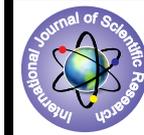


An Overview of Cost Based CPM Scheduling Techniques In Managing Construction Projects



Engineering

KEYWORDS : Construction Scheduling, CPM, Linear Scheduling

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ABSTRACT

After release of drawing from design office ,the implementation phase begins, for which a CPM network with schedules has to be prepared. 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 wisdom.

1.0 Introduction:

However, Gantt & Taylor can be said as pioneer in an attempt to solve work-scheduling problem by the use of Gantt Charts, by bar chart . Bar chart has certain fallacies, it

suffers from "morning glory complex". It blooms early in the project but is nowhere to be found later . This led to the development of the technique CPM. This 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. The main emphasis in this technique is identification of critical activities.

2.0 Understanding the Project from CPM View Point:

CPM is a networking tool, applicable to any type of project at any time and has got use in construction projects. Different network scheduling for specific civil engineering projects have been developed with different names. Civil engineering projects can be classified in three broad categories.

First type of project has non-repetitive discrete activities at one project and same is to be repeated at another project at different location are called non-repetitive project and uninterrupted utilization of resources on such projects are called with different names as under.

1. Line of Balance (O'Brien, 1969).
2. Construction Planning Technique (Peer, 1974).
3. Vertical Production Method (O'Brien, 1975).
4. Time Location Matrix Model (Birrel, 1980).
5. Time Space Scheduling Method (Stradal and Cacha, 1982).
6. Disturbance Scheduling (Whiteman and Irwing, 1988).
7. Horizontal and Vertical Logic Scheduling (Thabet and Beliveau, 1994).

In second type of project activities are continuously repetitive e.g. construction of high ways. In such projects progress is measured in terms of horizontal length. Such projects are called linear projects and scheduling technique of such projects is given different names as under.

1. Time Versus Distance Diagram (Gorman, 1972).
2. Linear Balance Charts (Barrie and Paulson, 1978).
3. Velocity Diagrams (Dressler, 1980).
4. Linear Scheduling Method (Johnston, 1981).

In third type of project in which activities are discrete and unique and there is no likelihood of repetition anywhere in near future.

In Repetitive construction, one optimises resource utilization and reduces project duration and cost of repetitive construction by fixing optimum crew size for each activity El-Rayes and Moselhi (2001) have developed automated, a practical optimisation model which uses dynamic programming along with scheduling and interruption algorithm.

Hegazy and Wassef (2001) have optimised repetitive non-serial activities for direct cost, indirect cost, interruption cost, incentives and liquidated damages for a project by using genetic algorithm.

El-Rayes (2001) has given object oriented model for repetitive construction scheduling. The model incorporates newly developed procedure for resource driven scheduling of repetitive activities (El-Rayes and Moselhi 1998), for optimising construction scheduling and integration of repetitive and non-repetitive scheduling techniques. The model is named LSCHEUDLER and is implemented as WINDOWS application .Harmelink (2001) has suggested rate float rather than float as more appropriate parameter for linear construction. Linear scheduling technique is better suited for the linear project. He has applied rate float characteristics to the linear scheduling model algorithm (CAP) controlling activity path in linear schedule (Harmelink and Rowings, 1998, Harmelink, 1995).

In linear projects machinery and men both move simultaneously with the repetitive activity but there is another type of linear activity in which machinery is fixed and repetitive activity happens, precast production falls in this category. Many scheduling technique such as Line of Balance (LOB) and analytical methods have been developed in past to solve repetitive scheduling problem. Leu and Hwang (2001) have proposed optimal repetitive scheduling model for precast production.

Yamin and Harmelink (2001) have done a comparative study for linear projects. They have presented the comparison in a tabular form as shown in Table- 2.

For very specific linear and continuous activity, LSM is superior to CPM but CPM is more comprehensive tool than LSM due to availability of analysis tools.

A comparative study of linear scheduling modelling (LSM) and repetitive scheduling method RSM shows similar results.

