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Earned Value Analysis for Construction Project Using Software

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ABSTRACT— The performance of a construction project can be judged by using different traditional approach like day to day monitoring, monthly or weekly management reports etc. In these approaches, the budget expenditures and actual expenditures are used as data sources. But it only gives what was planned to be spent versus what was actually spent at any given time and not the physical amount of work performed. Earned value method is the effective tool for monitoring and control of construction projects. EVM overcomes the limitations of traditional performance tools by giving information like what has actually been produced for the amount of money spent, whether it is being produced at the rate, or according to schedule, originally planned.

KEYWORDS— weekly management, Effective tool, EVM, traditional performance tools, money spent.

I. INTRODUCTION

The development business is imperative for the improvement of any country. From various perspectives, the pace of the financial development of any country can be measured by the advancement of physical frameworks, for example, structures, streets and extensions. Development extend advancement includes various gatherings, different procedures, distinctive stages and phases of work and a lot of info from both people in general and private segments, with the real point being to convey the venture to a effective conclusion. The level of achievement in doing development extend advancement exercises will depend vigorously on the nature of the administrative, monetary, specialized and hierarchical execution of the separate gatherings, while mulling over the related hazard administration, the business environment, and financial and political steadiness. As development is turning out to be more unpredictable, a more refined approach is important to manage starting, arranging, financing, outlining, affirming, actualizing and finishing a venture. The development business is for the most part considered to have failed to meet expectations contrasted with other ventures.

A venture is a brief endeavor embraced to make a one of a kind item, administration, or result. The transitory way of tasks shows that a venture has a distinct start and end. The end is achieved when the venture's destinations have been accomplished or when the venture is ended on the grounds that its goals won't or can't be addressed, or when the requirement for the venture no longer exists.

There are different exercises required in venture which could conceivably be subject to each other. Exercises are limited with the time or/and cost or/and asset. The achievement of any venture is straightforwardly relying on the auspicious consummation of exercises without over run the cost. This can accomplish by the powerful administration of venture which is an aptitude.

II. LITERATURE SURVEY

As Earned Value Management is the effective technique for monitoring of project both timely and cost wise, it is considered for the method for further work of this project and hence focus of literature is concentrated on EVM. There have been various studies performed on the Earned Value Management, some of the studies performed in this field are studied and presented in the following literature review.

Anthony Cabri, Mike Griffiths (2004) this paper reviews the concepts of Earned Value Management established in traditional project management, and determines whether and how they can be applied to software development projects

following an Agile methodology. First the origins and concepts of Earned Value are reviewed, followed by its application in traditional projects. Then the application of Earned Value Management to Agile software projects is investigated. Earned Value is a project management monitoring & reporting technique that has been developed and utilized over the course of the last 100 years in traditional engineering projects. It relies on an initial task-based baseline plan for measuring progress, and a project with well-defined scope that evolves in a sequential, linear fashion. In agile, projects evolve in an iterative, non-linear fashion, with feedback loops that affect the initial plan. Change is expected and frequent throughout the project lifecycle, thus measuring progress relative to the initial plan will be misleading. While there are issues with attempting to apply Earned Value to Agile projects, agile project management techniques such as burn charts (indicating the amount of functionality outstanding vs. Completed over time, etc.) provide status & progress information very similar to what Earned Value attempts to measure. Costs can be added to the charts to view the information together with rate of feature completion. All of these may be more valuable to the project manager and project stakeholders in monitoring an agile project, rather than attempting to apply traditional Earned Value. [1]

Attila Boydak (2013) This paper shares the author's views, as an adviser and practitioner, on the differences and the underlying reasons for these differences in EVM based project controls applications in four industries: Power, telecommunication, building construction, and transportation. This paper also reviews the influence of ownership structure and project service providers on EVM practice. According to author, it is branded as "EVM," the basic concept of recognition for the work completed is used successfully in many engineering and construction industries. This concept is widely used in the power, telecommunication, and several other industries where participants have higher risk exposure or lower risk tolerance than other industries. Commodity installation curves, craft and labor histograms, and physical percentage complete curves are some of the methods used in the permitting, engineering, and construction phases. [2]

