Operation Research on Project Evaluation & Review Technique & Critical Path Method: A Novel Study

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Abstract— Due of the growing effects of the globalization in various business environments, the manufacturing industry is expected to be effective and yet efficient. According to this, in planning, scheduling and controlling a project, which is a combination of various activities, project management techniques (PERT and CPM) are used. Therefore, the research question is how will the implementation of CPM and PERT influence the effectiveness and efficiency of Furniture Company. In oder to point out the importance of those methods in reducing the project completion time and costs. The data are taken from the furniture company "Dallas" and it will be combined with literature reviews. The research study is fuelled by the following objectives: First is to determine the activities that are involved in the manufacturing process in selected company. Second is to demonstrate the benefits, as well as the drawbacks that those methods might create in the organization. And third is to demonstrate the influence of CPM and PERT in the entire furniture industry and its competitiveness. Implications of this research paper are evaluation of the project completion time and control of the resources, in order to see that the project is completed within the planned time and cost by using mentioned methods. At the end of the study, the result is expected to help all the individuals as well as the companies to understand more the concept of CPM and PERT methods in reducing the project completion time and costs.

Key words: CPM, PERT

I. INTRODUCTION

A. Project Evaluation & Review Technique

Program (Project) Evaluation and Review Technique (PERT) is a project management tool used to schedule, organize, and coordinate tasks within a project. It is basically a method to analyze the tasks involved in completing a given project, especially the time needed to complete each task, and to identify the minimum time needed to complete the total project.

PERT assumes a beta probability distribution for the time estimates. For a beta distribution, the expected time for each activity can be approximated using the following weighted

B. Average

Expected time = (Optimistic + 4 x Most likely + Pessimistic) / 6

This expected time may be displayed on the network diagram. To calculate the variance for each activity completion time, if three standard deviation times were selected for the optimistic and pessimistic times, then there are six standard deviations between them, so the variance is given by: [(Pessimistic - Optimistic) / 6]

The PERT technique accepts that scheduling is a stochastic problem and takes this variability in the duration of activities into account. Normally the upside potential for early completion is smaller than the downside potential for delay. Linda (1989) discusses CPM and PERT techniques useful for library management. Yakhchali (2008) proposed new method called PERT11.This method is a novel approach to project scheduling with stochastic activity durations. This method helps to reduces beta distribution problem arises in PERT, as suggested method use montecarlo approach, and to minimize the drawback associate with it. This method use cumulative distribution function of/latest starting and finishing and floats of activities based on confidence interval

II. LITERATURE REVIEW

The Critical Path Method (CPM) has been useful for project planning yet its float calculation errors in cases of complex schedules hinders its ability to provide decision supports during project control, namely corrective action sand forensic analysis of schedules. To improve project control, Peter and Roy (2009) suggested CPM and Critical chain project management (CCPM) for organizations. The study focused that each organization using CCPM would have to identify its level of tolerance of risk and the possible decision making strategies that could use in case of the project slippage. They also discussed about various software packages which use different algorithms to analyse any project. T Hegazy (2012) in his study enhanced the critical path segments (CPS) scheduling technique and incorporates a rich visualization of all as-built events made by all parties, including work stops, accelerations, and rework. Its improved critical path calculation incorporates the decision variables used at the project control stage such as revised construction methods. It also uses a modified float calculation with forward-pass only to avoid float errors. A case study is used to demonstrate the proposed technique and its benefits for project control. This research has the potential to revolutionize scheduling computations to resolve CPM drawbacks and provide decision support capabilities to improve project planning and control.

CPM Li and Liu (2011) in their paper come up with an improved PERT Method which is suitable for risk assessment the suggested improved method useful for engineering project activity time and variance by formula nearer to practical situation. This method provides the revision policy to evaluate optimized results in terms of improved probability and risk rate due to interrelated activities mode and easily applicable on spliced network for engineering projects. Yaghoubi and Noori (2013) presented a heuristic method for consumable resource allocation problem in multiclass dynamic project evaluation and Review Technique network,this method use

Poisson processes with different arrival rates. Styen(2003)conducted a research on a comparison between combination of various network analysis approached to accelerate engineering projects. Moreover he emphasised on lack of holism in PERT and CPM techniques. Thus to compete in critical and concurrent engineering environment, he provided integrated CPM approach

In this method the activities time schedule considered in precise manner. Sharafi et al (2008) presented a model for project scheduling for fuzzy preceding activities. They presented a new method based on the fuzzy theory. In his study the duration of activities is triangular fuzzy numbers (TFN) where it is assumed that relationships between the activities are not crisp. Saeinia and Hashemin (2012) use the trapezoidal fuzzy number for time cost trade off in fuzzy projects with constrained consumable resource. Where in activity duration depend upon the amount of resource allocation. They proposed algorithm used to minimize the direct and indirect cost of the project.

