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Earned Value Management as a Strategic Tool for Cost, Schedule, and Resource Optimization in Construction Projects

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ABSTRCT

This research investigates the application of Earned Value Management (EVM) as an integrated project control technique for improving cost, schedule, and performance management in construction projects, particularly within the Indian construction industry where delays, budget overruns, and inefficient resource utilization remain significant challenges. The study addresses the limitations of traditional project monitoring methods, which often assess cost and time separately, by evaluating EVM's capability to provide a unified framework through key indicators such as Planned Value (PV), Earned Value (EV), Actual Cost (AC), Cost Performance Index (CPI), and Schedule Performance Index (SPI). A quantitative research methodology was adopted using a structured questionnaire survey of construction professionals, including project managers, engineers, contractors, and consultants, with data analysed through the Relative Importance Index (RII) method to rank critical factors affecting EVM implementation. Additionally, a practical case study of an Ahmedabad metro rail construction project was conducted to examine real-world EVM performance. The findings reveal that EVM significantly enhances cost control (RII = 0.89), schedule monitoring (RII = 0.87), resource optimization, and decision-making efficiency. The case study demonstrated that early identification of project deviations through EVM improved project performance, with CPI increasing from 0.76 to 0.92 and SPI from 0.84 to 0.95 after corrective actions. Despite these benefits, challenges such as limited awareness, inadequate training, and insufficient technological integration hinder widespread adoption. The study concludes that EVM is a highly effective and reliable tool for construction project control and recommends broader implementation supported by training, advanced software integration, and policy-level adoption to enhance project delivery efficiency and sustainability.

Keywords: Earned Value Management, Construction Project Control, Cost Performance Index, Schedule Performance Index, Relative Importance Index.

Introduction

Construction industry is critical for the process of development in terms of economic progress, infrastructure, and urbanization in particular within developing nations such as India. In light of the increasing involvement in transportation networks, housing and other infrastructure facilities, construction has taken on a much higher level of complexity as well as size. Yet the construction industry suffers from various issues including cost overruns, project delays, improper utilization of resources and lack of proper monitoring systems. All of these factors result in inefficiency of the project and high risk to its success as well as that of the stakeholders involved.

To address these limitations, Earned Value Management (EVM) has emerged as an effective project control tool that integrates scope, cost, and schedule into a unified performance measurement system. By analysing Planned Value (PV), Earned Value (EV), and Actual Cost (AC), EVM provides project managers with key indicators such as Cost Performance Index (CPI) and Schedule Performance Index (SPI). These indicators help identify project deviations early, improve forecasting, and support informed decision-making. As a result, EVM is increasingly recognized as an important methodology for improving construction project control and performance.

Despite its global acceptance, the practical implementation of EVM in Indian construction projects remains limited due to challenges such as low awareness, lack of technical expertise, resistance to change, and technological constraints. Moreover, much of the existing research emphasizes theoretical concepts rather than real-world applications in Indian conditions. Limited studies have also explored the integration of EVM with modern technologies such as Building Information Modelling (BIM), Artificial Intelligence (AI), and digital monitoring systems. Therefore, further practical research is essential to evaluate EVM's effectiveness and identify strategies to enhance its adoption for better cost management, timely project completion, and overall project success.

Need for the Study

Delays and cost overrun have been one of the most crucial problems facing the Indian construction sector. In spite of the existence of advanced tools in project management, many construction projects continue to use conventional systems of monitoring where progress measurement for cost and schedule is conducted independently, making the process inefficient in terms of assessing the progress of projects and implementing corrective measures. EVM offers an integrated approach considering scope, time, and cost to help project managers conduct better assessments. The research gap from the point of view of research in literature shows that, while EVM is known internationally, its application in Indian construction projects is minimal. Moreover, available literature emphasizes traditional project control methods and contains no empirical evidence regarding the application of EVM in Indian conditions and its implementation barriers.