Awad S. Hanna (2012) in this study the author introduces an earned value management system that allows electrical contractors to monitor construction progress, perform forecasts on the project, uncover problems occurring on-site, and respond to problems in the project as early as possible. The goal of this study was to determine how the EVS can best be used in electrical construction and effective implementation of the system and determine the accuracy of different methods for measuring output. The analysis reports for EVS includes the field personnel loading curve, S-curves, performance factor profiles, and work-hour forecasts. Results of this study showed that early determination of probable project outcome is possible. Early warning signs are discussed and explained by the author. Use of EVMS can also help to detect cost overruns and schedule variation in the project, which makes it possible to take corrective measures in a time. Through this project, many contractors were asked about the biggest benefit to implementing and using an earned value system. [3]

Bhosekar Sagar , Gayatri Vyas, (2012) This study discussed about the main parameters involved in the calculation of Earned Value Analysis (EVA) in the cost management of civil construction projects. Authors have developed Earned Value Analysis software in Visual studio 2008, SQL Server 2005, .Net (C# language). Further, comparison of selected parameters between M.S Project 2007, Primavera P6 and developed software has been done. The two Projects were analysed using the developed software (in C#, .Net & SQL server) and MS Project 2007 and Primavera P6 based on Earned Value Analysis Method. Planned Value, Actual Value, Earned Value, Cost Variance, Cost Performance Index, Planned Duration, Actual Duration, SV(t) - Schedule Variance respect to time these variables were considered for the comparison. A new parameter SV (t) (Schedule Variances respect to time) was identified and incorporated in developed software which was not in MS Project 2007 and Primavera 6.This comparison shows a strong relation between three softwares, with more than 99.5% accuracy. It can be concluded that the software could be used in a wide range of projects for Earned Value Analysis calculation. [4]

David S. Christensen (1998) this study addresses both the costs and the benefits of earned value. The earned value concept and the related criteria are considered. Based on a comprehensive literature review, studies reporting the costs or the benefits of earned value are summarized and synthesized. The result is a report that facilitates a more complete and objective evaluation of the earned value management process. [5]

Fernando Acebesa, et al. (2013) this paper, proposed an innovative and simple graphical framework for project control and monitoring, to integrate the dimensions of project cost and schedule with risk management, therefore extending the Earned Value methodology (EVM). EVM allows Project managers to know whether the project has overruns (over-costs and/or delays), but project managers do not know when deviations from planned values are so important that corrective actions should be taken or, in case of good performance, sources of improvement can be detected. From the concept of project planned variability, authors build a graphical methodology to know when a project remains "out of control" or "within expected variability" during the project lifecycle. To this aim, authors define and represent new control indexes and new cumulative buffers: the cumulative maximum buffer and the sum of the cumulative minimum buffer and the cumulative maximum buffer. With these new measures, the project manager can determine graphically whether the project is delayed or not and whether the departure from planned values remains within the expected or planned variability (similar reasoning applies to cost). If overruns are higher than the allowed values, corrective actions should be taken in order to drive the project to control. If good performance is achieved, the methodology alerts project managers about possibilities of improvement. The framework includes all the information deductible from EVM analysis, but in addition integrates risk analysis and the concept of project planned variability. It is a simple methodology, as it does not need more data than the data use to perform EVM analysis and Monte-Carlo simulation. The former is commonly used as a preferred methodology for project control, and Monte-Carlo simulation is frequently performed in risk analysis and PERT calculations. [6]

Frank T Anbari (2003) this paper shows major aspects of the earned value method, presents graphical tools that enhance its effectiveness, and provides useful simplifications and logical extensions of this important project management method. [7]

Lipke Walt Oklahoma (2008) the study shows Earned Value Management (EVM) methods for forecasting project duration have been taught in training courses and used by project managers for four decades. These EVM methods are generally considered to be accepted practice, yet they have not been well-studied and researched as to their predictive capability. Using real project data, this article examines and compares the duration forecasts from four EVM methods to the Earned Schedule (ES) prediction technique. Five methods of project duration forecasting were examined in this study, four from EVM and the ES technique. Performance data from 16 projects was used to assess the capabilities of the various forecasting methods. The analysis strategy segregated the project data into seven ranges of percent complete in order to isolate possible forecasting characteristics or tendencies among the methods. Each of the methods was used to create forecasts from the project data. The standard deviation of the forecasts from the actual final duration was computed for each project, and each percent complete range was studied. The forecasting methods were then ranked from best to worst using the standard deviations. [8]

