



# TO STUDY THE IMPROVED EARNED VALUE MANAGEMENT APPROACH IN CONSTRUCTION PROJECT AT IITM PASHAN PUNE

<sup>1</sup>Swapnil.B.Jinturkar, <sup>2</sup>Prof.V.R.Payghan, <sup>3</sup>Dr.N.V.Khadake

<sup>1</sup> Post Graduate Student from Construction Management, Department of Civil Engineering, Imperial College of Engineering & Research Wagholi, Pune, India

<sup>2</sup>Assistant Professor, Department of Civil Engineering, JSPM Imperial College of Engineering & Research Wagholi, Pune, India

<sup>3</sup>Professor and Head Civil Department, JSPM Imperial College of Engineering & Research Wagholi, Pune, India

**Abstract :** Construction directors cover systems on a frequent base to corroborate that they're performing as anticipated. The construction assiduity invests pregnant time and coffers to ameliorate quality and safety while lowering costs and scheduling counteraccusations. The construction business has a genuine thing to ameliorate construction design operating procedures in order to ameliorate effectiveness. Quality and safety underperformances have historically been caused by inadequately managed quality control and safety exercises. Poor quality work has always influenced construction operations in terms of cost and time. COVID-19's unanticipated issues and enterprises stressed the need to contemporize the construction assiduity's Earned Value Management (EVM) system to reflect these quality and safety conditions. The purpose of this content is to show the Earned Value Construction Operation (EVCN) system, which is a sophisticated EVM system. EVCN has a new suggestion that's linked to quality control exertion and increases the delicacy of design reporting in normal or epidemic structure surroundings. Detailing engineering and administrative safety practices during COVID-19, assaying effective PPE during an epidemic, and statistically assaying design data to demonstrate EVCN are all part of the fashion employed in this debate. This discussion's gift is a piece of field-validated data on the cost and schedule consequences of artificial construction during a COVID-19 terrain EVCN was also created to cast cost and schedule consequences while maintaining quality and safety using Excel template. The knowledge gained during this debate will ultimately ameliorate the construction assiduity's capability to respond to an epidemic and incorporate quality and safety conditions into a schedule that will allow them to track and manage progress more efficiently.

**Index Terms -** Earned value management, Earned value construction operation, Quality and Safety control, COVID-19, Excel Template

## I. INTRODUCTION

In an extreme illustration of design, schedule, and cost misgivings, the COVID-19 epidemic led to a complete lockdown throughout India. This global event drastically impacted artificial construction throughout the Country, as protocols for threat mitigation and needed PPE hadn't been developed or enforced for construction associations. The slow and uncharted response by construction associations during COVID-19 urged demanded for exploration and publication of effective protocols against COVID-19. The need for farther exploration was apparent when construction associations had difficulty furnishing mitigation and COVID-19 response plans. Research and participated mitigation plans were in their immaturity stages with unwarranted results, with recommended safety protocols and needed PPE coming from the BOCW, rather than through the development of norms that had been demonstrated to be effective in a construction terrain. The safety protocols and added PPE put in place during COVID-19 presented multitudinous challenges. The construction assiduity asked the knowledge of cost and schedule

Impacts and their goods on construction productivity. The critical demand to enhance construction systems return on investment is a precedence for stakeholders and possessors, anyhow of external circumstances including the COVID-19 epidemic. There's anecdotal substantiation that poor quality in systems leads to safety counteraccusations. The need for advanced quality in construction systems has a considerable impact on safety as accompanied connections of the two are needed to be effective. Quality Control (QC) is a vital conformance and examination process in all construction systems. A good QC examination plan increases conformance to specialized specifications and prevents construction crimes and installation of imperfect accoutrements and outfit.

Still, quality performance is traditionally not measured through EVM styles, nor does the schedule generally prisoner planned safety and quality control conditioning for a design.

Traditional schedules and the design schedule performance indicator (SPI) and cost performance indicator (CPI) calculated through EVM, and EVA neglect the significance of silent construction impacts similar as quality and safety. The issues of on-conformance and poor-quality during construction lead to increased cost and duration. Over the last decade, the global construction assiduity has placed a great deal of emphasis on managing quality and costs associated with poor quality. The cost impacts of quality and safety in construction have increased dramatically and can regard for 30 of the overall construction cost overruns. While navigating the tremendous challenges and misgivings of the COVID-19 epidemic, the need for advanced construction operation tools that are more comprehensive of the realities and triggers that need to be managed to ensure quality systems are delivered on time and within budget has been indeed more current.

