A STUDY ON EARNED VALUE MANAGEMENT AND RISK MANAGEMENT APPROACH IN CONSTRUCTION PROJECTS

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ABSTRACT

In this paper, we have taken three projects to study EVM, QEVM and Risk management approach in current projects by gathering data from respective stakeholders. For analyzing the data, by using traditional formulas without software as well as with software package i.e. Microsoft Project was used. The results obtained from analyzing these three projects have no intention of falsifying or validating any theory or whatsoever. After the implementation of Earned Value Management (EVM)to a project so we analyzing with cost and time , As the traditional method did not give any idea about the completed work, quality of that work so this data was not sufficient that's why we can easily use Quality earned value management ecosystem. Furthermore, quality problems only become visible in the last section of the construction project and become a non-bearable cost to the project. For this, a small Questionnaire survey conducted to study risk management approach and responsiveness to a non-bearable risk. After analyzing Questionnaire survey data, we easily get behavior of respective stakeholders towards risk management approach. In this paper we proposed two models for EVM, QEVM. The Flowchart for process Adopted for EVM, QEVM& Risk Management Approach and Proposed methodology model for EVM. We proposed a result in the form of graph chart.

Keywords: Earned Value Management, Quality Earned Value Management, Quality Schedule Performance Index, Cost, Project Duration.

I.   INTRODUCTION

In this paper our goal to conduct some interesting research that could be tested the theory. We found this possibility in the area of project management where many researchers already did a lot of research in Earned Value Management (EVM), Quality Earned Value Management and Risk Management approaches. This methodology was developed to help Project Managers in following up their projects and take appropriate action when the project gets out of hand. There are several developed Methods used in project control. Earned value analysis seems to be a widely known and accepted technique to use on projects to understand, manage and forecast performance. It is a Method that measures three important baselines in project management (scope, cost and time) to give the overall health and progress of a project. These measurements provide the project manager with an ability to review the projects beyond the independent reviews of this three baselines. As most of the projects almost certainly never go entirely according to the schedule plan and corrective rectification are required the information from the EVM process is crucial for evidence based decisions that take and actions needed to keep the project on its said planned baselines or as close as possible to planned.

II.   LITERATURE REVIEW

In [1] Amruta B. Vyas et al. (2016) has presented tracking of construction projects using Earned Value Management is useful in recognizing the risk factors of the construction projects and to forecast the problems in order to face the remaining project work. It helps the project teams in decision making and to be an effective in managing their projects. This paper is focused on the concept theory and importance of Earned Value Management (EVM). This includes elements and performance indicators used for the tracking and forecasting the project that benefits project manager and ultimately results in project success. In [2] Ankur Verma et al. (2014) have shown a proposed a project management system is directly responsible on efficient planning, monitoring and controlling of construction project with the use of project management software Primavera P6. This paper shows importance, implementation and unique features of earned value management that benefits project manager and ultimately results in project success. In [3] Lavanya S et al. (2019) have presented EVA is

the reliant to two important elements such as detailed cost information and practical developments (2016) have presented timely measuring of the said project. The profit of the project will get absolutely if this two elements are well organized. This paper summarizes the evolution with basic terminologies of EV analysis and effective use of it in the construction activities by using MS Project Software. There are more ways to implement EVM in the construction industry. In [4] Akshay R Manohar et al. (2016) has presented measuring project performance fortifies managers to identify and to mitigate upcoming problems. Earned value analysis is a most effective management technique for estimating how a project is doing in terms of its budget and plan schedule. This paper exhibits benefits of an Earned value analysis on the typical projects. In [5] Prof. B. Prakash Rao et al. (2015) has told discusses about how Earned Value Analysis (EMA) is introduced to a residential construction project. EVM calculates the performance in cost and schedule and pin points areas where improvements have to be made. It is predicted that if corrective actions are not made as per the current situation, the project will get delayed by its planned 17 days and also that the contractors are estimated to make an additional profit of an over six lakhs than what was originally planned.

