than bar charts, they possess most of the drawbacks inhert in bar charts.

Difference in PERT & CPM

- PERT is appropriate where time estimate are uncertain in the duration of activities as measured by optimistic time, most likely time, and pessimistic time, where as CPM is good when time estimates are found with certainty. CPM assumes that the duration of every event is constant and therefore every activity is critical or not.
- PERT is concerned with events, which are the beginning or ending points of operation while CPM is concerned with activities.
- PERT is suitable for non-repetitive projects while CPM is designed for repetitive projects.
- PERT can be analyzed statistically whereas CPM not.
- PERT is not concerned with the relationship between time and cost, whereas CPM established a relationship between time and cost is proportionate to time.

Developing a Project Network

i. Project Network is a tool used for planning, scheduling and monitoring project progress.
ii. It is a graphical flow chart of the project job plan.
iii. Critical path should be identified.
iv. It is used to take decision concerning project time, cost and performance.
v. The network depicts the project activities that must be completed, logical sequences and their inter dependencies.

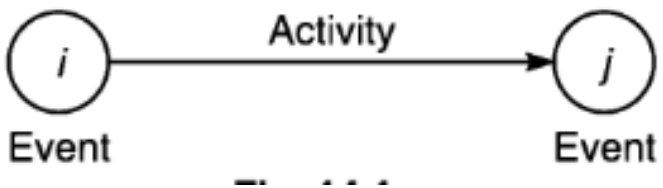
Network are built using nodes and arrows.

Nodes → Activity

Arrow → Project flow

Constructing a Project Network

- **Activity :** An activity is an element of the project. It usually represents one or more tasks from a work package.
- **Parallel Activity :** Activities that can take place at the same time
- **Path:** Sequence of connected, dependent activities.
- **Critical Path:** Longest path through the network.
- **Event:** It is a point in time when an activity is started or completed.



Dummy Activity

An activity which only determines the dependency of one activity on the other, but does not consume any time is called a dummy activity. Dummies are usually represented by dotted line arrows.

To illustrate the use of dummy, refer to Fig. 14.2 (*a*) and assume that the start of activity C depends upon the completion of activities A and B and that the start of activity E depends only on the completion of activity B. For this situation, figure 14.2 (*a*) is a faulty representation. This is corrected by introducing a dummy activity D as shown in Fig. 14.2 (*b*).

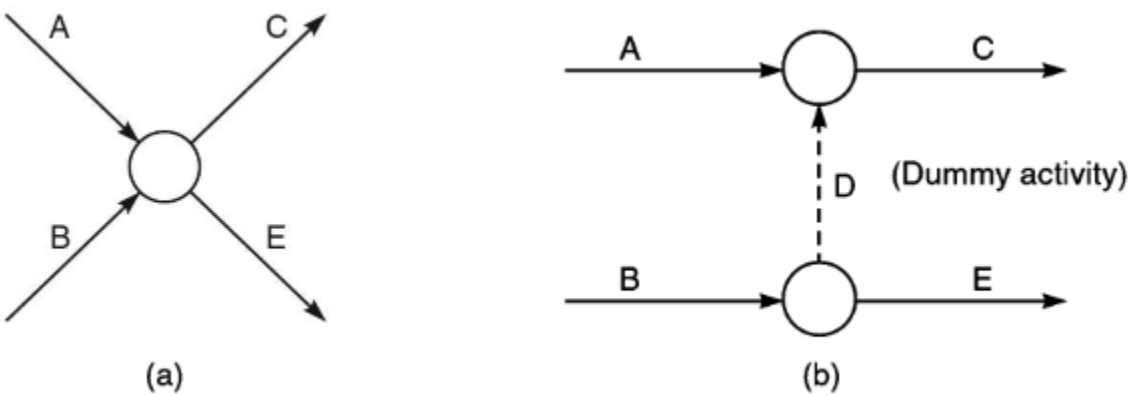
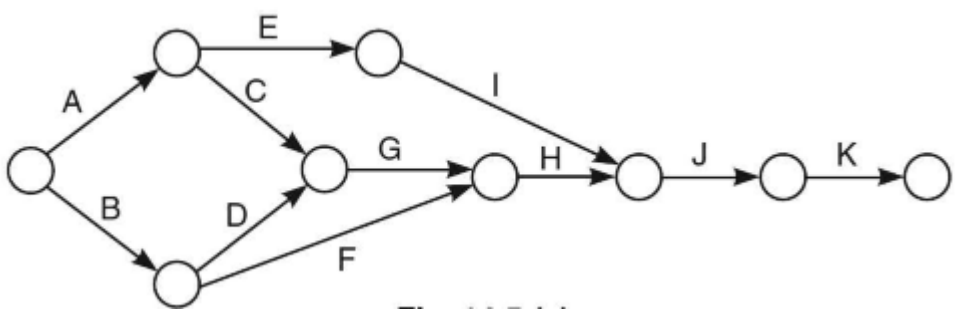