## II. OBJECTIVES OF STUDY

- To improve construction project management methods, especially during uncertain conditions such as the COVID-19 pandemic, by explicitly integrating quality and safety activities.
- To address this goal, an improved EVM method the Earned Value Construction Management (EVCN) method is developed.
- Describe industrial construction safety policies, best practices, and associated cost and schedule impacts in a pandemic.
- Develop and signify the value of EVCN using real-time constructional earned value (EV) data.

## III. SCOPE OF STUDY

The study's scope is to develop and apply an approved method of EVM to a simulated case study. Construction of Utility Building at IITM Pashan, Pune. This research addresses the additional safety protocols and personal protective equipment required during a pandemic, as well as the cost and schedule impacts to the projects from implementing the safety protocols and best practices. The study compares the significance before and during COVID-19, using statistical analysis of the performance indices. The scope of the study also demonstrates the cost and schedule impacts of the COVID-19 pandemic environments.

## IV. QUALITY MANAGEMENT PLAN (QMP)

It's a diligence practice for construction companies to have a commercial Quality Management Plan (QMP). The QMP outlines the programs, procedures, and processes of employing quality control (QC) and quality assurance (QA), Quality Control and QA are vastly different in the description but complement one another in a good QMP. Without these, the design can end up with examination gaps, construction issues, accouterments faults, and non-compliance to specifications and delineations.

The QASP outlines the chance for work and construction disciplines to be observed for compliance. The QASP supports QC examinations by reducing the number of findings and non-compliance construction issues. The QASP influences the demand for quality data and reporting necessary for quality process operation.

a) The contractor shall ensure quality construction in a planned and time-bound manner. Any sub-standard material/ work beyond the set-out forbearance limit shall be pithily rejected by the Mastermind-in-Charge.

b) The contractor shall insure quality control measures on different aspects of construction including accouterments, workmanship and correct construction methodologies to be espoused. The quality assurance program should include a system statement for colorful particulars of work to be executed along with checklists to apply quality control.

c) The contractor shall depute the Quality Manager simply for enforcement of quality control. A similar Quality Director should be a good mastermind with minimal Eight times of analogous experience. For other staff to be stationed for quality assurance, the contractor.

d) Wherever work is specified to be done through specialized agencies, their names shall be got approved well in advance from Mastermind in charge. Failure to do so shall not justify detention in prosecution of work. It's suggested that incontinently after award of work, contractor should negotiate with concerned specialist agencies and shoot their names for blessing to Mastermind in charge.

e) All accoutrements attained from Govt. Stores or else shall be got checked by the Mastermind-in- Charge or his any authorized administrative staff on damage of the same at point before use.

f) The contractor shall give at his own cost suitable importing and measuring arrangements at point for checking the weight/ confines as may be necessary for prosecution of work. The sealed samples are to be handed over to the testing lab by contractor in the presence of Junior Mastermind/ Adjunct Mastermind-in-Charge of work.

g) Samples of colorful accoutrements needed for testing shall be handed free of charges by the contractor. Testing charges, if any, unless else handed shall be borne by the contractor. All other expenditure needed to be incurred for taking the samples; vehicle, packing etc.

h) The contractor or his authorized representative shall associate in collection, medication, forwarding and testing of similar samples. In case, he or his authorized representative isn't present or doesn't associate him, the results or similar tests and consequences thereon shall

i) For certain particulars, if frequency of tests not mentioned in the CPWD Specifications and also applicable IS law shall be followed and tests shall be carried out as per the frequency specified therein.

j) If any cargo testing or special testing is to be done for any sample whose strength is doubtful, the cost of the same shall also be borne by the contractor.

