# Planning, Scheduling and Tracking Of Ongoing Bridge Construction Project Using Primavera Software and EVM Technique

**Suvarna P[1]**
*Research Scholar, School of Civil Engineering,*
*REVA University, Bengaluru, India*


**Yateen Lokesh [2]**
*Assistant Professor, Department of Civil Engineering,*
*MSRUAS, Bengaluru, India*


**Dr.S.P.Mahendra [3]**
*Professor, School of Civil Engineering,*
*REVA University, Bengaluru, India*

## Abstract

In construction industry it is very necessary to control and monitor the progress at every stage of the construction work to avoid the cost and time overruns of the project. This can be achieved by proper project management process. In the present study of, Sangapura bridge project is taken as a case study. Primavera software is used for Planning and scheduling of the bridge. Project tracking is done by considering the earned value management technique to check the cost and time overrun if exists. Project management increases the productivity of human resource and materials. Earned value management (EVM) is adapted for the project management application assessment techniques. This technology helps in comparing the actual cost and budgeted cost of work. This study relates to scheduling and the project monitoring process, also discussed along with the important parameters involved in calculation of EV analysis in the cost management of civil construction projects. Primavera software is used in the present study to plan and schedule the project activities and to carry out the Earned value management analysis. The results are represented in the form of graphs to explain the schedule performance index, schedule variance, cost performance index and cost variance. The present study concludes that the case study considered is ahead of schedule and within the budget.

**Keywords**: EVM, scheduling, Primavera, Project management, bridge construction

## 1. Introduction

A project planning is executed by considering the various tasks that are interrelated and have a time and cost constraint. (A. Naderpour, M. Mofid 1) have concentrated on the concepts of EVM and its method, performance measurement, such that the project manager could extract the required information of the project to mitigate the risk and to forecast the project progress. The analysis of the suitability of using project management software such as MS Project and Primavera P6 for the bridge construction project has been done by (Anuj Dubey, Tajammul Sayed 2) and they concluded that both software can be used to schedule and to analyze this type of project. (Hamed Zizidoostan, Hamidreza Ghaneh, et.al 3) have focused on the use of primavera software for the resources allocation and project evaluation of a civil engineering project. They have explored the need for optimal use of resources in the construction industry wherever essential. Multi project organization involves sensitive and challenging circumstances. The use of primavera software in planning, scheduling and tracking the residential project has been studied by (Unmesh. Y. Polekar, Rohit. R. Salgude 4) and they have concluded stating the needs and role of client organization, contractor and sub-contractor for effective performance of the project.

Construction Project Management is a holistic planning, coordination and control of projects right from the per planning phase to the liquidation phase of the project. Construction projects involve many uncertainties hence proper monitoring is necessary. Tracking the project in a frequent interval allows the project manager to hold grip on the performance of the project by coming up with any innovative strategy to avoid the cost overruns and time overrun, if present in the project.

Project management is an application of skills, knowledge, tools and technique to projects and activities, in order to meet the need of the project. Many of the tools and techniques to project for managing the projects are specific in project management. (PMBOK, 4th Edition, 2008). Fig 1 shows the location of ongoing bridge construction project near K.R.PET Tq, Mandya district which has been taken as the case study. Project work mainly deals with Major concepts of project management. It concentrates on estimating the cost of the

project, planning the activities using the work breakdown structure, scheduling the activities, Resource allocation and project tracking is done using earned value management technique to predict the cost and time overruns in the project.
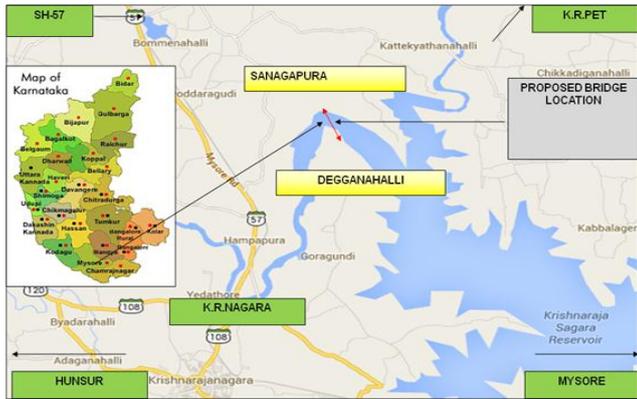


**Fig.1:** Location map

## 2.  Methodology

The present study involves use of primavera software which helps in scheduling much faster than the conventional method. By feeding the Work Breakdown Structure, tasks, subtasks, durations, predecessors, resources allocation and leveling for every activity, tracking of the project for every 15 days using earned value technique has been done.

