# Cost Analysis of Road Construction Project by Earned Value Analysis using Primavera P6

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**Abstract -** *Transportation is one of biggest basic need for the society. The construction of road gives the better transportation facility around the country. For better development of the country in the construction assertive, the project management is necessary. Time and Cost are the two basic parameters to control work in the execution of the road construction. Flow of cost and its usage is very important aspect for beneficial point of view. It is necessary to develop the planning software to easy the works and risks arises in the projects. For the cost analysis of the road works, EVA technique is used to overcome the problems raised during execution. To understand the cost values in the road construction projects, an industrial road work is considered as a case study. Earned value analysis of any construction industry which gives the warning messages to the planning process as well as during the execution of the project whether the project is going on time and it is under budget or over budget. Primavera P6 software gives the accurate Earned value results.*

*Key Words*: **Earned Value Analysis, Primavera P6, Project Management, Road Work, Cost, Time, EVA Parameters, Resources, Scheduling.**

## 1. INTRODUCTION

Transportation is one of biggest basic need for the society. The construction of road gives the better transportation facility around the country. For better development of the country in the construction assertive, the project management is necessary. Time and Cost are the two basic parameters to control work in the execution of the road construction. Flow of cost and its usage is very important aspect for beneficial point of view. It is necessary to develop the planning software to easy the works and risks arises in the projects. For the cost analysis of the road works, EVA technique is used to overcome the problems raised during execution.

In olden days, the project budgeted total cost is determined by the difference, between the actual cost, and planned cost. That means the project managers' focus was on only for planned cost and expenditure cost as actual cost. Now in the modern days many schedule properties and cost parameters are considered. Because it is very important in every

Construction project, losses are due to inadequate construction management and cost performances done by the contracts in the road construction projects. So it is necessary to develop the planning software to easy the works and risks arises in the projects. The mainly used software is MSP, Primavera P6 and some developed software. This software gives better scheduling methods and cost performances affectively.

## 1.1 Road Construction

Construction of roadway has the many scopes in the developing countries like India. The better quality of road work needs good quality of construction methods and better usage of the resources available near the working place. A good construction management gives the better quality of work.

## 1.2 Concept of EVA- Earned Value Analysis

Earned Value is a program management technique that uses "work in progress" to indicate what will happen to work in the future. EVA uses cost as the common measure of project cost and schedule performance. It allows the measurement of cost in currency, hours, worker-days, or any other similar quantity that can be used as a common measurement of the values associated with project work. EVA uses the following project parameters to evaluate project performance [1]

- Planned Value
- Earned Value
- Actual Value

**1. Planned Value (PV):** It is cost of the construction project as per the schedule of the project. It is also called as BCWS (Budgeted cost of work scheduled).

**2. Earned Value (EV):** It is budgeted cost, of the work performed till, the current date. It is cumulative budgeted cost occurred in activities that will complete on the due date.

**3. Actual Cost (AC):** It is the costs which are spent on complete the project during the execution till date. It is also called as ACWP (Actual cost of work performed).

Other earned value parameters like Cost variance and cost performance index, schedule variance, and schedule performance index, estimate to complete the project and its Variances are considered in this project work. The variances are used to check the deflection or deviation of the project from the path of original schedule. It is also used to analyse the extent and cause for the delays of works or tasks of the project. Following re two variances:

**Cost Variances (CV)***:* It is used to check the difference between the proposed planned project and present project on the specific date. It shows the variation of project in form of cost. The formula used for calculating cost variances is [7]
Cost Variance = Earned Value – Actual Cost

**Schedule Variance (SV):** It is used to examine the deflection of present project in from the planned project. If considerable change appears than the project objectives must be revised. The formula for calculating the schedule variance is [7]
Schedule Variance = Earned Value – Planned Value