Fig. 14.2. (a), (b)

EXAMPLE

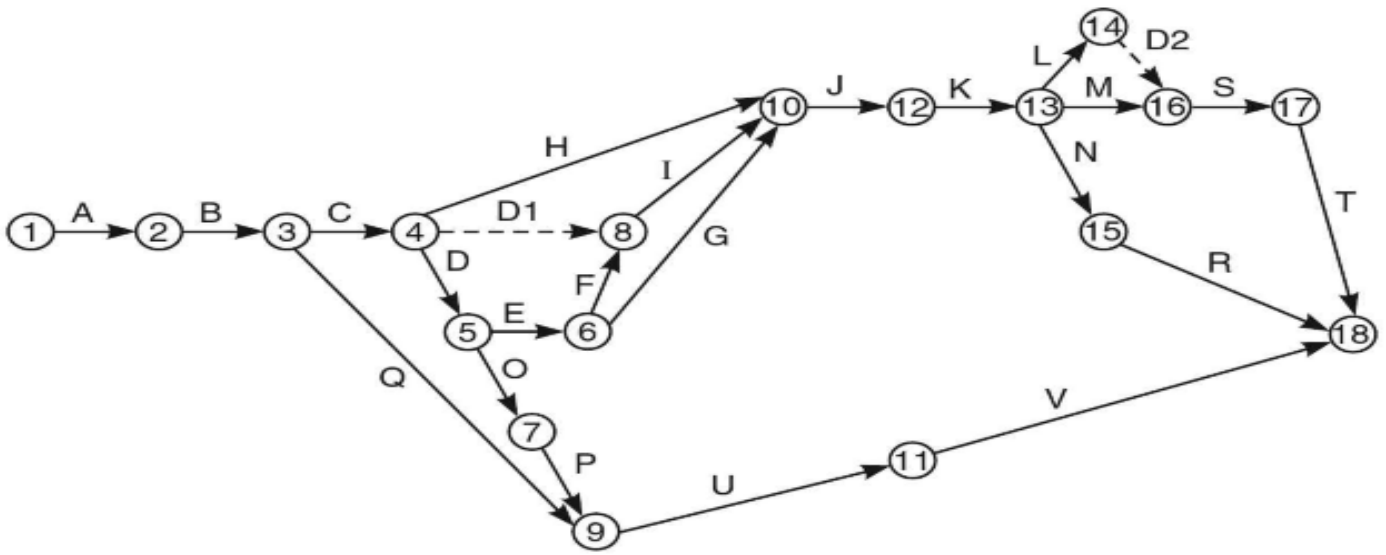
Draw a network for the simple project of erection of steel works for a shed. The various activities of the project are as under:

Activity	*Description*	*Preceded by*
A	*Erect site workshop*	—
B	*Fence site*	—
C	*Bend reinforcement*	*A*
D	*Dig foundation*	*B*
E	*Fabricate steel work*	*A*
F	*Install concrete pillars*	*B*
G	*Place reinforcement*	*C, D*
H	*Concrete foundation*	*G, F*
I	*Erect steel work*	*E*
J	*Paint steel work*	*H, I*
K	*Give finishing touch*	*J*



EXAMPLE *Draw the network diagram for the following list of activities:*

Activity	*Immediate predecessor*	*Activity*	*Immediate predecessor*
A	-	*L*	*K*
B	*A*	*M*	*K*
C	*B*	*N*	*K*
D	*C*	*O*	*D*
E	*D*	*P*	*O*
F	*E*	*Q*	*B*
G	*E*	*R*	*N*
H	*C*	*S*	*L,M*
I	*C,F*	*T*	*S*
J	*G,H,I*	*U*	*P,Q*
K	*J*	*V*	*U*



Critical Path Method

The critical path analysis consists of the following steps:

1. *Calculate the time schedule for each activity* : It involves the determination of the time by which an activity must begin and the time before which it must be completed. The time schedule data for each activity include the calculation of the earliest start, the earliest finish, the latest start, the latest finish times and the float.