### 2.1  Primavera P6

Primavera P6 software is designed to assist project manager in formulation of plan, resources allocation for tasks, tracking the work progress, analyzing the workload and managing the budget. Based on allocation of work and resource rates, budgets are created in Primavera. The allocation of resources to tasks and assigned of work is Estimated, Planned costs calculated work hours is equal to the rate of each volume up to the level of tasks, that rolls up to the task level and then to the many summary tasks and finally for the project level. Primavera P6 was used to create WBS, schedules and assign cost to each task. The software helped in evaluating the EVM technique and developing the CPM scheduling of the project.

**Table 1** Procedure in primavera

| 1 | Create EPS(Enterprise Project Structure) |
|---|---|
| 2 | Create Project |
| 3 | Define WBS |
| 4 | Creating Calendar |
| 5 | Define Activities |
| 6 | Durations for every Activity |
| 7 | Giving relation for every activity and Perform Scheduling |
| 8 | Allocating Resources/Budgeting |
| 9 | Leveling of resources |
| 10 | Creating Baselines |
| 11 | Updating schedule |
| 12 | Earned Value Analysis |
| 13 | Exporting of Reports |

### 2.2  Critical Path method (CPM)

CPM is an effective project management tool, originally developed by the US Navy in the 1950. This value depends on the scheduling of project activities is calculated. It is calculated in all types of projects, including software development, construction, product development, research projects and other activities planned for CPM longest path until the end of the project to use. CP is the longest sequence of which add up to the total duration of the activity. Any activities that incur delay in the critical path will have a direct impact on the project completion date. There are several critical paths in a project. The critical paths can be further classified into sub critical and non-critical network paths by considering the parallel paths duration which are shorter than critical path

The critical path for planned schedule was obtained by considering free float activities. These activities were given top priority during resource allocation, since time is essence of work. The resource leveling was done and the critical activities were given top priority. Fig 2 shows the resource over allocated for every resource and fig 3 shows the resource leveling using various methods in Primavera.
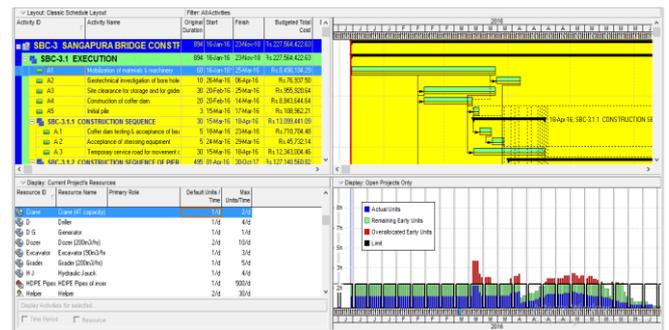
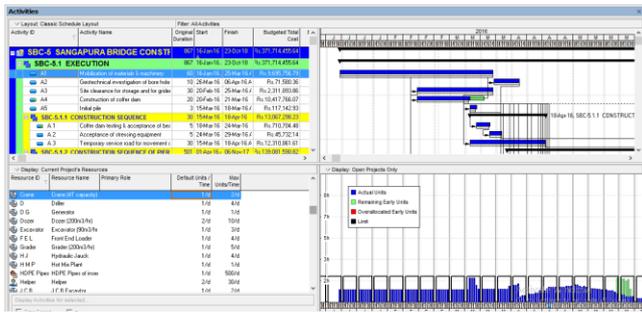

**Fig 2** Resource Allocation before leveling

**Fig 3** Resource Allocations after Leveling

## 2.3  Earned Value Management

EVM is a management practice for the integrating scope, cost, time for measurement of project performance progress, and the forecasting of the project outcome. By applying earned variance (EV) in initial phase of the project planning which contributes the value in cost and schedule baseline which provides exceptional base in project performance measuring during execution of work. Based on the actual performance of cost and schedule is compared against baseline which gives response of project stats and the data are utilized to predict the outcomes and provide management with effective decision making using the data. The Project manager measures the performance of the project with the help of EVM.

