Measuring Time: An Earned Value Performance Management Study

By Mario Vanhoucke[1]

Abstract

In this article, I briefly describe the various topics of a new book that I have written as a summary of a large research study performed during the past 5 years. The research described in the book deals with the project performance and control phase of the project life cycle and the corresponding feedback loop from control to planning and scheduling to take corrective actions when necessary (known as project tracking or project monitoring). More precisely, the focus is on a reactive scheduling early warning system by means of earned value management (EVM) and schedule risk analysis (SRA). For an overview of EVM, see e.g., Anbari (2003) or Fleming and Koppelman (2005). For an introduction to SRA, see Hulett (1996). Although EVM has been set up to follow up both time and cost, the majority of the research has been focused on the cost aspect. In the book, I focus on the time dimension, which has received relatively less attention in the last decennia.

The aim of my research is to measure the project performance sensitivity and the forecast accuracy (both in terms of time and cost, but with a focus on the time dimension) of the existing and newly developed metrics based on the principles of earned value management (EVM) and schedule risk analysis (SRA). The research question boils down to the determination of when and in which cases SRA and EVM could lead to improved project tracking and corrective action decision making.

Introduction

In previous editions of the *Measurable News*, I have briefly described parts of a research study on the accuracy of EVM predictive techniques for forecasting the final duration of a project. These results were obtained from a large simulation study initiated at the Ghent University and Vlerick Leuven Gent Management School. Ever since its start, I have continued this research project, and widened its scope toward project tracking and monitoring in general and to the comparison and validation of various techniques and their influence on the project tracking and corrective action decision making process. This research has finally resulted in a book that gives a summary of the various results obtained from the study.

The research study of this book has been presented on various conferences and workshops and has received attention from both the academic as well as the business world. Worth mentioning is the PMI Belgium event organized in Brussels on June 12, 2007, where approximately 160 people were attending the EVM sessions. This presentation resulted in a publication in the *Measurable News* titled "PMI-CPM Collaboration Extends to Europe" (Winter 2007–2008 Issue of the *Measurable News*). Somewhat later, in November 2008, the research study was awarded the IPMA Research Award in Rome (Italy) where I gave a presentation during the 22nd World Congress. Information can be found at the IPMA website (www.ipma.ch/awards). More recently, part of the research was presented at the first EVA Europe conference held in Geneva, Switzerland. Motivated by the enthusiastic response and never-ending stream of questions, I decided to bring all research done during the past 5 years together in a book. It also helped me to structure my teaching sessions at various company training sessions and motivated me to develop the new software tool Pro-Track as discussed later.

In the next section, I will briefly outline the main themes of the book.

Overview of the Book

The research study critically analyzes and evaluates various earned value based performance mea-

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surement and schedule risk analysis methods on a large group of projects. The aim of this experiment is threefold. First, the study searches for static and dynamic drivers of duration forecast accuracy to be able to select the most reliable method for a specific project. Second, the study embeds these project tracking methods in a corrective action decision-making framework to improve project performance. Finally, the research provides guidelines, based on extensive computational experiments, on how to set up a project tracking approach, which will likely lead to the most reliable results during project execution.

The research study consists of three main steps. First, the data collection consists of a well-balanced choice between fictitious and real life data. The fictitious project data have been generated under a well-defined setting to control various characteristics of projects. The real-life data serves as a validation of the research results. Second, the methodology used is Monte-Carlo simulation to set up a full-factorial simulation experiment under nine, well-defined and clearly non-overlapping scenarios. Finally, statistical techniques have been used to analyze the high amount of computational results based on well-

established techniques. The statistical information is summarized and linked with the corrective-action, decision-making process to provide guidelines and rules-of-thumb to the project manager to reveal which tracking approach and risk analysis technique should be used for his / her specific project.

Figure 1 presents a summary of the research study described in the book. A brief description of each study is outlined. The book consists of eight chapters that can be briefly summarized along the following sections.

