



PROGRAMMATIC APPROACH FOR FINDING THE PROJECT DURATION AND ASSOCIATED COST

KEYWORDS

Project duration, Project cost, EST, EFT, LST, LFT and Slack.

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ABSTRACT

This research paper provides an alternative approach for estimating the project duration and the associated cost by using C programming Language adopting mathematical representation. Project duration and cost play a prominent role in gratifying the cores of both the service provider and the client. A program is created for measuring the earliest starting time, latest starting time, latest finishing time and slack by taking input as normal time, crash time, normal cost and crash cost. The output is the objective of this paper, determining duration and the total cost of the project which condenses the time for project managers in decision making and project scheduling.

1. INTRODUCTION

J.E. Kelly of Remington-Rand and M.B. Walker of Dupont developed CPM in 1950's to assist in scheduling maintenance shutdowns of chemical processing plants. Pert was developed shortly after by the U.S. Navy to manage the development of the Polaris missile [6].

Ameen [1] developed Computer Assisted PERT Simulation (CAPERTSIM), an instructional tool to teach project management techniques. Students used the program to evaluate decision-making under uncertainty and cost-time relationships.

The critical path method (CPM) and the program evaluation review technique (PERT), two management science techniques developed in the late 1950s to plan, schedule, and control large, complex projects with many activities. These approaches differ primarily on how the duration and the cost of activities are processed. A project network representation is taken in use to illustrate the project mode and its associations. A network consists of a set of circles recognized as nodes and line connecting nodes jointly recognized as arcs. Its familiar approaches of a project network representation are motion on node (AON) or motion on arc (AOA). The node of the networks embodies the project motions and the arcs illustrate their prior relationships as the first approach. The next approach, the project activities are stated on arcs and nodes represent the starting or completion of activities. The immediate predecessors of an activity refer to those activities that must be completed prior to the starting time of a given activity. Similarly, immediate successors of an activity refer to those that follow the completion of a given activity [2].

The PERT method uses only the activity time means in calculating the critical path, reducing the stochastic model to a deterministic model. A single critical path is thus calculated and used, whereas in reality there may be numerous possible critical paths realized. For a large network the probability that any given path may be the critical one may be very small. As a result, the traditional PERT method of calculating the time to complete the project is almost always too low. The extent to which PERT underestimates completion times is examined for a variety of networks by Klingel (1966) [5].

Crowson proposed a modified CPM method that deteriorates a project network into sub - networks containing only specific nodes (the decision nodes) and the longest remoteness between them [3].

Program (Project) Evaluation and Review Technique (PERT) followed by CPM (Critical Path Method) is a method of modeling, testing, simulating and solving a wide range of complex large range problems. The same technique is used in this project to determine the critical path and the expected duration of the bottling unit startup [8].

Critical path is the sequence of activities which add up to the longest overall duration. It is the shortest time possible to complete the project. Any delay of an activity on the critical path directly impacts the planned project completion date (there is no float on the critical path). A project can have several, parallel, near critical paths. An additional parallel path through the network with the total durations shorter than the critical path is called a sub-critical or non-critical path. The Critical Path Method or Critical Path Analysis is a mathematically based algorithm for scheduling a set of project activities. The essential technique for using CPM is to construct a model of the project that includes a list of all activities required to complete the project, the time (duration) that each activity will take to completion and the dependencies between the activities. CPM calculates the longest path of planned activities to the end of the project and the earliest and latest that each activity can start and finish without making the project longer and determines "critical" activities (on the longest path) [4].

Complex projects require a series of activities which must be performed sequentially. These activities can be modeled as a network. Completing a project on time and within budget is not an easy task. A project can be defined as a set of a large number of activities or jobs that are performed in a certain sequence determined logically or technologically and it has to be completed within a specified time and cost whilst meeting the performance standards [9]. Using input values such as activities normal time, crash time, normal cost and crash cost, the program are developed for computing slack value, estimate, estimate, ltime and ltime by employing CPM techniques. Based on the slack value, which activity has critical path should be considered for evaluation. The cost of labouring and equipment materials everyday expenditure assigned in desiring the activity is the direct cost of labouring. The direct cost of an activity is the cost of labor and equipment employed in completing the activity.

The total cost of the project which is the aggregate summation of the direct project's activity costs and the indirect cost is multiplying with the total duration. On the other hand, the indirect cost will decline by decreasing the project duration, as the indirect cost are almost a linear function with the project duration [2]. Indirect project costs include general expenses that cannot directly be attributed to particular activities and exist regardless of activity progress. Indirect costs are typically assumed to be proportional to project duration [8]. Above mentioned manner, the problem analyzed and the result of this method give the total duration of the project and the associated cost.