In [6] Tejas A. Topkar et al. (2020) has proposed, Earned value performance reporting is intended to forewarn management of potential cost and scheduling problems so that corrective action may be implemented before problems that critical. A fast turnaround from project status, review to reporting the results will give management more time to devise alternate plans. Utilization of the EV technique for project control will result in better assessment of activity time and budget. In [7] Anabela Tereso et al. (2017) have proposed to clarify the mechanisms of this function, and in which points they meet or affect each other, with reference to PMBoK. The several techniques are somewhat disperse and not always coherent. With the several assumptions resulting from the interconnection between the two methods, a framework of integration between them is proposed, as well as its practical implementation in tool like software Excel, resulting in the sets of the tools that can be useful in the monitoring and the controlling a project. In [8] Antony Prasanth MA et al. (2014) has study, budgeted cost of work performed is compared against actual cost of work performed and budgeted cost of work scheduled to assess cost and schedule variances, respectively. The EVM method is a proven technique to evaluate work progress in order to identify schedule slippage and areas of budget overruns. Value earned for the given tasks are computed as the budgeted cost of the work performed and is a function of the time, work completed, and budget. In [9] Andrzej Czemplik et al. (2014) has presented Earned Value Method is the an efficient and well known software for the project management. Application of the technique together with complementary dedicated for Earned value Management known approaches that make the method well adjusted for use on dynamic and multidisciplinary construction sites. The concept of Schedule Forecast Indicator to be used as the addition to Earned Value management has been developed to support sites managerial decisions concerning variation orders. In [10] V. Rathna Devi et al. (2018) has proposed a study. The aim of this paper is to use earned value management as a quantitative technique to risk analysis. The earned value analysis can be used to forecast the cost at completion and percentage of completion with reference to the baseline estimate and schedule. This method of quantitative analysis considers financial risk and scheduling risk as major factor in the execution of propose project.

III.   METHODOLOGY

In this thesis, we have proposed a method for calculating the EVM technique. We proposed steps for calculating the EVM method. We have also done research on calculating EVM with formula method, QEVM with EVM, calculating EVM with the software and risk management approach. In this project, we have made a process with the help of a flow chart for calculating the EVM. This flow chart shows the steps for the calculation of the EVM method. In this project, we work on three ongoing constructions project. First we collect the site details and all related data of the ongoing project so that we can calculate the EVM efficiently. We also take a survey in the form of questions and answer from different people so that we know the people are aware of the method or not. In this project, we had use two software's for analysis the result. They are Microsoft project and Microsoft excel. MSP is the most used software for calculating the EVM.

In this paper, we work on three ongoing constructions project. They are, site-1 is located in Camp Amravati for National Health Mission project name, site-2 is located in Chikhaldara, Amravati, Maharashtra, and site-3 is

located in Ratnagiri, Maharashtra (Ratnagiri –Ganpatipule Road). The purpose of descriptive research is to obtain an accurate representation of persons or situations, thus describing the characteristics of the phenomenon being studied. Questionnaires are one of the most commonly used data collection techniques within the survey strategy. Each individual who is provided with the questionnaire is asked to respond to the same set of questions, enabling a resourceful way of collecting responses from a large sample prior to analysis. A survey design software i.e Google Form at An email invitation where sent out via email to a Indian construction companies, including both small, mid-sized and large actors. The aim was to obtain an overall representation of the industry with regard to RM. There were 17 questions divided into three sections.