The EVM has been done based on the Earned Value analysis, obtained after setting the final baseline of the project and tracking it progressively. The EV results have been obtained for 15 days based on the progress update done for every 15days. The actual cost incurred has also been considered in EV over time. Schedule variance is also calculated based on the earned value and planned value. CPI and SPI are also obtained by the formula described below.

### 2.3.1 Schedule Variance (SV)

Schedule variance is defined as the schedule status indicates budgeted works is completed as planned. Below equation shows Variance between the EV and PV.

**SV = Earned value   - Planned value**

### 2.3.2 Cost Variance (CV)

CV shows the difference in the cost that was planned and the actual cost incurred in performing task. Below equation shows Variance between the EV and AC

**CV = Earned Value – Actual Costs**

### 2.3.3 Performance Indices

Performance indices or the indices show the percent of variation between planned and actual. This analysis method provides two performance indices that are described below

**Schedule Performance Index, SPI = Earned value / planned value**

**Cost Performance Index, CPI = Earned Value / Actual Costs**

## 3.    Results and Discussion

Table 2 shows the results of planned value, earned value, actual cost of the project which was tracked for every 15 days intervals. The baseline has been set and the results of every 15days updation are shown in table 3.

**Table 2** Planned Value, Earned Value & Actual Cost

| No. | DATE | Planned Value (PV) | Earned Value (EV) | Actual Cost (AC) |
|-----|------|--------------------|-------------------|------------------|
| 1 | 01-02-16 | 2100747.3 | 2133066.49 | 2133066.49 |
| 2 | 15-02-16 | 4039898.66 | 5138751.1 | 4726906.55 |
| 3 | 01-03-16 | 12001510.55 | 11695146.21 | 11500721.27 |
| 4 | 15-03-16 | 22431284.45 | 19454982.06 | 19883986.79 |
| 5 | 01-04-16 | 33526682.43 | 35984877.96 | 35103888.77 |
| 6 | 15-04-16 | 41199868.2 | 48093330.28 | 47176410.02 |
| 7 | 02-05-16 | 48787175.51 | 51253865.99 | 50507255.97 |
| 8 | 16-05-16 | 59120623.52 | 67361043.65 | 66428687.39 |
| 9 | 01-06-16 | 66094453.5 | 73988244.29 | 73167430.67 |
| 10 | 10-06-16 | 68913094.94 | 76569590.29 | 75825177.58 |

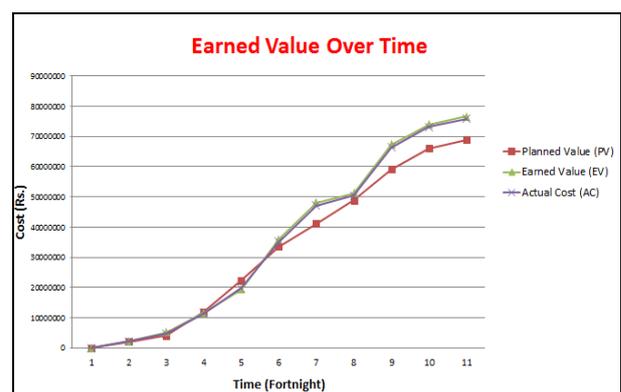**Table 3** Earned Value Parameters



**Figure 4** Earned Values over Time in MS Excel

Fig 4 represents the behavior of EV with respect to time. The analysis of earned Value over time depicts that the Project is fluctuating behind and ahead of schedule in the weeks 3rd to 11th, but it was observed that after 11th week the project was on schedule till the last update of the project as when compared to EV.

