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The Application of PERT and CPM Method in Building Construction Industry to Organize all the Project's Schedule Systematically: A Review Paper

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Abstract

In recent times, project planning and scheduling have become very efficient in the construction industry. It is instrumental in organizing a complex construction properly. However, in several cases, the management of a project becomes very poor and causes many annoyances throughout the entire project. So, introducing the PERT (Program Evaluation and Review Technique) and CPM (Critical Path Method) methods into the construction industry will eradicate all the deficiencies of a specific project in terms of time management. All the project activities are organized by creating a network diagram, and PERT and CPM-based network diagrams are essential for organizing a project. This paper aims to exhibit how to use the PERT and CPM methods in the construction industry to reduce project completion times and obtain a proper project model through PERT and CPM based networks using. The proposed methodology is to collect all the necessary data, precisely sequence the activities, construct a network diagram of a specific project, and schedule individual activities using Primavera P6. In adjunct to that, the critical path was also determined for a specific construction project. The outcome of this paper will encourage construction sector enthusiasts to utilize the PERT and CPM methods in a construction outline and accomplish a successful project policy

Keywords: *PERT (Program Evaluation and Review Technique); CPM (Critical Path Method); network diagram; scheduling; project policy*

1 Introduction

Planning, Scheduling (or organizing), and Control are seen as fundamental managerial activities, and CPM/PERT has been given appropriate weight in the literature on Operations Research and Quantitative Analysis. PERT/CPM gave a focus around which managers could brainstorm and put their ideas together, far more than the technical benefits. Most importantly, it evolved into a helpful instrument for assessing the performance of people and teams.

One of the most important problems facing technical management today is the coordination of numerous disparate operations towards a shared goal. Almost all engineering and craft skills, as well as the functions represented by research, development, design, procurement, construction, vendors, fabricators, and the customer, are engaged in a large engineering project, for example. Management must design plans that will tell them as precisely as possible how the efforts of the persons representing various functions should be directed towards the completion of the project. Many current project planning systems have flaws as a result of methodologies that are insufficient for dealing with complicated projects. In general, the various organizations involved in the task perform their own comprehensive planning and scheduling – mostly independently of one another (Manege & Kennedy, 2020). These disparate efforts result in a lack of coordination. Furthermore, it is customary in project work to create precise schedules from rough estimates of complete requirements and achievements based on previous experience. The major reason for this oversimplification is that unassisted humans are incapable of dealing with sheer complexity. As a result, several negative consequences may occur. Some critical parts of a project that should be considered from the start may be overlooked or overlooked. As a result, there may be a lot of confusion throughout the project. When this occurs, the project is managed by the coordinators and expediters. In such cases, management loses a lot of control over a project and never knows whether its goals are being met adequately.

Managers can access time estimates from foremen, suppliers, subcontractors, and other service providers. This data also allows them to provide a centralized metric of project completion time as well as a measure of dispersion (standard deviation). The probabilities of completing the project by a specific due date can be determined using the mean and standard deviation of the completion time distribution. Each activity in PERT has three-time estimates, assuming a beta probability distribution for the time estimations. The following weighted average can be used to estimate the time required for each activity.
PERT is a probability time estimate for activities in a project. However, CPM does not involve probability but actual time estimate of activities in a project. The time estimate is determined by the estimator, who is expected to be an experienced individual. The estimator would have had a long record of similar projects in the past. This paper aims to show how PERT and CPM methods help the project to manage properly and use of primavera p6 to utilize the project perfectly.