IV. MODELING AND ANALYSIS

There is Three Construction project Site on which Analysis of One Project is done on Microsoft Project 2013 and Earned value and their parameters are to be found out . Another Construction project Site analysis is done with EVM and QEVM for finding out the how much cost spent on quality. It is a measure of quality for each penny spent. For Analysis detailed steps are as follows:
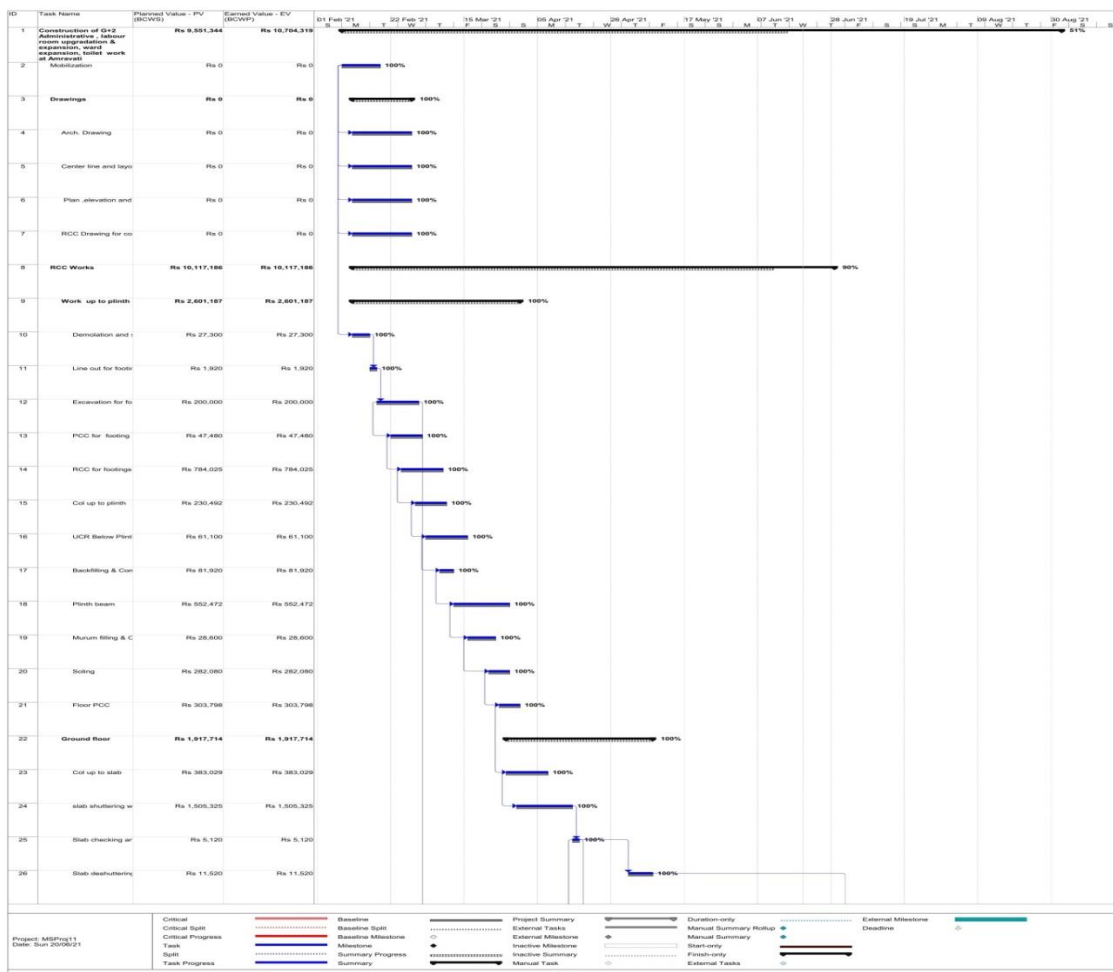

Figure 1: Gantt chart for proposed project site (Scheduling)

Creation of Gantt Chart and scheduled the project: The data collection process for all sites has to be done by reached out with respective department. There is two main stakeholders viz. Government Authorities like NRHM Amravati, Circle Akola, Public Works Department North Ratnagiri, and Public Works Department Amravati as well as on executing or construction side registered highly qualified firms like M/s.Raosaheb Sadashivrao Bobade and M/s.Shakil Ahmad. In this data collection process data like estimated value, planned value, actual cost, and Actual cost spent on each item of work. Existing Scheduling process, Cost variations,

