CO5	Conduct inspection of Projects and audit progress and bills

UNIT NO	Unit skill set(In cognitive domain)	Topics / Subtopics
5.Project Control, Review and Audit	Use Project Managementlifecycle knowledge to Control project parameters, review and audit project performance	Project Control, Problems of Project Control, Gantt Charts, Milestone Charts, Critical Path Method (CPM), Network Technique in Project Scheduling,Crashing Project Duration through Network, Project Review, Initial Review, Performance Evaluation, Abandonment Analysis, ProjectAudit Case Study 2c

5. Project Control, Review and Audit	5.1 Introduction
	5.2 Projected Control Purposes
	5.3 Problems of Project Control
	5.4 Gantt Charts
	5.5 Milestone Charts
	5.6 Critical Path Method (CPM)
	5.7 Construction of a Network
	5.8 Network Technique in Project Scheduling
	5.9 Crashing Project Duration through Network
	5.10 Project Review
	5.11 Initial Review
	5.12 Post Audit
	5.13 Performance Evaluation
	5.14 Abandonment Analysis
	5.15 Objectives of Project Audit
	5.16 Functions of Project Auditor
	5.17 Project Audit Programme
	5.18 Difficulties in Establishing Audit Purpose andScope

UNIT 5: PROJECT CONTROL, REVIEW AND AUDIT

5.1 Introduction:

Once the project has been launched, it is essential to control the projects to achieve the desired results.

In this process the control becomes closely inter- wined in an integrated managerial process.

Project control involves a regular comparison of performance against targets, a search for the causes of deviation and a commitment to check adverse variances.

Project control serves two major functions:

a. It ensures regular monitoring of performance.

b. It motivates project Personnel to strike for achieving project Objectives.

Steps in Projects Control:

There are two important steps in the project control viz;

1. Establishment of controls.

2. On-going controlling activities using above controls.

It is nothing but controlling a project when it enters the production period-using the controls established during the initiation period.

Control during the production period involves four steps, They are

1. Setting targets for what should be achieved,

2. Measuring of what is happening including anticipation of what may happen.

3. Comparison between what should happen and what is happening or likely to happen.

4. Taking corrective actions to make things happen, as they should.

5.2 Projected Control Purposes :

The Projects Control can be exercised on different aspects. Such as

1. On the progress of the activities.

2. On the performance of project activities.

3. On project Schedule.

4. On Projects Cos.t

5.3 Problems of Project Control:

Effective control is critical for the realization of project objectives. Control of projects in practice tends to be ineffective. There are three main reasons for poor control of projects viz.,

1. Characteristics of the project Largeness and complexities -Maintenance of non-routine activities Co-ordination and communication problem.

2. People Problems

Managers do not have required experience & training Lack of competence and inclination to control projects.

3. Poor control and information system: Delay in reporting performance inappropriate level of detail Unreliable information.

5.4 Gantt Charts :

In dealing with complex projects is pictorial representation showing the various jobs to be done, and the time and money they involve is generally helpful.

One such pictorial charges, also known is the bar chart, was developed by Henery Gantt around 1900. It consists of two coordinate axes, one representing the time elapsed and the other, jobs or activities performed. The jobs are represented in the form of bars .

The length of a bar indicates the duration the job or activity take for completion. Generally, in any project some jobs can be take up concurrently and some will have to be completed before others can begin.

Hence, in a bar chart representing a projects, some of the bars run parallel or overlap each other times-wise (these correspond to concurrent jobs) and some run serially with one bar beginning after another bar ends (corresponding to an activity that succeeds a preceding activity).

In fig. for example activities A, B and C can start at the some time and proceed concurrently or in parallel, though they take different time intervals for their completion. Activity D, however, cannot begin until activity A is over. The bars representing A and D therefore run serially.

Let us consider a specific example. A piece of equipment is made of two parts A and B which are to be assembled together before they are dispatched.

Part A is of cast steel, which requires a pattern and a mould.

Part B is a machined item made on special machine M which needs to be purchased and installed.

Part A requires specialised-treatment before assembly.

The assembly needs to be tested with a specially constructed rig before dispatch.

The time scale for each activity is as follows:

Preparing a pattern for casting	4 Weeks
Preparing a mould	2 Weeks
Costing the cleaning operation of A	1 Weeks
Heat-treatment of A	2 Weeks

Machine part B	5 Weeks
Assembling part A and B	3 Weeks
Preparing the test rig	4 Weeks
Testing the assembly	2 Weeks
Packing for dispatch	1 Weeks

The bar chart for this project is shown in Fig. The various activities are shown along the ordinate or the vertical axis and the time elapsed along the horizontal axis.

The chart is self-explanatory.

WEAKNESSES IN BAR CHARTS

The bar chart may appear to be a excellent pictorial representation of a project. However, in practice, bar charts have serious limitations. A few of these are:

1.Interdependent of activities:

In a programme where there are a large number of activities that can be started with a certain degree of concurrency, the bar chart cannot show clearly the interdependent among the various efforts or activities. This is a serious deficiency.