2 PERT and CPM in Project Management

Effective project management necessitates optimizing project length in order to reduce total project time and cost. Project managers always use the Project Evaluation Review Technique (PERT) and the Critical Path Method (CPM) to break big complicated projects into sub-activities, deploy resources, and manage the project cycle in order to minimize the total cost and time of the project. As a result, PERT and CPM are operational research tools used to drive project effectiveness and efficiency, and these approaches can be used to a variety of industries or sectors, including construction, aviation, the military, and education, as well as the civil government. PERT/CPM is used by project managers to provide solutions to the following project-related essential issues: How long will it take to complete the project? What are the start and finish dates for each individual sub activity? Which sub-activities or tasks are crucial and must be done exactly as planned in order for the project to proceed as intended? How long can non-critical sub-activities be delayed before they cause the project's completion date to be pushed back? What is the likelihood that the project will be completed at any given moment if the activity time is unknown? If there is a cost associated with "crashing" each action, what is the additional cost of finishing the project sooner than usual? PERT and CPM aid management in determining the longest time-consuming or consuming path through a network of tasks or activities as a basis for project planning, execution, and control. The strategies assist managers in optimizing the longest time length to reduce total project cost and time. These tools assist project managers by helping them through the various stages of project management. The procedures are mathematically simplified and provide critical path and slack time, project documentation, and are extremely beneficial in project cost monitoring. However, when comparing the benefits of both methodologies to project management, PERT is event-oriented, probabilistic, and concerned with time alone, and it applies to projects with an unknown time horizon. CPM, on the other hand, is an activity-oriented, deterministic model that is utilized for projects that are repetitive in character and are small in size (Manege & Kennedy, 2020).
The PERT and CPM models make basic planning, scheduling, and control operations easier. The planning step divides a whole project into specific material, manpower, and equipment requirements. It is involved with organizing well-defined jobs into a performance time sequence. PERT and CPM give management a clear definition of time cost, an operational network that connects all activities to a time dimension, resource requirements, and a means for displaying critical and non-essential tasks. The application of these network models encompasses sectors as diverse as product development and distribution, shipbuilding, turnaround maintenance of a facility, and where timing activities necessitate project planning and scheduling.
An activity in project management is a task that must be completed by a project team. An event is a significant occurrence that marks the completion of one or more activities. All preceding activities must be performed before an activity can begin. Project network models are abstractions or representations of project activities and milestones using arcs/arrows and nodes, respectively. The PERT/CPM diagrams shown below explain how projects are split down into several sub-activities and how the duration of the project is optimized to minimize total time and cost.

3 Project Evaluation Review Technique

Managers can access time estimates from foremen, suppliers, subcontractors, and other service providers. This data also allows them to provide a centralized metric of project completion time as well as a measure of dispersion (standard deviation). The probabilities of completing the project by a specific due date can be determined using the mean and standard deviation of the completion time distribution (Manege & Kennedy, 2020).

Each activity in PERT has three-time estimates, assuming a beta probability distribution for the time estimations. The following weighted average can be used to estimate the time required for each activity. These estimates are designated as:
a = optimistic time estimate, that is, the minimum reasonable time taken to perform an activity.
b = pessimistic time estimate, that is, the maximum reasonable time taken to perform an activity.
m = most likely time estimate, that is, the most likely time accepted to perform an activity. As an estimate of activity completion time, the beta distribution is used, which is a reasonable approximate expression of activity duration.
The expected time t e which approximates the mean, the standard deviation σ for the beta distribution is given as:

$$T_e=(a+4m+b)/6$$

4 Critical Path Model

PERT is a probability time estimate for project tasks. CPM, on the other hand, does not incorporate probability but rather an actual time estimate of project operations.
The estimator, who is expected to be an experienced professional, determines the time estimate. The estimator would have a long track record of similar projects. There are four-time estimations for each activity:
1**) Early start (ES)** refers to the earliest time at which an activity can begin. The assumption is that all previous activities begin as soon as feasible; otherwise, a late start to the preceding action will result in a late start to the following activity. The ES of an action is the sum of all previous activities on that path. When an activity has more than one preceding activity, the early start of that activity is determined by the early completion of the activity with the longest duration or the longest ES time, t.
2) **A late start (LS)** is a pause in the beginning of an activity. The latest time an activity can commence without causing a delay in project completion.
3) **An early finish** (EF) is an action that begins early and ends early. The activity is assumed to begin with ES and terminate with t. EF = ES + t. The precedence relationship demonstrates that the early commencement of an activity is dependent on the early finish of the action immediately preceding it. This means that ES + t = EF (Forward induction/movement).
4) **Late finish (LF**)—A late start will result in a late finish. The delay in the late start of an activity, which results in the late end of that activity, should not cause the project completion time to be pushed back. We suppose that EF = LF for the final activity in the critical path, and that LF t = LS denotes a reversal process known as Backward induction/movement. The LF of the prior activity (ies) determines the LS of the current activity. When an activity has more than one preceding activity, that is, when two or more paths converge on an activity, the path with the least total LS time is chosen as the previous activity's or activities' LF. paragraphs.

5 Methodology

The study employed an integrated review approach to examine conceptual and empirical references to project evaluation review methodologies and critical path methods, with a focus on work examples and analysis. Project management entails the processes required to ensure that the project is completed on time. Plan schedule management, define activities, sequence activities, estimate activity durations, design a timetable, and regulate the schedule are the procedures.