2. *Calculate the time schedule for the completion of the entire project* : It involves the calculation of project completion time.

3. *Identify the critical activities and find the critical path* : Critical activities are the ones which must be started and completed on schedule or else the project may get delayed. The path containing these activities is the critical path and is the longest path in terms of duration.

The *earliest start time* (E) for an activity represents the time at which an activity can begin at the earliest.

If only one activity converges on an event, its earliest start time E is given by E of the tail event of the activity plus activity duration. If more than one activity converges on an event, E's via all the paths would be computed and the highest value chosen and put around the node.

The *latest finish time* (L) for an activity represents the latest by which an activity must be completed in order that the project may not be delayed beyond its targeted completion time.

If only one activity emanates from an event, compute L by subtracting activity duration from L of its head event. If more than one activity emanates from an event, compute L's via all the paths and choose the smallest and put it around the event at hand.

earliest finish time (T_{EF}) and the *latest start time* (T_{LS})

$$T_{EF} = \bar{E} + t_{ij},$$
$$T_{LS} = L - t_{ij}$$

Float is, thus, the positive difference between the finish times

$$F = L - T_{EF} \text{ or } F = T_{LS} - E.$$

Activity	:	1-2	1-3	2-3	2-5	3-4	3-6	4-5	4-6	5-6	6-7
Duration (weeks)	:	15	15	3	5	8	12	1	14	3	14

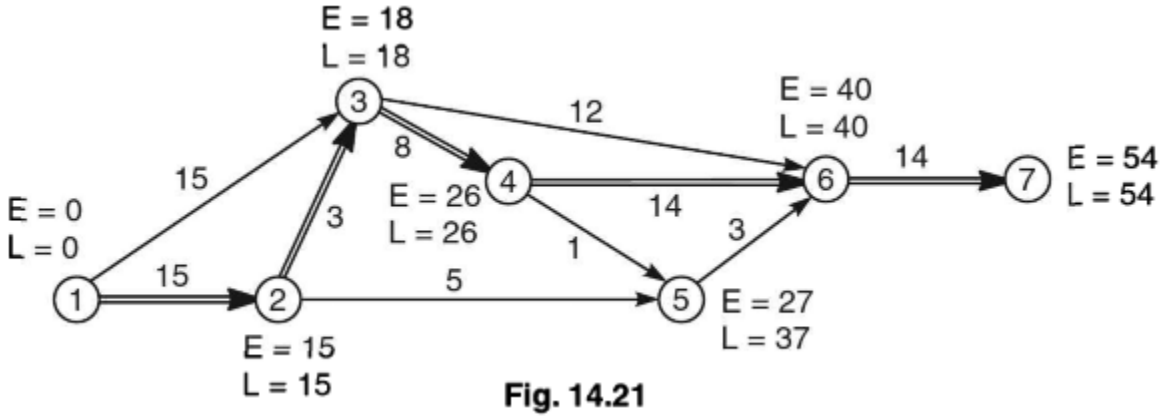


Fig. 14.21

column 4 = column 6 – column 2,
column 5 = column 3 + column 2,
column 7 = column 6 – column 5,
= column 4 – column 3.

Activity (i – j)	*Duration (D)*	*Start time*		*Finish time*		*Total Float*
		Earliest	*Latest*	*Earliest*	*Latest*	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1-2	15	0	0	15	15	0
1-3	15	0	3	15	18	3
2-3	3	15	15	18	18	0
2-5	5	15	32	20	37	17
3-4	8	18	18	26	26	0
3-6	12	18	28	30	40	10
4-5	1	26	36	27	37	10
4-6	14	26	26	40	40	0
5-6	3	27	37	30	40	10

