

PERT & CPM

Program Evaluation and Review Technique & Critical Path Method

Objective

PERT (Program Evaluation and Review Technique) and CPM (Critical Path Method) are two of the most widely used techniques for planning and coordinating large-scale projects. Although PERT and CPM were developed independently, they have a great deal in common. PERT is a statistical tool, used in [project management](#), which was designed to analyze and represent the tasks involved in completing a given [project](#). It is commonly used in conjunction with the [critical path method](#)(CPM).It is applied as a decision-making tool designed to save time in achieving end-objectives, and is of particular interest to those engaged in research and development programs for which time is a critical factor.

The main objective of PERT is

1. To facilitate decision-making
2. To reduce both the time and cost required to complete a project.

PERT : The emphasis was on completing the program in the shortest possible time.

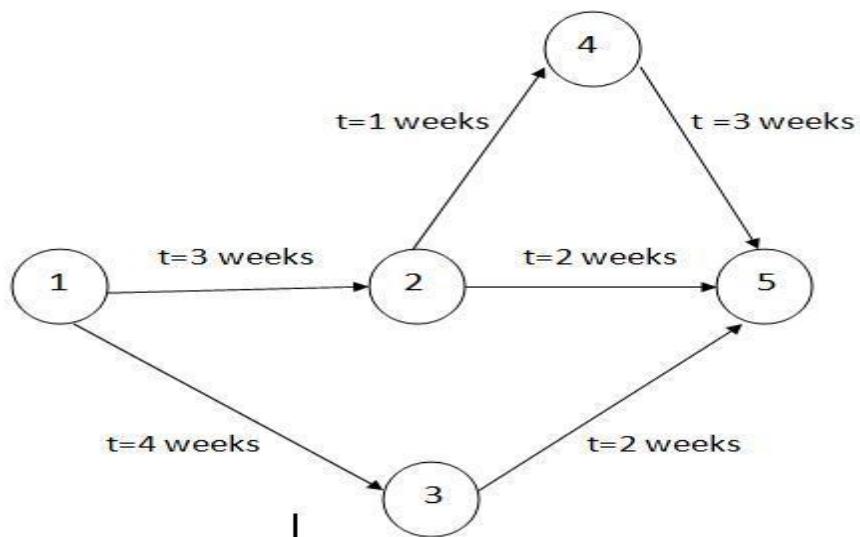
CPM : The emphasis was on the trade-off between the cost of the projects and its overall completion time.

Overview

The program evaluation and review technique (PERT) chart is used to schedule, organize, and coordinate tasks within the project. The objective of PERT chart is to determine the critical path, which comprises critical activities that should be completed on schedule. This chart is prepared with the help of information generated in project planning activities, such as estimation effort, selection of suitable process model for software development, and decomposition of tasks into subtasks. The advantages of using PERT chart are:

- It represents the project in graphical form.
- It provides information about the expected completion time of the project.
- It describes the probability of completion of project before the specified date.
- It specifies the activities that form the critical path.
- It specifies the start and end dates of activities involved in project.
- It describes the dependencies of one or more tasks on each other.

Below figure shows example of PERT chart. The milestones are numbered as '1', '2', '3', '4', '5' and are represented either by circles or rectangles. When a milestone is completed, it is assigned a greater number than the milestones. Each milestone is linked with one or more arrows. The activities of the projects are represented by 'A', 'B', 'C', 'D', 'E', 'F'. The direction of arrows determines the sequence of activities. When activities are completed in sequence, they are known as serial activities. When activities are completed in sequence, they are known as serial activities. Here activities 'A', 'C', 'F' are performed in a sequence. Similarly, activities 'B', 'E' are serial activities. On the other hand when two or more are performed simultaneously, they are known as concurrent activities or parallel activities. Here, activities 'A', 'B' and activities 'C', 'D' are performed concurrently. Each activity is allocated a specific amount of time, which is depicted by 't'. Here activity 'A' requires three week to get completed, activity 'B' requires four weeks, and so on.