Literature Review

According to the literature on Earned Value Management, this approach is gradually becoming not only an innovative tool for measuring project costs and progress but also an integrated framework for managing project performance and sustainability. Initially, several fundamental papers, namely works by Anbari (2003), Vandevoorde and Vanhoucke (2006), Fleming and Koppelman (2010), and Kerzner (2017), confirmed the effectiveness of EVM as a means for assessing project progress in terms of scope, cost, and schedule with the help of indexes like CPI and SPI. Nevertheless, there is a range of studies which found limitations of EVM in forecasting accuracy during project execution and predicting schedules (Mahdi et al., 2016; Ballesteros-Pérez et al., 2015). In order to eliminate these problems, researchers developed new frameworks for improving prediction such as ES, EDM, and stochastic methods based on Monte Carlo simulations which allowed for more reliable estimation of project outcomes (Elsaid et al., 2025; Acebes et al., 2024). Recent literature on the topic pays attention to applying EVM together with technological tools such as BIM, artificial intelligence, Lean 5.0, and statistical control in order to increase forecasting efficiency (Luna Alexandra, 2025; Khoshkonesh et al., 2024). Thus, in conclusion, one can say that although EVM

Methodology

In this study, Quantitative research methodology has been used for analysing the effectiveness of EVM in construction project management. The sample size has been calculated for 95% confidence level and 5% confidence interval using Cochran's formula which results in sample size of 385 respondents. Considering time constraints, the sample size considered for this study is around 82 respondents who have enough knowledge related to EVM. This sample includes construction project managers, engineers, construction companies/contractors, and consultant firms through structured questionnaires with 5-point Likert scale. The survey includes important aspects of EVM such as EVM awareness, cost control, schedule control, performance measurement, and software usage in construction projects.

Application of the Relative Importance Index (RII) technique helped to analysed and prioritize the collected data, thereby making it possible to identify the key drivers for EVM adoption. Standard EVM metrics such as CV (cost variance), SV (schedule variance), CPI (cost performance index), and SPI (schedule performance index) were considered as the tools for measuring performance. Data collection and analysis was performed using Microsoft Excel and Google Forms.

In addition to analysis of the survey, a case study analysis of a construction project of metro rail in Ahmedabad was carried out to understand the implementation of EVM in reality. The analysis of the project performance metrics like planned value, earned value, and actual costs helped identify cost overrun and schedule delays. Additionally, the corrective measures that have been taken by understanding EVM indicators have also been discussed.

This was done to maintain ethical standards by maintaining voluntary participation, anonymity of the respondent, and ensuring that the information collected would be used in an academic manner only. This research methodology offered a dependable framework for measuring the effectiveness of EVM in construction management projects.

Results

The results of the current research clearly demonstrate that Earned Value Management is an effective strategy for managing construction projects, which brings together cost, schedule, and scope performance measures into one comprehensive system. The analysis of the survey answers provided by construction managers using the Relative Importance Index approach indicates that the most important advantage of EVM is related to cost management, with RII equal to 0.89, while schedule management, decision-making process improvement, resource management, and forecasting follow with RII equal to 0.87, 0.85, 0.83, and 0.82, respectively. These results prove that the implementation of EVM can greatly enhance the performance of construction projects by allowing managers to identify cost and schedule deviations in time by evaluating metrics like Cost Performance Index and Schedule Performance Index. The case study on the Ahmedabad metro rail project also verified the above conclusions since the project inefficiency at the beginning of the project (CPI = 0.76, SPI = 0.84) was greatly addressed through the adoption of EVM-based corrective measures, leading to efficient performance in terms of cost (CPI = 0.92) and schedule management (SPI = 0.95). This indicates that EVM is an early warning system and facilitates timely action for enhancing project performance. On the other hand, the study reveals some of the critical barriers to the implementation of EVM, which include lack of knowledge about the method, inadequate professional training, and minimal use of software packages like Primavera and Microsoft Project. Nonetheless, the study results indicate that the application of EVM in the construction industry has great benefits in improving financial control, efficient scheduling, forecasting, and transparency in projects.

