# Abstract

Earned Value Management (EVM) is a project management methodology that integrates scope, cost, and schedule measures to help the project management team assess and measure project performance and progress effectively. It is a systematic project management process used to find variances in projects based on the comparison of worked performed and work planned (Fleming & Koppelman, 2016).  
  
EVM is used to control cost and schedule objectives during the life cycle of the project. It provides quantitative data for project decision making (Anbari, 2003). EVM is able to predict future performance based on current progress and performance. It is a technique that uses work breakdown structure (WBS), organizational breakdown structure (OBS), and control accounts to measure project performance (Project Management Institute, 2017).  
  
EVM also provides an early warning of performance problems while enhancing the basis for forecasting the project outcomes. It allows for the pinpointing of problem areas at all levels from task through functional to total project level (Fleming & Koppelman, 2016). Thus, providing a disciplined, systematic approach to performance measurement and analysis is central to EVM.  
  
Despite its effectiveness, implementation of EVM can be complex and may require significant training and practice to master (Humphreys, 2011). However, when implemented correctly, EVM can provide project managers with a wealth of data, enabling comprehensive analysis and better decision-making, ultimately leading to successful project outcomes.  
  
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# Introduction

Earned Value Management (EVM) has become an essential tool in project management and control. It provides quantitative data for project performance analysis, allowing project managers to measure and control the time and cost performance of their projects (Fleming & Koppelman, 2016). This concept, which was originally developed in the 1960s by the Department of Defense (DoD) to control large defense contracts, has been adopted and implemented in a range of industries and settings (Anbari, 2003).  
  
EVM integrates project scope, time, and cost variables into a comprehensive and cohesive system (Solanki, 2012). It enables managers to evaluate and quantify project performance and progress in an integrated, objective, and standardized manner. By using EVM, project managers can identify deviations from the plan and implement corrective actions to ensure that the project is delivered on time and within budget (Fleming & Koppelman, 2016).   
  
The value of EVM is widely recognized. The Project Management Institute (PMI) includes EVM in its Project Management Body of Knowledge (PMBOK® Guide) as a recommended technique for project cost management (PMI, 2017). Many organizations worldwide have implemented EVM as a standard procedure in their project management methodology, signaling its practical benefits and utility in project management (Solanki, 2012).  
  
EVM is, however, not without its challenges and limitations. These include the need for accurate estimation of project parameters, the complexity of the technique, and the potential for misuse or misinterpretation of EVM data (Christensen & McLeod, 2019). Despite these challenges, the benefits of EVM, when properly implemented, can greatly outweigh its limitations, making it a valuable tool for effective project management.  
  
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# Literature Review

Earned Value Management (EVM) is a project management technique that quantitatively measures the performance and progress of a project (Fleming & Koppelman, 2010). EVM integrates the three pivotal elements of project management - scope, time, and cost, in order to provide a holistic perspective on project performance (Lipke, 2003).   
  
The body of literature on EVM is extensive, highlighting the importance and relevance of the technique in contemporary project management. A critical examination of the literature reveals that EVM is a reliable tool for assessing the project's health and predicting its future performance (Anbari, 2003).   
  
EVM has three fundamental elements: Planned Value (PV), Earned Value (EV), and Actual Cost (AC) (Fleming & Koppelman, 2010). PV refers to the budgeted cost for the work scheduled, EV is the budgeted cost for the work actually performed, and AC is the actual cost incurred for the work performed (Fleming & Koppelman, 2010). The comparison of these elements provides crucial insights into the project's status and predictive indicators for the project's future performance (Solanki, 2013).  
  
The literature also presents various EVM performance indices and variances that are critical in the evaluation of project performance. The Cost Performance Index (CPI) and the Schedule Performance Index (SPI) are the most commonly used performance indices (Solanki, 2013). CPI provides insights into cost efficiency, while SPI provides information about schedule efficiency (Solanki, 2013). The Cost Variance (CV) and Schedule Variance (SV) are also used to understand the deviation from the planned cost and schedule (Fleming & Koppelman, 2010).  
  
Despite its efficiency, the application of EVM is not without challenges. A common criticism is the difficulty in applying EVM in projects where the scope is not clearly defined or where the progress is hard to measure (Christensen, 1998). Furthermore, EVM may not account for the qualitative aspects of project performance, such as stakeholder satisfaction or the quality of the delivered product (Lipke, 2003).  
  
In conclusion, the literature presents EVM as a powerful tool for project management, providing quantitative data that aids in decision-making processes and project control. However, it also calls for a more comprehensive approach that includes qualitative performance measures, alongside the quantitative measures provided by EVM.  
  
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# Key Concepts

Earned Value Management (EVM) is a robust project management technique that integrates cost, schedule, and scope to provide quantitative data for project performance analysis and forecast (Anbari, 2003). Originating from the United States Department of Defense's Cost/Schedule Control Systems Criteria (C/SCSC) in the 1960s, EVM has gained global recognition as a fundamental project control process (Fleming & Koppelman, 2005).  
  
The core of EVM lies in its three key metrics: Planned Value (PV), Earned Value (EV), and Actual Cost (AC). PV represents the budgeted cost of work scheduled, EV indicates the value of work actually performed, and AC delineates the total cost incurred for the work performed (Project Management Institute, 2013).  
  
EVM generates two essential variance figures: Cost Variance (CV) and Schedule Variance (SV). CV is calculated by subtracting AC from EV, and it reflects whether the project is under or over budget. On the other hand, SV is obtained by subtracting PV from EV and indicates whether the project is ahead of or behind schedule (Anbari, 2003).  
  
Aside from variance analysis, EVM also offers robust forecasting tools, namely Estimate at Completion (EAC) and Estimate to Complete (ETC). EAC provides a forecast of the total project cost at completion, while ETC estimates the cost to complete the remaining project work (Project Management Institute, 2013).  
  