Work breakdown structures for project and basic details of project has to be collected.After that Gantt chart is to be prepared in Microsoft Project 2013.
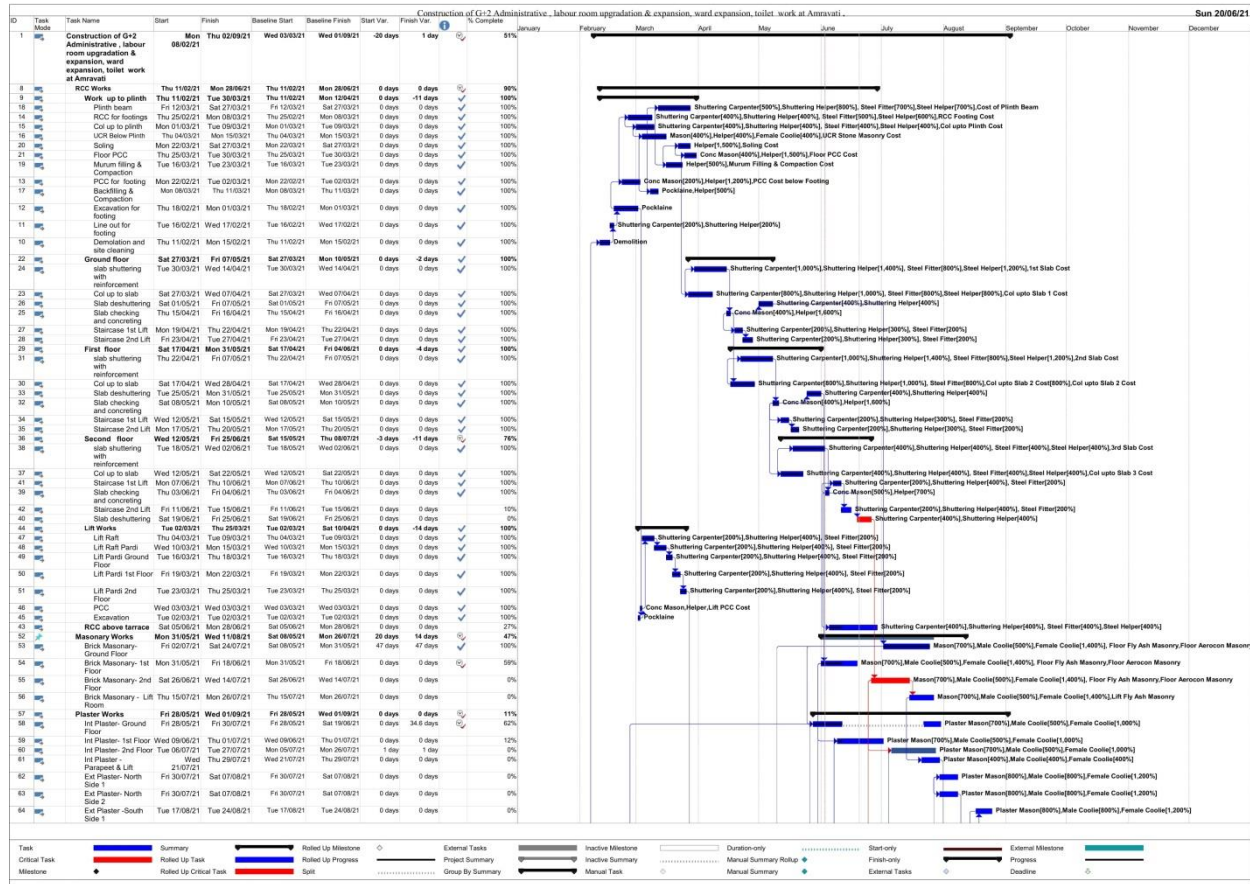

Figure 2: Creation of Baseline (At status Date)

Creation of Baseline on Status date: The baseline in project management is a clearly defined starting point for your project plan. It is a fixed guide point to measure and compare your project's progress against. This allowed us to assess the performance of your project over time. If your schedule baseline has a four-week completion, you can tell that there is a problem, and our team may need to make adjustments to speed up your progress.A project baseline has three components: schedule, cost, and scope. These three baselines are separately monitored, controlled, and reported to ensure each is on track. When fully integrated, it may be guided to as a performance measurement baseline. As work on our project progresses, we can update the plan with the actual start and finish dates, actual work, actual and remaining duration, and the current percent complete and percent work complete.As shown in above figure.

Earned Value Analysis for an Proposed Project By using Microsoft Project(2013): By update to status date and resource sheet, so we get EVM parameters for finding earned value for that project. When the baseline is set up, the project is tracked and followed up on a monthly basis. In Microsoft Project this is done by adding a period and filling in the real duration of the activities that were executed in that period. Also the actual cost deviation is inserted to calculate the Actual Cost (AC). The Earned Value (EV) is calculated automatically when the percentage completed for each activity is defined.At the end of the project, a summarized tracking overview is available that contains all metrics and parameters that are necessary for an in-depth analysis.