This paper aims to give an outline and scope of the study that will be undertaken in this work. Once again, this is too critical that the ability of the project team to identify these paths and formulate

policies and procedures to measure and monitor the critical paths if there are large amount of data. Thus, the focus of this study is to determine the total duration and the associated cost using Critical Path Method.

2. MODEL DESCRIPTION

Here, it is shown C Programming Language to compute the total duration and the total cost of the project. The procedure consists of many variables to compute, is the study of the focal study. The Variables are

1) Normal Cost: It is the lowest cost of completing an activity in minimum time employing normal means that is not using overtime or special resources. The variable is *ncost*.

2) Normal Time: It is minimum time required to achieve the actual cost. The variable is *ntime*.

3) Crash Cost: It is a least cost of completing an activity by employing all possible means like overtime, additional machinery and proper materials. The variable is *ccost*.

4) Crash Time: It is an absolute minimum time associated with the crash cost. The variable is *ctime*

5) Critical Path: It is the sequence of project network terminal elements with the longest overall duration, determining the shortest time to complete the project.

6) The earliest start time (estime): It is the time when an activity can start without affecting the total project time. If the activity has no predecessor, its *estime[i] = 0*, otherwise its earliest start time is calculated as *estime[i] = maximum value of earliest starting time of predecessor activities + ntime[i]*

7) The earliest finish time (eftime): It is the earliest possible time at which an activity can finish without affecting the total project time. *eftime[i] = estime[i] + ntime[i]*.

8) The latest start time (lstime): It is the latest possible time by which an activity must start without affecting the total of the project. *lstime[i] = lftime[i] - ntime[i]*.

9) The latest finish time (lftime): It is the latest time by which an activity must get completed without delaying the project completion. *lftime[i] = minimum value of latest finish time of successor activities - ntime[i]*.

10) Slack: the slack time for an activity delivers to the durability of time that can be endured without incurring a delay in the scheduled projection time of completion. The slack time per activity needs to be measured primarily to recognize the critical path, by considering either the begin time of finish time. Hence, for each of the activities in the project network, the slack time can be calculated as

$slack = lftime[i] - eftime[i]$ i.e., $i=0$ to 7
Consider an example, the *slack[1]* is

$slack[1] = lftime[1] - eftime[1]$ i.e., $slack[1] = 8 - 8$, $slack[1] = 0$

11) Total project duration (tdur): Project completion duration computed using critical path method (CPM).

```
tdur=0;
for(i=0;i<n;i++)
{
if(slack[i]==0)
{
tdur=tdur+ntime[i];
}}
```

12) Indirect cost (incost): Project overhead/indirect cost. This is a fixed monetary value expended each duration unit the project elapses.

3. PROCEDURE

The procedure for abbreviating and finding the project duration can be short out in the following steps:

Step 1: Declaring variables for normal time, crash time, crash cost, normal cost, earliest start time, earliest finish time, latest start time, latest finish time and slack so on.

Step 2: Imparting values to *ntime*, *ctime*, *ncost* and *ccost* according to their source path to destination path.

Step 3: Compute the value for earliest start time, earliest finish time, latest start time, latest finish time and also slack for all activities.

Step 4: Perform CPM calculations and identify the critical path, using slack value which is equal to zero and find the total duration of the project.

Step 5: Compute the Direct cost value by summing all the activities normal cost values and the resultant value is obtained.

Step 6: Getting the value for Indirect cost, the Total cost of the project is calculated by adding the direct cost value with the value which is the indirect cost multiplied with total duration of the project.

4. APPLICATION OF THE MODEL ON HYPOTHETICAL PROJECT

Giving input values for activities source, destination, normal time, crash time, normal cost and crash cost of example project by user. These values assigned to the variables of *source[i]*, *destination[i]*, *ntime[i]* and *ctime[i]* respectively as well as all the activities *ncost[i]*, *ccost[i]* values through the C program.

Source	Destination	Normal Time (Days)	Crash Time (Days)	Normal Cost(\$)	Crash Cost(\$)
1	4	10	7	20000	30000
1	2	8	6	15000	20000
2	4	5	4	8000	14000
2	3	6	4	11000	15000
3	4	0	0	0	0
2	5	8	5	9000	15000
5	6	5	4	5000	8000
4	6	12	8	3000	4000

Table 1. Project Information table

Based on the formulae, *lstime*, *lftime*, *estime* and *eftime* to be calculated as well as the resultant values are assigned. Critical path is identified based on the slack value of each activity. If the activities slack value is zero then the critical path exists in that activity. And the corresponding project completion duration is computed. Under the normal circumstance the cost of this project is obtained from the program by retrieving from the variable *tcost* which is calculated by summing all the normal cost and the indirect cost.