**Schedule Performance Index (SPI):** SPI can be used to estimate the projected time to complete the project. It is calculated as follows,
SPI = Earned Value / Planned Value
SPI = 1 means Project is on Schedule
SPI < 1 means Project is behind Schedule
SPI > 1 means Project is ahead of Schedule [7]

**Cost Performance Index (CPI):** CPI can be used estimate the project cost to complete the project based on performance to date. It is calculated as follows,
CPI = Earned Value / Actual Cost
CPI = 1 means Planned and Actual cost are same
CPI < 1 means Project is under Budget
CPI > 1 means Project is over Budget

**Estimate at Completion (EAC):** The Estimate at Completion is the actual cost to date plus an objective estimate of costs for remaining authorized work. The most common is
EAC = Actual cost + Estimate to Complete [7].

## 1.3 Objectives of Study

The objectives of the studies are

- To determine the actual project cost of the road work.
- To determine the practical durations that are required to complete the activities.
- To determine the difference in estimated cost and actual cost of the project.

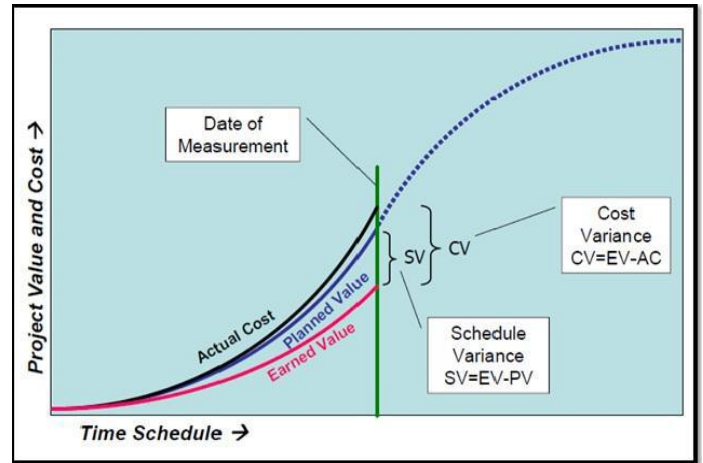- To find out the various cost parameters and their values by software Primavera P6 and by formulae.



Fig-1: Standard Earned Value Analysis Graph

## 2. LITERATURE REVIEW

**Sagar and Gayatri (2012)** has discussed "Cost controlling using EVA in construction Industries" is about controlling the cost in the projects by using EVA. If the cost of the project is over run, then the construction project management team adds the good engineering program or techniques to overcome the problems. Cost reduction involves reduce of scope & quality in few parts of the work. And also it can be reduced by giving the extra money to the existed works for the further work with cash flow. Similarly, if the time is less for the execution work, the program is made like fast tracking or crashing the durations. The paper includes better improvements and utilization of earned values to achieve the estimation @ completion, based on economical techniques and traditional indices of earned values. The author has taken a residential building as a case study. The total building area of the project is 120 sqm. The study included the parameters to calculate the cost values using developed software. Therefore the author has taken two more software MS project and Primavera to compare with the developed Software. The result shown a strong relation between each software and gave 99.5% accuracy. So the author concluded that there is no much difference between each software and all project planning software can be used in the construction industry [1].

**Andrew and Sachin (2013)** carried out "project monitoring and project controlling using primavera software". The author observed the progress of the work with respect to time, scheduling during the execution of work and resources which are identified for lagging of the project to carry out at the attention and to get actions. Construction of standard design factory building was the case study to understand the proper monitoring and proper planning. The important

objective of the study is to understand the importance of monitoring and controlling of the project in the execution progressive within the time. It is proved that, the progress and specific problems are raised in the process of work can be reduces by the proper attention. They concluded that the drawbacks of management and need of effective project planning software like primavera P6 [2].