k) Samples of all accoutrements and fittings to be used in the work in respect of brand manufacturer and quality shall be got approved from the Mastermind-in-Charge, well in advance of factual prosecution and shall be saved till the completion of the work. However, the same shall be used after getting the same approved from Mastermind-in-Charge, If a particular brand of material is specified in the item of work in Schedule of Volume. Wherever brand/ quality of material isn't specified in the item of work, the contractor shall submit the samples as per approved list of brand names given in the tender document/ fresh specifications for blessing of Mastermind-in-charge. For all other particulars, accoutrements and fittings of ISI Pronounced shall be used with the blessing of Mastermind-in- Charge. Wherever ISI Pronounced material/ fittings aren't available, the contractor shall submit samples of accoutrements/ fittings manufactured by enterprises of character conforming to applicable specifications or IS canons and use the same only after getting the blessing.

l) To avoid detention, contractor should submit samples as stated over well in advance so as to give timely orders for procurement. However, indeed though approved by Mastermind-in- Charge is plant imperfect or not conforming to specifications shall be replaced/ removed by the contractor at his own threat & cost, If any material.

m) The contractor shall get the source of all other accoutrements, not specified away in the document, approved from the Mastermind-in- Charge. The contractor shall stick to the approved source unless it's absolutely necessary. Any change shall be done with the previous blessing of the Mastermind-in- Charge for which testsetc. Also, the contractor shall submit brand/ make of colorful accoutrements not specified in the agreement, to be used for the blessing of the Mastermind-in- Charge along with samples and once approved, he shall stick to it.

n) The contractor shall get the water tested with regard to its felicity and conforming to the applicable IS Code. The contractor shall gain written blessing from the Mastermind-in- Charge before he proceeds by using the same for prosecution of work. The water testing charges shall be borne by the contractor. However, the contractor shall arrange External water or from any other source at his own cost and nothing redundant shall be paid on this account, If tube well water isn't suitable. The water shall be got tested at frequency specified in rearmost CPWD Specifications/ BIS Code.