Chapter 1: An EVM overview

Chapter 1 gives an overview of the often confusing terminology used in EVM and reviews all formulas and metrics used throughout the remaining chapters of the book. This chapter pays a lot of attention to the three forecasting methods to predict the final project duration: the planned value method (Anbari, 2003), the earned duration method (Jacob, 2003) and the earned schedule method (Lipke, 2003) and illustrates their use on various fictitious as well as real-life project examples.
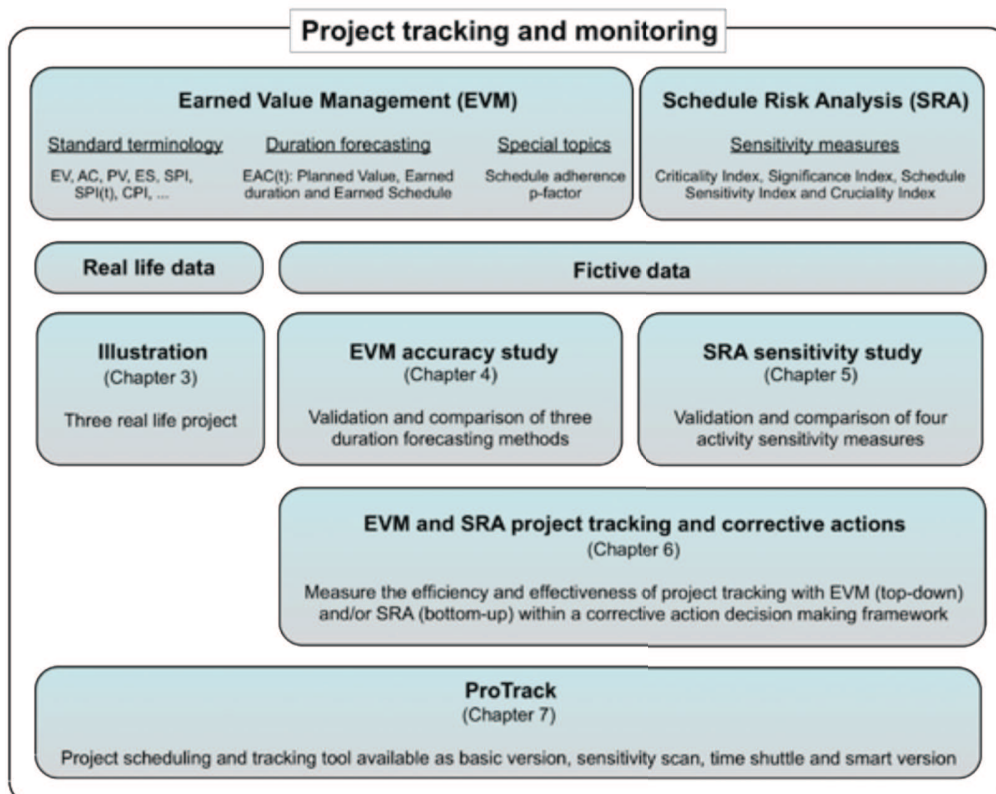

Figure 1. Measuring time an overview of the different topics.

Chapter 2: Schedule adherence

Chapter 2 critically reviews the p-factor approach (Lipke, 2004), which measures the schedule adherence of a project during execution based on the traditional earned value metrics. This new, earned value-based measure provides the connection of project output to EVM and is equal to the portion of earned value accrued in congruence with the baseline schedule, i.e., the tasks that ought to be either completed or in progress. It allows the detection of project impediment and / or portions of work performed under risk, based on the calculation of the traditional earned value metrics.

Chapter 3: A case study

The illustrations and results of this section are drawn from an implemented earned value management approach for managing complex system projects of an airport luggage handling system at Fabricom Airport Systems in Brussels (Belgium). This chapter serves as an illustration of the concepts and methods discussed in the previous chapters, rather than a study to draw general results. The empirical results confirm the theoretical foundations and claims presented in the previous chapters, but due to the lack of a sound methodology during the analysis of the EVM results, a more profound study is presented in chapters 4 through 6.

Chapter 4: A comparison study

This chapter presents two extensive simulation studies to test the relevance and accuracy of the concepts and metrics introduced in the previous chapters. The first simulation study has been set up to test the accuracy of the three duration methods (planned value method, earned duration method, and earned schedule method) as presented in Chapter 1 to predict the final duration of a project. The second simulation study tests the relevance of the schedule adherence concept (measured by the p-factor) as presented in Chapter 2.