The mere fact to or more activities are scheduled for simultaneous or overlapping times does not necessarily make them related or interdependent, or completely independent.

Consider, for example, the project represented in Fig. Such activities as preparing a pattern, preparing a mould, costing and cleaning,and heat-treating have to run sequentially, i.e., one activity must be completed before the other can begin.

The bars representing these activities are not allowed to overlap. On the other hand, installing machine M and preparing the test rig can proceed simultaneously because they are completely independent activities and hence the bars representing them can run parallel to each other. However, this is exactly the weakness of the bar chart, because two parallel bars need not necessarily stand for independent activities, as the following example will show.

Suppose a project involves digging foundation, erecting side boards or shuttering, and pouring concrete. The time consumed is shown against each activity:

Digging foundation	20 Weeks
Erecting side boards	14 Weeks
Pouring concrete	16 Weeks

If the activities are not allowed to run in parallel but in strict sequence, the total time taken for the completion of the project is 50 weeks.

As we can easily see, erection of the sideboards can start after the completion of, say, one-half offoundation digging.

Similarly, pouring of concrete can start, say, 5 Weeks after the erection of side boards. The bar charts for these activities will as shown in Fig.

According to this plan, the side board erectors still have 4 weeks of work after the excavation job is over. However, if due to certain unexpected difficulties the excavation is delayed by 1 or 2 weeks, how will reflect on the sideboard erection or the concrete pouring job? This is not revealed by the bar chart.

2.Project progress:

A bar chart cannot be used as a control device since it does not show the progress of work.

A knowledge of the amount of work in progress or jobs completed is absolutely necessary in a dynamic programme.

Changes in plans are a necessary part of a large project and a bar does not offer much assistance under such circumstances.

However, a conventional bar chart can be modified to give this additional information. Suppose 16 weeks have elapsed after project started and the progress made in the project can be depicted by partially filling in the blank bars. This will indicate which process is behind schedule.

3.Uncertainties

One of the most important deficiencies of the bar chart is its inability to reflect the uncertainty or tolerances in the duration times estimated for various activities.

The modern day space system programmes or other complex projects are largely characterized by extensive research, development and technological progress.

Thetraditional knowledge or practices play a very insignificant role. In such situations, the completion of various stages or jobs cannot be forecast with precision.

Uncertainty about a test becoming successful or a sudden break though in technology to know-how will always provide situations which will make rescheduling of various events a necessary part of the project and give it a dynamic character which is not reflected in a bar chart.

5.5 Milestone Charts :

Because of the shortcomings or the inadequacies of the chart in meeting the requirements of the modern day management, efforts have been made to modify it by adding new elements.

Another important modification, relatively successful, has formed a link in the evolution of the Gantt chart into the PERT or CPM network.

This modification is called the milestone system. Milestones are key events or point time, which can be identified when, completed as the project progresses.

In the Gantt chart a bar which represents a long-term job is broken down to several pieces, each of which stands for an identifiable major event.

Each event is numbered and an explanatory table given identifying the number with the event. These are specific events (points in time) which management has identifies as important reference points during the completion of the project. This work breakdown increases the awareness of the interdependent between tasks.

From a Gantt chart and milestone charts, two important points to be notices are that: (a) the long time jobs are identified in terms of specific events or milestone; and (b) these milestones or key events are plotted against the time scale indicating their achievements by specified dates.

While the milestone chart was definitely an improvement on the bar chart, it still had one great deficiency, i.e., it did not clearly show the interdependent between events.

In a milestone chart the events are in chronological, but not logical,sequence. A natural extension of the milestone chart was the network where the events are connected by arrows in a logical sequence.

5.6 Critical Path Method (CPM) :

The critical path analysis is an important tool in production planning and scheduling. Gantt charts are also one of the tools of scheduling but they have one disadvantage for which they are found to be unsuitable. The problem with Gantt chart is that the sequence of operation of a project or the earliest possible date for the completion of the project as a whole cannot be ascertained. This problem is overcome by this method of Critical Path Analysis.

CPM is used for scheduling special projects where the relationship between the different parts of project is more complicated than of a simple chain of task to be completed on after the other. This method (CPM) can be used at one extreme for the very simple job and at other extreme for the most complicated tasks.

A CPM is a route between two or more operations which minimizes (or maximizes) some measures of performance. This can also be defined as the sequence of activities, which will require greatest normal time to accomplish. It means that the sequences of activities, which require longest duration, are singled out. It is called at critical path because longest duration is singled out. It is called as critical path because any delay in performing the activities should be taken should be taken up first.

ACCORDING TO JOHN L. BURBIDGE, "One of the purpose of critical path analysis to find the sequence of activities with the largest sum of duration times, and thus find the minimum time necessary to complete the project. This critical series of activities is known as the 'CRITICAL PATH".

Under CPM, the project is analyzed into different operation or activities and their relationship are determined and shown on the network diagram. So, first of all a network diagram is drawn. After this the required time or some other measure of then combined to develop a schedule which minimizes or maximizes the measure of performance for each operation. Thus CPM marks critical activities in a project and concentrates on them. It is based on the assumption that the expected time is actually the time taken to complete the object.