## V. PROJECT METHODOLOGY

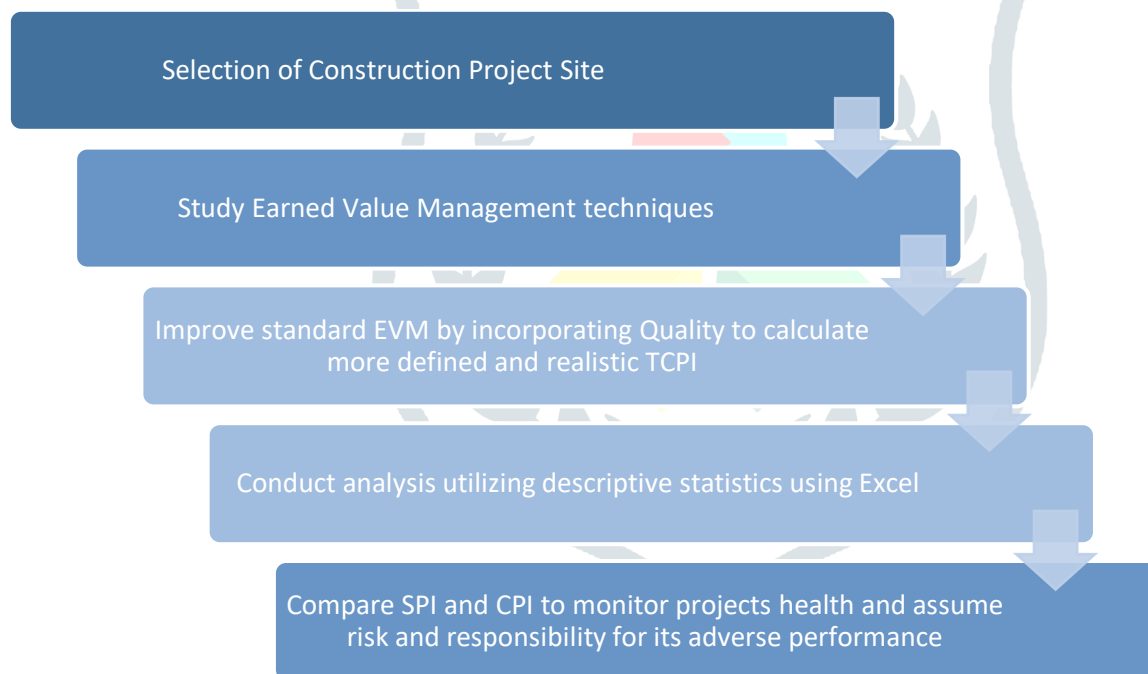


Fig.1 Flowchart of Methodology

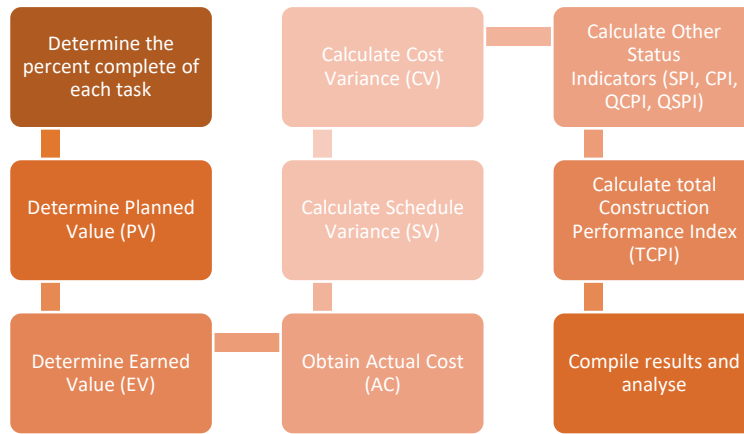


Fig.2 Flowchart of EVM process

The improved methodology has two contributions to enhance the value of a more accurate total performance index incorporating quality control. The first part uses standard EVM formulas but with improved formulas by incorporating the QSPI to calculate a more defined and realistic total construction performance index. The second part is conducting analysis utilizing descriptive statistics Excel. The analysis reviews the mean, standard deviation, upper and lower confidence intervals. The descriptive statistics compare EVM metrics of without a quality control index.

The Earned Value Construction Method (EVM) uses prescriptive formulas to calculate indices and variances. In construction, most managers are familiar with the basic concepts of EVM. The construction project manager uses two indices and the variances for evaluating project performance. The first index is the Cost Performance Index (CPI), which is needed to monitor the project’s cost. The second index is the Schedule Performance Index (SPI) that monitors the schedule’s health. The use of cost and schedule variances to determine if trends are occurring.

The data inputs are the project deliverables converted into a value. The values are numeric in representing time, quantities, or actual measurements. This value is known as the planned value (PV).

The indices have two known outputs, CPI and SPI, which are interpreted in equal to, greater than, and less than 1.0. If the result is greater than or equal to 1.0, the project executes as planned or better. When the result is less than 1.0, there is a reason to believe that the project’s health is impacted. The project construction manager assumes the risk and accepts responsibility for its adverse performance.

**VI. RESULTS AND DISCUSSION**

**6.1 Results of Descriptive Statics of Study Parameters**

<b>PROJECT START DATE</b>	13-Oct-2019
<b>PROJECT END DATE</b>	08-Oct-2021
<b>PLANNED VALUE (PV)</b>	50971008
<b>EARNED VALUE (EV)</b>	50034959.04
<b>ACTUAL COST (AC)</b>	50974211
<b>BUDGET AT COMPLETION (BAC)</b>	51485760

