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Measuring the efficiency of project control using fictitious and empirical project data

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Abstract

Dynamic scheduling refers to the integration of three important phases in the life cycle of a project: baseline scheduling, schedule risk analysis and project control. In this paper, the efficiency of controlling a project is measured and evaluated using a Monte-Carlo simulation study on fictitious and empirical project data. In the study, the construction of a project baseline schedule acts as a point-of-reference for the schedule risk analysis and project control phases. The sensitivity information obtained by the schedule risk analyses (SRA) and the earned value management (EVM) information obtained during project control serve as early warning control parameters that trigger corrective actions to bring projects back on track in case of problems. The focus in this paper lies on the time performance of a project, and not on the prediction and controlling of the project costs.

The contribution of this paper is twofold. First, this paper summarizes the main conclusions of various experiments performed in a large simulation study on the efficiency of project control techniques and the ability to trigger corrective actions in case of project problems. The main purpose of these simulation experiments is to understand why EVM and/or SRA work so well in some projects and fail so miserably in others. This study has been awarded by the International Project Management Association in 2008 on the IPMA world congress in Rome (Italy). Secondly, the paper compares the results obtained on fictitious project data with additional tests performed on a set of real-life data from 8 Belgian companies from various sectors.

Keywords: Project management; Project control; Simulation study

1. Introduction

Project scheduling began as a research track within the mathematical field of Operations Research in order to mathematically determine start and finish times of project activities subject to precedence and resource constraints while optimizing a certain project objective (such as lead-time minimization, cash-flow optimization, etc.). The initial research done in the late 1950s mainly focused on network based techniques such as CPM (Critical Path Method) and PERT (Programme Evaluation and Review Technique) which are still widely recognized as important project management tools and techniques. From this moment on, a substantial amount of research has been carried out covering various areas of project scheduling (e.g. time scheduling, resource scheduling, cost scheduling). Today the project scheduling research continues to grow in the variety of its theoretical models, in its magnitude and in its applications.

While the research has expanded over the last decennia, leading to project scheduling models with deterministic and stochastic characteristics, single- and multi-mode execution activities, single and multiple objectives, and a wide variety of resource assumptions, the practitioners and software tools mainly stick to the often basic project scheduling principles. This can probably be explained by the limited capability of a project schedule to cope with the uncertainty that characterizes the real life execution of the project. Indeed, the benefits of a

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resource-constrained project schedule have been questioned by many practitioners, and the effort someone puts into the development of a project schedule is often not in line with the benefits. Moreover, “a project schedule will change anyway due to circumstances” is often a widely used excuse to skip this important step in the project life cycle.

Nevertheless, project scheduling plays a crucial role in the life cycle of a project and can play a key role in the failure or success of a project. In order to appreciate the importance of a project schedule, it should be generally accepted that the usability of a project schedule is rather limited and only acts as a point of reference in the project life cycle. Consequently, a project schedule should especially be considered as nothing more than a predictive model that can be used for resource efficiency calculations, time and cost risk analysis, project control and performance measurement, and so on. In this paper, the project baseline schedule is assumed to be given and plays a central reference point in the analysis of a project schedule’s risk and during the project performance measurement and control phase. This triangular relation between the project schedule, the risk analysis and the project control phase is called *dynamic scheduling* throughout this paper.

The purpose and contribution of this paper is twofold. First, it aims at reviewing previous research efforts on project management control using schedule risk analysis and earned value management. Although various papers have described these two techniques, little effort has been done to put these techniques in a dynamic project control environment. To that purpose, a review on research results will be given in order to filter out practical rules-of-thumb interesting for project managers. Secondly, it lies in the intention of this paper to illustrate that both fictitious and empirical data are used to validate the obtained results. It should be noted that this paper takes a strict time focus on the project and hence little or no attention is paid to the dynamic nature of cost performance measurements and predictions.

The following sections of this paper are structured as follows: Section 2 gives an overview of the three dimensions of dynamic project scheduling and refers to important research sources in literature. In a first subsection, an overview is given of the main measures used in a schedule risk analysis (SRA) study and references to recent studies are highlighted. A second subsection deals with the project control dimension which makes use of earned value management (EVM) parameters to measure a project’s time performance. The recent and renewed attention on EVM for measuring and controlling the duration of a project is briefly summarized in this section. In a third subsection, the use of the SRA and EVM information as early warning control parameters to trigger corrective actions are explained in detail. In a final subsection, three research hypotheses are formulated that will be tested in the computational experiment of this paper. Section 3 describes the input parameters of the computational experiment using Monte-Carlo simulations and gives an overview of the main conclusions that can be drawn on the efficiency of controlling projects and their corrective actions. These results are obtained on both fictitious project data as well as on an empirical data set containing project information of 8 Belgian companies. Section 4 draws general conclusions and highlights paths for future research.

2. Project control and corrective actions

This section starts with a brief review of the three dimensions of dynamic scheduling with references to the main research efforts done in the past. In the following subsections, more details are given on their use in the simulation experiments of this paper. In Section 2.1, four sensitivity parameters of a schedule risk analysis are reviewed with references to previous research studies where these parameters are used. Section 2.2 briefly reviews the main parameters used in earned value management and displays references to the recent literature on time performance measurement. Section 2.3 explains how and why these two sources of information (EVM and SRA) can be used in a project control environment, and how they can trigger actions in case a project is in danger. In a final Section 2.4, three research questions are given that will be tested in the computational experiment discussed later in this paper.

Dynamic scheduling is used to refer to a dynamic project management process to control projects using information from a project’s baseline schedule and its corresponding risk. More precisely, it refers to three integrative phases of the project life cycle in order to trigger and steer the corrective action decision making process to bring projects back on track in case of problems. These three crucial dimensions of dynamic scheduling can be briefly outlined along the following lines and are summarized in Fig. 1.

- Baseline scheduling: construct a timetable that provides a start and end date for each project activity, taking activity relations, resource constraints and other project characteristics into account, and aiming to reach a certain scheduling objective. Literature on project baseline scheduling can be found in the overview papers written by Brucker et al. (1999), Herroelen et al. (1998), Icmeli et al. (1993), Kolisch and Padman (2001) and Özdamar and Ulusoy (1995). More recently, Kolisch and Hartmann (2006) have given an update on experimental results on project scheduling with heuristics, while Hartmann and Briskorn (2010) have given a survey of variants and extensions on the traditional resource-constrained project scheduling problem.
- Risk analysis: analyze the strengths and weaknesses of a project baseline schedule in order to obtain information about the schedule sensitivity and the possible changes that undoubtedly occur during project progress. Two excellent overviews on schedule risk analysis are given by Williams (1995) and Hulett (1996) and in the Practice Standard for risk management (PMI, 2009).
- Project control: measure the (time and cost) performance of a project during its progress and use the information obtained during the baseline scheduling and risk analysis steps to monitor and update the project and to take corrective actions in case of problems. In this paper, project control is mainly discussed from an earned value management point-of-view. More information on this control technique can be found in Fleming and Koppelman (2005) and in the Practice Standard for earned value management (PMI, 2005).