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# Application of Earned Value Management System for Road Construction Project: A Case Study

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**Abstract:** With large infrastructure projects in India are in a development phase and if proper planning and management is done it will help in increase the development rate faster in well-organized manner by using proper management techniques. Earned Value Management System is a technique which attempts to resolve built-asset stakeholders opt for controlling and monitoring a project and also measuring project progress performance in an objective manner.

**Keywords:** Earned Value Management (EVM), Road Construction, Planning, Scheduling, Cost Performance Index (CPI), Schedule Performance Index (SPI),

## I. INTRODUCTION

Today increasing number of companies, agencies, construction firms, commercial constructions, infrastructure constructions are embracing principles of sustainability of progress of work by managing their activities in a precise manner. This systematic approach focuses on the overarching goal by considering key environmental, social and economic parameters in the decision making process. Earned Value Management is a technique which helps to achieve all the above factors in a well-defined manner. In simple words Earned Value Management System is a process which measures the progress of all the activities in a project by comparing it to the planned value to actual value thereby informing or indicating the probability of meeting the scope, time and cost of budget of an activity or project and if need for any corrective measures to be taken.

## II. EARNED VALUE MANAGEMENT SYSTEM

Earned Value Management System attempts to encompass a much wider spectrum of competencies that some time may be regarded as outside the normal training of building Professionals. In simple words EVM can be defined as a method of performance measurement. Earned Value Management is a program management technique that uses “work in progress” to indicate what will happen to work in the future. Earned Value is an enhancement over traditional accounting progress measures. Traditional methods focus on planned accomplishment and actual costs. Earned Value goes one step further and examines actual accomplishment. This gives managers greater insight into potential risk areas.

## III. EARNED VALUE MANAGEMENT PARAMETERS

### A. Planned Value (PV)

It is the cumulative planned value sanctioned work scheduled for completion on date at contract rate.

### B. Earned Value (EV)

It is the cumulative value of the sanctioned work actually executed on a given date at contract rate.

### C. Actual Cost (AC)

It is the cumulative actual cost incurred of the project on data date.

## IV. EVM VARIANCE MEASURE

### A. Cost Variance (CV)

In project management, getting an early indication of problems is the silver bullet that allows the project manager to correct the problems before they start. Cost Variance, usually abbreviated as CV, is one of the fundamental parameter of the Earned Value Management System.

Formula:  $CV = EV - AC$

If CV is negative, the task is over budget, If CV is zero, the task is on budget. If CV is positive, the task is under budget.

#### B. Schedule Variance (SV)

Schedule Variance (SV) indicates how much ahead or behind the schedule a project is running.

$$\text{Formula: } SV = EV - PV$$

If SV is negative, the task is behind planned schedule, If SV is zero, the task is on planned schedule, If SV is positive, the task is ahead of planned schedule.

### V. EVM EFFICIENCY MEASURE

#### A. Cost Performance Index (CPI)

Cost Performance Index measures the value of work completed to the actual cost incurred on the project. It shows the cost efficiency of the work completed. Cost variance indices indicate the cost overrun/under-run.

$$CPI = EV / AC$$

Cost Performance less or more than one indicates cost over-run and cost under-run respectively.

#### B. Schedule Performance Index (SPI)

Schedule Performance Index determine deviations from the schedule. The time over-run/under-run reveal the cost and time the project is behind or ahead of schedule.

$$SPI = EV / PV$$

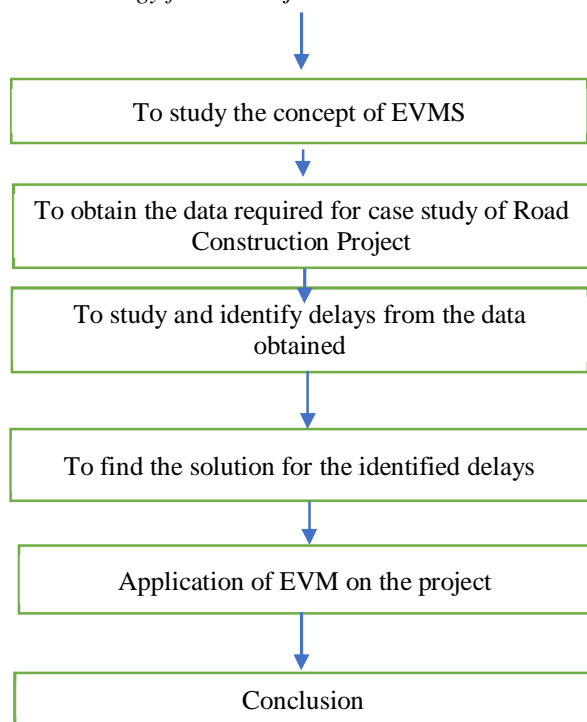
Schedule Performance less or more than one indicates unfavorable performance and favorable performance.