STEPS FOR CREATING PERT CHART

1. **Identify activities and milestones:** In this step, the activities and milestones that are required to complete the project are described. Once the tasks and milestones are specified, it is easy to understand the sequence and duration of each activity.
2. **Identify sequence of activities:** In this step, the sequence of activities is determined. The sequence describes the dependency of one activity on another. These activities can either be serial or concurrent. Based on the sequence and dependency of activities, the relationships among activities are depicted. Note that this step is sometimes combined with step 1.
3. **Prepare PERT chart:** In this step, the PERT chart is prepared.
4. **Estimate the time consumed in activities:** In this step, the amount of time consumed in carrying out each activity is specified. The time can be estimated in months, weeks, or days.
Generally, the time estimates followed to determine the time consumed in activities are:
 - (a.) **Optimistic time:** It is the shortest time in which activity can be completed.
 - (b.) **Most likely time:** It is the shortest time in which an activity can be completed.
 - (c.) **Pessimistic time:** It is the longest time that an activity may require for completion.
5. **Determine critical path:** In this step, the critical path for completion of activities is specified. Critical path determines the calendar time required to complete a series of activities according to the project schedule. Note that the speed-up or delays in activities that are outside the critical path do not affect the total project time.
6. **Update PERT chart:** In this step, the PERT chart is modified as changes take place in the project and on completion of each activity. This chart is also updated when there is delay in completion of activities or when additional resources are required to complete the project on time.

CPM (Critical Path Method)

Critical path method is a technique that determines those activities, which have the least scheduling flexibility (that is, critical activities). Note that if the critical activities are delayed, the entire project is delayed. After determining these activities, CPM specifies the project schedule according to the activities that lie on the critical path.

The advantages of using the critical path method are:

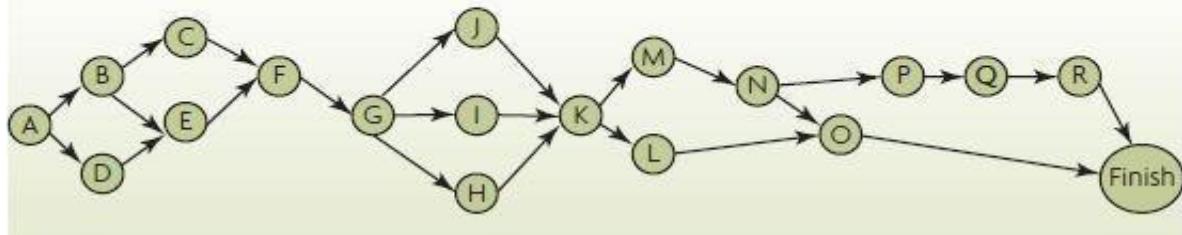
- It represents the project in graphical form.
- It predicts the time required to complete form.
- It specifies how to speed up the project so that it is completed on schedule.
- It specifies the optimal plan for speeding up the project.

Procedure

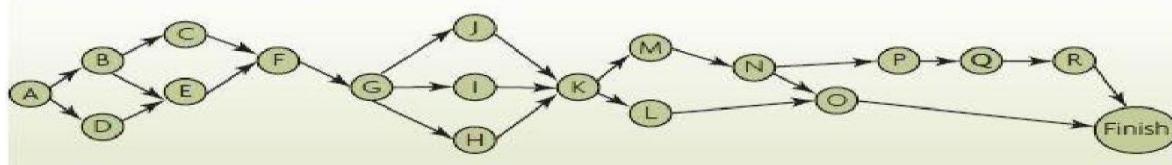
PROJECT NETWORK REPRESENTATION FOR - AIRPORT GATE MANAGEMENT SYSTEM

A project network representation is used to depict the project activities and their relationships., a network consists of a set of circles referred to as nodes and lines connecting nodes together referred to as arcs. The two common approaches of a project network representation are activity on node (AON) or activity on arc (AOA). In the first approach, the nodes of the network represent the project activities and the arcs show their precedence relationships. In the second approach, the project activities are reported on arcs and nodes represent the starting or the completion of activities. We focus on the activity on node representation, given its large adoption in many software packages. It is common in this approach to add one dummy source activity node (referred to as Start) and connect it to all activities nodes with no immediate predecessors as well as one dummy destination activity node (referred to as Finish) and connect it to the project network with arcs from activities with no immediate successors. This ensures that there is one starting point and one finish point in the project network. Below figure shows the network representation of the airport gate management system acquisition project example. Note that a dummy Finish node is added to ensure that the project network has one starting node and one finish node. Since there is only one node without a predecessor (A), no dummy Start node is added in this network

Network Representation for the AGMS Acquisition Project



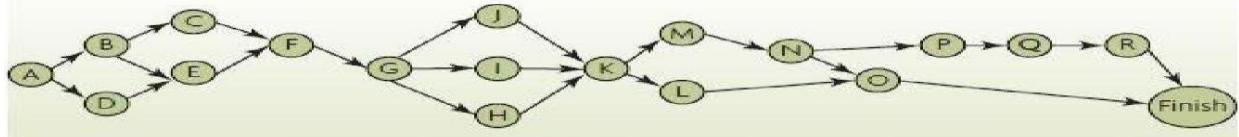
Network Representation for the AGMS Acquisition Project



