APPLICATION OF PROJECT SCHEDULING IN A BOTTLING UNIT STARTUP USING PERT AND CPM TECHNIQUES

Siddharth Chatwal*

Abstract: *PERT (Project Evaluation and Review Technique) followed by CPM (Critical Path Method) is a method of modeling, testing, simulating and solving a wide range of simplex 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. The entire setup is broken down into smaller activities with the probabilistic duration of the individual activities. The precedence relationship using activity on node network construction is shown. The advantages offered by the methodology are precedence relationships, large projects and greater efficiency. The PERT method gives the expected duration following which CPM is used to pay special attention to the activities falling under critical path. The generated model is a powerful tool to help a plant manager and supervisor take optimum decisions on completion dates, scheduling, budgeting, critical activities and earliest finish with minimum time consumption.*

Keywords: *Bottling Unit, PERT, CPM, Project Scheduling*

*Student, Vellore Institute of Technology, Vellore, Tamil Nadu, India

INTRODUCTION

Martin K. Starr [1] shows the importance and role of project management in a fact response organization using PERT/CPM techniques. In his work he mentioned the growth of upcoming fast response organizations (FRO) and the easy of managing them using the above mentioned techniques. Kishan Mehrotra , John Chai and Sharma Pillutla [2] carried out their research in the School of Computer information and Science, Syracuse University regarding the approximation of job completion time using PERT. The conclusion drawn is that explicit recognition of dependence between paths enhances the accuracy of first two moments of distribution of TCJ (Total Completion of Job). Nasser Eddine Mouhoub, Abdelhamid Benhocine and Hocine Belohuada [3] discussed a new model for constructing a minimum PERT network. They proposed a new method for constructing, for a given project scheduling problem, a PERT network having as small as possible the number of dummy arcs by using some results on line graphs. This algorithm deals with the existence of transitive arcs. The paper contains illustrative examples, proofs of some theoretical results as well as a comparative study with a similar algorithm known in the literature. Computational results showed the superiority of their algorithm. The new approach is very simple to be applied. It gives minimal PERT in a number of dummy arcs in a very short time. The techniques used in the seven rules of the algorithm can be exploited in other fields by specialists in the graph theory. The experimental results are very positive even when networks are of a very large size. Another major benefit that is worth noting is the fact that the algorithm works without any problem in the presence of transitive arcs.

Albert D Baker [4] conducted a survey on factory control algorithms that can be implemented in a multi agent hierarchy: dispatching scheduling and pull. Wane A. Haga and Tim O' Café [5] have created a simulation approach of crashing of PERT network. The traditional method of crashing PERT networks ignores the stochastic nature of activity times, reducing the stochastic model to a deterministic model and simply using activity time means in calculations. The project is arbitrarily crashed to some desired completion date, without consideration for what the penalty for late project completion is. Additionally, the method ignores the fact that reducing some activity times may reduce the mean project completion time more than others, due to bottlenecks. The authors created a computer simulation model to determine the order in which activities should be crashed as well as the optimal crashing strategy for a PERT network to minimize the expected value of the total (crash +overrun) cost, given a specified penalty function for late completion of the project. Kala C. Seal [6] gives a generalized PERT/CPM implementation in a spreadsheet. The problem is of importance due to the recent shift of attention to using the spreadsheet environment as a vehicle for delivering MS/OR techniques to end users. This paper shows a way of accomplishing that task by using some simple but innovative spreadsheet layouts and formulas. The model presented not only solves the PERT/CPM problem by following the critical path method, it is also easily extendable when activities are added and deleted or predecessor relationships are changed. With a few simple copies the entire model can be extended from n activities to n+ 1 activity. It is, of course, possible to avoid the use of the critical path method in solving PERT/CPM problems by using LP formulation and then invoking the built-in spreadsheet LP solver. However, that introduces an extra step in the modeling process and also masks the more efficient critical path algorithm.

Nasim Monjezi, Mohammad Javad Sheikhdavoodi and Hadi Basirzadeh [7] have given an Application of Project Scheduling in Agriculture (Case Study: Mechanized Greenhouses Construction Project). Network models are increasingly powerful tool for modeling, scheduling, planning, controlling, and analyzing of agricultural projects. The generated PERT network model is increasingly powerful tool to help manager who could able to make optimum decision. By drawing the WBS graph, the following four goals are being met: determining the deliverable products of the project, assigning the boundaries of the project, specifying the table of activities which should be done to accomplish operation of delivering project products.