MAIN OBJECTS OF CPM

The main objects of CPM are:

(i) To find difficulties and obstacles in the course of production process

(ii) To assign time for each operation,

(iii) To ascertain the starting and finishing times of the work

(iv) To find the critical path and the minimum duration time for the project as a whole.

SITUATION WHERE CPM CAN BE EFFECTIVELY USED:

CPM techniques can be used effectively in the following situation:

(a) In production planning

(b) Location of and deliveries from a warehouse

(c) Road systems and traffic schedules

(d) Communication network

ADVANTAGES OF CPM

The application of CPM leads to the following advantages:

(i) It provides an analytical approach to the achievement of project objective which are defined clearly.

(ii) It identifies most critical elements and pays more attention to these activities.

(iii) It assists avoiding waste of time, energy and money on unimportant activities.

(iv) It provides a standard method for communicating project plains, schedules and cost.

Thus CPM technique is a very useful analysis in production planning of very large project.

PERT (PROGRAMME EVALUATION AND REVIEW TECHNIQUE)

There are so many modern techniques that have developed recently for the planning and control of large projects in various industries especially in defence, Chemical and construction industries. Perhaps, the PERT is the best known of such techniques.

PERT is a time-event network analysis technique designed to watch how the parts of a programme fit together during passage of time and events. The special project office of the U.S. Navy developed the technique in 1958. It involves the expected time of any operation can never by determined exactly.

Major feature of PERT or Procedure or Requirement for PERT

The following are the main feature of PERT:

(i) All individual tasks should be shown in a network. Events are shown by circles. Each circle representation event a subsidiary plans whose completion can be measured at a given time.

(ii) Each arrow represents and activity the time consuming element of a programme, the effort that must be made between events.

(iii) Activity time is the elapsed time required to accomplish element an event. In the original PERT, three-time values are used as follows:

(a) **t1 (Optimistic time)** : It is the best estimate of time if everything goes exceptionally well
(b) **t2 (Most likely time):** It is an estimated time what the project engineer believes necessary to do the job or it is the time which most often is required if the activity is repeated a number of times.
(c) **t3 (Pessimistic time)** : It is also an activity of under adverse conditions. It is the longest time and rather is more difficult to ascertain.

The experiences have shown that the best estimate of time out of several estimates made by the projects engineer is:

$$V(t) = \frac{t3 - t1}{6}$$

And the variance of t is given by-

$$t = \frac{t1 + 4t2 + t3}{6}$$

Here it is assumed that the time estimate follows the Beta distribution.

(v) The next step is the compute the critical path and the slack time. A critical path or critical sequence of activities is one, which takes the longest timeto accomplish the work and the least slack time

ADVANTAGE OF PERT

PERT is a very important of managerial planning and control at the top level concerned with overall responsibility of a project. PERT has the following merits.

(i) Pert forces managers and subordinate manger's to make a plan for production because time event analysis is quite impossible without planning and seeing how the pieces fit together.
(ii) PERT encourage management control by exception. It concentrates attentions on critical element that may need correction.
(iii) It enables forwards-working control, as a delay will affect the succeeding events and possibly the whole project. The production manager can somehow make up the time by shortening that of some other time.
(iv) The network system with its sub-systems creates a pressure for action at the right spot and level and at the right event.
(v) PERT can be effectively used for re-scheduling the activities.

LIMITATIONS IN USING PERT

The uses of PERT techniques are subject to the following limitations:

(i) It is a time-consuming and expensive technique.
(ii) It is based on Beta Distribution and the assumption of Beta Distribution may not always be true.
(iii) PERT is not suitable when programme is nebulous and a reasonable estimate of time schedule is not possible.
(iv) It is not useful for routine planning of recurring events such as mass production because once a repetitive sequence is clearly worked out; elaborate and continuing control is not required.
(v) The expected time and the corresponding variance are only estimated values.

DIFFERENCE IN PERT AND CPM

Although these techniques (PERT and CPM) use the same principles and are based on network analysis yet they in the following respects from each other:

(i) PERT is appropriate where time estimate arte uncertain in the duration of activities as measured by optimistic time, most likely time, and pessimistic time, where as CPM (Critical Path Method) is good when time estimates are found with certainty. CPM assumes that the duration of every activity is constant and therefore every activity is critical or not.

(ii) PERT is concerned with events, which are the beginning or ending points of operation while CPM is concerned with activities.

(iii) PERT is suitable for non-repetitive projects while CPM is designed for repetitive projects.

(iv) PERT can be analyzed statistically whereas CPM not.

(v) PERT is not concerned with the relationship between time and cost, whereas CPM established a relationship between time and cost is proportionate to time.

5.7 Construction of a Network :

We may take up a project involving manufacture of a new model car. The activities involved are in table- with their sequential order indicated. The duration and labour needs are also presented.

