

# Suitability of Linear Scheduling over CPM in Scheduling Highway Projects

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**Abstract**—Constructions of Highway, Tunneling, Water canal, Pipe Laying, Pavements and Laying of Railway Track are the some of the best examples of Linear Projects. The most adopted technique of scheduling in Construction field is the CPM and PERT. These techniques may also be called as the Conventional Methods of scheduling as these techniques are followed for many decades and most widely followed scheduling technique. Even the most following Scheduling software's like Microsoft Office Project and Primavera are also developed on the basis of CPM. Apart from CPM and PERT special Linear Scheduling techniques are also available which is rarely followed or unnoticed. The Linear Scheduling techniques possess many advantages and merits than the CPM and PERT. Computer Software's are also developed on the basis of Linear Scheduling technique. TILOS is one of the Software developed on the basis of Linear Scheduling technique. In this thesis the typical schedule of a Highway Project is developed in both CPM and Linear Scheduling Technique. The advantage of CPM over the Linear Scheduling Technique is studied. However, the Linear Scheduling is better suitable for simple linear project and not for complicated multiple repeating activities like Multi storey Building etc. In such case the schedule may be developed on both CPM and LSM for better planning.

## I. INTRODUCTION.

### A .Background.

There are varieties of Scheduling techniques available for scheduling construction projects. The most known method of Scheduling Techniques is Critical Path Method and Program Evaluation Review Technique. The CPM is deterministic and known for its longest duration path analysis, it is adopted for the project in which the activities involved are inter dependent on one another and have sequential order with known duration and also known as the Network Analysis. Wherein, the PERT is Probabilistic, which means it is adopted for the project in which the durations of the activities are not known and which are scheduled with approximately expected duration. PERT is suitable for the Research projects. Apart from this two Scheduling technique there is a third kind of Graphical scheduling Method known as the as the Linear Scheduling. In Linear Scheduling the activities are plotted on two axes, distance versus time.

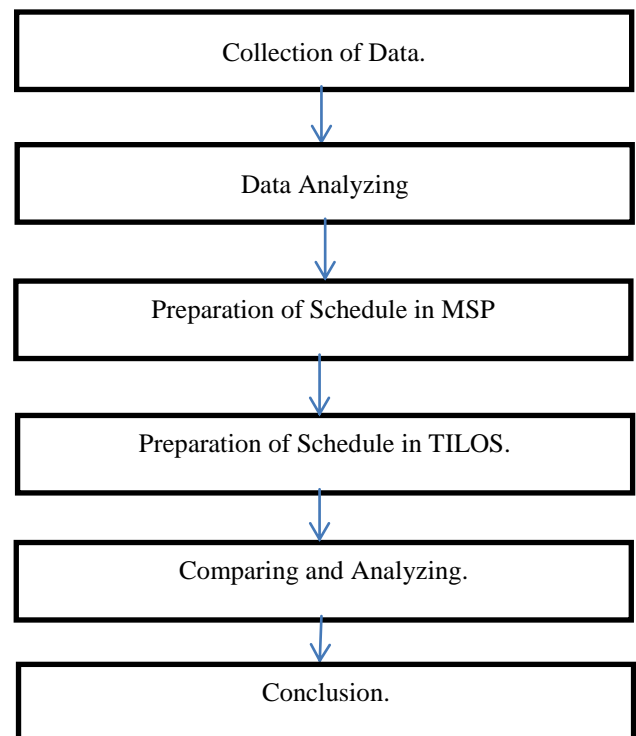
### B .Scope.

In this thesis work the advantage of Linear Scheduling Method over the Critical Path Method is studied and compared for Scheduling Highway Project. A State Highway by Tamil Nadu State Highway Department in

BT Road at Solangapalayam to Pambagoundenpalayam in Kilambadi Town Panchayat is selected for this thesis work. The scheduling is done by using Computer Software's, for CPM in Microsoft Office Project office and for Linear Scheduling Method using the software TILOS. The MS Office Project is the most widely used software in India in both field level and education level. The TILOS software is very rarely followed in India.

## II. METHODOLOGY.

The methodology explains the procedure and sequence of steps that are framed to follow in the project. The methodology is divided into six different phases, accordingly the project procedure is divided. The methodology is depicted in a flow chart format for easy understanding.



A Schedule or BOQ of a Highway Project is the Data needed for this research work. A new Highway to be established between Solangapalayam to Pambagoundenpalayam is the Project selected for this research. The Data was collected from the Tamil State Highways Department office Thitakudi.