III. MATHEMATICAL PROGRAMMING

Mathematical Programming (MP) is the use of mathematical models, particularly optimizing models, to assist in taking decisions. The term 'Programming' antedates computers and means 'preparing a schedule of activities'. Mathematical Programming is more restrictive

IV. PROJECT NETWORKS

A network used to represent a project is called a project network. A project network consists of a number of nodes (typically shown as small circles or rectangles) and a number of arcs (shown as arrows) that connect two different nodes. (If you have not previously studied Chap. 9, where nodes and arcs are discussed extensively, just think of them as the names given to the small circles or rectangles and to the arrows in the network.) As Table 22.1 indicates, three types of information are needed to describe a project. 1. Activity information: Break down the project into its individual activities (at the desired level of detail). 2. Precedence relationships: Identify the immediate predecessor(s) for each activity. 3. Time information: Estimate the duration of each activity. The project network should convey all this information. Two alternative types of project networks are available for doing this. One type is the activity-on-arc (AOA) project network, where each activity is represented by an arc. A node is used to separate an activity (an outgoing arc) from each of its immediate predecessors (an incoming arc). The sequencing of the arcs thereby shows the precedence relationships between the activities. The second type is the activity-on-node (AON) project network, where each activity is represented by a node. Then the arcs are used just to show the precedence relationships that exist between the activities. In particular, the node for each activity with immediate predecessors has an arc coming in from each of these predecessors. The original versions of PERT and CPM used AOA project networks, so this was the conventional type for some years. However, AON project networks have some important advantages over AOA project networks for conveying the same information. 1. AON project networks are considerably easier to construct than AOA project networks. 2. AON project networks are easier to understand than AOA project networks for inexperienced users, including many managers. 3. AON project networks are easier to revise than AOA project networks when there are changes in the project.

V. THE CRITICAL PATH

A path through a project network is one of the routes following the arcs from the START node to the FINISH node. The length of a path is the sum of the (estimated) durations of the activities on the path.

VI. THE VALUE OF PERT/CPM

Much of the value of PERT/CPM derives from the basic framework it provides for planning a project. Recall its planning steps: (1) Identify the activities that are needed to carry out the project. (2) Estimate how much time will be needed for each activity. (3) Determine the activities that must immediately precede each activity. (4) Develop the project network that visually displays the relationships between the activities. The discipline of going through these steps forces the needed planning to be done. The scheduling information generated by PERT/CPM also is vital to the project manager. When can each activity begin if there are no delays? How much delay in an activity can be tolerated without delaying project completion? What is the critical path of activities where no delay can be tolerated? What is the effect of uncertainty in activity times? What is the probability of meeting the project deadline under the current plan? PERT/CPM provides the answers. PERT/CPM also assists the project manager in other ways. Schedule and budget are key concerns. The CPM method of time-cost trade-offs enables investigating ways of reducing the duration of the project at an additional cost. PERT/Cost provides a systematic procedure for planning, scheduling, and controlling project costs. In many ways, PERT/CPM exemplifies the application of OR at its finest. Its modeling approach focuses on the key features of the problem

VII. THE FUTURE

Despite its deficiencies, PERT/CPM undoubtedly will continue to be widely used for the foreseeable future. It provides the project manager with most of what he or she wants: structure, scheduling information, tools for controlling schedule (latest start times, slacks, the critical path, etc.) and controlling costs (PERT/Cost), as well as the flexibility to investigate time-cost trade-offs. Even though some of the approximations involved with the PERT three-estimate approach are questionable, these inaccurances ultimately may not be too important. Just the process of developing estimates of the duration of activities encourages effective interaction between the project manager and subordinates that leads to setting mutual goals for start times, activity durations, project duration, etc. Striving together toward these goals may make them self-fulfilling prophecies despite inaccuracies in the underlying mathematics that led to these goals

VIII. CONCLUSIONS

CPM and PERT considerably reduce the project completion time At the end of the study, the result is expected to help all the individuals as well as the companies to understand more the concept of CPM and PERT methods in reducing the project completion time and costs. Apparently, as it is expected the final, quantitative results point out the importance of implementing those methods in planning, scheduling and controlling a project in terms of providing effectiveness and efficiency of furniture company. The basic concepts of the PERT technique and an illustrative example have been discussed in the current chapter as a valuable tool to deal with a (low) degree of uncertainty in activity estimates. Although the basic concepts of the critical path scheduling approach have been outlined in this chapter, an overview of the main characteristics of the Critical Path Method (CPM). The application of PERT/CPM begins by breaking the project down into its individual activities, identifying the immediate predecessors of each activity, and estimating the duration of each activity. A project network then is constructed to visually display all this information. The type of network that is becoming increasingly popular for this purpose is the activity-on-node (AON) project network, where each activity is represented by a node. PERT/CPM generates a great deal of useful scheduling information for the project manager, including the earliest start time, the latest start time, and the slack for each activity. It also identifies the critical path of activities such that any delay along this path will delay project completion. Since the critical path is the longest path through the project network, its length determines the duration of the project, assuming all activities remain on schedule. However, it is difficult for all activities to remain on schedule because there frequently is considerable uncertainty about what the duration of an activity will turn out to be. The PERT three-estimate approach addresses this situation by obtaining three different kinds of estimates (most likely, optimistic, and pessimistic) for the duration of each activity. This information is used to approximate the mean and variance of the probability distribution of this duration. It then is possible to approximate the probability that the project will be completed by the deadline. The CPM method of time-cost trade-offs enables the project manager to investigate the effect on total cost of changing the estimated duration of the project to various alternative values. The data needed for this activity are the time and cost for each activity when it is done in the normal way and then when it is fully crashed (expedited). Either marginal cost analysis or linear programming can be used to determine how much (if any) to crash each activity in order to minimize the total cost of meeting any specified deadline for the project. The PERT/CPM technique called PERT/Cost provides the project manager with a systematic procedure for planning, scheduling, and controlling project costs. It generates a complete schedule for what the project costs should be in each time period when activities begin at either their earliest start times or latest start times. It also generates periodic reports that evaluate the cost performance of the individual activities, including identifying those where cost overruns are occurring

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