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Success model of project management information system in construction

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ABSTRACT

Among various IT solutions, the internet-based (or web-based) PMIS has been highlighted because of its strong advantages. While not sufficient to insure project success, using PMIS to manage projects has thus become a necessity. Establishing a success model of a specific information system is critical to understand the mechanism of IS success, the various dimensions of IS performance, and the factors and their causal relations in IS success. As one of the key IT applications, the project management information system (PMIS) has played a significant role in construction management processes. While not sufficient to insure project success, using PMIS to manage projects has thus become a necessity. However, research that attempts to establish or apply an IS success model have relatively recently begun to emerge and not many have been carried out as yet. Therefore, the main propose of this study is to develop and validate the ASP-PMIS success model based on the DeLone and McLean (2003) IS success model. A questionnaire instrument was remitted to experienced users (CMs and constructors), and 253 completed questionnaires were retrieved. Using AMOS 18.0, we used Structural Equation Modeling for hypothesis testing. The validated ASP-based PMIS success model can serve as a foundation for positioning and comparing PMIS success research, and can provide users with a useful framework for evaluating PMIS success.

1. Introduction

The architectural, engineering, and construction (AEC) industry is characterized by fragmentation which exists both within individual phases as well as across project phases [1]. Because of this fragmentation, participants from various organizations who are involved in a project phase or in different project phases are facing ineffectiveness and inefficiency in their coordination, collaboration and communication processes. As a tool to reduce the problems generated by this fragmentation, Information Technology (IT) is routinely and extensively used in the construction industry [2]. Powerful project management software has become a prerequisite to manage the projects more efficiently and effectively, and aid the project managers in their decision-making [3]. The advantage of an information system is that it helps to promote productivity by effectively processing and providing necessary information to an organization and supporting their efficient work performance.

The importance of information has been emphasized for enhancing communication, and the efficient management of construction information has been emerging as an element that determines the success of a project that involves many stakeholders [4]. Thus, in construction projects, various types of IS, such as construction management or business software, have been developed, applied, and widely used [5]. In the Korean construction industry, in particular, a project management information system (PMIS) is being extensively utilized due to its numerous advantages. It is very important to systematically assess the effects of the utilization of IS as well as other managerial resources on project management. Such assessment is essential for establishing and utilizing effective, efficient IS. Moreover, it is necessary to assess the success and performance of an established IS with appropriate criteria for continual improvements.

The research related IS assessment, which has been actively conducted, can be divided largely into research to assess quantitative performance and qualitative performance [6]. Nevertheless, in both types of research, it is as important to determine the factors affecting the success of IS utilization as it is to assess its performance. This is because the factors can be used to predict the performance or success of an IS or to define a mechanism for achieving the success of an IS. In this respect, IS success models are significant in relevant research fields for the following reasons. First, IS success models are used to provide a generalized framework that explains IS success, enabling researchers to select and define one dimension that is appropriate for a certain condition [7]. Second, based on proven IS success models, a systematic combination of individual criteria that correspond to the IS success category can facilitate the establishment of a comprehensive scale for measuring the success of an IS [8]. Third, IS success models can be used by researchers to explore the causal relationship between the success of an IS and its drivers and can be used as a mechanism by end-users to determine whether the expected performance of an IS has been achieved [9]. Fourth, numerous studies that

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attempted to empirically verify IS success models firmly support the relationship of the criteria to success and help to ascertain the causal structure in models [7]. One of the most widely applied IS success models is the DeLone and McLean IS success model. DeLone and McLean proposed various views and variables of the success of an IS [10] and, since then, a significant amount of research in many fields has been conducted to verify, extend, and improve the model. In the construction field, research using IS success models has recently been carried out to examine a success model for enterprise resource planning (ERP) in construction [11,12], the utilization of electronic document management (EDM) [13], and the effect of a PMIS on project managers and project success [14]. Nonetheless, research of success models for ASP-based PMIS that reflect construction project stakeholders' opinions are scarce in Korea and, accordingly, any mechanism for the performance achievement or the success of ASP-based PMIS has yet to be defined.

The main purpose of this research is to develop and validate the ASP-based PMIS success model based on a revised version of the DeLone and McLean IS success model that is already widely applied [5]. This research is structured as follows. First, we review IS Success Models developed by other researchers and PMIS in construction and define PMIS success in construction. Second, based on a literature review, each measured item of the PMIS success model and a comprehensive set of hypotheses are proposed. Third, the methods and results of a survey are presented. Finally, theoretical and managerial implications and directions for future research are discussed.

