

## **Earned Value Management: Contemporary Trends in Research Approaches** by Cole J. Kupec II, Ph.D., M.B.A

*“You cannot manage what you cannot measure...and what gets measured gets done.”  
- Bill Hewlett, Hewlett Packard*

### **Earned Value Management Research**

“Earned Value Management is a methodology for determining the cost, technical, and schedule performances of a complex program or project by comparing work that is planned with work that is accomplished in terms of the dollar value assigned to the work (Damaré & Peterson, 2005).” Earned Value Management (EVM) is a project management tool set used to manage the cost, schedule and scope of a project. To effectively gather and analyze data generated from the EVM process requires training in the fundamentals of the acquisition process and the fundamentals of EVM metrics. (Damaré & Peterson, 2005)

EVM was originally designed and developed by the United States navy just over fifty years ago. To this day EVM is closely affiliated with the United States Department of Defense (DoD) though it is also used across a broad range of industries including construction, defense, information technology and others. Project managers use EVM to manage and predict project issues in project environments that continue to grow larger and more complex (Abba, 2000). The aim of this article is to provide a review of contemporary research approaches to EVM. This paper is by no means an all-inclusive list of current EVM research; however, it does provide a cursory listing of prominent, representative contemporary research approaches. The research questions for each study can be found in Table 1, on the following page.

**Table 1. Research questions found in contemporary EVM studies**

<b>Author(s)</b>	<b>Title</b>	<b>Research Question(s)</b>
Iranmanesh, S., & Zarezadeh, M.	Application of Artificial Neural Network to Forecast Actual Cost of a Project to Improve Earned Value Management System	How did the application of Artificial Neural Network impact the actual cost of a project based on the earned value management system?
Kim, Y., & Ballard, G.	Management Thinking in the Earned Value Method System and the Last Planner System	1) What management thinking (theory of management) underlies project control methods and tools? 2) Is the MBM more suitable to daily project production system where each task is highly interdependent?
De Marco, A., Briccarello, D., & Rafele, C.	Cost and Schedule Monitoring of Industrial Building Projects: Case Study	How can assessing time and cost performance measurement progress on a construction project help with forecasting?
Iranmanesh, S., & Mokhtari, Z.	Application of Data Mining Tools to Predicate Completion Time of a Project	How have data mining tool predictors impacted earned value management duration predictors?
Kim, B., & Reinschmidt, K. F.	Probabilistic Forecasting of Project Duration Using Bayesian Inference and the Beta Distribution	How do project analysts use the Bayesian beta S-curve method on project management approaches to project forecasting?
Owen, J. K.	Implementing Earned Value Management in a R&D Environment	What earned value management practices are earned value management analysts using to access programs effectively on research and development projects?
Buell, M.	Producing Earned Value from a Geographic Information System Where Scheduling Tools Were Impractical	How can geographic information systems be used to produce earned value?
Maheshwari, S., & Credle, S.	Project management: Using earned value analysis (EVA) to monitor a project's progress	How has earned value analysis been used by analysts to monitor a project's progress?
Whiteside II, J. D.	Craft Curves for Estimating and Project Evaluation	What earned value management practices are earned value management analysts using to access project forecasting curves?
Byung-Cheol, K., & Reinschmidt, K. F.	Probabilistic Forecasting of Project Duration Using Kalman Filter and the Earned Value Method	1) How can corporate management and project owners know how long will it take to finish the project? 2) How can corporate management and project owners know how much a project will cost at the end?

## Research Approaches and Designs

Some studies listed in this article used interviews or literary findings to establish their results. However, case studies made up over half of the studies explored. Most of the studies listed in this article use lessons learned from a qualitative perspective in conjunction with quantitative EVM data to support their findings. The measures used gathered useful, statistically supportable EVM data. The data was used in a variety of ways depending on the study. The most common constructs measured in the studies were the assumptions used by EVM analysts to construct and interpret their data.

The external research design validity on all the studies listed was well developed. All ten of the studies used reasonable representative samples and a majority of them are based on real world data. The studies also demonstrated good external validity in that none of them used inappropriate generalizations. In only a few studies did the authors approach their research from a grounded theory perspective, accessing a project through its multiple stages and interpreted the data at the different stage perspectives (Table 2). In a few cases the researchers compared two or more projects together to contrast EVM forecasting results.