III. CONCEPT OF EARNED VALUE MANAGEMENT

Earned esteem is the estimation of work that venture administrators used to assess the advance of a venture in view of the cost of work performed until the venture status date. At the point when a Project's earned esteem is figured, as a matter of course it thinks about unique cost assessments to the genuine work performed in order to figure out if the venture is on spending plan or not. Earned Value is a estimation that shows the amount of the financial backing ought to have been spent, when contrasting the cost of the work performed to the pattern cost for the errand, asset or task.

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Volume 3, Issue 1, January 2017

Earned Value Management is a subset of Project Management. Earned Value Administration gives how much cash and time a specific occupation is probably going to require preceding beginning and once expressed, how much cash was invested at any given energy. What's more, once begun, what work has been expert to date for the assets exhausted (what you got for what you spent?) and, what the aggregate occupation will cost at culmination, and to what extent it will take to finish?

Phases of Earned Value Management-

The Earned Value Management framework can be divided into three phases:

1. Inputs - what is needed to implement Earned Value
2. Earned Value Methods – formulas, metrics and performance measurements used
3. Outputs – reporting requirements

Phase I consist of following inputs:

- Work Breakdown Structure (WBS)
- Organizational Breakdown Structure (OBS)
- Project Schedule
- Time-phased Baseline Budget

Phase II consist of Earned Value Field:

- Planned Value (PV), Earned Value (EV) Actual Cost (AC)
- Metrics and Performance Measurements
- Forecasting
- Integrated Baseline Review

Phase III consist of following Outputs:

- Reporting requirements
- Proper Analysis of Reports
- Correct Action taken

If any of items from phase I and two are not completed or are not completed appropriately, the Earned Value management outputs will not properly represent the current and future status of project.

Organization breakdown structure- An Organizational Breakdown Structure is a transitional level of an alternate graph that a hefty portion of you are now acquainted with: the work breakdown structure. Organization Breakdown Structure (OBS) speaks to the administration in charge of the undertakings in a progressive system. The OBS for the most part mirrors the administration structure of an association, from top-level faculty down through the different levels constituting the business. Association Breakdown Structure (OBS) is a progressive course of action of an association's administration structure. OBS ought to address with assigning every errand in the WBS to a board or a man.

The OBS shows authoritative connections and afterward utilizes them for doling out work to assets in a venture. Like its originator, the OBS permits complex activities to be separated, giving a more sorted out representation of the work to be finished. While the WBS is utilized to characterize the venture amid early phases of its cycle, the OBS gives a hierarchical structure for the venture as it moves to finishing.

Work Breakdown Structure - The Project Management Body of Knowledge (PMBOK) characterizes the work breakdown structure as a "deliverable arranged progressive deterioration of the work to be executed by the venture group." The work breakdown structure outwardly characterizes the extension into sensible errands that a extend group can comprehend, as every level of the work breakdown structure gives encourage definition and detail. WBS is made to

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characterize and arrange the venture components in order to obviously distinguish the deliverables, report and condense calendar and cost information at various levels to sum things up. A WBS speaks to a various leveled breakdown of a venture into components. WBS is likewise called as an composed technique for separating an item into sub items at lower levels of detail. In a venture, the WBS is produced by beginning with the end objective and progressively subdividing it into sensible segments as far as size, term and obligation which incorporate all means to accomplish the goal. It will give a simple approach to compress information alongside a superior understanding. A WBS outline shows and characterizes the item to be created and additionally delivered. It relates the components of work to be proficient to each other and to the finished result. The venture group makes the work breakdown structure by distinguishing the major utilitarian deliverables and subdividing those deliverables into littler frameworks and sub-deliverables. These sub-deliverables are further deteriorated until a solitary individual can be appointed. At this level, the particular work bundles required to create the sub-deliverable are distinguished and assembled together. The work bundle speaks to the rundown of undertakings to deliver the particular unit of work. From a cost viewpoint, these work bundles are typically assembled and doled out to a particular division to create the work. These divisions, or cost records, are characterized in an hierarchical breakdown structure and are apportioned a financial plan to deliver the particular deliverables. By coordinating the cost accounts from the authoritative breakdown structure and the venture's work breakdown structure, the whole association can track budgetary advance in expansion to venture execution.