The various activities involved in the project have to be analyzed and reviewed along with the corresponding duration and resources needed for the Project. The planning should be done in such a way that the schedule follows the resource availability and the resource is planned according to the schedule.

The schedule planning is first done in the Microsoft Office Project. This software is basic project planning tool around the globe. It is developed on the basis of CPM. In MSP the scheduling is done by listing the activities along with duration and the resource.

The TILOS software is developed on the basis of LOB specially for Linear Projects.

Comparing and analyzing the result output of schedule prepared in both the software for attributes and factors.

### III. SCHEDULING OF HIGHWAY PROJECT.

Two schedules are prepared for same Highway project in different Planning Soft wares. The scheduling is done in Microsoft Office Project developed on the basis of CPM and TILOS developed on the basis of LSM. The total distance of the Project is 21 KM, which is planned to be laid in 3KM's

TABLE I  
LIST OF ACTIVITIES INVOLVED IN PROJECT.

ACTIVITIES	DURATION
1.Site Clearance	4
2.Excavation	4
3.Marking and levelling	5
4.Natural soil or Embankment Fill	4
5.Sub Grade	8
6.Aggregate Base	4
7.Asphalt base	3
8.Asphalt Binder	4
8.Asphalt Binder	3

TABLE II  
RESOURCES NEEDED TO EXECUTE THE PROJECT

ACTIVITIES	RESOURCES
1.Site Clearance	Backhoe, Machine Operator and Helper.
2.Excavation	Machine Operator and Labour.
3.Marking and levelling	Labour, Surveyor and Helper.
4.Natural soil or Embankment Fill	Compactor, Machine Operator and Tipper.
5.Sub Grade	Tipper, Boulder, Compactor
6.Aggregate Base	Compactor, Tipper, Machine Operator, Labour and Aggregate.
7.Asphalt base	Asphalt, Paver, Tipper, Machine Operator, Compactor and Aggregate.
8.Asphalt Binder	Asphalt, Labour and Compactor

#### A. Microsoft Office Project Planning.

It is the most widely adopted planning software for many kind of project planning. The MSP is considered as one of the primary Project planning software. The MSP software is developed on the basis of CPM. In this Software the list of activities involved in the project is listed out along with the duration in logical relationship. On the basis of activity listed with successor and predecessor relationship, the network model of schedule is generated. The other inputs like resource and cost can be defined later. The schedule can be reviewed in both network model presented in Gantt chart and in activities listed as input Data. The process like Resource Allocation and Resource Levelling can also be done in Microsoft Office Project. It allows creation of a project portfolio, including workflows, hosted centrally, so that the information is available throughout the enterprise, even from a browser. It also includes reporting tools to create consolidated reports out of the project data. MSP is most suitable for Non Linear Project planning like Construction of Dam, Industry, and Commercial Building etc. It is very user friendly than the other Project planning software.

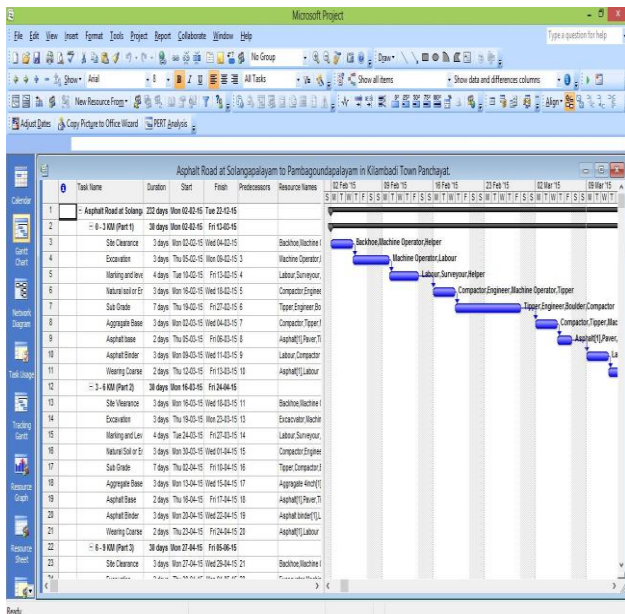


Fig 1. Highway Project planned using Microsoft Office Project.

### B. TILOS Planning.

The TILOS software is developed on the basis of LSM. This software is developed by a German based construction firm. This software is specially programmed to plan linear Projects like Highways, Pipeline, Tunnelling, Transmission line, Water Canal etc. The same inputs that is given in the Microsoft office Project is used in TILOS also. Apart from this the Geographical details about the Working site and Map plan of the Project can also be given as input Data in case of TILOS. The Schedule output is presented in a graphical manner with Duration on Y – axis and length of the work done in X – axis.