Table – : New Model car – Network Activities

Activity Letter	Activity Description	Preceding activities	Duration (days)	No. of employees needed
A	Start	Nil	0	---
B	Design	A	8	3
C	Build frame	B	2	5
D	Build doors	B	1	2
E	Fix axles, wheels & fuel tank	C	1	3
F	Build body shell	B	3	7
G	Fit doors to body shell	D,F	1	2
H	Build & test engine	B	6	5
I	Assemble and test chassis	E,H	3	3
J	Paint body	G	2	4
K	Interior	J	1	3
L	Mount body to chassis	I,K	1	3
M	Road test the car	L	1	2
N	Finishing touch	M	1	2

For the above project we can construct a network. Before we do it a descriptive of how to construct a network is presented. A network contains connected 'events' and 'activities'. 'Event' refers to the 'starting' or 'completion' of specific jobs. The 'circles' in the network indicate the 'events'.

Otherwise, the circles are known as 'nodes'. 'Activity' refers to progress to work leading from 'one event to other event'. This is indicated by the 'arrows' in the network. When drawing a network physical neatness, avoiding criss-cross, 'loops' must be avoided. A 'loop' results when two activities have the same 'start' and 'end' nodes or events.

In such a case, a 'dummy' activity, with time zero as well as resource needs zero, is introduced to avoid a loop. Now, the network for the car project is attempted.

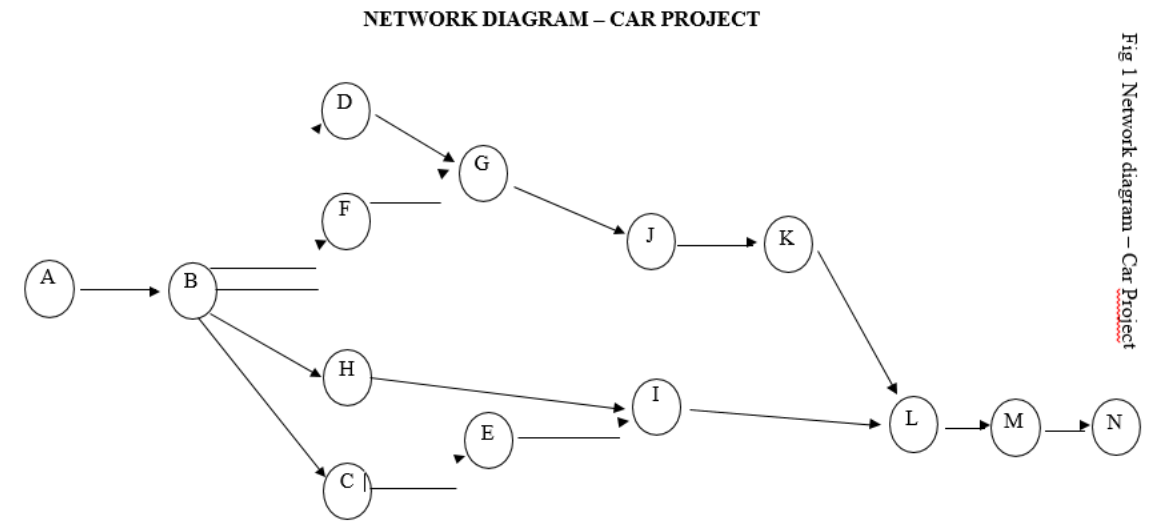

Fig 1 Network diagram – Car Project

A brief description is presented on the network in Fig. 1. Node or event A is the starting point. Node B indicates the completion of 'design' work, A – B, therefore indicates the progress of design activity, which needs 8 days for completion.

The numbers above the arrows thus indicate the time required for completion of respective activities. Until design, B, is completed activities C, D, F and H cannot be taken up. Hence, all these activities have common start node, viz B. Activity 'G' cannot be taken up, until activities B and F are over. So activities D & F coverage at 'G', and so on. No dummy activity is needed for the project.

In the network, only one time estimate is given for each activity. As against this, pessimistic (longer), optimistic (shorter) and most likely (via media) time estimates may be given for each activity. These time estimates are notated as tp, to & tm. From these estimates, expected time (te) is worked out as follows:

(tp + 4 tm to) / 6 = te

The 'te' is taken as the activity duration and written above the activity arrow in the network. The 'te' computation given above is based on 'beta' distribution which underline very low probability for tp and to and very large probability for tm.

Now, the different routes of the network can be deduced. A route simply means the course of project from the starting point to the ending point of the project accordingly, the routes of the project are:

Route I : A – B – D – G - J – K – L – M – N

Route II : A – B – F – G – J – K – L – M – N

Route III : A – B – H – I – L – M – N

Route IV : A – B – C – E – I – L – M – N

The time duration of the different routes can be worked out by adding together the time duration of individual activities falling in the respective routes, Accordingly.

Route I involves : 8+1+1+2+1+1+1+1 = 8 days

Route II involves : 8+3+1+2+1+1+1+1 = 18 days

Route III involves : 8+6+3+1+1+1+ = 20 days

Route IV involves : 8+2+1+3+1+1+1 = 17 days

The longest route is : A – B – H – I – L – M – N, which takes 20 days. This route is called the critical path. The network diagram represents the critical path by thick arrows or double line arrows, just to indicate the critical path prominently.