IV. EARNED VALUE ANALYSIS METHODS

Earned Value is determined by what has been physically accomplished. But how do you determine the “physical” accomplishment? Physical accomplishment is determined by measuring the progress of a given activity.

There are numerous EV methods to measure progress.

- Fixed Formula
- Milestone Weights
- Milestone Weights with % Complete
- Units Complete
- Percent Complete
- Level of Effort

The following points will focus on the techniques of Earned Value Methods.

1. Fixed Formula:

The Fixed Formula strategy for deciding advancement applies to work bundles and control accounts that traverse a brief timeframe (inside a bookkeeping period, < 3 months). This strategy applies a percent finish to the begin and complete of an action. For the most part, the rates utilized in the recipe are 0/100, 50/50, or 25/75.

- 0/100 - Nothing is earned when movement begins however 100% of spending plan is earned when finished
- 50/50 - half is earned when action begins and the adjust is earned on finishing 25/75
- 25% is earned when movement begins and the adjust is earned on fulfillment

The points of interest and burdens of Fixed Formula strategy are:

Points of interest: Works well for fleeting work bundles, and requires insignificant push to status.

Hindrances: No huge detriments for short term, low esteem work bundles. Not exceptionally powerful for longer term work bundles.

2. Breakthrough Weights:

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The Milestone Weighting strategy appoints spending an incentive to every turning point. Not until full consummation of every point of reference is the financial backing earned. Turning point Weighting is utilized as a technique for work bundles with long haul spans and in a perfect world ought to have points of reference every month or bookkeeping period.

The focal points and burdens of Milestone Weighting are:

Advantage: Requires objective quantifiable turning points, which most clients or Project Supervisors lean toward.

Detriment: Does not permit fractional credit for in-process work, and requires itemized breakthrough arranging.

3. Milestone Weights with % Complete:

The Milestone Weighting with Percent Complete strategy relegates spending an incentive to every breakthrough, furthermore, it is earned in view of the percent of work Completed against every individual breakthrough. Like Development Weighting, Milestone Weighting with Percent Complete is utilized as a technique for work bundles with long haul spans and in a perfect world ought to have breakthroughs every month or bookkeeping period.

The favorable circumstances and inconveniences of Milestone Weighting with Percent Complete are:

Favorable circumstances: Requires objective quantifiable points of reference, which most clients incline toward, also, takes into account fractional credit against points of reference.

Detriments: Requires a Control Account Manager evaluation of the % finish for every breakthrough and requires documentation of appraisal technique.

4. Units Complete:

The Unit Complete strategy utilizes a physical tally to figure out what is earned. To utilize Unit Finish you should have units that are indistinguishable or comparable and they should have similar spending plan esteem. The preferences and detriments of Unit Complete are:

Focal points: A target and simple method for deciding the earned an incentive for a movement.

Weaknesses: Limited to creation sort climate of comparable things that are settled unit costs. Does not mull over work changes so may distort genuine EV.

5. Percent Complete:

The Subjective Percent Complete technique applies a percent finish to a spending an incentive to figure out what is earned. The percent finish esteem is dictated by the Control Account Supervisor or other assigned people. The percent finish is connected to the Budget at Consummation (BAC) for an offered action to decide the present and combined EV.

The points of interest and disservices of Subjective Percent Complete are:

Points of interest: This is one of the more subjective strategies. Earned Value depends on the Control Account Manager's evaluation of the work bundle advance. Nitty gritty arranging at the point of reference level is not required.

Burdens: Customer Satisfaction possibly low because of the subjective included and the absence of nitty gritty arranging, in any case, Control Account Managers are required to give the client with their appraisal approach.

6. Level of Effort:

The Level of Effort strategy depends on the progression of time. A month to month spending worth is earned with the progression of time and is constantly equivalent to the month to month arranged sum. When utilizing Level of Effort, the PV is constantly equivalent to the EV. This strategy is generally utilized for records that are additional time related than errand arranged.