Table I: Major Benefits of EVM Based on RII Analysis

Factor	RII Value	Rank
Cost Control	0.89	1
Schedule Monitoring	0.87	2
Resource Management	0.84	3
Performance Measurement	0.82	4
Decision-Making Efficiency	0.80	5

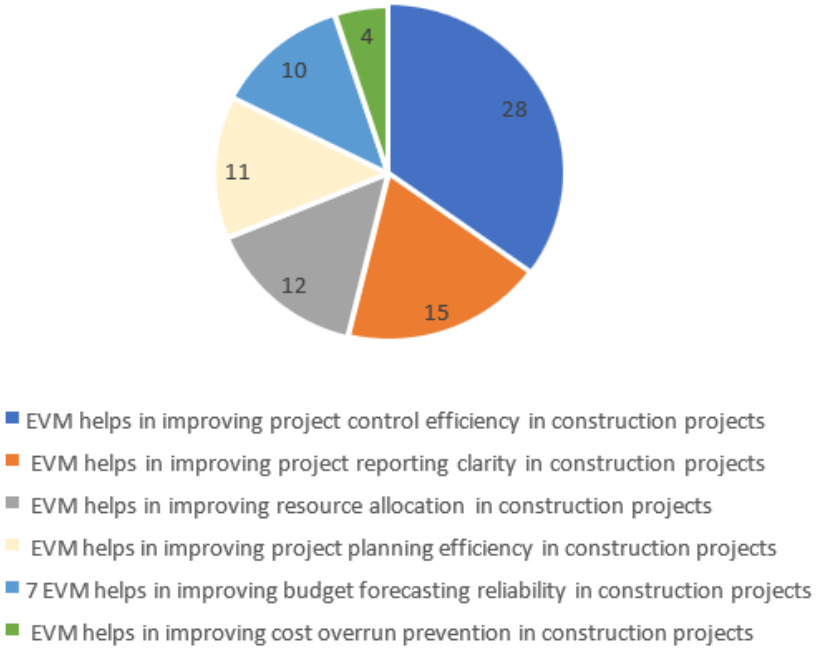

Chart 1: survey result

Discussion

From the results of this study, one can conclude that the implementation of EVM is a viable approach to controlling construction projects. This method ensures considerable improvement in the performance of construction projects owing to its ability to integrate cost, scheduling, and scope management processes. The integration of Earned Value Management in the construction projects leads to better cost control because of its capability to track costs constantly. The method allows detecting overspending, thus facilitating better financial control in the process. Concerning scheduling, the application of EVM helps monitor the progress of the project precisely and detect possible delays that can occur in the course of construction work. This method helps project managers apply necessary measures to prevent project delay. It is proven that EVM contributes to effective decision-making since it provides useful performance measurements such as CPI and SPI and forecasting. The integration of EVM also contributes to the effective utilization of human resources and other necessary resources in the construction project. Moreover, the practical application of the case study proved that EVM acts as an early warning system whereby organizations can detect any deviation in performance and implement necessary changes to enhance project success. Notwithstanding its numerous strengths, it is important to state that poor knowledge, lack of adequate training, and failure to incorporate necessary software have been revealed as critical barriers hindering the widespread implementation of EVM. Generally, it can be concluded that EVM is a complete model of project management which increases construction efficiency, reduces delays and costs, and promotes successful project completion.

Conclusion

This study conclusively demonstrates that Earned Value Management (EVM) is a powerful, reliable, and effective tool for construction project monitoring and control. Through integration of scope, time, and cost into a single measurement framework, EVM enables project managers to detect deviations early, forecast future project outcomes with accuracy, and make timely, data-driven decisions.

The RII survey analysis confirms that EVMs greatest contributions are to cost control (RII = 0.89) and schedule monitoring (RII = 0.87), both of which are critical success factors in construction project management. The Ahmedabad metro rail case study provides compelling empirical evidence of EVM's practical effectiveness CPI improved from 0.76

to 0.92 and SPI from 0.84 to 0.95 following structured EVM-based interventions, resulting in substantial cost savings and schedule recovery.

However, the study also identifies that EVM adoption in India remains constrained by limited professional awareness, insufficient training, and restricted use of advanced software and digital tools. These barriers must be systematically addressed through training programmes, policy-level mandates, and organizational change management to unlock EVM's full potential.

Looking forward, the integration of EVM with modern technologies such as Building Information Modelling (BIM), Artificial Intelligence (AI), predictive analytics, and real-time digital dashboards represents a high-impact opportunity for advancing construction project control in India. It is recommended that EVM be adopted as a standard practice in all medium- and large-scale construction projects, supported by clear implementation guidelines, professional development programmes, and government infrastructure policy frameworks.

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