The time required for completion of the project is given by the time duration of the critical path. If everything goes well, by end of 20^{th} day the new model car would by ready, for this to happen, each activity in the critical path has to be taken up and completed as per schedule.

That is 'B' must be over by the 8^{th} day, H must be commenced on beginning of 9^{th} day and completed on 14^{th} day. I to begin on 15^{th} day and completed by 17^{th} day, L to begin on 18^{th} day and completed on the same day, M to begin on 19^{th} day and completed on the same day and N to begin on 20^{th} day and completed on the same day.

Now the concepts of earliest start time (EST), earliest finish time (EFT), latest short time (LST), latest finish time (LFT), slack, total slack and free slack may be presented.

EST refers to when a particular activity can be taken up at the earliest. Activity A–B has to begin at day 0 day and will go till the end of day 8. Actually B-D, B- F, B-H and B-C can be taken up immediately after A-B is over, i.e. from end of day 8. (i.e. the beginning of day 9).

So, the EST for B-D, B-F, B-H and B-C is end of day 8. B-D will be over by end of day 9 day and that the EST for D-G is end of day 9 (i.e. the beginning of day 10). The EST for G-J is not however end of day 10, by which time D-G will be over.

Because G-J cannot be commenced until F-G is also completed. F-G will be over by end of day 12. So, for G-J the EST is end of day 12 or beginning of day 13 and so on.

EFT refers to when a particular activity can be completed, assuming it has been commenced as per its EST. for A-B it is end of day 8, for B-D it is end of day 9, forB-F it is end of day 11 and so on. For G-J the EFT is end of day 14.

LST and LFT are computed backwards from last activity, viz, M-N in this project. M-N must be over by end of day 20. So, its LFT is end of day 20. Its LST is end of day 19, so that by end of day 20. If you go backward, for activity L-M the LST is end of day 18 and LFT is end of day 19.

Table- gives the EST, EFT, LST and LFT for the various activities.

Table – : EST, EFT, LST and LFT

Activity	EST	EFT	LST	LFT	Total (LFT-EFT) or (LST-EST)	Free Stack
A-B	1	8	1	8	0	0
B-D	9	9	12	13	4	0
D-G	10	10	14	14	4	2
B-F	9	11	11	13	2	0
F-G	12	12	14	14	2	0
G-J	13	14	15	16	2	0
J-K	15	15	17	17	2	0
K-L	16	16	18	18	2	2
B-H	9	14	9	14	0	0
H-I	15	17	15	17	0	0
B-C	9	10	12	13	3	0
C-E	11	11	14	14	3	0
E-I	12	14	15	17	3	3
I-L	18	18	18	18	0	0

K-M	9	19	19	19	0	0
M-N	20	20	20	20	0	0

Slack or float refers to be extent an activity can be delayed without affecting completion of the project on time. This is given by LST – EST or LFT – EFT, Table 2 gives this also under total slack column. You will note that activities falling on the critical path have no slack.

Because, none of the activities can be delayed, lest projects duration will increase. There are two concept of slack: total slack and free slack. Total slack is simple LST – EST or LFT – EFT. Free slack refers to slack or spare time available for an activity when all succeeding activities in the network can be started at their respective EST. Only three activities D-G, K-L and E-I have free slack.

5.8 Network Technique in Project Scheduling :

Network technique is predominantly used in project scheduling. When will each activity be commenced, when the same has to be completed, which activity can be delayed, when will the project be completed and related questions are answered by PERT and CPM techniques. All these require time estimates and sequential relations between jobs.

Time estimates are made based on past experience, the job nature and availability of resources. In PERT, 3 estimates of time for each activity is made as was already stated and the expected time worked out using a formula already dealt with. This is needed since PERT deals with uncertain business environment, In CPM only one time estimate is made as it assume certainty condition. But estimates may be revise in both the cases as in assurance in past estimates come to light.

The sequence of operations is to be known thoroughly. This is crucial to project scheduling. Again experience and through knowledge of the activities of the project help in setting up the sequence.

Once time estimates and sequential relations are known activities scheduling can be prepared. You have to find out EST, EFT, LST, LFT, total slack and free slack.

All these have been already explained. Then activities can be taken up as per their EST or LST or some in between times taking advantage of slack of activities. Of course, for critical activities EST and LST are same, also EFT and LFT are also same. That is, they have no slack.

Under PERT we can find the probability of finishing a project by certain date. For this we need to know the standard deviation of activity times for critical activities.

Std. deviation in the case of activity times is given by:

(tp-to)/6

This formula again is unique to beta distribution. Calculate the std. deviation for each of the critical activities. Square each of std. deviation figures. Add the squared figures. Take square root for the summated figure. This is taken as the project std. deviation of the earliest finish time.

An 'Z' value is calculated as follows:

$$Z = \text{std. normal variate} = \frac{\text{Due date - Expected date of completion}}{\text{Project std. deviation}}$$

Corresponding to the 'Z' obtained, from the normal distribution table 'area' under normal curve is found. From that figure, the probability of completion by the due date is known.