**Mohammad and Devanand (2014)** Made "analysis on resource planning, cost estimation and tracking of project by earned value management" by taking a duplex apartment as a case study. The focus was on planned expenditures and actual cost. The duration of the project was 160 working days. So four set of tracking were done at different intervals. Earned value concept revealed the future opportunities and it also examines actual accomplishment. So the key point here that EVA that enable us to spot a potential problem early in the project and rectified the situation that rose in the project [3].

**Sandeep and Attarde (2015)** have discussed about "the time and cost planning and during the execution of the construction projects". Author found the causes of delays in the project and given guidelines for proper planning for the saving of time and cost. The main factor that delayed the project was the material management due to contractual agreements or delay in the settling running account bills, management problems delayed the project completion. Those delays affected on the cost of the projects that lead into over budget. So they concluded that, the delays can be avoid or minimize only when the causes are identified in the construction project [5].

**Subramani and Sekar (2015)** has discussed about "the preplanning and scheduling of road construction by using project portfolio management" in primavera P6 module R .1 software. Author discussed about the advantages of preplanning in the road construction project in detail and maintained a baseline to compare how the project is running v/s the original plan v/s the last update cycle v/s six months ago, etc. This study has given brief explanation for preplanning project management. The study concludes that the Primavera P6 software offers the flexibility when determining who is responsible for the activity during the execution of project in every stages of the work. CPM scheduling provided CPM scheduling, which used the activity durations, relationship between activities and calendars to estimate the activities that affects the completion date for the project or an intermediate deadline [4].

**Unmesh and Rohith (2015)** has explained about the proper "planning, scheduling and tracking of a residential project using primavera software". They defined project monitoring is like a warning mechanism which includes watching the project with respect to time and scheduling performance and resources used during the execution of the project. As a case study, the author has taken a residential building which is

located in Bhugoan, owner of this project was kalashree developers. The author has made research on the project and found defects in the planning, Scheduling procedure done by the organization. The results revealed that the contractors and subcontractors plays vital role in the completion of the project. The study conclude that the organization has found that monitoring and tracking the project using software is very useful, So the organization has changed their planning and scheduling methods by weekly targets given to the contractors instead of monthly. Training was given to the project managers and engineers to use the software during the project planning and monitoring [6].

**Abuzar and Geetha (2016)** has discussed about the "Time and Cost management using project planner software". For time and cost analysis it is important to do project monitoring. Project monitoring acts like a warning mechanism, it is the process of recording project performance that the Project manager and others wants to know. The author has taken a case study of residential apartment under the Shanti Builders. If, time is the main consideration, then cost will be more and vice-versa. The Study concluded that the time and cost analysis is very important factors in the project planning and project planner software are very helpful to all construction industries. In this paper the results were obtained from the software were very useful to the apartment constructions and the construction finished under the budget[8].

**Suhas and Vijay (2016)** had discussed about the "base line fixing and EVA in construction industries using primavera". They have taken residential apartment as a case study for the cost controlling and optimization of EVA. The project details are taken from the Drushti constructions. The activities entered including from excavation to building handling over. They maintained various baselines to compare the each stages of the work with time and cost. Setting a base line is very helpful to concentrate on the usage of resources and the cost controlling throughout the execution of the work. The study conclude in this paper as by setting baselines for a project gives more accuracy in the cost management and optimization in the usage of resources with suitable durations [7].

