Cost Aspect of Scheduling in CPM Network an Overview.
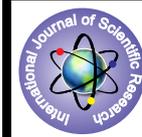
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ABSTRACT

After release of drawings from office of architect and structure engineer, the next phase of project is implementation phase in which blue print are converted into material reality before the implementation phase a CPM network with schedule has to be prepared the scheduling of CPM network is an importantly stage in project life cycle . In this paper various scheduling techniques for CPM network has been discussed at length. The accuracy or certainty of the schedule depends on experience of scheduler, human judgement and his wisdom.

1.0 Introduction:

The CPM was first used by E.I du Pont de Nemours Company for planning and scheduling of construction project . Since then it is being modified and thoroughly used for construction project, as it is best suited for the same. Today there is no dearth of such network techniques but still CPM has not lost its importance. The first stage for CPM network is construction planning.

2.0 THE CONSTRUCTION PLANNING

Construction planning involves followings elements

1) Time duration of individual activity
2) Total duration of project
3) Logical sequence of different activity.
4) Constraints or availability of resources.

In construction planning constraints is always a stumbling block for the free movement of the project after the construction planning at macro level the next phase is construction scheduling. Construction Scheduling is a judicious plan for optimal use of available human and non human resources this scheduling plays a vital role in success of project. So a clear understanding of inherent nature of resources is necessary for the scheduler .

3.0 THE RESOURCES

In network preparation of CPM it was assumed that all types of resources are unlimited and are available at desired time.

This situation should always be maintained with critical activities. It is the duty of construction manager to provide work for their crew to retain them within the organisation, as it is not practically possible to call men on the one-day and send them off next day. To avoid such situation float time should be used in spreading out crew assignment. Crew scheduling arrows are added to recognise such situation.

Sometimes planners have a notion that they have planned the project more carefully than ever before and do not take feedback from the people who are at the helm of affairs. In early CPM applications, the CPM network was left to its own devices once the project was in progress. Today, it needs very close monitoring otherwise it will be a case of breakdown of engine of a new car because of poor maintenance.

The network technique: Critical Path Method (CPM) is in extensive use in construction industry for construction planning and scheduling and monitoring of the project. In conventional CPM approach the major objective is to build a basis for feasible duration needed to accomplish a specific project. The assumption of unlimited resources is a non-pragmatic thinking. The construction resources like crew size, equipment and materials are limited at the real construction site. Due to resource availability constraints; activity duration and sequence of activities may need adjustments. Subsequently the project cost may also change accordingly.

To deal with such situation of availability of resources, construction scheduling must incorporate resource allocation. Since resource allocation is a practical problem of construction and manufacturing industry. So this issue has been studied intensively. In general this problem can be classified in three broad categories.

1. Time / Cost Trade-Off.
2. Resource Constrained Allocation.
3. Unlimited Resource Levelling.

Many analytical or heuristic models have been developed in past. Hegazy,Moselhi and,Fazio(1993), Hegazi and Moselhi (1994) have tried to solve the problem in each category, for different types of project. The handicap with analytical model is; inability to solve huge and more complex problem effectively. The heuristic models are problem dependent so it gives specific solution. Such solutions cannot be applied to all construction cases in a straightforward manner. It has been found that heuristic model is not always optimal solution. Moreover, traditional heuristic and analytical model generally focus on a single objective.

4.0 TIME COST TRADE OFF

In any construction project network, a set of tasks is to be completed according to some precedence relationship. The sole objective is to select appropriate resources; human and non-human, equipment and technology to complete the task within given duration with minimum cost. This problem is referred as time cost trade off problem.

In past many studies have been done on developing analytical technique for solving time cost trade off problem. These studies include genetic algorithm approach by Li, Cao and Love (1999), Hegazy and Ayed (1999).

Genetic algorithm is the set of tools based on natural selection and the mechanism of population genetics developed by John Holland. GAs make a direct search inspired by the process of natural evolution and the principle of "survival of the fittest" for locating the global optimal solution.

GAs have maximum utility for optimisation problem in construction scheduling where other methods have failed. Firstly, they do not experience combinatorial explosion and secondly they do not rely much on assumptions or on heuristic rules. This makes it a robust tool.

Every project needs a certain level of optimisation in terms of time and cost but in construction project it has paramount importance because of huge investment, duration uncertainty, influence of weather. All these factors ultimately affect total cost of the project. So many models have been suggested in past to deal with time cost trade off. Leu, Chen and Yang (2001) have used fuzzy set theory to model the uncertainty of activity duration and genetic algorithm was used to search optima.

5.0 RESOURCE ALLOCATION

CPM and PERT are powerful tool but they do not incorporate constraints of cost, resource and time but these constraints are harsh reality of the project. The resource allocation is sometimes referred as constrained resource scheduling; attempts to reschedule the project tasks, so that project can be completed in minimum possible time by efficiently utilizing limited number of resources.

So many attempts have been done in past going back to 1960s (e.g. Wiest 1964) to optimise the resource allocation problem

with the help of optimisation technique and heuristic method. The optimisation technique used are Integer Programming, Branch and Bound and Dynamic Programming.Hegazy (1999) has solved the problem by genetic algorithm.

Resource allocation problem is common to all manufacturing industries. The models developed for such industries are not directly applicable to construction projects. So many mathematical models have been developed for the same but these models are inflexible in nature and difficult to apply in field conditions.

Abeysasinghe (2001) has proposed a more flexible resource allocation model "LINERS" algorithm. It is claimed that "LINERS" algorithm is better than widely used "MINSLK" algorithm.

6.0 RESOURCE LEVELING

What are needed to successfully manage a construction project are manpower, machines, materials, money, information and management decisions (Halpin and Woodhead, 1980). These factors must be synchronized in most efficient manner in order to complete a project on schedule and within budget.

Resource levelling is concerned with minimising peak resource requirements and period-to-period fluctuation in resource assignment while maintaining the desired project duration.

Ordinarily resource planning is tied to scheduling methods. Resource levelling means to reduce the magnitude demand of a particular resource needed for very short duration or in other words to avoid peaks in resource utilization and time curves. Therefore, resource levelling sometimes referred as resource smoothing which tries to reduce sharp variations between the peak and valleys in the resource demand histogram while maintaining project duration (Moselhi and Lorterapong, 1993).

The minimum moment approach (Harris, 1978) is one of the several methods commonly used for resource levelling. Mattila and Abraham (1998) have applied integer linear programming for resource levelling for linear schedules of highway construction.

Hegazy (1999) uses genetic algorithm for resource levelling along with resource allocation. He has used heuristics of double moment approach Hiyassat (2000) suggested modification to the minimum moment approach for activities with single resource. Hiyassat (2001) has applied modified minimum moment method to multiple resource levelling. The approach is equally applicable to combined resource levelling and levelling resource in series.

7.0 Conclusion:

Scheduling of CPM network is basically a decision making on the basis of mathematical results like other profession scheduling in practice is an art. there is no substitute for the experience of the man preparing the schedule . He should be an experience, multi-skilled and knowledgeable person and he should take holistic view of the problem rather than using the computer output blindly.

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