We may find the probability of completion by 22nd day from commencement for out car project, given the expected completion by 20th day.

We need to know the three time estimate for the critical activities which are as follows:

Activity	Tp	Tm	To	(Tp-To) / 6
B	10	9	2	(10 – 2) / 6 = 4/3
H	9	4.5	3	(9 – 3) / 6 = 1
J	5	3	1	(5 – 1) / 6 = 2/3
L	5	3	1	(5 – 1) / 6 = 2/3
M	5	1.5	1	(5 – 1) / 6 = 2/3
N	5	1.5	1	(5 – 1) / 6 = 2/3

Std. deviation of project = $\sqrt{(4/3)2+(1)2+(2/3)2+(2/3)2+(2/3)2}$

$$= \frac{16}{9} + 1 + \frac{4}{9} + \frac{4}{9} + \frac{4}{9} + \frac{4}{9}$$

$$= 40/9 = 6.4/3$$

$$\text{Z varite}=\frac{due\ date-expected\ date}{proj\ std\ deviation}$$

$$= \frac{22-20}{6.4/3} = \frac{2\times 3}{6.4} = \frac{60}{64} = 0.9375$$

Area under normal curve corresponding to Z = 0.9375 is equal to = 0.825. That is,there is a probability of 0.825 or 82.5% that the project would be completed by 22nd day.

The probability computation is helpful in project rescheduling, if need be, where the 'P' is very small, there is need for speeding up the work through commissioning more resources or in postponing the due date. Hence the use of PERT and CPM in project scheduling.

5.9 Crashing Project Duration through Network :

Sometimes a project has to be completed sooner than the planned time. In our case the project duration is 20 days. Say, you want to complete the project in 15 days for some pressing reason. Can you? May be you can. By commissioning extra resources you may be able to achieve this. Why extra cost arises? May be you have to work overtime incurring double the normal cost per time. May be you have to hire additional facility paying more than normal hire charges.

Table – gives normal time and cost and crash time and cost for the activities of out car project. The normal cost is Rs. 1,19,000 and the crash cost is Rs. 1,55,750.

But you can complete this in 15 days, the new critical path duration with a cost less than Rs. 1,55,750. How? You have to proceed methodically.

Table : Normal and Crash time / cost

Activity	Normal		Crash		Cost to reduce per day
	Time (day)	Cost Rs.	Time (days)	Cost Rs.	
B	8	24,000	6	30,000	3,000
C	2	10,000	1	11,000	1,000
D	1	2,000	0.5	6,000	8,000
W	1	3,000	0.5	6,000	6,000

F	3	21,000	2	22,000	1,000
G	1	2,000	1	2,000	---
H	6	30,000	4	36,000	3,000
I	3	9,000	2	15,000	6,000
J	2	8,000	1	9,250	1,250
K	1	2,000	0.5	6,000	6,000
L	1	3,000	0.5	6,000	6,000
M	1	2,000	0.5	4,500	5,000
N	1	2,000	1	2,000	---
		1,19,000		**1,55,750**	

(i) Find those activities in the critical path (or paths) where time can be cut substantially with minimum extra rupees spent. The goal is greatest reduction in project time for the least increase in project cost.

(ii) You have to work out the cost of crash per day for each activity. This simply:

(Crash cost – Normal cost) / (Normal time – Crash time)

Some activities could not be crashed at all as from table

Route-III is the original critical path. Activity N cannot be crashed. And only activities B, H, I, L and M can be crashed and the crash cost per day works out to Rs. 3,000, Rs. 3,000, Rs. 6,000 and Rs. 5000 for these activities respectively. We take up the least crash-cost-per-time-activity. B or H is our choice. Say you take 'B' for crashing fully.

Two days you save now and extra cost is Rs. 2 x 3,000 = Rs. 6,000. Now route III and route II are critical as both have 18 days duration. To cut project duration you have to reduce the duration of both routes.

In route II the crushable activities are F(Rs. 1,000), J(Rs. 1,250) and K(Rs. 6,000) and L and M in common with route III. So, the least crash cost activity is F.

In route III the least crash cost activity is H(Rs. 3,000). By crashing F & H by one day, the project duration becomes 17 days and extra cost is Rs. 1,000 + Rs.3,000 = Rs. 4,000.

Now routes II, III & IV becomes critical each with a duration 17 days. To reduce project duration, crashing has to be done in all these three routes T.

The crushable activities in route-IV are: C(Rs.2,000); E(Rs.6,000) andI(Rs.6,000) and I and in common with routes II and III. We choose C for crashing as it is least cost alternative. In route-III, still H is crushable by a day with extra cost Rs.3,000. In route-II, 'J' can be crashed by a day with extra cost of Rs. 1,250.

So by crashing 'C' in route IV, H in route-I II and 'J' in route II, project duration is cut by a day to 16 days at an extra cost of Rs. 5,250, i.e. (Rs. 1,000 + 3,000 + 1,250). Now all the four routes are critical with 16 days duration each. We want to reduce the project duration to 15 days i.e. the duration of each of the 4 routes has to be cut by a day.

