Early-warning performance monitoring system (EPMS) using the business information of a project

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Abstract

An early-warning performance monitoring system (EPMS) is proposed to objectively measure and monitor the performance of a project for early detection of inherent poor performance problems. The EPMS is built based on project progress data and consists of a database of business information, an optimized theoretical model used as a performance measurement baseline, and an index for monitoring and forecasting the performance. By monitoring the performance through an application of the EPMS to the Korean construction project, the quarterly variation of index was found to differ by project type. These results could explain the environmental changes in the project execution. Therefore, the EPMS is expected to be an alternative for objective performance monitoring and forecasting while applying the existing methods is difficult because of the limited available data on performance indicators. The development procedures may also be useful to researchers interested in approaches to quantitatively analyze trends in various industries.

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1. Introduction

As Peter Drucker mentioned in the expression “If you cannot measure it, you cannot manage it,” performance measurement has been evaluated as a prerequisite for establishing an effective project management plan (Yu et al., 2007; Jeon and Yu, 2012). Various sectors, ranging from manufacturing to cutting-edge industries, are paying attention to performance monitoring based on objective measurement results as a key method of achieving the goals of project-participating organizations because of the complex and competitive changes in the project execution environment (Abdul-Rahman et al., 2011; Samoilenko and Osei-Bryson, 2013). Reflecting these trends, a growing interest in ways to detect early poor performance problems, which may obstruct the successful project execution, has been observed (Haji-Kazemi and Andersen, 2013; Kim, 2017).

The performance of a project can be monitored in various ways, from standards published by organizations, such as the Project Management Institute (PMI) and the Global Alliance for Project Performance Standards (GAPPS), to methods, such as the key performance indicator (KPI), benchmarking and metrics (BM&M), and earned value management system (EVMS). Among these standards, the PMI set of guidelines and standard known as the Project Management Body of Knowledge (PMBOK) provides common knowledge according
to the life cycle, from initiation to closing (Bredillet et al., 2015). In addition, GAPPS, which focuses on clarifying the global standards of project management practices, has developed a framework of performance-based standards (GAPPS, 2007; Hyman, 2016). The UK and USA, which are the leading countries in project management, have implemented methods, such as the KPI, BM&M, and EVMS, to objectively measure and monitor project performance (Bassioni et al., 2004; Cha and Kim, 2008). KPI and BM&M are implemented by specialized organizations (i.e., Constructing Excellence (CE) and the Construction Industry Institute (CII)) providing published measurement results that can be benchmarked at regular intervals using credible data on various performance indicators (Hwang, 2008; Kim et al., 2009). EVMS was proposed based on the PMBOK, being a baseline and index result that objectively monitors performance by simultaneously considering project cost and schedule (Kim, 2010; Ichsan, 2010). Thus, stakeholders can use existing standards and methods to properly monitor the performance of an ongoing project and as preliminary information to make decisions for a successful project execution.

However, existing standards and methods have limitations when applied to performance monitoring when collecting credible data on the indicators is difficult because of the following situations: (1) conservative stance of the stakeholders on the disclosure of information caused by the recognition that the data of performance indicators, such as cost, are directly linked with the business secret (Yoo and Kim, 2015; Kim, 2017) and (2) absence of specialized or non-governmental organizations responsible for continuous performance measurement and monitoring of projects. In other words, sharing performance indicator data to implement existing standards and methods lacks consensus. In this situation, performance monitoring based on progress information may be a reasonable alternative to track the project performance with limited available data. Progress, which is defined as the percentage of work completed based on the budget, has traditionally been used to measure this performance (Barraza et al., 2000). Furthermore, the GAPPS framework sets progress as a critical management element, providing detailed performance criteria (GAPPS, 2007).

This study proposes an early-warning performance monitoring system (EPMS) using progress data to quantitatively measure and monitor the performance of projects on the macroscale and provide an early detection of the inherent poor performance problems. The EPMS is an improvement over the results presented by Kim (2017) and comprises (1) a database containing information, such as the progress and contract amount, (2) an optimized theoretical model used as the performance measurement baseline, and (3) an index for quantitatively tracking and monitoring variations in the performance. The optimized model and index are estimated based on the database of disclosed information for over 20 years. Therefore, the changes in the performance trends can be estimated by considering the inherent characteristics of the project based on the historical execution process.

This paper is organized as follows: first, the existing studies, standards, and methods related to performance measurement and monitoring are reviewed, and implications that should be considered for EPMS development are derived; second, the EPMS components are derived from the abovementioned implications, and the overall development process is presented; third, the procedures for the database construction are presented, such as data collection, refinement, and preprocessing; fourth, the growth curve and a genetic algorithm are used to present optimized theoretical models that can be used as a performance measurement baseline; fifth, the results of estimating the index to quantitatively monitor and forecast performance are presented, and the analysis is conducted in relation to the results and the market trend; and finally, the obstacles and the implications during the development process are discussed along with future improvements of the EPMS.

2. Review of existing studies, standards, and methods

2.1. Literature review

Previous studies were reviewed to consider various aspects (e.g., to examine existing standards and methods for monitoring the project performance, derive key performance indicators, set the performance measurement baseline, and suggest a system and framework for quantitative performance monitoring).

With regard to the existing standards and monitoring methods, Shim and Kim (2001) investigated the performance measurement methods of construction projects in the UK and Australia and suggested items, problems, and constraints that should be considered for adoption in Korea. Bassioni et al. (2004) reviewed performance measurement methods, such as KPI, Balanced Score Card (BSC), and the European Foundation for Quality Excellence Model. They identified the gaps in knowledge and practice when these methods are applied to UK construction firms. Yang et al. (2010) comprehensively reviewed previous studies that were generally related to performance measurement. They derived a performance measurement framework and research techniques mainly used in the construction industry. Crawford (2013) introduced the overall GAPPS standard and discussed its development direction (e.g., through a combination with other project management standards). Bredillet et al. (2015) reported the philosophical implications of a manager’s competence on performance achievement through a review of the existing standards. Hyman (2016) proposed an international framework to support the successful implementation of global projects through a contrastive analysis of project management standards. Rehacek (2017) conducted a comparative analysis of general project management standards and presented directions for their application and usage.

Previous studies also made various attempts to establish key indicators for project performance measurement and monitoring. Yu et al. (2005) derived the key indicators needed to develop a performance measurement system for construction projects in Korea. Cha and Kim (2008) defined the performance indicators of construction projects and a calculation formula for a quantitative evaluation. They verified their work through expert consultation and survey. Jeon et al. (2010) and
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