PMIS in construction can be largely categorized into three types of information systems: those that are self-developed and used in construction firms; systems based on a widely distributed application service provider (ASP); and specialized systems used in specific capital projects [15]. The data used to test the research model were obtained from a sample of experienced users (CMs and constructors) of PMIS. To generalize the results, the respondents were spread across construction sites. Using AMOS 18.0, we used structural equation modeling (SEM) for hypothesis testing. A two-phased approach was used, based on Anderson and Gerbing [16]. First, the measurement model was estimated using confirmatory factor analysis (CFA) to test the overall fit of the model, as well as its validity and reliability. Second, the hypotheses were tested between constructs using the structural model.

Based on this analysis, this study will also discuss whether an existing IS success model can be effectively applied to ASP-based PMIS and will make suggestions for the development of an IS success model suitable for an ASP-based PMIS. The elements of success that are verified through the ASP-based PMIS success model suggested in this study can be used to assess systems and predict their success. Moreover, the implications of this research are expected to contribute to the development of a success model with higher explanatory power in the future.

2. Theoretical background

2.1. IS success model

The concept of information system (IS) success is widely accepted for the evaluation of information systems [17]. In management information systems (MIS) scholarship, a wide range of research has proposed IS success models [7,10,18–21]. These models postulate their own definitions of IS success and factors that affect the defined IS success; the models are theoretically grounded and empirically tested. Therefore, various studies have been carried out in which the success factors of the models are applied to the evaluation of IS success or performance.

After reviewing over 180 papers on IT investment assessment factors published in the 1970's and 1980's, DeLone and McLean [10] presented an IS Success Model with six factors related to the success of information systems: system quality, information quality, user satisfaction, system use, individual impact, and organizational impact. While the model integrates the comprehensive dependent variables used by IS researchers, it has received several criticisms. First, IS use in the DeLone and McLean model offers too many interpretations for it to be appropriately examined. IS use is also argued to play a problematic and controversial role in modeling system success. Second, because User Satisfaction represents the individual impacts of IS in an organizational setting, investigating the cause path from User Satisfaction to individual impacts is fruitless. Finally, and most importantly, the model does not explain clearly and fully the relationship between user satisfaction and individual/organizational impact [22]. The definition of constructs is as follows.

① System quality: measures of the information processing system itself
② Information quality: measures of information system output
③ (Information) use: recipient consumption of the output of an information system
④ User satisfaction: recipient response to the use of the output of an information system
⑤ Individual impact: the effect of information on the behavior of the recipient
⑥ Organizational impact: the effect of information on organizational performance(Fig. 1)

Seddon and Kiew [18] tested a modified version of the DeLone and McLean model [10], with the following three major differences: (a) use was replaced by usefulness, (b) a new variable, system importance, was added to help explain the variations in the users' perceptions of usefulness and user satisfaction, and (c) the simultaneous causality between Use and User Satisfaction was replaced by one-way causality, i.e. usefulness causes user satisfaction, and not vice versa. Their empirical results provided substantial support for the 'upstream' two thirds of the DeLone and McLean model [10]. Also, Seddon [19] presented an IS Success Model in which society impact as a net benefit of the information system is added (Fig. 2).

The IS success model of Pitt et al. [20] added Service Quality as a quality factor to the DeLone and McLean model [10]. Measurement items for assessing service quality consist of the modified SERVQUAL proposed by A. Parasuraman et al. [23]; validity was then tested (Fig. 3).

Myers et al. [21] proposed a success model by extending the model of DeLone and McLean [10] and Pitt et al. [20]. Their model differs from that of DeLone and McLean and Pitt et al. as follows: (a) the addition of service quality and (b) the addition of a workgroup to consider organization and external environment in terms of the contingency theory approach (Fig. 4).

Ten years later, DeLone and McLean [7] presented an updated model reflecting the criticisms by other researchers and the situation at the time. As the service concept was added to IT with the use of the Internet, they increased the number of information system success factors to seven, including service quality, and analyzed the interdependence and correlation of these seven factors (Fig. 5).

Drawing from previous research, many empirical studies supported the left-hand part of the DeLone and McLean model, which assumed that 'System Quality', 'Information Quality' and 'Service Quality' cause 'System Use' and 'User Satisfaction'. It has been shown that quality influences attitude and behavior in an IS context. However, many debates have arisen on the construct of information system success. The construct of information system success is varied according to the domain.

In the field of construction, researches that attempt to establish or apply an IS success model have relatively recently begun emerging and few have yet to be carried out. Studies of IS success models in the field of construction include the following. (a) Based on the DeLone and McLean IS Success Model and the technology acceptance model (TAM), Chung et al. [11,12] attempted to determine the elements of