## 3. METHODOLOGY

The road construction project is larger in budget and that needs a sequence of work with the required cost estimates. To understand the earned value analysis in the road construction field, the research methodology is used. An industrial KIADB road work is taken as a case study. This project has more cost for the upgrading of KIADB industrial area roads. There are mainly two phases in the methodology and are collections of necessary data and second phase is to analyze the collected data through Primavera P6. For the cost analysis, research methodology adopted is as follows,
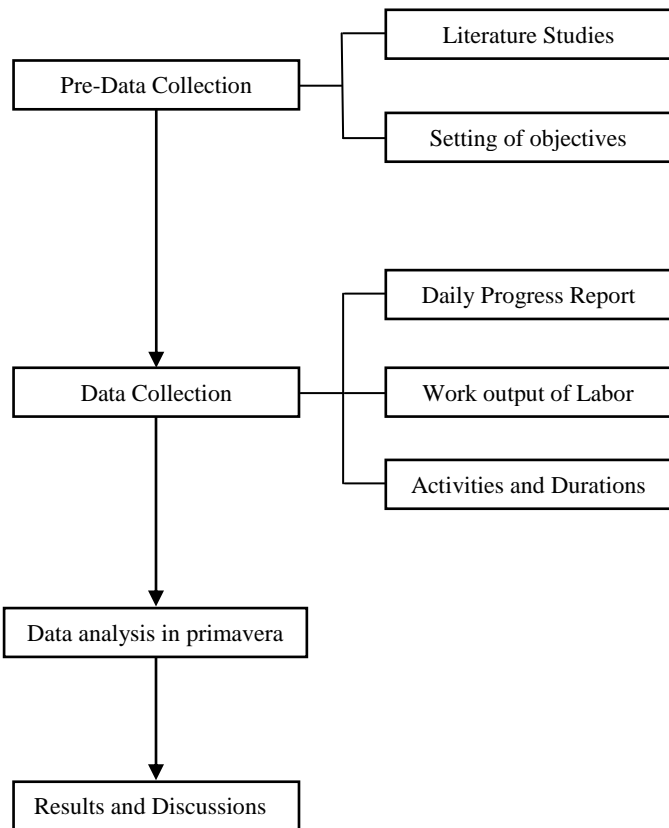
Chart -1 : Research Methodology

## 3.1 Site Details

The working site details are tabulated in the table 3.1

Table-1 Site Details

| Name of the Project | KIADB Road Work |
|---|---|
| Owner of the Project | PWD, Karnataka |
| Contractor | Er. Venkatesh H Daroji |
| Project manager | Er. Santosh Hulsoore |
| Location | Industrial Area, Gokak. |
| Total length of road | 750 m |
| Project Start date | January 29, 2017 |
| Project Duration | 82 Days |
| Planned Project Cost | Rs. 1,30,00,000 |

**3.2 Pre-Data Collection:** In this stage, pre data collections are made which are required to study on the concept of earned value analysis and adopting this analysis for the future purposes in the road construction projects. It consists of study of literature reviews which includes the concept of planning, scheduling and earned value Analysis and the discussions made are studied thoroughly. After the literature reviews, objective of studies are made to clear understanding of the project.

## 3.3 Data Collection

In the data collection part, the data required for the study of planning, scheduling and earned value analysis are collected. These data collections are made in three parts and are as follows.

- DPR (Daily progress report).
- Work output of the Labor.
- Activities with planned duration.

## 3.4 Data Analysis in Primavera P6

The activities of the road construction are collected and entered in the primavera P6 software for the further calculations. The sequence of construction activities are found out on site and by field training. Linking of activities with the Predecessors and successors is made. After that resources required for each activity are assigned. After the results generated form the primavera are collected and EVA is calculated by the formulae.

Table-2 Procedure in primavera Software

| 1 | Create Project |
|---|---|
| 2 | Define WBS |
| 3 | Creating Calendars |
| 4 | Define Activities |
| 5 | Appoint Activity Durations |
| 6 | Allocating resources/budgeting |
| 7 | Tracking, updating |
| 8 | Run Reports |
| 9 | Generating Earned Value Reports |

## 4. ANALYSIS AND CALCULATIONS

In this analysis part, the detailed procedure is explained starting from the entering of the activities to the generating the report of resources sheets and earned value reports.