Table 3 shows the results of SV and SPI for every 15days updation of the project progress it was observed that observed that EV performance against cost depicts that the project was under budget from 3rd week to 11th week and it was on budget till last update of the

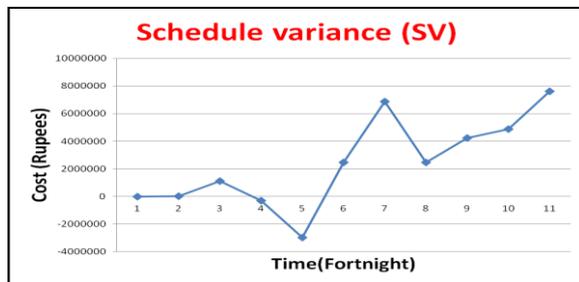| Nos. | DATE | Schedule variance (SV) = (EV-PV) | Schedule Performance Index (SPI) = (EV/PV) | RESULT |
|------|------|------|------|------|
| 1 | 01-02-16 | 32319.19 | 1.02 | On time |
| 2 | 15-02-16 | 1098852.44 | 1.27 | Ahead Of Schedule |
| 3 | 01-03-16 | -306364.34 | 0.97 | Behind Schedule |
| 4 | 15-03-16 | -2976302.39 | 0.87 | Behind Schedule |
| 5 | 01-04-16 | 2458195.53 | 1.07 | Ahead Of Schedule |
| 6 | 15-04-16 | 6893462.08 | 1.17 | Ahead Of Schedule |
| 7 | 02-05-16 | 2466690.48 | 1 | On time |
| 8 | 16-05-16 | 8240420.13 | 1 | On time |
| 9 | 01-06-16 | 7893790.79 | 1 | On time |
| 10 | 10-06-16 | 7630130.57 | 1 | On time |

project.



**Figure 5**  Schedule Variance (SV) over Time

Fig 5 represents the graph shows the project has a positive schedule variance of Rs.76, 30,130.57 that means the project is on time.
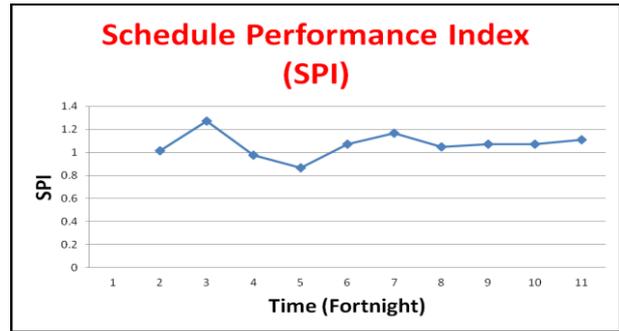


**Figure 6** Schedule Performance Index (SPI) over Time

Fig 6 represents the graph of SPI. Based on SPI it is observed that performance of work against time shows that the project is under budget from 3rd week to 11th week and it is on budget till last update of the project.

**Table 4** Earned Value Parameters

| Nos. | DATE | Cost Variance (CV) | Cost Performance Index (CPI) | RESULT |
|------|------|------|------|------|
| 1 | 01-02-16 | 0 | 1 | On Budget |
| 2 | 15-02-16 | 411844.55 | 1.09 | Under Budget |
| 3 | 01-03-16 | 194424.94 | 1.02 | Under Budget |
| 4 | 15-03-16 | -429004.73 | 0.98 | Over Budget |
| 5 | 01-04-16 | 880989.19 | 1.03 | Under Budget |
| 6 | 15-04-16 | 916920.26 | 1.02 | Under Budget |
| 7 | 02-05-16 | 746610.02 | 1 | On Budget |
| 8 | 16-05-16 | 932356.26 | 1 | On Budget |
| 9 | 01-06-16 | 820813.62 | 1 | On Budget |
| 10 | 10-06-16 | 718047.93 | 1.01 | On Budget |

Table 4 shows the results of CV and CPI for every 15days updation of the Project is under Budget till 11th week but it is observed that after 11th week the project is on Budget till the last update of the project as when compared to EV.
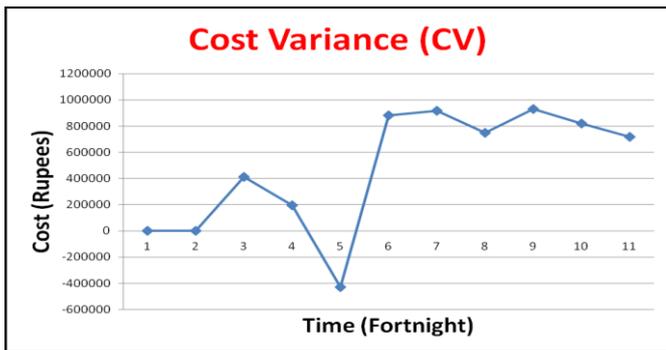
**Figure 7**  Cost Variance (CV) over Time