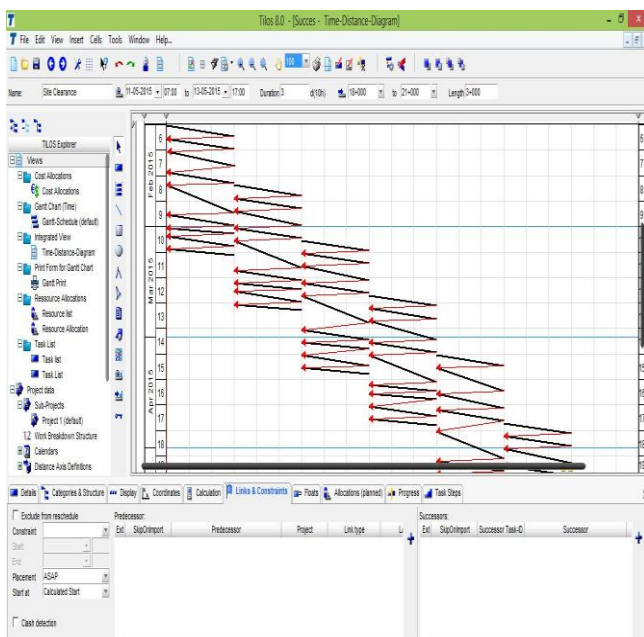


Fig 2. Highway Project planned using TILOS.

## IV. COMPARING AND ANALYZING

Comparing the Schedule output of Highway Project planned in Microsoft Office Project and TILOS.

The Following Attributes are to be analyzed in the Schedule outputs.

- Ease of Planning.
- Allocating the Resource.
- Representation of the Schedules.
- Resource Continuity.
- Resource Levelling.
- Visualizing with real time pattern.
- Easy updating.

### A. Ease of Planning.

In LSM the scheduling is done visually considering the duration, quantity and place on working activity.

The CPM is network representation in which the activity not only logical based but also analytical based.

### B. Allocating the Resource.

In LSM the resource allocation does not interfere with the work continuity of the project.

In case of CPM the Resource allocation do depend on the sequence of the activity, which interfere the work continuity of the project

### C. Representation of schedule.

In LSM the schedule is represented graphically which enables easy understanding and the entire schedule can be represented in a single page.

IN CPM the schedule is represented in both text format and network model. This does not provide the instant of the project progress.

### D. Resource Continuity.

The Resource can be continuously made by making no resource is idle, which is done by allotting the resource to any another activity.

This kind eliminating resource idleness and making efficient use of resource is very tough process and is not easy as in LSM.

### E. Resource Levelling.

In LSM the scheduling is done on the basis of availability of resource, which makes the resource levelling easier, so the resource levelling and scheduling is done simultaneously.

In Case of CPM the scheduling is completely logic based which cannot be altered on the basis of resource availability.

*F. Visualizing with real time pattern.*

The Geological pattern and the map plan can be aligned with the schedule. This enables effective learning of project natural strategies.

No such extra data can be included in CPM schedules other than the duration, resource and the cost, which can also be done in LSM Schedule.

*G. Easy Updating.*

Any changes in plan due to unavoidable reason, the schedule can be easily updated.

The updating in CPM is possible, but it is very tedious process and makes other process like Resource Allocation and Levelling still more complicated.

*H. Duration of the Project.*

Duration in MSP – 237 days.

Duration in TILOS – 132 days.

## V. CONCLUSION

The attributes of both CPM and LSM were identified and compared for the most suitable method of scheduling for Highway Projects

The details of the Project Schedule are conveyed easily in LSM when compared to CPM. The LSM is simple to handle and easy to train. The Graphical illustration of the schedule in LSM is based on the time versus distance. In CPM the distance of the project progress is not illustrated in Gantt chart as in LSM scheduling. The reading and understanding of the Schedule is very simpler when compared to the CPM. The software TILOS developed on the basis of LSM possess variety of special options that is needed for a Highway Project. The prime concern during a Project planning like Resource constraints and Work Continuity is achieved effectively in LSM.

On the Analysis of the several factors and attributes, it is recommended that LINEAR SCHEDULING METHOD is more suitable than CRITICAL PATH METHOD in Scheduling Highway Project.

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