Figure 2 Activity details with durations and budget cost
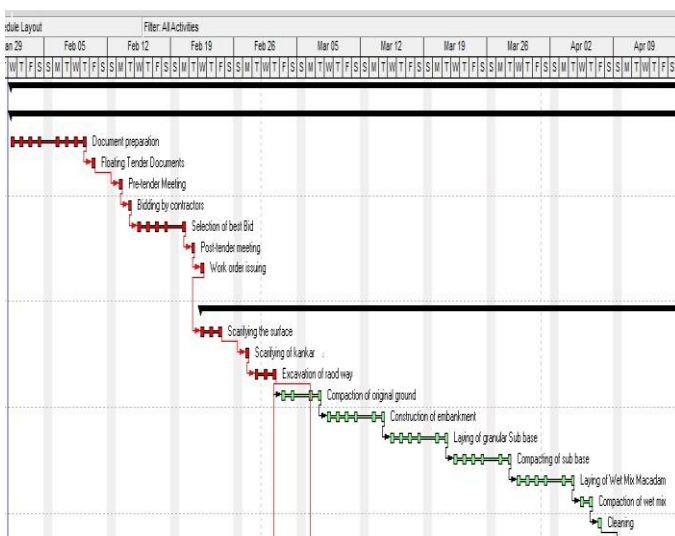
Figure 3 Resource Sheet



Figure 4 Critical Path

Various Earned value parameter results are obtained from the primavera software which is generated by the analysis process and earned value = Rs. 2,08,83,846 actual cost = Rs.1,13,09,392 planned value = Rs. 1,25,58,350 are obtained by primavera. By using formulae, the various parameter values are obtained as follows.

1) Cost variance = EV- AC = 20880846 – 11309392
$$CV = Rs. 9,51,454/-$$
2) Schedule Variance = EV-PV = 20883846-12558350
$$SV = Rs. 1,96,25,496/-$$
3) Cost Performance Index = EV/AC
$$= 20883846/11309392$$
$$CPi = 1.184$$
4) Schedule Performance Index = EV/PV
$$= 20883846/12558350$$
$$SPi = 1.6$$
5) Estimate to Complete (ETC): This project is completed in May 24 as per the schedule and under the budget given by the govt. So, estimate cost to complete that road work project is same as the cost of actual project cost.
6) Variance at Completion (VAC): Variance at completion values of the project is under the budget, therefore there is no over budget of the project.

# 5. RESULTS AND DISCUSSIONS

The results are obtained from the software as well as by formulae are accurate to nearer values. The cost parameter results obtained from the analysis in primavera has given positive results and that will help to the company in future projects. Following earned value results are obtained from the software.

## Table 5.1 Results Obtained From the Calculations

| | |
|---|---|
| Project Budgeted Cost | Rs. 1,23,56,750 |
| Total Duration of the Project | 82 Days |
| Actual Cost | Rs. 1,13,09,392 |
| Planned value | Rs. 1,25,58,350 |
| Earned Value | Rs. 2,08,83,846 |
| Cost variance | Rs. 9,51,454 |
| Schedule Variance | Rs. 1,96,85,496 |
| Cost Performance Index | 1.18 |
| Schedule Performance index | 1.6 |

# 6. CONCLUSIONS

Obtained values from the primavera P6 given the satisfactory results which are very helpful for the project managers and the site engineers. Earned value management system given very helpful guidelines to work.

> - Cost variance (CV) is Rs. 9,51,454 has the positive value, it indicates that the project is under budget.
> - Schedule variance (SV) is Rs. 1,96,25,496 has positive value,it indicates that the project is ahead of the schedule.
> - Cost Performance Index (CPi) is 1.18, so the value obtained is more than 1 that indicates the performance of the project is good.
> - Schedule Performance Index (SPi) has the value of 1.6 which is greater than one, it indicates the project schedule performance is good.
> - Estimate At Completion (EAC) is the same as the actual cost obtained from the total project cost of the work.
> - Variance At Completion (VAT) of the project is 1,20,000, because there is only maintenance cost for the road work if the road become repair.
> - The project is under planned durations, therefore the overall project is within the schedule and under the budget,

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**ACKNOWLEDGEMENT**

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