Attribute / dimension	CPM	LSM
Uncertainty and risk	CPM schedules use fixed duration for activities.	In LSM determination of uncertainties, completion time is difficult.
Production and economical operation.	With the incorporation of resource levelling / allocation techniques, CPM schedules can be improved the overall completion time and costs by affecting production (add or remove resources).	Limited capabilities in improving production by changing resources.
Understanding of objectives.	In complex projects, CPM network can be very convoluted. This complexity makes them difficult to understand and communicate.	LSM is very easy to understand, and it can be used at every level of the construction project.
Accurate calculations	CPM allows the PM to calculate the time it would take to complete projects,	Location / time calculation is easily done.
Critical path	It is the main feature of the CPM, which can be done very easily.	The LSM algorithm calculates the controlling activity path (CAP), which is equivalent to the critical path, with the additional feature of locational criticality.

Ease of use	Specialised training is needed to execute CPM network	Little training is needed to apply LSM
Easy to update	Updating of schedule is difficult	Updating in LSM is simple.

Table : 1 COMPARISON OF CRITICAL PATH METHOD (CPM) AND LINEAR SCHEDULING METHOD (LSM) ALONG WITH IMPORTANT PROJECT MANAGEMENT ATTRIBUTES

3.0 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.

If the data are available before hand network can be made with different orientations.

4.0 THE CONSTRUCTION SCHEDULING

Network analysis like CPM has been intensively used in construction industry for construction, planning and controlling. In traditional CPM approach major objective is to build up the feasible duration required to perform a specific project ignoring availability of resources, The problem associated with CPM can be broadly classified in three groups: (1) Time / cost trade off, (2) Resource constrained allocation, (3) Unlimited resource levelling. Many analytical or heuristic models were generated to solve the problems in each category. All the models can be summarised as in Table- 3.

It is clear from the table that in all the categories number of objective is only one. The entire project can be dealt in various stages treating distinct sub-problem one after the other rather than simultaneously. Therefore, none of the technique or combination guarantees a project schedule that optimises the project in totality.

	Traditional CPM	Time / cost trade off	Limited resource allocation	Unlimited resource levelling
Objective	Feasible project duration	Minimum project cost	Minimum project duration	Minimum variation of resource profile.
Characteristic of objective	Single	Single	Single	Single
Cost	Not considered	Considered	Not considered	Not considered
Resource limitation	Not considered	Not considered	Considered	Not considered

Table - 3 : SUMMARY OF CONSTRUCTION SCHEDULING MODELS

Leu and Yang (1999), Hegazy and Erashin (2001) have developed multi objective or multi criteria model for overall schedule optimisation by using genetic algorithm.

CPM is being used, for planning and controlling of construction project since 1950. For monitoring purpose, two integrated system; cost / schedule / work method and the Earned Value System was proposed by US Department of Energy (1979). These methods make use of S-Curves to represent cumulative cost linked or linearly related to the project schedule integration.

In spite of best use of CPM, S-curves in construction project suffer from delays and cost over runs (Sha-ath and Singh, 1994). Apart from the problem of cost over run and delays; classical CPM approach has strong limitation in dealing with variegated nature of construction project because of factors like inhospitable terrain, weather, labour productivity. Since CPM is deterministic in nature and defines the duration of the project with a single specific number. Barraza, Back and Mata (2000) have studied probabilistic project performance monitoring by using stochastic progress based S-curves (PB-S) curves. Stochastic SS-curves can be applied for more meaningful forecasting of possible final cost values and completion date distributions using actual cost and actual progress with simulation of variability of future activities. In this way a project can be monitored by comparing distribution of planned SS-curves with those of forecasted SS curves.

Conclusion:

Scheduling of CPM network in practice is an art there is no substitute for the experience the man preparing the schedule should be an experience multi skilled knowledgeable person the result of computer output should not be used blindly after all human wisdom is supreme.

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