M Nazrul, Eugen and M Sharif [8] analyzed a mathematical model for estimating the project completion probability after crashing PERT/CPM network. Here we reduced the pessimistic time of the activities on critical path to reduce the expected project completion time which increase the probability of the project completion on or before the scheduled time. Some additional cost is required for the activities along critical path to speed-up the project. The increment of the estimate cost decreases the pessimistic time of the activities along critical path and indirectly decreases the total expected project duration.

PROBLEM STATEMENT:

The major idea behind the network analysis is to use techniques like PERT, CPM and GERT to find out the time required to carry out the various activities involved any process. Further these methods also tell the co-relation and interdependence of the subset activities on each other. Any startup faces many challenges especially the pressure of time which is the predominant factor for the work to begin on time. Any small delay can lead to large problems and complications which have to be avoided in all possible scenarios; this is done by the engineers using these techniques so that the constraints are met in time. Further special attention has to be given to the activities on the critical path whose delay or failure has an adverse effect on the startup.

DATA COLLECTED

Table 3.1 The data collected from the company

Activity Description		Acitivity Code		Expected Duration Days				Time (days)
				Optimistic (a)	Most Likely (m)	Pessimistic (b)		(a+4m+b)/6
Acquisition of rent land		1		45	60	90		62.50
Soil and water test analysis		2		12	15	17		14.83
Preparing of plans and layout		3		10	15	18		14.67
Getting industry establishment license		4		24	30	34		29.67
Land excavation and levelling		5		13	15	18		15.17
Construction of wall and fencing		6		14	15	19		15.50
Raw material storage building		7		26	30	33		29.83
Main building (factory) construction		8		26	30	32		29.67
Office building construction		9		7	10	13		10.00
Guard building		10		3	4	5		4.00
Compressor building		11		5	7	9		7.00
Boiler and chimney building		12		14	15	17		15.17
Layout of lines and roads		13		7	8	10		8.17
Ordering machines (conveyors, bottle washer, UV testing, Capper, Palletizer etc.)		14		27	30	35		30.33

Electrification (membership fee, installation of transformers and cabling and power generators)	15		15	17	18		16.83
Water supply	16		12	15	22		15.67
Cooling establishments (cooling fans, towers)	17		13	16	20		16.17
Ordering office equipment	18		7	10	11		9.67
Labor search and induction	19		3	7	12		7.17
Installation	20		28	30	35		30.50
Validation and trial	21		29	30	37		31.00
Final approval	22		1	3	6		3.17
						Total	416.67
						month	13.889

The essential technique for using PERT/CPM is to construct a model of the project that includes the following:

The data collected from the company gives us the rough idea of the time it will take for the major activities involved in the startup of a bottling unit. This time period is hence taken as Optimistic time (Least time, a), Pessimistic time (maximum time, b) and the most feasible time period (m). Thus using the formula t= (a+ 4m + b)/6, we can find the time taken to perform each activity and the total time taken. This is the theoretical time involved in setting up the unit. The actual time involved is roughly taken from the past records of the company taking into consideration the various factors such as location, labor etc. These two are compared and the necessary conclusions are drawn. Other than this, it is very necessary for us to know the critical path of the startup. This is because special attention has to be paid in this path. A list of all activities required to complete the project (typically categorized within a work breakdown structure. The time (duration) that each activity will take to completion and the dependencies between the activities is noted. Using these values, 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. This process determines which activities are "critical" (i.e., on the longest path) and which have "total float" (i.e., can be delayed without making the project longer). In project management, a critical path is the sequence of project network activities which add up to the longest overall duration. This determines the shortest time possible to complete the project. Any delay of an activity on the critical path directly impacts the planned project completion date (i.e. 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 above mentioned activities can be classified into 4 broader and bigger categories on the whole:

1) Site Finalization – 3 months
2) Equipment Finalization – 2 month
3) Civil Work – 4 months
4) Commissioning – 3 months
5) Trials and Approvals – 2 month

Total months required is (3+2+4+3+2= 14 months)

For the actual process to be completed the time required is close to 15 months.

The network generated is as follows and the critical path is analyzed after the calculation of the earliest start time and the latest finish time.