6 Discussion

Here a demo two story shopping mall complex construction is managed with Primavera P6 project management software. This two-story construction has been completed with approximate 5 months. As PERT and CPM method plays a vital role in project management, this construction uses these two methods to schedule, control and monitor the project. In this project numerous activities were used. So it helps the project to schedule it precisely and save the time. Here also network diagram is constructed through the Primavera P6. It helps to identify the specific order to complete the project

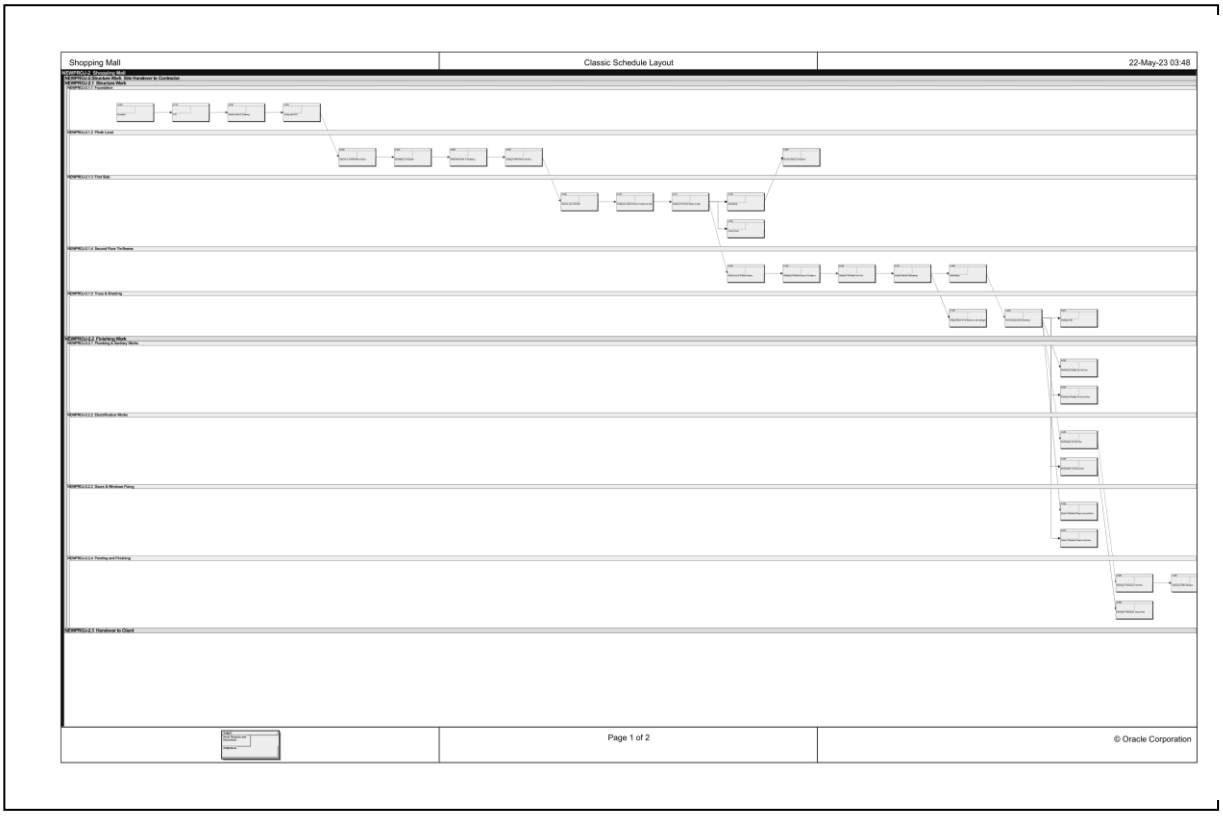

Figure 1: Network Diagram of the sample Project

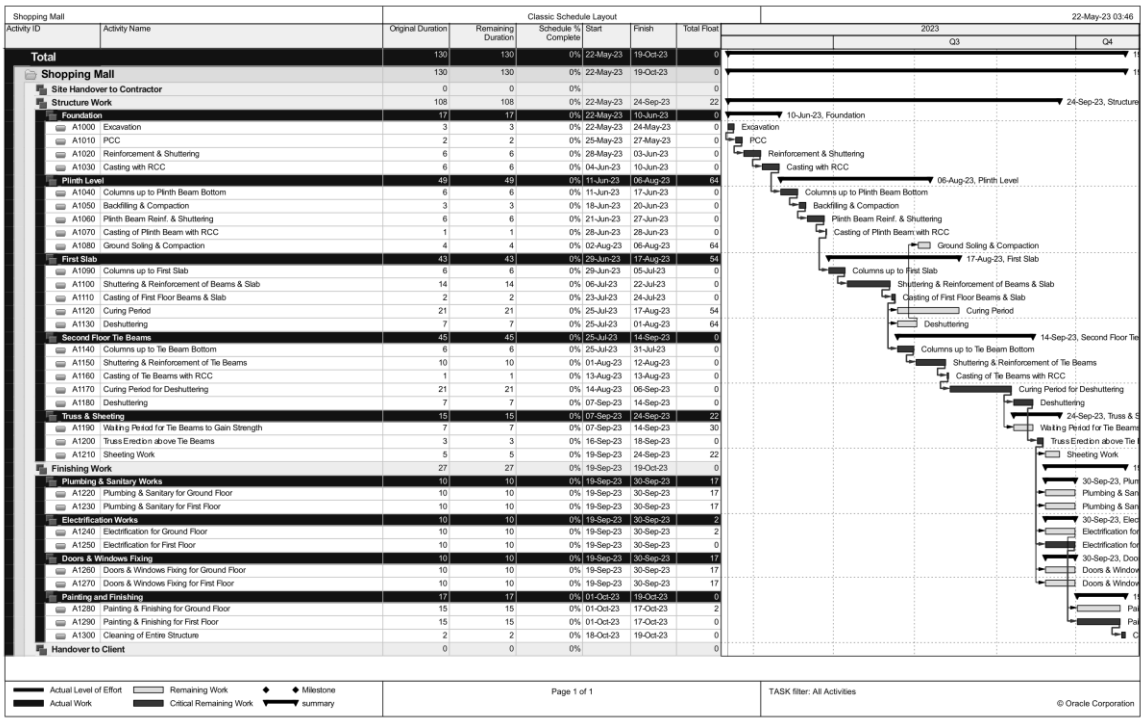

Figure 2: Scheduling of the sample Project

7 Conclusion

Operational research approaches are required to manage project circles by optimizing project duration in order to reduce overall project time and cost. The Project assessment and review technique and the Critical route approach are methods for planning the scheduling and optimal staffing of individual activities and controlling projects to completion within a specified time frame. Large-scale project management demands coordinating multiple activities across the organization, and these tools are used to facilitate the step-by-step tasks in a priority relationship, with the goal of minimizing total project cost by controlling time and project efficiency. CPM is driven by network activities, which optimize project duration, cost minimization, and project time. As a result, they are useful tools for managing large, small, and medium-sized projects. PERT provides management with a clear definition of time and cost, an operational network that relates all activities to a time dimension, resource requirements, and a method for showing critical and non-critical activities when considering a project with uncertain activities or an estimated start and end date for each specific activity. These tools (PERT and CPM) are now being used in projects such as building, transportation, education, and telecommunications. It is crucial to highlight, however, that traditional project management methods or the use of the Gant chart limit project success.