Data come out after the Analysis done by Microsoft Project 2013 for site one is

Planned value (PV):95,51,344/- ,

Earned value (EV):1,07,04,319/-,

Actual Cos t(AC):1,07,04,320/- At status date, Percentage of completion =51% ,

Percentage required for completion 49 %. Start variance =20 days.

Estimate at completion (EAC) : 1,45,19,245/- Cost Performance Index (CPI)=1

Scheduled Performace Index (SVI)=1,152,975

ID	Task Name	Planned Value - PV (BCWS)	Earned Value - EV (BCWP)	AC (ACWP)	SV	CV	EAC	BAC	VAC	CPI	Baseline Start	Baseline Finish	Earned Value Method	Status	(i)	% Comple
1	Construction of G+2 Administrative , labour room upgradation & expansion, ward expansion, toilet work at Amravati	Rs 9,551,344	Rs 10,704,319	Rs 10,704,320	Rs 1,152,975	-Rs 1	Rs 14,519,245	Rs 14,519,206	-Rs 39	1	Wed 03/03/21	Wed 01/09/21	Physical % Complete	On Schedule	☑	51%
2	Mobilization	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	0	Mon 08/02/21	Thu 18/02/21	Complete	Complete	✓	100%
3	Drawings	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	0	Thu 11/02/21	Sat 27/02/21	Complete	Complete	✓	100%
4	Arch. Drawing	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	0	Thu 11/02/21	Sat 27/02/21	Complete	Complete	✓	100%
5	Center line and layo	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	0	Thu 11/02/21	Sat 27/02/21	Complete	Complete	✓	100%
6	Plan ,elevation and	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	0	Thu 11/02/21	Sat 27/02/21	Complete	Complete	✓	100%
7	RCC Drawing for co	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	Rs 0	0	Thu 11/02/21	Sat 27/02/21	Complete	Complete	✓	100%
8	RCC Works	Rs 10,117,186	Rs 10,117,186	Rs 10,117,186	Rs 0	Rs 0 s	Rs 10,217,306 s	Rs 10,217,306	Rs 0	1	Thu 11/02/21	Mon 28/06/21	Complete	On Schedule	☑	90%
9	Work up to plinth	Rs 2,601,187	Rs 2,601,187	Rs 2,601,187	Rs 0	Rs 0	Rs 2,601,187	Rs 2,601,187	Rs 0	1	Thu 11/02/21	Mon 12/04/21	Complete	Complete	✓	100%
10	Demolition and	Rs 27,300	Rs 27,300	Rs 27,300	Rs 0	Rs 0	Rs 27,300	Rs 27,300	Rs 0	1	Thu 11/02/21	Mon 15/02/21	Complete	Complete	✓	100%
11	Line out for footi	Rs 1,920	Rs 1,920	Rs 1,920	Rs 0	Rs 0	Rs 1,920	Rs 1,920	Rs 0	1	Tue 16/02/21	Wed 17/02/21	Complete	Complete	✓	100%
12	Excavation for fo	Rs 200,000	Rs 200,000	Rs 200,000	Rs 0	Rs 0	Rs 200,000	Rs 200,000	Rs 0	1	Thu 18/02/21	Mon 01/03/21	Complete	Complete	✓	100%