### VI. AIM AND OBJECTIVES

- A. To Study Concept of Earned Value Management System
- B. To Study Application of Earned Value Management System on a Road Construction Project (A Case Study)
- C. To study Statistical Analysis of Earned Value Management System on the Project
- D. To suggest and recommend effective use of Earned Value Management System concept for the Project

### VII. METHODOLOGY

#### A. Methodology for the Project



### VIII. CASE STUDY: A ROAD CONSTRUCTION PROJECT

#### A. Brief Points of Project

- 1) Total Project Cost – 400 Crores Approximately
- 2) Project work start date – September 2017
- 3) Project Milestone I date – February 2018
- 4) Project Milestone II date – September 2018
- 5) Project Milestone III date – June 2019
- 6) Expected work to be done up to milestone I is the company should use 10% of the tender cost with respect to the work.
- 7) Expected work to be done up to milestone II and III is the company should use 30% and 70% of the tender cost with respect to work.
- 8) Present work done by the company is 2.5%.
- 9) Penalty for the work done if the milestones are not achieved is 0.05% of the total tender cost per day.

#### B. Delays Identified From The Obtained Data

- 1) Cutting of Trees
- 2) Tree Girth – 300mm, Tree Girth – 600mm, Tree Girth – 900mm, Tree Girth – 1200mm, Tree Girth – 1800mm and above.
- 3) Clearing of Grass and Shrubs
- 4) Dismantling/Shifting/Removing of Electricity poles, Electricity Cables and Transformers
- 5) Shifting of Telephone Lines / Water Pipelines
- 6) Demolition of Existing Structures
- 7) Excavation of Road Construction
- 8) Soil Investigation

#### C. Recommendations Or Solutions To The Identified Delays

- 1) *Cutting of Trees*
  - a) Categorizing the trees of different girth
  - b) Starting cutting of the trees on the finalized alignment
  - c) Simultaneous dumping should be carried out and Re-plantation of trees also should be carried out and a record is to be maintained for future clearance from Forest Dept.
  - d) As the work progresses the resources should be shifted to the cutting of trees of larger girth or for clearing of grass and shrubs for speedy work progress.
- 2) *Dismantling/Shifting/Removing of Electricity poles, Electricity Cables and Transformers / Telephone Lines / Water Pipelines*
  - a) Communication and co-operation amongst the dept. in government sector is a challenge which should be realized or identified earlier for smooth progress of work.
  - b) The solution to it is when the alignment of the road is finalized and the company or contractor is granted the permission to start the execution of work
  - c) He should visit the State Electricity Board (SEB) Dept. firstly along with the detailed project report (DPR) and the cross-sectional drawings of the alignment.
  - d) As each and every dept. have their jurisdictions assigned and they have all the reports, drawings within their jurisdictions, a request to be made to find out if any Electrical poles, cables, transformers or any other structure are crossing in between the finalized alignment of construction of road.
  - e) Though the above process to be followed is suggested for speedy progress of work.
  - f) Important point to be noticed here is the work of shifting or dismantling of electric lines, electrical cables, transformers are performed by the contractor himself and he is also getting paid for it but the time consuming in this process is more.
  - g) Instead of putting that work load on the contractor the SEB department should perform the respective work themselves as they will be having the detailed drawings of the alignment and the drawings of their department regarding all the utility services, the work to be done will be fast and progress of work will be maintained.
  - h) Thus, the Government should definitely analyze and adopt the process suggested above which will not only be useful to the current project but also for all future infrastructure projects.



- i) Similar process to be followed for Shifting of Telephone Lines and Water Pipelines
  - j) This can be very helpful for both the department for the work to be completed
- 3) *Demolition of Existing Structures*
- a) All the structures to be demolished should be categorized and starting from the beginning patch of construction of road should be proffered first.
  - b) Repairing of Culverts should be done
  - c) The construction of new culverts on the finalized alignment should be started earlier instead of reaching to the point of culvert and waiting for the construction of culverts to be finished will waste a lot of duration and ultimately cost will be affected of the project.
- 4) *Soil Investigation and Excavation of Roads*
- a) A soil investigation process or task is necessary to provide information for design and construction and for environmental assessment for a road construction.
  - b) Whether the soil is useful or change of soil is needed with respect to the specifications can be determined by the values obtained from soil investigation.
  - c) Soil Investigation should be the first priority of the contractor and the work should be started before or along with the site clearance activity to make further changes if any and to avoid delay
  - d) All the tests should be carried out prior to the start of work.
  - e) While testing of material to be used for laying the subgrade. Continuous supervision from the authority of Soil testing laboratory should be done.

Above are the recommendations or solutions suggested to the delay caused for the project and if followed it incontestably will help the company to achieve the milestones decided. Project manager should be appointed for overall completion of work because of which there will be continuous supervision and monitoring of the work and a weekly review or meetings to be conducted to check the progress of project work.

#### D. Application of Earned Value Management System

Appropriate Planning by performing a work breakdown structure with respect to performance of sequential activities and Scheduling of the project is done by using Microsoft Project Software.