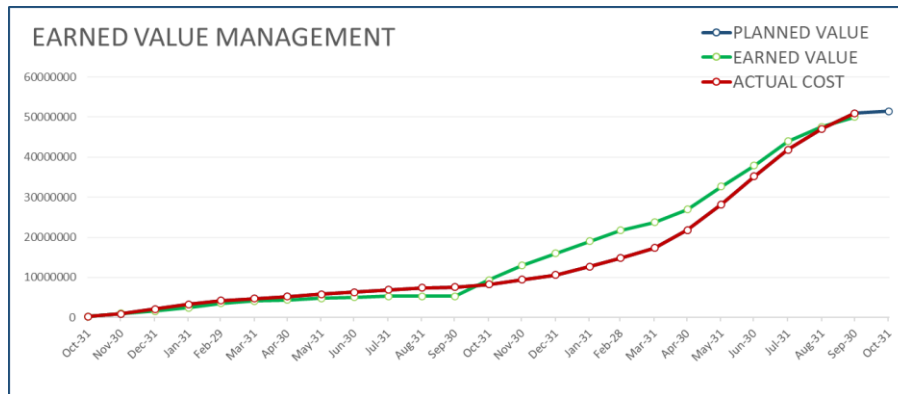
Table 4.1 Parameters of EVM

<b>VARIANCES</b>		
<b>SCHEDULE VARIANCE (SV)</b>	-936048.96	<b>BEHIND SCHEDULE</b>
<b>COST VARIANCE (CV)</b>	-939251.96	<b>OVER PLANNED COST</b>
<b>INDICES</b>		
<b>SCHEDULE PERFORMANCE INDEX (SPI)</b>	0.98	
<b>COST PERFORMANCE INDEX (CPI)</b>	0.98	
<b>TO-COMplete PERFORMANCE INDEX (TCPI)</b>		
<b>Option 1: To Complete On Planned Budget</b>	2.84	<b>HARDER TO COMPLETE</b>
<b>Option 2: To Complete on new EAC Budget</b>	0.98	<b>EASIER TO COMPLETE</b>

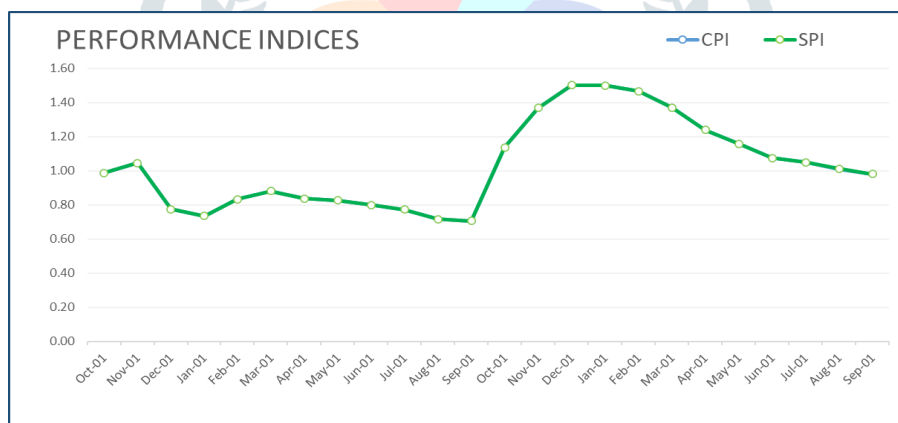
Table 4.2 Variance and indices

FORECASTING	
METHOD	
ESTIMATE TO COMPLETE (ETC)	1478035
ESTIMATE AT COMPLETION (EAC)	52452246
VARIANCE AT COMPLETION (VAC)	-966486
ESTIMATED COMPLETION DATE	21-Oct-2021

Table 4.3 Forecasting



GRAPH 1 EARNED VALUE MANAGEMENT GRAPH



GRAPH 2 PERFORMANCE INDICES

The project has shown many variations in different month firstly in month of October the project was behind schedule then by rescheduling and proper tracking and monitoring we were able to control the deflection in month of August as both the CPI and SPI were 1.01 and the project was on track but due to the crisis the project lately was behind schedule in month of September.

Finally, the total Construction Performance Index (TCPI) is calculated by adding all the indices and dividing them by 3.0. Each performance indices are weighed equally as they have equal impact to a project.

$$TCPI = \frac{CPI+SPI+OSPI}{3} = \frac{0.98+0.98+1}{3} = 0.9867$$

As the TCPI is below 1 it indicates that the project is lagging behind the schedule and has largely been affected by the pandemic, thus quality earned value management is an effective management tool in program execution and it realizes real time monitor and integrated management of the three targets of schedule, cost and quality. The level of its application will be extremely important to the realization of the program's target.

## VII. CONCLUSION

1. Comparing to traditional earned value method, quality earned value method not only indicated the execution of the program, but also indicates the increase or decrease in cost caused in any part by the increase of quality cost and schedule.
2. Quality earned value management enables the establishment of scientific program management system, including work breakdown structure, tracking and reporting system, program cost accounting system, complete system support, integrated monitor system of schedule, cost and quality, highly effective information management system, richen management system and scientific human resource management system.
3. As a result of practicing the protocols described in this study, social distancing, wearing proper PPE, sanitizing practices, and medical pre-screening IITM saw few positive cases of COVID-19 but added additional the cost to the project.
4. EVM's potential reasons for promising outcomes include improved work efficiencies, fewer re-work required, limited field change orders, reduced engineer errors and omissions, and work scope not as complex as previously understood. However, if not applied effectively or at all, you can expect cost overruns, scope creeps, push and pull management decisions with limited data, increased costs, and late schedule completion.