All simulation results are compared and validated under various simulation scenarios, using more than 4000 fictitious project networks. The methodological approach is outlined in detail and numerous results are presented in various tables and graphs. This chapter aims to give answers on questions like:

- Which method do you use best for your project with given characteristics?
- What is the expected accuracy of your project measurement system?
- What are the parameters that influence your project performance measurement accuracy?

Chapter 5: Schedule sensitivity

This chapter highlights another time dimension in project management using the well-known schedule risk analysis (SRA) technique (Hulett, 1996). Therefore, a third simulation study is performed to measure the ability of various sensitivity metrics to dynamically improve the time performance during project execution. Activity sensitivity information is used to guide the corrective action decision making process to improve a project's time performance, while varying the degree of management's attention.

Chapter 6: Corrective actions

This chapter serves as an integrative summary research study relying on the results obtained from the three previous simulation studies discussed in Chapters 4 and 5. More precisely, a bottoms-up and a top-down project tracking approach within a corrective action framework is compared, and general summary conclusions are presented. The top-down tracking approach relies on a traditional EVM system investigated in detail in Chapter 4, while the bottoms-up tracking mechanism makes use of the well-known SRA method discussed in Chapter 5.

This chapter aims to give answers on questions like:

- What are the parameters that influence your corrective action decision making process?
- Does EVM and / or SRA provide reliable "early warning signals" to improve project tracking?
- When do you take the best corrective actions (= project tracking) to bring the project back on track?

Chapter 7: A new software tool

ProTrack (acronym for Project Tracking) is a project scheduling and tracking software tool developed by OR-AS to offer a straightforward, yet effective, alternative to the numerous project scheduling and tracking software tools. The software has been built based on the results of the research study discussed in this book and the many discussions with practitioners using EVM. The scheduling and tracking approach is based on the current best practices of EVM and the novel concepts introduced and tested in this book.

Conclusion

I believe that the research study in this book enhances the project management profession and discipline for the following four reasons. It provides a theoretical background and hence a more objective opinion on the quality of different EVM methods. It offers a clear understanding on advantages and disadvantages of EVM and SRA and presents results on project performance measurement that can be easily translated to practical projects. It provides clear and simple guidelines and rules-of-thumb on how to track projects (bottoms-up or top-down project tracking) and gives guidelines on what aspects of project performance measurement a project manager should focus on. All results have been commercialized in a new software tool that can be used for project planning and tracking as well as a learning tool for project management training.

For those interested, the book is titled *Measuring Time — Improving Project Performance using Earned Value Management* and is available on www.springer.com or www.or-as.be/measuringtime. Most of the material discussed in the book and the various, related research topics have been published elsewhere in academic literature. The work presented in Chapter 1 can be found in the overview paper published by the International *Journal of Project Management* (Vandevoorde and Vanhoucke, 2006). Parts of the simulation study of Chapter 4 have been published in the *Measurable News* (Vanhoucke and Vandevoorde, 2007a, 2008) and the *Journal of the Operational Research Society* (Vanhoucke and Vandevoorde, 2007b) or are in press in *Omega — The International Journal of Management Science* (Vanhoucke, 2009). Other chapters or parts of chapters are still under submission (Vanhoucke, 2008a,b) and hopefully will be published soon in academic literature. The book, however, brings an integrated view on project control and EVM as shown in Figure 1 with fictitious examples, real-life illustrations, and details about the methodological approach.

Acknowledgements

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About the Author

Prof. Dr. Mario Vanhoucke is an associate professor at the Ghent University and the Vlerick Leuven Gent Management School (Belgium). He teaches Project Management, Business Statistics and Applied Operations Research. He is the programme director of the Commercial Engineers and an advanced Master in Operations and Technology Management. He is a partner of the company OR-AS (www.or-as.be) and is co-developer of ProTrack (www.protrack.be), a new project scheduling software tool with earned schedule tracking capabilities.

His main research interest lies in simulation and optimization models in project scheduling and scheduling in the health-care sector. He is an advisor for various PhD projects, in collaboration with different university hospitals. He has had articles published in international journals, such as *Annals of Operations Research*, *Management Science*, *Operations Research*, *The Accounting Review*, *International Journal of Production Research*, *Journal of the Operational Research Society*, *Journal of Scheduling*, *International Journal of Project Management*, *Project Management Journal*, *European Journal of Operational Research,* and *Lecture Notes on Computer Science*.

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