EVM's integrative approach provides a comprehensive view of project performance and offers project managers the ability to identify potential issues earlier than traditional methods, allowing for timely corrective action (Fleming & Koppelman, 2005). Despite its benefits, EVM implementation requires rigorous planning and accurate data tracking, which may pose challenges, especially for small-scale projects (Anbari, 2003).  
  
In conclusion, EVM is an invaluable tool for managing project performance. Its ability to integrate cost, schedule, and scope metrics allows for a comprehensive analysis of project performance, assisting in the early detection of potential issues and enabling effective decision-making.  
  
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# Methodology

Earned Value Management (EVM) is a widely recognized project management methodology that integrates scope, cost, and schedule measures to assess project performance and progress objectively and accurately (Project Management Institute, 2013). The essence of this approach is to compare the planned value (PV) and the earned value (EV) against the actual cost (AC) at various points throughout the project lifecycle.   
  
The PV or budgeted cost of work scheduled (BCWS) is the baseline against which performance is measured. This value is the authorized budget assigned to the scheduled work (Anbari, 2003). The EV, also known as the budgeted cost of work performed (BCWP), represents the value of the actual work completed up to a specific point in time (Lipke, 2003). The AC, or actual cost of work performed (ACWP), on the other hand, is the total cost incurred for the work during a particular period (Fleming & Koppelman, 2010).   
  
The comparison of these components allows the calculation of two key performance indices, the cost performance index (CPI) and the schedule performance index (SPI). The CPI is calculated as the ratio of EV to AC, while the SPI is the ratio of EV to PV (Anbari, 2003). A CPI or SPI value less than 1 indicates that the project is over budget or behind schedule, respectively.   
  
In addition, EVM forecasts the future performance of a project based on its current performance. Estimates at Completion (EAC) and Estimates to Complete (ETC) are two commonly used forecasting tools in EVM. The EAC predicts the total cost of the project at completion, whereas the ETC estimates the cost to complete the remaining work (Fleming & Koppelman, 2010).   
  
The adoption of EVM has several benefits. It provides a common language for communication across all stakeholders, enhances the forecasting accuracy, and improves decision-making through the visibility of project performance (Project Management Institute, 2013). However, it is important to note that the successful implementation of EVM requires comprehensive planning, disciplined tracking, and professional analysis.   
  
In conclusion, the EVM methodology provides a robust and systematic approach to monitor, control, and forecast project performance, which is crucial in the successful completion of any project.  
  
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# Results and Discussion

Results and Discussion  
  
Earned Value Management (EVM) is a systematic project management process used to find variances in projects based on the comparison of worked performed and work planned. EVM is used to control cost and schedule. The benefits of EVM are reflected in the ability to quantify the project performance, providing early warning to project managers about the possible risks ahead (Fleming & Koppelman, 2016).  
  
According to Anbari (2003), EVM is an excellent technique for integrating project scope, cost, and schedule measures to help the project management team assess and measure project performance and progress. It provides a method that allows the comparison of the amount of work planned with what is actually accomplished to determine if cost and schedule performance is as planned.  
  
There are three key components of EVM: Planned Value (PV), Earned Value (EV), and Actual Cost (AC). PV is the authorized budget assigned to the scheduled work (Project Management Institute, 2017). EV measures the work performed in terms of the budget authorized for that work, while AC represents the realized cost incurred for the work performed.   
  
In the EVM analysis, two main metrics are used: Cost Variance (CV) and Schedule Variance (SV). CV equals to EV minus AC, and SV equals to EV minus PV. A positive CV indicates a cost under-run, while a negative CV indicates a cost overrun. Similarly, a positive SV indicates ahead of schedule, while a negative SV indicates behind schedule (Kerzner, 2013).  
  
EVM has proven its effectiveness in many industries and types of projects. For example, in a study by Abba (2013), it was found that EVM helped in improving project performance in the construction industry. Similarly, EVM has been successfully applied in IT and software development projects (Lipke, 2003).  
  
However, EVM is not without challenges. Fleming and Koppelman (2016) identified some potential problems with EVM, including inaccurate estimate at completion, lack of understanding of the EVM concept, and difficulty in determining the earned value. Therefore, for EVM to be implemented successfully, a good understanding of the EVM concept and its metrics is essential, and the project team must be trained adequately.  
  
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# Conclusion

In conclusion, Earned Value Management (EVM) is an indispensable tool for project management that allows for comprehensive performance measurement and cost control (Anbari, 2003). By integrating project scope, cost, and schedule measures, EVM provides a quantitative approach to assessing project performance and progress, aiding in the early detection of performance issues and enabling timely and effective decision-making (Fleming & Koppelman, 2005).  
  
EVM has continually evolved from its origins in industrial manufacturing to its widespread adoption in various sectors, including construction, information technology, and the public sector, underscoring its efficacy and versatility (Anbari, 2003; Kim, Wells, & Duffey, 2003). The consistent use of EVM in these sectors has led to increased project success rates, demonstrating its practical value and reinforcing the argument for its broader application (Lipke, Zwikael, Henderson, & Anbari, 2009).  
  
However, it is important to note that the successful implementation of EVM requires a thorough understanding of its principles and a commitment to the systematic collection and analysis of data (Christensen & Payne, 1992). Additionally, organizations must foster a culture that values and uses EVM information for strategic decision-making and continuous improvement (Cioffi & Kano, 2017).  
  
Thus, while EVM presents substantial benefits, it also demands rigorous application and continued organizational support. Future research should focus on identifying strategies for enhancing the adoption and application of EVM, and exploring its potential for integration with other project management tools and methodologies.  
  
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