



Original Article

A Better Approach for Linear Projects: LOB or CPM

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Abstract - Scheduling is a very crucial element in the management of projects, particularly the linear type of projects that follow a sequential pattern, such as highways, pipelines, and high-rise buildings. This paper compares two main scheduling techniques: the Critical Path Method (CPM) and the Line of Balance (LOB) technique. Despite the fact that CPM has been widely adopted in the construction industry for many years, LOB has particular advantages for projects with repetitive activities. This research investigates both methods' strengths, limitations, and situational applicability for linear project environments. This paper aims to assist project managers in determining which scheduling technique to adopt depending on the project characteristics, resources, and management goals and objectives based on the performance of the techniques in terms of certain parameters.

Keywords - Critical Path Method, Line Of Balance, Linear Projects, Project Scheduling, Construction Management, Repetitive Projects, Schedule Optimization, Resource Management.

1. Introduction

Linear projects are also large construction and infrastructure development projects whereby the activities are done in a line or from one point to another. Some include highways, railways, pipelines, and multi-story buildings with typical floors. They have some problems that are not typical for scheduling discrete and non-repetitive projects. Of the two, the most common linear management techniques are the critical path method and the line of balance technique [4]. CPM, on the other hand, was developed in the 1950s, and it focuses on establishing the sequence of activities that identifies the least time within which a project can be accomplished. LOB derived from industrial production scheduling focuses on the free flow of resources in the cycle of activities [7]. While CPM is the most popular scheduling technique in the construction industry, it has been found that in linear projects with repetitive characteristics, LOB may have certain advantages. This paper compares these two methodologies, their principles, their applicability to linear projects, and their performance under different project conditions.

2. Literature Review

The critical path method has been under research ever since it was developed, with much focus being placed on enhancing the algorithms and their flaws. Research

conducted in the past decade analyzes different algorithms used in time analysis of CPM networks and the potential performance of these algorithms in terms of time and solution when solving complex scheduling problems [1]. This paper proves that CPM is relatively well-developed, yet there is a continuous effort to increase its effectiveness in projects with more complications. In repetitive projects, various specialized scheduling techniques have been developed to counter the problems of the CPM. Based on the literature review of dispersed repetitive projects, several optimization models have been proposed to enhance resource utilization and project duration [2]. These advances demonstrate the progress made in scheduling over time to respond to specific issues in repetitive work environments.

Linear programming has been applied in planning and scheduling to determine the most suitable solution for mechanical installation projects where activities are sequenced. It has also been confirmed that these mathematical optimization techniques are helpful in resource allocation and the project duration for CPM scheduling [3]. These findings suggest the possibility of enhancing the scheduling results beyond CPM by employing quantitative optimization methods. The research made so far in the cross-sectional analysis of planning in different countries has provided some insight into the possibility of various planning schedules. The studies conducted in Brazil, Finland, and the USA established that each of the mentioned methods is effective depending on the type of project and the organizational culture of project management [4]. The research also found that there is no ideal method of scheduling for all projects.

The impact of resources on scheduling techniques has recently become a topic of interest. Certain studies comparing various methods that can be used in scheduling projects under resource-constrained environments reveal that while CPM is beneficial in identifying critical activities, it is not very useful when resources are limited [5]. LOB, one of the approaches based on the continuity of resources, can be regarded as more suitable for such cases. Because of this, fuzzy logic has been incorporated into construction projects' linear and repetitive scheduling methods. This integration has been determined to have the ability to address probability questions in construction durations and improve schedule risk [6]. Such advancements are attempts to eliminate determinative barriers in traditional scheduling systems.

3. Problem Statement

The construction industry has not been able to decisively determine and adopt the proper scheduling methodology for linear projects despite the application of the schedule for several decades. The continuous use of CPM scheduling, even in repetitive work, hampers the efficient use of resources, poor workflow, and poor schedule communication [7]. This is due to education and training that have long promoted CPM over other possibilities. These software tools are primarily developed to support CPM, contracts that require CPM outputs, and organizational reluctance to change methods [4]. Moreover, several theoretical benefits of LOB for linear projects are not achievable in real-life scenarios because of implementation difficulties, compatibility with other systems, and the requirement for professional knowledge. It is, therefore, apparent that there is a need for more detailed information on the conditions under which each of the methodologies is appropriate and how it should be implemented.