**Table 2. Research approach of contemporary EVM studies**

Title	Research Approach
Application of Artificial Neural Network to Forecast Actual Cost of a Project to Improve Earned Value Management System	Provides an example of how network structure can be applied to EVM analysis. It illustrates grounded theory by assessing a program forecast at multiple stages of development.
Management Thinking in the Earned Value Method System and the Last Planner System	The empirical evidence for this study is derived from a case study in which the researchers interviewed twenty two managers. It is a good example of a phenomenological study. The study looked at Cost Performance Index (CPI) improvement after the EVM alternative plan was implemented. It provides a good example of comparing EVM analysis techniques to the techniques of a program management alternative.
Cost and Schedule Monitoring of Industrial Building Projects: Case Study	This study compared end project cost forecasts derived from two different methods for the same project. The comparison between the methods was done at different progress points in time throughout the project. The two different methods used for forecasting were the linear estimates at complete and a logistic model.
Application of Data Mining Tools to Predicate Completion Time of a Project	The researchers generated random sample data for seventy six time periods. They created a decision tree with chosen output parameters. They applied the data to the decision tree to come up with a population of estimated forecast for the end of the project. They accessed the curve of estimated forecasts to come up with a most likely forecast. The study uses a large sample size.
Probabilistic Forecasting of Project Duration Using Bayesian Inference and the Beta Distribution	This study explores a project management forecasting tool. The researcher discusses the implementation of a Bayesian betaS-curve method on two project management approaches. The study provides a unique forecasting perspective. The study uses two sample projects to describe its approach to the implementation of the Bayesian betaS-curve method.

Implementing Earned Value Management in a R&D Environment	This study reviewed the process of implementing EVM into the Jet Propulsion Laboratory (JPL). It reviewed the timeline and organizational resistance to the implementation of EVM from a case study perspective.
Producing Earned Value from a Geographic Information System Where Scheduling Tools Were Impractical	This study is a review of a project where a unique mapping tool was used in order to set up an effective EVM system on a project. The researcher described how effective the mapping tool was in facilitating the EVM system to be used on the project.
Project management: Using earned value analysis (EVA) to monitor a project's progress	This study was based around a case study on a small government contractor looking to implement an effective EVM system. It provided a detailed perspective of EVM implementation and metric analysis.
Craft Curves for Estimating and Project Evaluation	This study is a qualitative analysis of forming project completion curves for estimating project cost and schedule data. The study uses two sample projects to demonstrate the EVM practices it describes.
Probabilistic Forecasting of Project Duration Using Kalman Filter and the Earned Value Method	This study presents a cost and schedule forecasting method. The study lays out parameters and assumptions that must be considered when implementing its suggested forecast method. The study uses two sample projects to demonstrate the use of its suggested cost and schedule forecasting method.

Populations in the studies explored in this article were wide ranging. One study included twenty two managers being interviewed, while other randomly generated data to fit the size needed for the study. Populations of randomly generated work packages were processed through different methodologies to determine if forecasting methods had potential value. However, though some studies presented statistical modeling methods that are mathematically useful, they failed to elaborate on how a manager could effectively use the model. One of the primary purposes of EVM is to provide managers with control data to assist in the management of their projects, which is why project managers have embraced EVM (Evans, 2005).

Some studies listed in this article included survey or interview data, collected from qualified managers who were familiar with EVM processes. The studies stress objectivity in their analysis and very few of the studies took a literal approach to EVM.

### Contributions

Although it is not possible to go into the depth needed to address the contributions of each of the studies, Table 3 (next page) provides a very brief description of the contributions. The studies explore a wide range of methods, contexts, and techniques. This article serves to provide a review of contemporary research approaches to draw patterns and to aid in the approach of future research in the field.

**Table 3. Contributions in contemporary EVM studies**

Title	Brief Contribution Description
Application of Artificial Neural Network to Forecast Actual Cost of a Project to Improve Earned Value Management System	The study assessed the average absolute error for two samples using the different Neural Network structures. The result of this study showed that better forecast data could be shown if performance is based on the Mean Absolute Percentage Error (MAPE).
Management Thinking in the Earned Value Method System and the Last Planner System	The study found that quality assignment criteria were missing from earned value and concluded that EVM is not an appropriate way to manage from an operational level. The study suggests that managing by means is a better alternative for the operational level.
Cost and Schedule Monitoring of Industrial Building Projects: Case Study	The study found that prior to a project being twenty percent complete, linear estimates are the most reliable. Beyond twenty percent complete the logistic model was a more reliable estimate. This data was found by comparing the data at different progress points to the actual data at the completion of the program.
Application of Data Mining Tools to Predicate Completion Time of a Project	The study states that there are modeling input parameters to suggest comparable forecasts.
Probabilistic Forecasting of Project Duration Using Bayesian Inference and the Beta Distribution	The study compares two common approaches to forecasting and demonstrates when they are useful.
Implementing Earned Value Management in a R&D Environment	The study reviewed the audit findings and corrective actions taken during the transition process from an organization without an EVM system to one with an EVM system.
Producing Earned Value from a Geographic Information System Where Scheduling Tools Were Impractical	The unique method used in this study was able to make accurate forecasts in the form of a graphical representation.
Project management: Using earned value analysis (EVA) to monitor a project's progress	The study showed data analysis of projected and actual data to demonstrate forecasting effectiveness. It also looked at the most effective practices implemented by the project management.
Craft Curves for Estimating and Project Evaluation	The study provides a forecasting analysis technique.
Probabilistic Forecasting of Project Duration Using Kalman Filter and the Earned Value Method	The study shows how probabilistic forecasting can be used in combination with EVM data to provide accurate forecasting models.

## About the Author



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- Operations Researcher, BCF Solutions.
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Cole J. Kupec II publishes articles on a variety of topics including Andragogy, the defense industry, cost estimating, Earned Value Management (EVM), and STEM education.

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