References

Orumie Ukamaka, C. (2020). Implementation of Project Evaluation and Review Technique (PERT) and critical path method (CPM): A comparative study. *International Journal of Industrial and Operations Research*, *3*(1). doi:10.35840/2633-8947/6504

Bagshaw, K. B. (2021). New pert and CPM in project management with practical examples. *American Journal of Operations Research*, *11*(04), 215–226. doi:10.4236/ajor.2021.114013

Trietsch, D., & Baker, K. R. (2012). Pert 21: Fitting pert/CPM for use in the 21st Century. *International Journal of Project Management*, *30*(4), 490–502. doi:10.1016/j.ijproman.2011.09.004

Abbasi, G. Y., & Mukattash, A. M. (2001). Crashing pert networks using Mathematical Programming. *International Journal of Project Management*, *19*(3), 181–188. doi:10.1016/s0263-7863(99)00061-7

Mouhoub, N. E., Benhocine, A., & Belouadah, H. (2011). A new method for constructing a minimal Pert Network. *Applied Mathematical Modelling*, *35*(9), 4575–4588. doi:10.1016/j.apm.2011.03.031

Pontrandolfo, P. (2000). Project duration in stochastic networks by the Pert-Path Technique. *International Journal of Project Management*, *18*(3), 215–222. doi:10.1016/s0263-7863(99)00015-0

Mohan, A., & Balaganesan, M. (2022). Planning and scheduling a project by using Fuzzy Critical Path Method. *2ND INTERNATIONAL CONFERENCE ON MATHEMATICAL TECHNIQUES AND APPLICATIONS: ICMTA2021*. doi:10.1063/5.0108997

Iqbal, S., Asghar, W., Munir, A., & Khalid, M. N. (2020). An empirical analysis of the relationship between Project Success Criteria and project planning techniques used in construction industry of Pakistan. *Review of Applied Management and Social Sciences*, *3*(3), 475–483. doi:10.47067/ramss.v3i3.83

McCahon, C. S. (1993). Using pert as an approximation of Fuzzy Project-network analysis. *IEEE Transactions on Engineering Management*, *40*(2), 146–153. doi:10.1109/17.277406

Lappe, M., & Spang, K. (2014). Investments in project management are profitable: A case study-based analysis of the relationship between the costs and benefits of Project Management. *International Journal of Project Management*, *32*(4), 603–612. doi:10.1016/j.ijproman.2013.10.005