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The favorable circumstances and burdens of Level of Effort are:

Favorable circumstances: This EVM does not require statusing, and is suitable for managing errands like Program Management.

Inconveniences: Level of Effort work bundles are frequently tested by the client. This EV strategy ought to be kept to an insignificant number of work bundles. Level of Effort work bundles require precise appraisal (arranging) of month to month execution.

V. STUDY OF PRIMAVERA SOFTWARE

ABOUT PRIMAVERA: In this venture, Primavera (programming) is received for the examination of the venture. There are two modules, Project Management module and Methodology Management module of Primavera P6. The Project Management module is far reaching, multiproject arranging and control programming, based on Oracle and Microsoft SQL Server social databases for big business wide extend administration versatility. The Project Management module empowers association to store what's more, deal with its activities in a focal area. The module underpins work breakdown structures (WBS), authoritative breakdown structures (OBS), client characterized fields and codes, basic pathmethod (CPM) booking, and asset leveling. Primavera P6 oversees and controls exercises identified with venture administration and additionally portfolio administration. Assets speaking to work, materials and gear are utilized to track time and expenses for the venture. Undertakings' exercises are overhauled bringing about the alteration of time related bars.

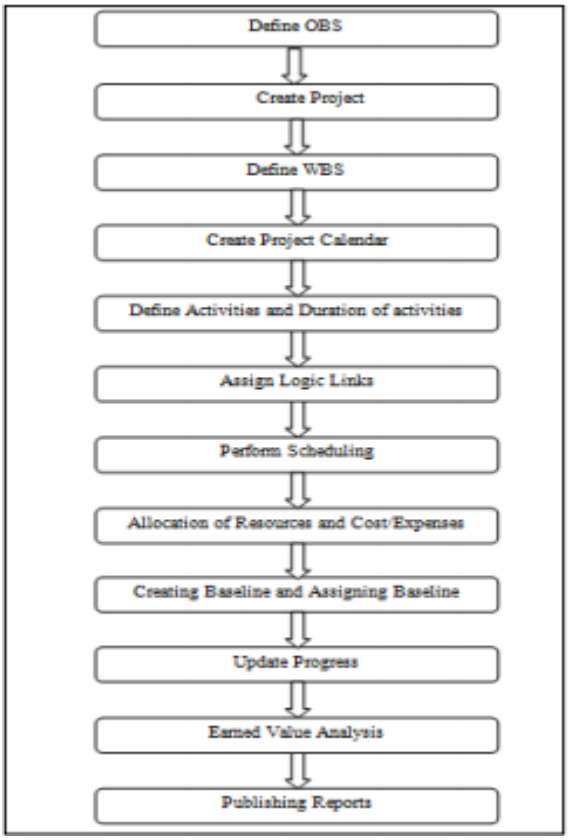

Fig.1 Flowchart of Earned Value Steps in Primavera

VI. EXPECTED RESULTS

1. To study earned value analysis for project performance evaluation of construction project.
2. To investigate the factors involved in earned value analysis of a construction project using software.
3. To understand the relation between various factors involved in project performance evaluation of construction project.

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Volume 3, Issue 1, January 2017

VII. CONCLUSION

Earned Value Analysis is extremely compelling device for the execution estimation as it encourages advance of venture as far as cost and calendar investigation and it additionally predicts future execution. From the investigation of this venture work it is presumed that Earned Value Management is "early cautioning signal" that empowers specialist to recognize and control the issues before they turned out to be unconquerable. It permits activities to be overseen better – on time and under spending plan. Extend administration framework is specifically mindful on viable arranging, legitimate checking and controlling of development venture with utilization of venture administration programming, Primavera P6. This examine demonstrates significance, execution and one of a kind elements of earned esteem administration that benefits extend administration and at last outcomes in venture achievement.

The development divisions which don't utilize Project Management programming devices proficiently need to build their interests in preparing and instructing their utilized venture groups, too as in setting up data innovation frameworks that will support and Project Management groups. The utilization of such programming's finishes the venture on calendar time and cost.

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