Tasks A, B, C,..., H, I constitute a project. The precedence relationships are

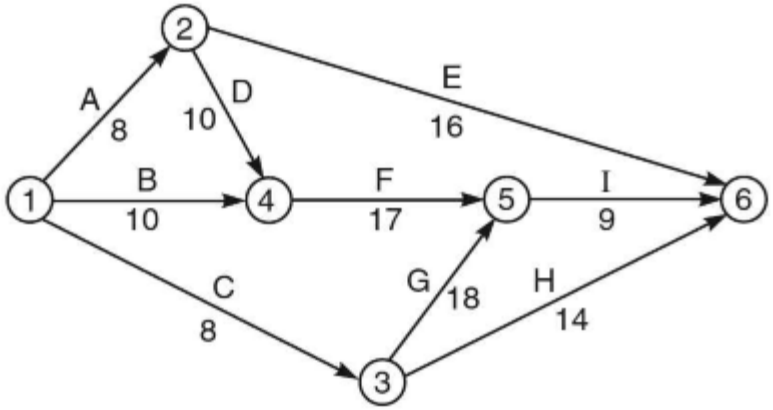
$$A < D;\ A < E;\ B < F;\ D < F;\ C < G;\ C < H;\ F < I;\ G < I.$$

Draw a network to represent the project and find the minimum time of completion of the project when time, in days, of each task is as follows:

Task	:	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*
Time	:	*8*	*10*	*8*	*10*	*16*	*17*	*18*	*14*	*9*

Also identify the critical path.

Path	*Duration (days)*
1–2–6	8 + 16 = 24
1–2–4–5–6	8 + 10 + 17 + 9 = 44
1–4–5–6	10 + 17 + 9 = 36
1–3–5–6	8 + 18 + 9 = 35
1–3–6	8 + 14 = 22



		Start time		*Finish time*		
Activity	*Duration*	*Earliest*	*Latest*	*Earliest*	*Latest*	*Total Float*
1-2	8	0	0	8	8	0
1-3	8	0	9	8	17	9
1-4	10	0	8	10	18	8
2-4	10	8	8	18	18	0
2-6	16	8	28	24	44	20
3-5	18	8	17	26	35	9
3-6	14	8	30	22	44	22
4-5	17	18	18	35	35	0

PROGRAMME EVALUATION AND REVIEW TECHNIQUE (PERT)

Time Estimates

(*i*) *The Optimistic Time Estimate (t_o or a)* : The shortest possible time required for the completion of an activity, if all goes extremely well. No provisions are made for delays or setbacks while estimating this time.

(*ii*) *The Pessimistic Time Estimate (t_p or b)* : The maximum possible time the activity will take if everything goes bad. However, major catastrophes such as earthquakes, floods, storms and labour troubles are not taken into account while estimating this time.

(*iii*) *The Most Likely Time Estimate (t_m or m)* : The time an activity will take if executed under normal conditions. It is the modal value. It is assumed that the situation is normal with usual setbacks or lapses.

$$t_e = \mu = \frac{t_0 + 4t_m + t_p}{6}.$$

$$Z = \frac{T - T_{cp}}{\sigma},$$

T is called *the desired time*

$$V = \sigma^2 = \left(\frac{t_p - t_0}{6}\right)^2$$

$$\sigma = \frac{t_p - t_o}{6},$$

The expected time is then used as the activity duration and the critical path is obtained by the analytical method explained earlier.

The variance or standard deviation is used to find the probability of completing the whole project by a given date.

EXAMPLE

Consider the network shown Fig. 14.31. For each activity, the three time estimates t_o, t_m and t_p are given along the arrows in the $t_0 - t_m - t_p$ order. Determine variance and expected time for each activity.