Figure 3: Analysis Earned Value Managements

ID	Task Name	Planned Value - PV (BCWS)	Earned Value - EV (BCWP)	AC (ACWP)	SV	CV	EAC	BAC	VAC	CPI	Baseline Start	Baseline Finish	Earned Value Method	Status	(i)	% Comple
13	PCC for footing	Rs 47,480	Rs 47,480	Rs 47,480	Rs 0	Rs 0	Rs 47,480	Rs 47,480	Rs 0	1	Mon 22/02/21	Tue 02/03/21	Complete	Complete	✓	100%
14	RCC for footings	Rs 784,025	Rs 784,025	Rs 784,025	Rs 0	Rs 0	Rs 784,025	Rs 784,025	Rs 0	1	Thu 25/02/21	Mon 08/03/21	Complete	Complete	✓	100%
15	Col up to plinth	Rs 230,492	Rs 230,492	Rs 230,492	Rs 0	Rs 0	Rs 230,492	Rs 230,492	Rs 0	1	Mon 01/03/21	Tue 09/03/21	Complete	Complete	✓	100%
16	UCR Below Plint	Rs 61,100	Rs 61,100	Rs 61,100	Rs 0	Rs 0	Rs 61,100	Rs 61,100	Rs 0	1	Thu 04/03/21	Mon 15/03/21	Complete	Complete	✓	100%
17	Backfilling & Con	Rs 81,920	Rs 81,920	Rs 81,920	Rs 0	Rs 0	Rs 81,920	Rs 81,920	Rs 0	1	Mon 08/03/21	Thu 11/03/21	Complete	Complete	✓	100%
18	Plinth beam	Rs 552,472	Rs 552,472	Rs 552,472	Rs 0	Rs 0	Rs 552,472	Rs 552,472	Rs 0	1	Fri 12/03/21	Sat 27/03/21	Complete	Complete	✓	100%
19	Murum filling & C	Rs 28,600	Rs 28,600	Rs 28,600	Rs 0	Rs 0	Rs 28,600	Rs 28,600	Rs 0	1	Tue 16/03/21	Tue 23/03/21	Complete	Complete	✓	100%
20	Soling	Rs 282,080	Rs 282,080	Rs 282,080	Rs 0	Rs 0	Rs 282,080	Rs 282,080	Rs 0	1	Mon 22/03/21	Sat 27/03/21	Complete	Complete	✓	100%
21	Floor PCC	Rs 303,798	Rs 303,798	Rs 303,798	Rs 0	Rs 0	Rs 303,798	Rs 303,798	Rs 0	1	Thu 25/03/21	Tue 30/03/21	Complete	Complete	✓	100%
22	Ground floor	Rs 1,917,714	Rs 1,917,714	Rs 1,917,714	Rs 0	Rs 0	Rs 1,917,714	Rs 1,917,714	Rs 0	1	Sat 27/03/21	Mon 10/05/21	Complete	Complete	✓	100%
23	Col up to slab	Rs 383,029	Rs 383,029	Rs 383,029	Rs 0	Rs 0	Rs 383,029	Rs 383,029	Rs 0	1	Sat 27/03/21	Wed 07/04/21	Complete	Complete	✓	100%
24	slab shuttering w	Rs 1,505,325	Rs 1,505,325	Rs 1,505,325	Rs 0	Rs 0	Rs 1,505,325	Rs 1,505,325	Rs 0	1	Tue 30/03/21	Wed 14/04/21	Complete	Complete	✓	100%

Figure 4: Analysis Earned Value Managements

For Project site 2:, construction of a highway is of 10 km with a Total Budget amount of Rs.200,000/km over a duration of 1-year . The total budget at completion (BAC) is Rs.20,00,000/-.After three 3 months completion , it is found that 2 km have been completed at a cost of Rs.4,40,000/-. At this stage according to plan,2.5 km should have been installed by now, Therefore PV=500,000/-,EV=4,00,000/-, and AC=4,40,000/- The simple graph is shown in the figure below;
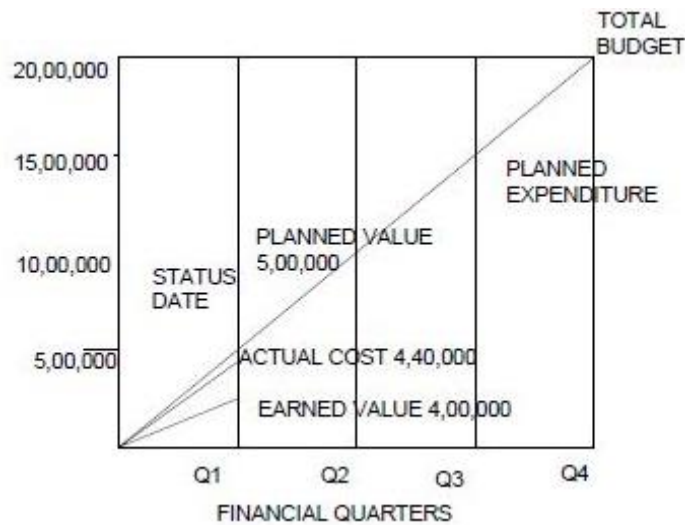
Figure 5: Analysis Earned Value Managements with financial Quarters