5. PROGRAM

```
#include<stdio.h>
#include<conio.h>
#include<math.h>
void main()
{ int estime[20],eftime[20],lstime[20],lft,spath[20],dpath[20];
float slope[20],mrt[20],sum,tcost;
int b,a,d,c,g,new3[20],min2[20],slack[20],add[20],tdur;
int incost,f,count,mslope[20];
int
source[20],des[20],ntime[20],ctime[20],np[20],ns[20],ncost[20],cco
st[20];
```



```
{ if(big<m[i])
big=m[i];}
return(big);
}
int minimum(int m[],int v)
{int small,i;
small=m[0];
for(i=0;i<v;i++)
{ if(small>m[i])
small=m[i];}
return(small);
}
```

[7]. S. Sakellariopoulos, A.P. Chassiakos, "Project time-cost analysis under generalized procedure relations". *Advances in Engineering Software* 35,2004, pp.715-724.
 [8]. Siddharth Chatwal, "Application of Project scheduling a bottling unit startup using PERT and CPM techniques", *International Journal of Advanced Research in Engineering and Applied Sciences*, vol.3, No.6, June 2014.
 [9]. Wallace Agyei, "Project planning and scheduling using PERT and CPM techniques with Linear programming: case study", *International Journal of Scientific & Technology Research*, vol.4, Issue 08, August 2015, pp.222-227.

6. OUTPUT

Source	des	ntime	ctime	ncost	ccost	np	ns	estim	eftime	lftime	lstime	slack
1	4	10	7	20000	30000	0	1	0	10	14	4	4
1	2	8	6	15000	20000	0	3	0	8	8	0	0
2	4	5	4	8000	14000	1	1	8	13	14	9	1
2	3	6	4	11000	15000	1	1	8	14	14	8	0
3	4	0	0	0	0	1	1	14	14	14	14	0
2	5	8	5	9000	150000	1	1	8	16	21	13	5
5	6	5	4	5000	8000	1	0	16	21	26	21	5
4	6	12	8	3000	4000	3	0	14	26	26	14	0

Critical path: 1-->2 2-->3 3-->4 4-->6
 Total duration: 26
 Enter indirect cost: 300
 Total normal cost: 71000
 Total cost = 78800

The critical path exists on the path 1 → 2, its normal time is 8, the next critical path 2 → 3, its normal time is 6, the next critical path 3 → 4, its normal time is 0 and the other critical path 4 → 6, its normal time is 12, these normal time will be summed to find the total duration of the project (26). The program analyses the data and given the solution that the total duration is 26 days.

The implementation of the program showed more efficient and reliable results and generated a remarkable utilization and saving along with an increase in robustness.

7. ANALYSIS AND RESULTS

Exploring the method of finding the total duration of the project and their cost is the major criteria of the study. Using C programming language and run on an example data set, a program was created. The output of the model indicates that the total duration of the project is 26 days and the cost is Rs.78800 when the indirect cost is 300.

8. CONCLUSION

This study shows ,a C program that is created to equip the total duration and the cost. It is resulted, the project managers schemes of inputs and its consequences of output. Its reliable result of feeding and earning, the project manager wishes to moderate the value of indirect cost, the method will be resulted as the total duration and cost of the project. It proposes a condition; a large number of activities of manual approach are very difficult process, complex and time consuming.

9. REFERENCES

[1]. Ameen, D.A., "A computer assisted PERT simulation", *J. Syst. Manage.*, 1987, 38, pp.6-9. <http://portal.acm.org/citation.cfm?id=34619.34620>
 [2]. Chapter 8. Project Scheduling: PERT/CPM
 Source: Adapted from an original case by Robert J. Thieraus, Margaret Cunningham, and Melanie Blackwell, Xavier University, Cincinnati, Ohio.
 [3]. Crowson WB, "Decision CPM. Network reduction and solution". *Oper Res Quart* 1970, 21(4), pp. 435-52.
 [4]. Jesse Santiago & Desirae Magallon, "Critical Path Method (Cee 320 - VDC Seminar)", 4 Feb, 2009.
 [5]. Klingel, A. R. (1966), " Bias in PERT completion times calculations for a real network", *Management Science*, 13(4), 476-489.
 [6]. Navy Special Project Office, Bureau of Naval Weapons (1958). PERT Summary Report, Phase I, National Technical Information Service, AD-735902.