This easily done by crashing L and M at an extra cost of Rs. 3,000 + 2,500 = Rs.5,500. So, the extra cost of crashing is Rs. 6,000 for 2 days cut + Rs. Rs. 4,000 for 1 day's cut + Rs. 5,250 for 1 day's cut + Rs. 5,500 for 1 day cut =Rs. 20,750. So, the crash cost of the project is only Rs. 20,750, more than normal cost of we adopt the methodology of network techniques for project time crashing.

You note that we crashed only activities B, C, F, H, J, L and M. Others are not crashed. Still we have not exceeded the crash time project duration, viz, 15 days.

5.10 Project Review:

Project review is an important aspect in the process of planning. Every socio-economic programmes needs to be assessed for its results. One can say that the need for and importance of review of planned programmes was realized and stressed along with the initiation of the planning exercise itself.

Review is an important tool to identify the short comings during the entire implementation period and to develop or initiate corrective actions to improve the delivery and administrative purposes.

Such studies answer question like: whether the project is implemented in the ways specified; whether the methods, process, procedures etc. adopted are appropriate to achieve the set goal; whether the personnel are sufficiently motivated, trained and adequate for the success of the project. Similarly, the project evaluation studies are conducted for assessing the impact of the project and also to examine the project efficiency.

Thus the role, function, objective and purpose and of Project Review is not only to help, guide, direct and aid the planners, project sponsors, policy formulators but also help the administrators, executives, scholars and academicians. In review, the most fundamental task is the formulation of criteria of review and also determination of the time for the study. On the basis of these criteria of Review and

also determination of the time for the study. On the basis ofthese criteria the results or outcome of the projects are assessed.

Review/Evaluation process essentially involves some important steps viz. Data collection, estimation of cost benefits and profitability of the project and comparing it with the required rate of return to decide acceptance or non-acceptance of the project. Data collection may be made both from secondary sources or published documents viz. company balance sheets, government publications, publications of independent research bodies or industrial association as well as from primary sources like the industry and market.

Once the data is collected, it is necessary to shift the same for eliminating the irrelevant and retain only the significant information. On the basis of the data collected and collated an estimate may be prepared of the cost of the project starting from cost of the land and building and going through elements like cost of plant going through elements like cost of plant and machinery, duties, and taxes, working capital needs, estimated pre-operative expenses and contingencies to arrive at an estimate of total cost of the project.

Once the cost of the project is estimated, it is necessary to make certain assumption as regards the schedule of implementation, capacity build-up of production, cost of raw material, other related costs, realizable selling prices etc. in order to arrive at the returns and the profitability of the project.

A comparison of the estimated and required profitability will form the basis of selection or rejection of the project. What constitutes estimate/required profit ability? It really depend on the nature and focus of project evaluation.

Project review is the final phase of Project Management. The various facets of project review are

- Initial review
- Performance evaluation
- Abandonment analysis
- Behavioral issues in project abandonment
- Administrative aspects of capital budgeting
- Evaluating the capital budgeting system of an organization.

5.11 Initial Review:

It is the first stage in the project review process. The initial review of a project is of two types.

- Control of project in progress
- Post audit

Control of Project in Progress

The expenditure authorization for a project generally specifies how much can be spent by whom and when. To ensure that the actual expenditure does not deviate significantly from the authorized expenditure, periodical control is exercised during project implementation.

5.12 Post Audit :

An audit of a project after it has been commissioned is referred to as post audit or post completion audit. Most firms do a post audit for almost every project above some threshold limit. Such an audit compares actual performance vis-à-vis planned performance when the operations of the project stabilize.

5.13 Performance Evaluation :

While the post audit is typically a one-time exercise, performance evaluation is done periodically. It seeks to measure the performance of the project on an ongoing basis.

Performance evaluation may be done in terms of economic rate of return or book return on investment.

$$\text{Economic rate of return for a given year} = \frac{\text{Cash flow} + \text{Changes in present value}}{\text{Present value at the beginning of the year}}$$

$$\text{Book return rate of return for a given year} = \frac{\text{Cash flow} + \text{Changes in book value}}{\text{Book value at the beginning of the year}}$$

5.14 Abandonment Analysis:

Ordinarily a project is analyzed on the assumption that the firm will operate it for a given period. Often, however, it may be possible to abandon the project before this period. This possibility of abandonment, when considered explicitly in project analysis, may change the decision itself.

A basic rule of capital budgeting says that investment decisions should be guided by the net present value criterion. Applied to a project 'continuation versus abandonment' decision, this rule says the project must be abandoned if the net present value associated with abandonment is greater than the net present value

associated with continuation is greater than the net present value associated with abandonment.

5.15 Objectives of Project Audit:

The objectives of project auditing can be viewed in terms of the help it renders to the enterprise management in:

- Creating awareness among the project staff of the types and magnitude of the problems that are likely to be encountered in completing the project and producing quality products, in planned volume and at competitive costs.
- Providing a clean picture, from time to time, of the actual status of the project.
- prompt identification of the factors that might cause product quality problems or lead to time and/or cost overruns
- timely spotting of a variety of generic problems that are associated With execution of projects.
- Enabling the creation of a good information base for a proper estimation and costing of the project.
- Assisting in the establishment of appropriate standards and system And recommending suitable work techniques;
- Identifying the specific training needs with references to the project tasks; and
- Formalizing the experience and expertise in project management in Order to be able to provide consultancy services to other enterprises.