List of Activities for the Airport Gate Management System (AGMS) Acquisition Project

Activity	Description	Immediate Predecessors	Estimated Time (weeks)
A	Set up the project acquisition team	—	2
B	Write down the software requirements	A	2
C	Develop a contractor evaluation grid that will be used to evaluate proposals	B	1
D	Identify and select potential contractors	A	1
E	Develop and send out a request for proposal to potential contractors	B, D	4
F	Audit candidate contractors, select one contractor, negotiate and sign an agreement contract with the selected contractor	C, E	2
G	Prepare the definition of functional specifications	F	5
H	Develop a software testing plan	G	2
I	Software customization phase I	G	12
J	Purchase and install the hardware	G	2
K	Test the first release	H, I, J	1
L	Develop a training plan for key users	K	1
O	Train key users	L, N	2
M	Software customization phase II	K	6
N	Test the second release	M	1
P	Software customization phase III	N	3
Q	Test the final release	P	2
R	Software deployment and project sign-off	Q	4

Network Representation for the AGMS Acquisition Project



List of Paths for the AGMS Acquisition Project

Path #	Sequence of Nodes	Length (total time in weeks)
1	A-B-E-F-G-I-K-M-N-P-Q-R-Final	44
2	A-B-E-F-G-J-K-M-N-P-Q-R-Final	34
3	A-B-E-F-G-H-K-M-N-P-Q-R-Final	34
4	A-B-C-F-G-I-K-M-N-P-Q-R-Final	41
5	A-B-C-F-G-J-K-M-N-P-Q-R-Final	31
6	A-B-C-F-G-H-K-M-N-P-Q-R-Final	31
7	A-D-E-F-G-I-K-M-N-P-Q-R-Final	43
8	A-D-E-F-G-J-K-M-N-P-Q-R-Final	33
9	A-D-E-F-G-H-K-M-N-P-Q-R-Final	33
10	A-B-E-F-G-I-K-M-N-O-Final	37
11	A-B-E-F-G-J-K-M-N-O-Final	27
12	A-B-E-F-G-H-K-M-N-O-Final	27
13	A-B-C-F-G-I-K-M-N-O-Final	34
14	A-B-C-F-G-J-K-M-N-O-Final	24
15	A-B-C-F-G-H-K-M-N-O-Final	24
16	A-D-E-F-G-I-K-M-N-O-Final	36
17	A-D-E-F-G-J-K-M-N-O-Final	26
18	A-D-E-F-G-H-K-M-N-O-Final	26
19	A-B-E-F-G-I-K-L-O-Final	31
20	A-B-E-F-G-J-K-L-O-Final	21
21	A-B-E-F-G-H-K-L-O-Final	21
22	A-B-C-F-G-I-K-L-O-Final	28
23	A-B-C-F-G-J-K-L-O-Final	18
24	A-B-C-F-G-H-K-L-O-Final	18
25	A-D-E-F-G-I-K-L-O-Final	30
26	A-D-E-F-G-J-K-L-O-Final	20
27	A-D-E-F-G-H-K-L-O-Final	20

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Critical Path

A path is a sequence of connected nodes in the network from the start node to the finish node.

The length of the path is given by the sum of the durations of the activities on the path. For the network shown in Figure, the corresponding paths are shown in Table In this list, path # 1 is the longest, while paths # 23 and # 24 are the shortest.

Path # 1 is critical, because any delay in the duration of an activity located in this path will delay the entire project. For instance, increasing the duration of activity A by 2 weeks will increase the length of path # 1 by 2 weeks for a total duration of 46 weeks. Whereas, for path # 23 and # 24, the length will only increase to 20 weeks, respectively. Hence, in any project network, the path with the longest duration is called a critical path and the corresponding activities are called critical activities in that they must be completed as scheduled to meet the scheduled project completion time. Therefore given by the length of the critical path. It is possible to find more than one critical path in a network project, but all critical paths will have the same length. For the network shown in Figure, the critical path is A-B-E-F-G-IK- M-N-P-Q-R and its corresponding length is 44 weeks. Therefore, the project's estimated duration is 44 weeks. All activities in the critical path are called critical activities, whereas the remaining activities (C, D, H, L, and O) are non-critical activities.

Boundary time calculations

BTC can be very useful in software project scheduling. In the design of one function, for example, can retard further development of other functions. Here is a description boundary times used in the program.