For Construction Project site 3: From the data collected from the Government Department and contractor, the project is completed in 180 day and the cost of the project is Rs. 22,75,106/-. So the data collected from the Contractor, the amount spent on the project till 15 Feb 2021 is Rs. 16,00,000/-

On 15 Feb 2021, on review, 75 % of work has been completed.

so,

The actual cost of work (AC):16, 00,000/-

Earned value (EV):70% of Budget at completion(BAC)=0.70*2275106=15,92,575/-

Planned Value(PV):85 % of Budget at completion(BAC)=0.85*2275106=19,33,840/-

Schedule Variance(SV): Earned value- Planned Value=15, 92,575-19, 33,840= -3, 41,265/-

Cost Variance (CV): Earned value- Actual cost= 15, 92,575-16, 00,000 = -7,425/-

Cost performance index (C.P.I.):Earned Value /Actual cost =15,92,575/16, 00,000=0.99.

Schedule Performance Index (S.P.I.): Earned Value/ Planned Value=15,92,575/19,33,840=0.82

Estimate Cost to completion (ETC):(BAC-EV)/CPI

=(22,75,106-15,92,575)/ 0.99

=682531/0.99=6,89,425

V.   RESULTS AND DISCUSSION

As per the data, analysis of this paper for site-1 Planned value (PV):95,51,344/- ,Earned value (EV):1,07,04,319/-, Actual Cos t(AC):1,07,04,320/-.Generally at status date, we saw a project on schedule, but only 51% work completed to track with allotted budget, but the overall concern about the said project is that still we have to complete remaining 49 % of work. Because of the limitations of Earned value Management discussed above chapters. In the long run, the start variance of 20 days is there. For site-2, estimate at Completion (EAC)shows that the expected total cost of the project at completion is based on the performance of the data date 22,75,106/- divide by 0.99 is 22,98,086/-. Hence EAC is 22,98,086/-. It means that, since the project is getting only 0.99 rupees out of every rupee, the project will cost 22,98,086 instead of 22,75,106/- that was planned. For site-3, the project has an unfavourable cost variance of 7,425 which means the project is over budget. A CPI of -0.9091 gives that the project is presently running over budget by 1% that is for each rupee we spend, we get a value of rupee 0.99. Estimate at Completion (EAC) shows that the expected total cost of the project at completion is based on the performance of the data date is 21,99,978/-Hence EAC is 21,99,978/-. This project is behind schedule and required 3 more months for c5ompletions. The schedule variance comes out to be Rs.1, 00,000/-. If in the future rate of progress changes to increased, we see drastically changes in EVM parameters.
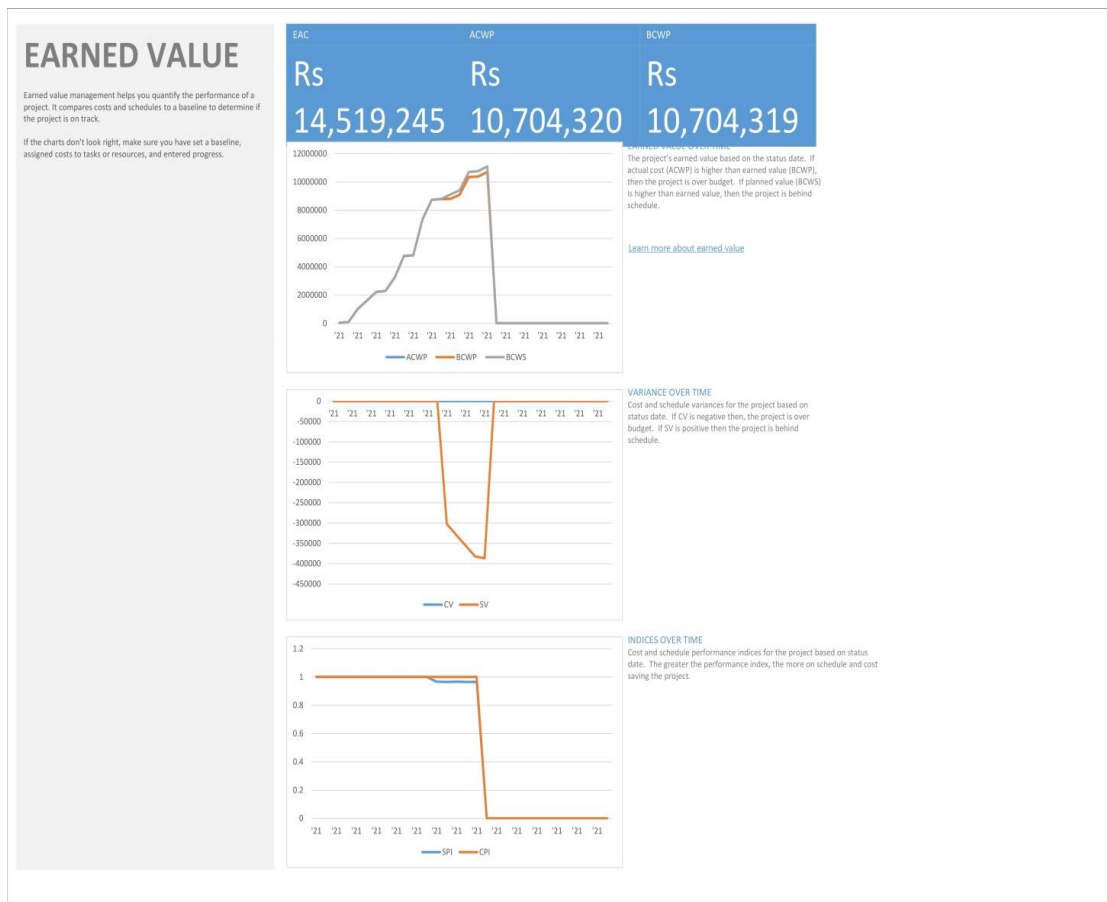
EV chart