The project auditor has to investigate the underlying records. Ascertain the tangible results of work done, look at the process and caliber of project management, examine the project methodology and techniques and get a picture of the project organization and controls. Having gone through the above aspects, he has to express his comments deliberately one the following lines:

1. Comment on current status;
2. forecast the future status;
3. Highlight critical management issues;
4. Point out exposure to risk and potential losses.
5. Solution on different parameters to avoid project rejection separately.

The project audit report on current status covers aspects of project performance, in relation to schedule, progress performance quality performance compliance with work commitments and compliance with management's expectations.

Statement on progress performance compares the work done with related costs and highlights deviations from the financial assumptions made at the time of planning the project. A separate report focuses on the quality of performance of the project to enable revisions or modification of methods or work or control mechanisms.

In the light of the progress to date, the forecast of the project status for future time periods or milestones has to be made and compared with contract or work commitments and management expectations. These reflect the project auditor's considered conclusions assuming the observed trends persist, except to the extent that some observable trends of improvements are reckoned.

Aspects of particular significance that require management attention should be identified and reported. Observed and existing weakness or deficiencies that are bound to undermine the progress and outcome of the project, unless prompt and effective managerial actions are taken, come for special mention.

Some of the possible occurrences or events, that have some probability of occurrence, have to be interpreted in terms of adverse effects on the contractor or customers or other interested parties. The management can then consider possible actions to protect the interests of those likely to be affected. Mounting project costs may lead to pricing decisions that will impair the financial results of the clients.

If the management has special expectations from the project audit these have to be listed out. The contractual documents and agreements have to be studied and their adequacy assessed. The commitments of the owner or management in respect of providing infrastructure or other facilities also have to be studied and the impact of inadequacy, if any, in this regard on project's success has to be assessed. The project's organization, administration, record keeping and controls also come for scrutiny.

5.16 Functions of Project Auditor:

The project auditor is an expert in measuring, confirming, investigating and reporting the status of a project with a view to reducing the uncertainties that encompass project.

He should not arrogant to himself the role of a consultant or technical expert. He should not fill his report with recommendations or suggested action plans should confine himself to interpretation of studied facts.

The project auditor is required to give advice to make recommendations. Solicited action plans should be the outcome of the conviction of the enterprise management that the auditor is competent to prepare action plans and has the requisite time and information for verification.

Unsolicited action plans should come up only if the project auditor feels strongly the items covered in his recommendations are very important in the context of thefindings of project unit.

The auditor will have to evaluate the contract base lines and give his judgment on their adequacy or otherwise for achieving the objectives of the project. Contract baseline comprises the set of documents that establish what the project

should do, when and how. It is the baseline with reference to which the auditor should measure the present and future state of the project. The current documents relating to commandments and agreements relevant to the project constitute the formal contract baseline. There can be informal baselines also in the form of verbal agreements or document not signed by authorized persons. The contract baselines also relate to contractor's agreements with subcontractors, suppliers, etc., and these will also come under project auditor's purview.

5.17 Project Audit Programme:

After getting a clear understanding of the scope as expected by the owner or audit requester, the next step is to define the project baseline in more detail, in consultation with the project team and with the help of visits to the project sites. This will involve the identification and analysis of the set of contractual documents which collectively define the extent and details of the project's obligations, determination of additional management's resource allocation, pricing and costing assumption and the development of the detailed audit programme.

The phase of audit programme execution will have the following steps:

- Preliminary examination of the project's organization, administration record keeping, controls and planning and working methods and techniques performed in order to establish the extent to which they are an adequate basis for building up the statements of project status, current and future.
- Preparing the statements of project status, current and future, giving a detailed list of completed work as compared with the project's performance baseline, recording the costs expended by the project team to carry out the work to date, comparing the fulfillment of contractual obligations against commitments, establishing the quality of work done by the project team, and recording observed facts on project planning, project organization and staffing, project administration and record keeping, working methods and techniques, communications, project facilities and environment, contract administration and controls, and controls over suppliers and subcontractors etc.

5.18 Difficulties in Establishing Audit Purpose and Scope :

The purpose of project audit is to clarify the state of the project in certain key areas for the enterprise management.

It is part of a quality control effort. The auditor could often be misled by wrong information or out of date or incorrect documentation. He should have a system of cross verification and checks so as not to be led astray. It might

sometimes be found that persons who are to be working on the project are not there and those who are not supposed to be in the project are there. The auditor will have to report these aberrations indicating their implications for the project.

Difficulties might arise in identifying the baseline contract or work statement set. Work could be carried out on the basis of verbal agreements without proper contract documentation.

Absence of deliverable specifications in the contract baseline and inadequacies in delivery procedure or acceptance criteria are often problems requiring special attention. The auditor will have to resolve such ambiguities.