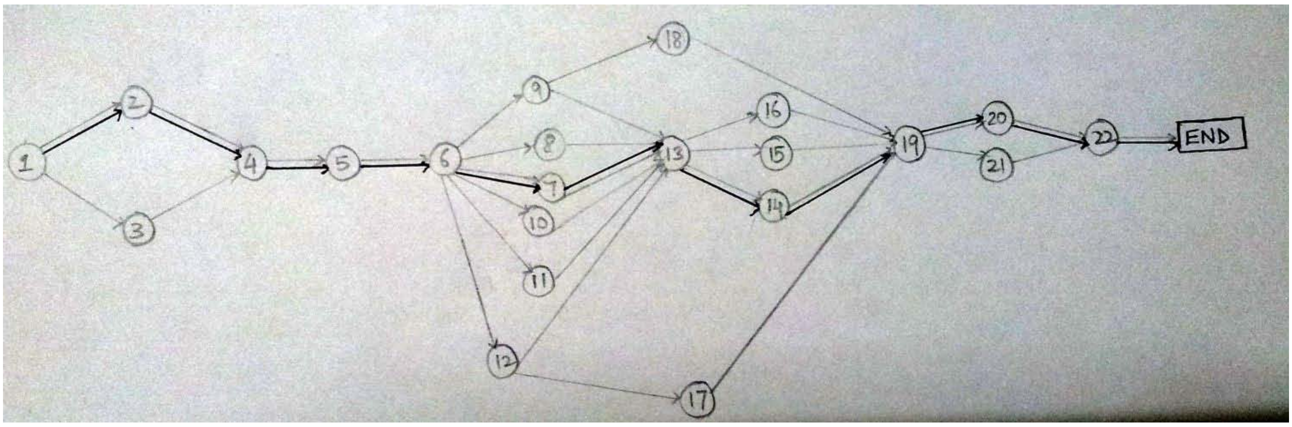

Fig: The critical path generated from the given data

RESULTS AND DISCUSSIONS

Network models are increasingly powerful tool for modeling, scheduling, planning, controlling, and analyzing of agricultural projects. The generated PERT network model is increasingly powerful tool to help manager who could able to make optimum decision.

Using PERT as the tool, the startup time after taking all the possible variation in the time comes out to be less than the actual time taken by the company. This data is verified with the original startup which took around 15 months. The optimum time required is 13 months and 25 days. Moreover, the critical path was found and the time of activities on the critical sums up to be nearly 246 days. The activities which lie on the critical path acquisition of rent land (1), soil and water test analysis (2), getting the establishment license (4), land excavation and leveling (5), construction of wall and fencing (6), raw material storage building (7), layout of lines and roads (13), ordering machines (14), getting labor (19), installation (20) and final approval (22).

CONCLUSION

The requirement of the project necessitates the preplanning. It increases the harmony and coordination. It usually predicts and determines the troublesome items. It specifies and segregates the responsibilities. It refines the thoughts and increases the knowledge of user about related subjects and their relative importance in whole operation. It attracts the management attention to those activities which may face problems or seems to be associated with them. It specifies the optimum start and finish points of each activity in the operation. It facilitates the possibility of readjusting of the project for new conditions. It facilitates the reporting and instructing procedures. It is a very useful device for educating employees in different fields of operation. It is the most suitable tool for presenting the organizational chart and their relation. It shows the relation between activities. It is adjustable and also updatable. Changing and modifying the program in new and unprecedented situations will accomplish easily. Every parts of the network can be changed easily. Hence we conclude that that the PERT and CPM techniques were successfully used to generate the time in which activities should be completed in a startup and how they actually depend on each other. These techniques showed that the actual time taken is more than the calculated time because of certain delays that go against the circumstances. Thus CPM was used to show that the activities which are of high priority should be given special consideration as any effect on them can lead the project down.

APPLICATIONS AND ADVANTAGES

Project Evaluation Review Technique and Critical Path Method (CPM) are scheduling techniques used to plan, schedule, and budget and control the many activities associated with projects. Projects are usually very large, complex, custom products that consist of many interrelated activities to be performed either concurrently or sequentially. The planning horizon for PERT/CPM typically extends beyond the six-month time frame of traditional short-range planning used in the other production processes. Utilizing PERT/CPM involves breaking the total project down into many different individual activities with identifiable time requirements. Each activity must be accomplished as part of the total work to be done. Custom products (made to customer specification) are produced with a project process; therefore, the customer's desired completion date is the focal point for scheduling. The time to begin work on the project is determined by working backward from the customer's desired completion date. Project managers must coordinate each of the activities so the project can be completed at the desired date and with minimal costs. The PERT/CPM schedule allows for converting the project plans into an operating timetable; thus, provides direction for managing the day-to-day activities of projects. Although application of both PERT and CPM follow the same steps and use network diagrams to schedule and control projects, the primary difference between these two techniques is that PERT is probabilistic where CPM is deterministic. PERT/CPM are the most appropriate techniques when it comes to scheduling and controlling large projects. They are favorable because they are not only accurate to a large extent but also straight forward and not mathematically complex. Moreover, graphical networks help to perceive relationships among project activities. Critical path analysis gives those activities which have to be precisely taken care of and watched. Also, the final analysis gives the exact project documentation and graphics point out who is responsible for various activities. Lastly, these techniques are applicable for a wide variety of products both in manufacturing and service sectors as well.

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