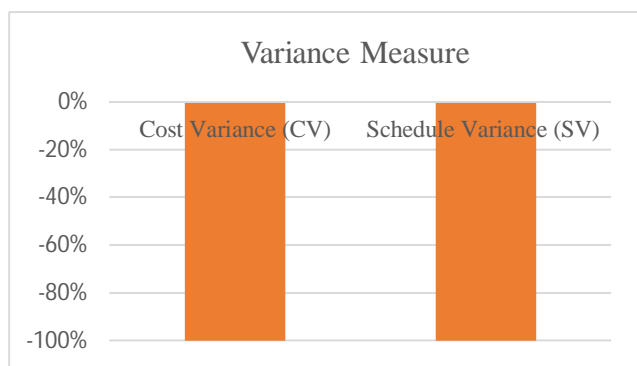


Fig.1 Variance Measure

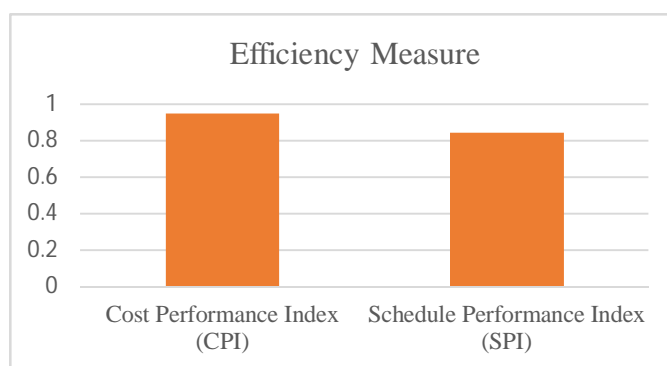


Fig.2 Efficiency Measure

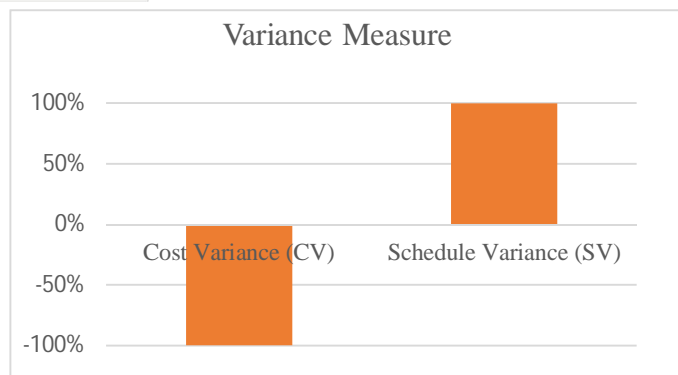


Fig.3 Variance Measure

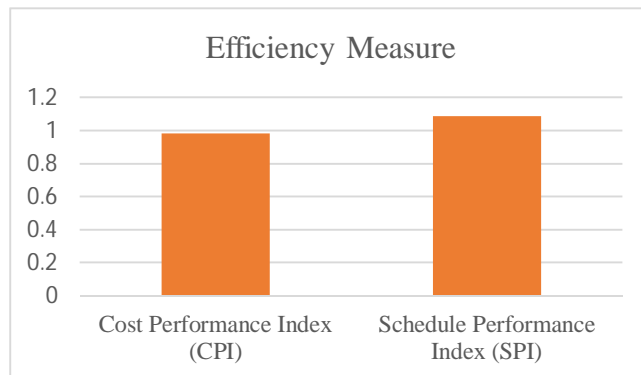


Fig.4 Efficiency Measure

### VIII. CONCLUSION

- A. From Fig.1 and Fig.2 Variance and Efficiency Measure are not satisfying the project criteria's. It shows that they are lagging behind planned schedule of work and which results in project cost over-run.
- B. To achieve the milestone the company or contractor has to use additional resources.
- C. From Fig.3 and Fig.4 Schedule Variance and Schedule Performance Index are showing positive results and favorable performance and it is because of proper planning by WBS formation and Scheduling of work.
- D. As to achieve milestone the company or contractor had to use additional resources to achieve milestone in Fig. 3 and 4 Cost Variance and Cost Performance Index are showing negative results but to avoid penalty whose costing is more than the costing of use of additional resources it was necessary but as the results of SV and SPI are positive i.e. project is ahead of planned schedule further milestone will be achieved easily.
- E. Formation of precise work breakdown structure of the project is the key to successful implementation of Earned Value Management to obtain positive results and keep a check on the project schedule.
- F. Earned Value Management gives a clear sight of project progress. It keeps the project management team on their toes, as the monitoring of the project is done periodically and the management team has to make sure that all the project parameters are on track.
- G. By Earned Value Management System along with proper planning and scheduling it provides consistent and smooth communication of progress at all management levels and also improves project accountability.
- H. Using Earned Value Management defines clear responsibility of the work and accordingly the work responsibilities can be assigned in a proper manner.

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