4. Solution

The best method of scheduling a linear project is to decide between CPM and LOB depending on the characteristics of the project or, in some cases, a combination of the two techniques. LOB is beneficial for projects with high repetition and constant production rates since it offers enhanced visualization of the continuity of the workflow and the usage of resources [7]. Implementation should be directed at defining the recurring work cycles, setting the right rhythm of work, and determining the crew's movements to keep work going. Resource optimization in linear projects is a different problem from the conventional resource leveling done in CPM. It is also important to note that other tools, like linear programming, can address resource constraints and duration goals more effectively than the scheduling tools [3]. To develop the best schedules, these should include crew size, productivity rates, and work continuity. To mitigate uncertainty in linear projects, it is recommended to use fuzzy logic models consisting of probabilistic duration estimations [6]. These techniques can be applied under CPM or LOB to obtain more realistic forecasts and predict work process interruptions.

5. Uses

Critical Path Method scheduling is still applicable for several characteristics of linear projects. CPM is also useful when the project has non-repetitive activities, complicated logical dependencies, or contractual deliverables linked to specific activities [1]. It is also used during the feasibility study of all linear projects to set overall duration and constraints before location-based scheduling. Line-of-balance scheduling provides better scheduling for linear projects with repetitive activities and similar work. As for the LOB application, highway construction, pipeline construction, and construction of high-rise buildings with typical floor and mass housing development are some of the ideal ones [7]. It is beneficial for projects where the continuity of the crew is essential since the method is excellent for crew movements and continuity of workflows, and the progress can be easily visualized in relation to

location. In resource-constrained environments, LOB offers particular advantages for linear projects. This is because it simplifies the representation of crew movements and production rates, which helps organize resources and makes resource contention more distinguishable than in CPM networks [5]. This visibility assists the project managers to be able to see problems that are likely to slow down the project before they occur.

6. Impact

The decision between CPM and LOB for linear projects dramatically impacts the performance in the following ways. It was also revealed during the research that proper selection of the methodology contributes to a time-saving of about 10-15% of the total time in project implementation due to appropriate utilization of resources and flow of work [2]. These time savings go a long way in translating to cost and time benefits in favor of project owners and faster revenue generation. Resource efficiency is another impact area that can be considered as somewhat necessary. LOB is commonly used in linear projects. By this means, it is possible to increase the use of resources by 15-20% more than CPM, where crews are used more constantly, and there is less downtime between operations. This efficiency is also helpful in cutting down the costs of projects and improving the stability and satisfaction of the employees in the workforce. The selection of methodology also impacts consistency in scheduling to a large extent. LOB scheduling technique has also been identified to be more realistic in developing schedules for linear projects in that they have a 25-30% variance between the planned and actual durations compared to CPM schedules [7]. This makes the decision more reliable, and there will not be a tendency to change the plan repeatedly.

7. Conclusion

Given the above analysis of CPM and LOB for linear projects, it can be concluded that the choice of methodology should not be dictated by the company's tradition or some standards observed in specific industries. While CPM is better suited for handling logical relations and non-repetitive activities, the LOB is more suitable for repetitive activities because it offers better visualization of the work, use of resources, and schedule intention. The best approach is to use CPM to define the overall project structure, critical interfaces, and LOB to enhance repetitive work sequences. The challenges associated with adopting LOB include software, training, and contracts, which are feasible challenges. Linear projects should be improved by working on the methodology and creating the criteria for choosing the proper method depending on the type of linear project. Software vendors should also increase their backing of location-based planning strategies. In addition, contract configurations should incorporate other scheduling deliverables where applicable to the kind of project.

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