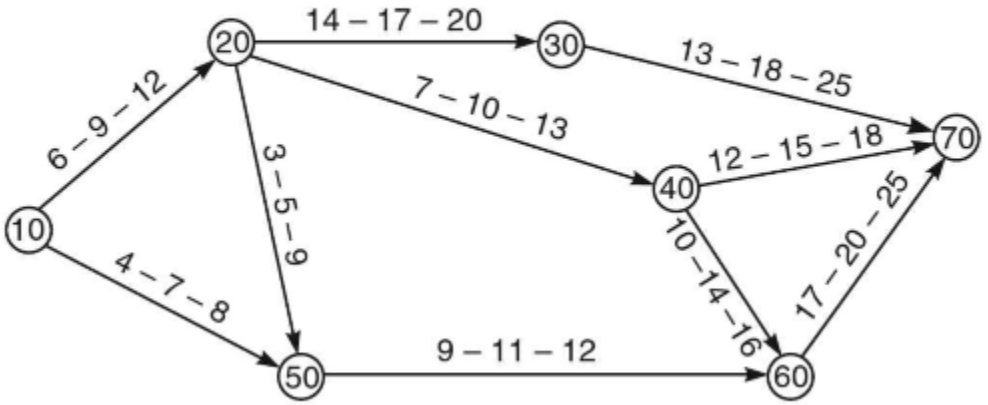
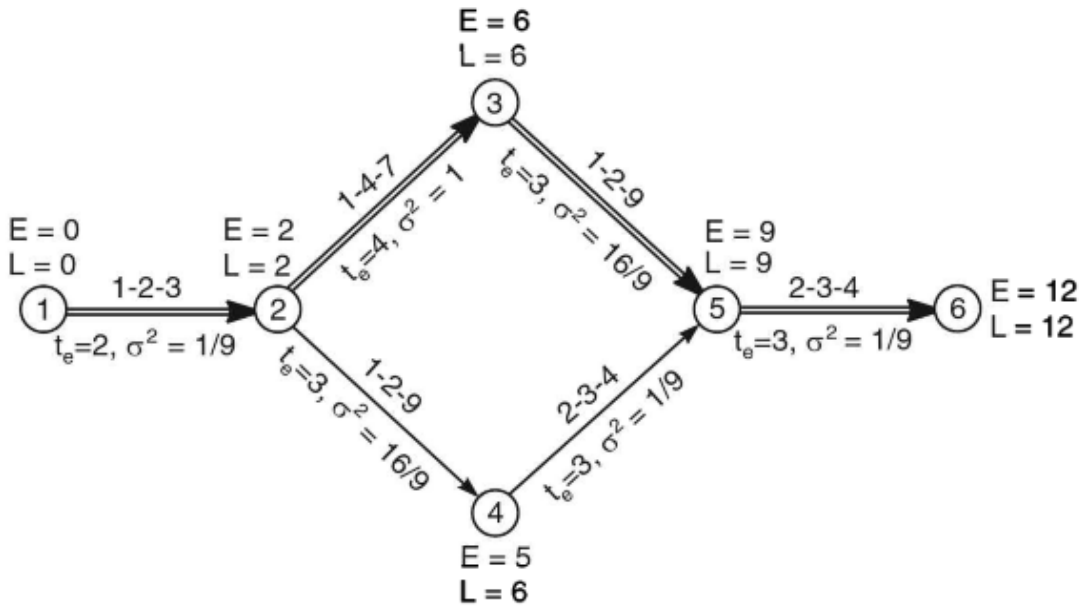


Fig. 14.31

Activity i-j		t_o	t_m	t_p	$\sigma^2 = V = \left(\frac{t_p - t_0}{6}\right)^2$	$t_e = \frac{t_0 + 4t_m + t_p}{6}$
Predecessor event i	*Successor event j*					
10	20	6	9	12	1.00	9.0
10	50	4	7	8	0.44	6.7
20	30	14	17	20	1.00	17.0
20	40	7	10	13	1.00	10.0
20	50	3	5	9	1.00	5.33
30	70	13	18	25	4.00	18.33
40	60	10	14	16	1.00	13.67
40	70	12	15	18	1.00	15.00
50	60	9	11	12	0.25	10.83

EXAMPLE

Consider the network shown in Fig. 14.34. The three time estimates, the expected activity durations and the variances are shown along the arrows. The earliest expected times and the latest allowable occurrence times are computed and put along the nodes. What is the probability of completing the project in (i) 12 days (ii) 14 days (iii) 10 days ?



Solution

We identify that the path 1-2-3-5-6 is the critical path and expected project length is 12 days.

(*i*) Here, $T_{cp} = 12$ days, $T = 12$ days.

Standard deviation for the project length, $\sigma = \sqrt{\Sigma\sigma_{ij}^2}$ for all ij on the critical path.

$\therefore \quad \sigma = \sqrt{1/9 + 1 + 16/9 + 1/9} = 1.73.$

$\therefore$ Normal deviate, $Z = \dfrac{T - T_{cp}}{\sigma} = \dfrac{12 - 12}{1.73} = 0.$

$\therefore$ Probability of completing the project (from table C.2) = 50%.

(*ii*) Here, $T = 14$ days.

$\therefore \quad Z = \dfrac{14 - 12}{1.73} = 1.16.$

$\therefore$ Corresponding probability = 87.7%.

(*iii*) Here, $T = 10$ days.

$\therefore \quad Z = \dfrac{10 - 12}{1.73} = -1.16.$

$\therefore$ Corresponding probability = 1 – 0.877 = 0.123 = 12.3%.

Thank You