## VIII. ACKNOWLEDGMENT

This is to acknowledge and thank all the individuals who played defining role in shaping this project report. Without their constant support, guidance and assistance this project report would not have been completed.

I am extremely thankful to Prof. Vinayak Ramdas Payghan, Professor JSPM's Imperial College of Engineering and Research, Wagholi, Pune for supporting me and guiding me with his valuable suggestions and advice throughout my project.

I acknowledge with thanks, Prof. Abhijit Narendra Bhirud, PG-Coordinator, JSPM's Imperial College of Engineering and Research, Wagholi, Pune for his valuable guidance, continual encouragement and advice throughout our project work.

I am extremely thankful to Dr. N. V. Khadake, Head of Civil Department, JSPM's Imperial College of Engineering and Research, Wagholi, Pune for his valuable guidance, continual encouragement throughout our project work.

I am also thankful to our Principal Dr. R. S. Deshpande, JSPM's Imperial College of Engineering and Research, Wagholi, Pune, for providing all facilities to us in the form of infrastructure of the college. I would like to thank all staff members of Civil department for timely help and encouragement of fulfilment of project work.

I conclude this by thanking my parents and my friends supporting me morally.

## REFERENCES

- [1] Ricardo Viana Vargas, MSc, IPMA-B, PMP (2003), "Earned Value Analysis In The Control Of Projects: Success Or Failure?"
- [2] Jose Angelo Valle, Carlos Alberto Pereira Soares (2004), "The Use Of Earned Value Analysis (Eva) In The Cost Management Of Construction Projects"
- [3] A. NADERPOUR, M. MOFID (2011), "Improving Construction Management of an Educational Center by Applying Earned Value Technique"
- [4] Sagar K. Bhosekar, Gayatri Vyas (2012), "Cost Controlling Using Earned Value Analysis in Construction Industries"
- [5] Sunil Ganpat Mahadik, Pankaj P. Bhangale (2013) "Study & Analysis of Construction Project Management with Earn Value Management System"
- [6] Jordy Batselier and Mario Vanhoucke (2015) "Empirical Evaluation of Earned Value Management Forecasting Accuracy for Time and Cost"
- [7] Suqrat Babar; Muhammad Jamaluddin Thaheem, Ph.D, Aff.M.ASCE; and Bilal Ayub, Aff.M.ASCE (2016), "Estimated Cost at Completion: Integrating Risk into Earned Value Management"
- [8] David Bryde, Christine Unterhitzberger, Roger Joby (2017) "Conditions of success for earned value analysis in projects"
- [9] Jordy Batselier, Mario Vanhoucke (2017), "Improving project forecast accuracy by integrating earned value management with exponential smoothing and reference class forecasting"
- [10] Ahmed, Reem and Afifi Mohamed (2018), "Integrating Quality Into Earned Value Management"

- [11] Solomon Sackey, Dong-Eun Leeb, and Byung-Soo Kimc (2020), “Duration Estimate at Completion: Improving Earned Value Management Forecasting Accuracy”
- [12] Amirhossein Balali, Alireza Valipour, Jurgita Antucheviciene and Jonas Šaparauskas (2021), “Improving the Results of the Earned Value Management Technique Using Artificial Neural Networks in Construction Projects”
- [13] Sajad Soltana and Maryam Ashrafi (2020), “Predicting project duration and cost, and selecting the best action plan using statistical methods for earned value management”
- [14] Kieran Bennett and Mohammad Mayouf (2021), “Value Management Integration for Whole Life Cycle: Post COVID-19 Strategy for the UK Construction Industry”
- [15] Mr. Pavan D. Ippakayal & Dr. M. B. Kumthekar (2021), “A Review on Earned Value Management Analysis in Construction Industry”