Fig. 7 shows that the project has a positive cost variance of Rs.7, 18,047.94 which indicates that the project is on budget.
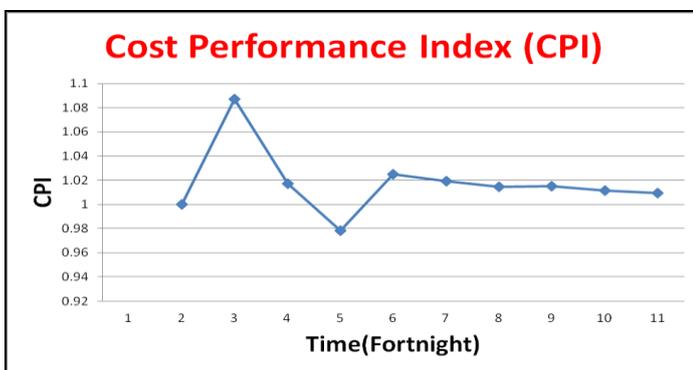


**Figure 8** Cost Performance Index (CPI) over Time

Fig.8 represents the behavior of EV with respect to cost. Analysis of the Value Cost depicts that the Project was under Budget till 11$^{th}$ week but it was observed that after 11$^{th}$ week the project was on Budget till the last update of the project as when compared to EV.

1. Performance based on project completion as per EAC is Rs.37, 09, 96,407.7.
2. Cost Estimate required for completion of remaining work ETC is Rs.29,51,71,230.1
3. VAC shows the deviation in the total cost from the expected cost. VAC 7, 18,047.94. Thus it is evident that the project is on budgeted at that particular period.
4. The time estimate at completion shows if the current progress will continue the time needed to complete project is 33 months.

The result can benefit the project managers to know the present situation of the project so that they can manage the project expenditure in the best.

## 4. Conclusion

The Construction started in January 2016. Duration of Project as per baseline Schedule is 867 days. Tracking till June 2016 revealed 90% completion of piling work and 100% Girder Reinforcement and over all completion of 16%. The Schedule Variance, Cost Variance and CPI in addition to SPI were clearly indicated through Earned Value Analysis.

- Present study is proved to be helpful in measuring time and cost performance of a project in EVM
- The present study has enabled the analysis of the efficiency of various parameters related to the progress of the project

## 5. Future Scope of Work

- Inventory management can be performed for similar projects
- In the present study, EVM has been applied over a period of 5 months. Analysis can be made for the entire project period, so that we can get actual performance status of the project
- Role of EVM in Projects with incorporating Risk and Delay Analysis can be carried out and analyses the changes or savings in cost and time as per planned costs and schedule

## References

[1]. A Anuj Dubey and Tajammulsayed, (Jan 2015), Bridge Construction Scheduling, Indian journal of applied research, Volume – 5, Issue – 1, ISSN - 2249-555X.

[2]. A.Naderpour, M.Mofid, (2011), "Improving Construction Management of an Educational Center by Applying Earned Value Technique", Procedia-ScienceDirect, ELSEVIER.

[3]. Hamed Ziaidoostan, Hamidreza Ghanesh, Matin Amanin, MohamadmahiGholipoor, (Apr 2013), "Using Primavera Software in Resource Allocation and Project Evaluation of Construction Projects" Interdisciplinary journal of contemporary research in business, volume 4, no 12.

[4]. Unmesh. Y. Polekar, Rohit. R. Salgude, (May 2015), "Planning, Scheduling and Tracking of a residential Project using Primavera Software", International Journal of Advance Research in Computer Science

and Management Studies, Volume 3, Issue 5, ISSN: 2321-7782.

**[5].** Project Management Institute "A Guide to the Project Management Body of Knowledge", (PMBOK Guide), ANSI/PMI 99-001-2008. Fourth Edition, 2008.

**[6].** Project Management Institute "Practice Standard for Earned Value Management-Second Edition. PMI, 2011.