- EST (Earliest Start Time): The earliest time that can begin when all preceding tasks are completed in the shortest possible time. The EST is the maximum of all paths from \square start to this task.
- EFT (Earliest Finish Time): It is the earliest time(EST) + duration of a task.
- LST (Latest Start Time): The latest time that a task can begin, is the difference between MT and maximum of all paths from this task to the finish.
- LFT (Latest Finish Time): It is the min (LST of all predecessors).
- Slack (slack Time): The amount of surplus time allowed in scheduling tasks but staying on schedule. It is LST-EST and equivalently can be written as LFT-EFT.

The MT (minimum time) to complete the project is the maximum of all path from start to finish.

- A critical path is one with a zero slack time.
- A path from the start node to the finish node containing only critical tasks is called path.

“Critical path is when all stack times=0.”

Activity	Successors	Predecessors	Duration	Est	Eft	Lst	Lft	Slack Time
A								
B								

R								

Example:

STEPS FOR CREATING PERT CHART for ATTENDANCE MAINTENANCE SYSTEM

1. Identify activities and milestones.

- a) Specification of Requirements
- b) Design Database
- c) Design GUI
- d) Code for Database
- e) Code for GUI
- f) Write user manual
- g) Integrate and test

2. identify sequence of activities

- a) Specification-Design database-code database-Integrate and test
- b) Specification-Design GUI-Code GUI-Integrate and test
- c) Specification-Write user manual
- d) The above mentioned sequences can be performed simultaneously

3. Prepare PERT chart

4. Estimate the time consumed in activities.

Assumptions are made for various activities in days:

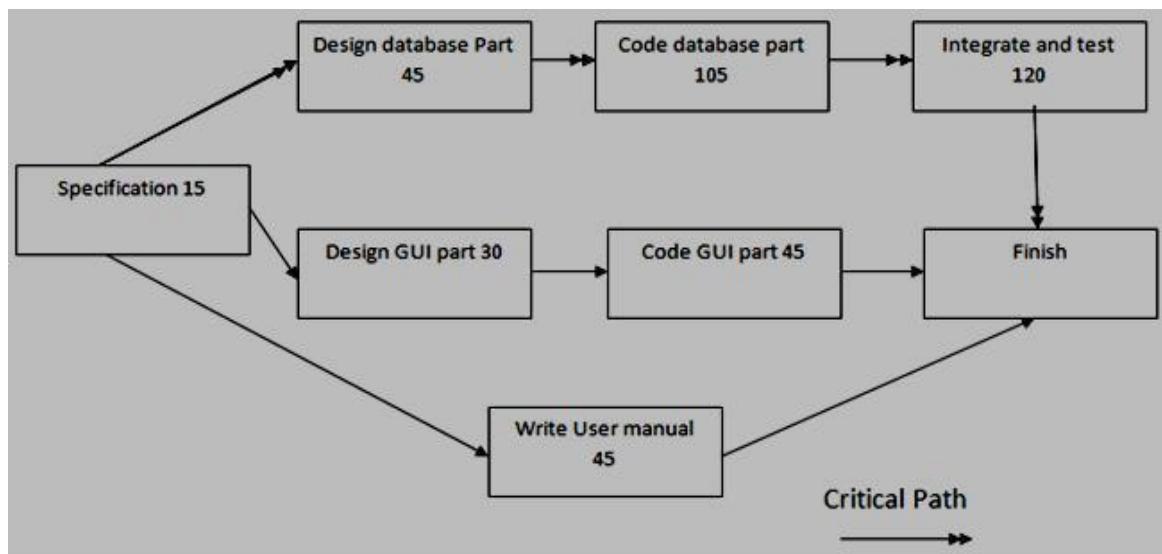
- a) Specifications - 15 days

- b) Design Database - 45 days
- c) Design GUI - 30 days
- d) Code for Database - 105 days
- e) Code for GUI - 45 days
- f) Write User Manual- 45 days
- g) Integrate and Test - 120 days

5. Determine critical path

The longest path from start to finish in a PERT chart

Time-Line Chart:



Critical path: Specification-->Design database part-->code database part-->integrate and test-->Finish

Project Table:

Tasks	EST	EFT	LST	LFT	ST
Specification part	0	15	0	15	0
Design Database part	15	60	15	60	0
Design Database part	15	45	90	120	75
Code Database part	60	165	60	165	0
Code GUI part	45	90	120	165	75
Integrate and Test	165	285	165	285	0
Write User-Manual	15	75	225	285	210

Viva-Voice Questions

1. What is a critical path?
2. What are pros of PERT and CPM?
3. What are the steps to create PERT chart?
4. What are the differences between PERT and CPM?
5. How can you complete the project in a shortest possible time?

Lab Report

After successful completion of this lab, the student will have the ability to create a PERT chart and to understand the critical path strategy.

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