VI.   ADVANDATAGES & LIMITAIONS

Advantages:

- EVM is a single management control system which provides reliable data.
- EVM integrates work, schedule, and cost using the work breakdown structure(WBS).
- The associated database of completed projects is an useful for comparative analysis in EV Analysis.
- The cost performance index (CPI) provides an early warning signal in the said project .
- The schedule performance index(SPI) provides an early warning signal in the said project.

Limitation:

- In EVM data which is used for analysis is not properly documented, so it is incomplete.
- In EVM an unused or unaccepted WBS is found.
- In EVM there is Integration problems of plan with WBS-Schedule-Budget.
- In EVM ,there is an incorrect schedule and/or budget.

VII.   CONCLUSION

This paper summarizes the basic terminologies of earned value analysis and quality earned value analysis with risk management approach and effective use of it in the construction activities by using MS Project Software as well as traditional manual calculations with using formulas. There are more ways to implement EVM in the construction industry. In this project thesis we proposed two models for EVM, QEVM. The Flowchart for process Adopted for EVM, QEVM& Risk Management Approach and Proposed methodology for EVM model. In the proposed methodology for EVM, there are different parameter are presented they are, Data Collection, Data Entry, Analyze data in a Microsoft project, Survey to find out Risk management approach, result, conclusion. And the flowchart includes the Gathering Data, Create Project schedule in Microsoft Project 2013, Define WBS & Create Calendars, Enter activities, Assign Durations, Link activities, Perform scheduling, Allocating Budgets &

Resources for activities, Creates Baselines for activities & update a schedule, Analysis of EVM , Track & published EVM report, Report, Result, Check Risk management approach by Que. Survey, Find out parameter of EVM, Analysis of EVM, Find out QEVM parameters, Published Report, Result, Check Risk management approach by Questionnaire Survey. We work on three ongoing sites. In these the result of our work is, site-1 start variance of 20 days is there. This creates a delay for the last activity. site2, estimate at Completion (EAC)shows that the expected total cost of the project at completion is 22,98,086/-., The project will cost 22,98,086 instead of 22,75,106/- that was planned. And for site-3 effect of Schedule performance on project (QSPI) is 0.80, Effect of cost performance (QCPI) is 0.9091, Effect of Quality Performance (QPI) is -0.1.

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