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The Effects of Industry Classification on a Successful ERP Implementation Model

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Abstract
Organizations in some industries are still hesitant to adopt the Enterprise Resource Planning (ERP) system due to its high risk of failures. This study examined how industry classification affects the successful implementation of the ERP system. To achieve this goal, we reinvestigated the existing ERP Success Model that was developed by Chung with the data from various industry sectors, since Chung validated the model only in the engineering and construction industries. In order to test to see if the Chung model can be applicable outside the engineering and construction industries, the relationships between the ERP success indicators and the critical success factors in the Chung model and those in the sample data collected from ten different industry sectors were compared and investigated. The ten industry sectors were selected based on the Global Industry Classification Standard (GICS). We found that the impact of success factors on the success of implementing an ERP system varied across industry sectors. This means that the success of ERP system implementation can be industry-specific. Thus, industry classification should be considered as another factor to help IT decision makers or top-management avoid ERP system failures when they plan to implement a new ERP system.

Keywords
Enterprise Applications, Enterprise Resource Planning, ERP Industry, ERP Success

1. Introduction

The globalization of the business world and the widespread use of the Internet have created massive opportunities for even small businesses to sell their products and services to customers all over the world. With this potential for growth also comes a greater level of complexity. The larger the company, the more complex the problems of customer communication, inventory, and supply chain management become, not to mention the management of employees and their benefits as well as site management [1]. Viewed at a macro level of management, it is clear that the prospect of having a single system to manage all of these factors would hold very high appeal for upper management.

The objective of Enterprise Resource Planning (ERP) systems is to integrate all departments and functions across a company onto a single computer system that can serve different departments' particular needs [2]. According to McNurlin and Sprague [3], system integration is the "main method

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of building systems." Furthermore, system integration is, "by far the biggest software problem CIOs face." Information system (IS) management is an increasingly important element of company strategy designed to enhance production capacity.

The key to the implementation of an effective and efficient IS management strategy is the integration of IS management and information technology [4]. This implies that successful ERP system implementation will lead to higher levels of productivity [5]. Thus, ERP has been implemented in millions of organizations worldwide over the last decade [6], and companies have spent a huge amount of money and time implementing ERP systems [7]. According to recent research, the total ERP market revenue reached US$47.5 billion in 2011 and is expected to grow to an estimated US$67.7 billion by 2017 [8].

However, the problem is the actual implementation. In spite of the promised advantages of the successful implementation of ERP systems, the adoption of ERP systems has been painfully lagging in some industries. Additionally, companies of all sizes have reported sub-optimal experiences in their implementation. The costs and potential changes in organizational culture when implementing ERP are critical issues. The cost of ERP system implementation generally ranges from half a million to US$300 million, with an average cost of US$15 million [9]. About 90% of ERP implementations are not delivered on time and within budget [10]. Moreover, 70% of ERP implementations did not meet the expected benefits [11]. In fact, an ERP project not only has a tendency to become costly to implement but also involves a productivity stemming from disruptions in operations and conflicts among individuals within the organizations [12-14]. Despite the documentation on both sides, one set espouses the benefits of a successful implementation and the other discusses the costly risks associated with the poor implementation of an ERP system

There are several models that purport to deliver an enhanced probability of success in the implementation of an ERP system. Each of these models was based on research designs that varied from one another. Most of them focused on success factors without providing emphasis on the causes of failures in ERP implementation. Unlike other models, Chung developed a model that is designed to define the elements of an ERP implementation process, the inclusion of which will enhance the probability of ERP implementation success for an organization [15]. An advantage of this model is that the underlying research focused on success factors and on failure factors related to the implementation of ERP systems. The disadvantage of the study is that the underlying research and the resulting implementation model focused specifically on engineering and construction companies. Thus, in order for organizations to feel more comfortable attempting to implement a system that could benefit them, this model needs to be tested outside of this particular limited domain to see if the model is applicable across different industry sectors [16].

This study focused on investigating the applicability of the Chung model in various industry sectors. In doing so, we found the strengths and weaknesses of the Chung model.

The remainder of this paper organized as follows: Section 2 reviews the ERP related work already done. In Section 3, we propose research goals and method. Section 4 consists of the discussion of the results and Section 5 concludes the paper.

2. Related Work

ERP systems, as previously noted, continue to be controversial. The reasons for the controversy include conceptual complexity, misunderstandings associated with system costs, and sub-optimal system implementation experiences. Each of these reasons has at least some basis. The negative aspects of these reasons, however, can be overcome [17,18].

Conceptual complexity becomes a manageable factor through organizational training. System costs largely disappear when they are more than offset by the benefits of successful system implementation and functioning. Sub-optimal system implementation experiences are largely eliminated when best-practice protocols are observed [19,20]. Among the three reasons listed above that fuel the controversy that surrounds ERP systems, the most perplexing appears to be sub-optimal experiences with the ERP system implementation process. If the promised potential of the ERP concept is to be realized, problems surrounding the ERP system implementation process must be overcome.

ERP system implementation is a complicated, costly, and time-consuming process. Recent research indicated that the average cost of implementation has been US$7.3 million and the average duration for the implementation process has been 16.6 months. The extra cost and time spent to implement these systems does not seem to have a positive impact on the amount of benefits organizations receive [21]. The most common definition of ERP success presented by project managers or ERP consultants is completing the project implementation on time and within budget. However, it is obvious that a successful ERP implementation requires users' satisfaction, in order to enhance organizational effectiveness [22,23]. However, few studies have been reported that have attempted to validate ERP success from both the project implementation and the user acceptance perspectives. Most of the studies dealing with ERP implementation projects tend to focus on specific firms, firms in related industries, firms within a single country, or some other factor that limits the universal application of the findings.

Amongst various ERP implementation success models, Chung focused on developing the ERP success model, which incorporated both project completion and users' acceptance perspectives. A primary measure of project completion was on time and within budget implementation. Also, perceived usefulness of the system was found to be a primary predictor of a user's acceptance. However, as mentioned previously, this model needs to be tested outside of its specific domain to see if it is applicable across different industry sectors since Chung validated this model only in the engineering and construction industries. The Chung ERP Success model is a synthesis of three well-known models that have been empirically validated by many scholars. The three models are: 1) the Technology Acceptance Model, 2) the DeLone & McLean (D&M) Information System (IS) Success Model, and 3) Ferratt et al. Success Factors for ERP Implementation [24]. Thus, it is necessary to investigate these models in order to better understand the Chung model.

2.1 Technology Acceptance Model

The Technology Acceptance Model (TAM), which was introduced by Davis in 1986, is based on the theory of reasoned action and is an IS theory that models how users come to accept and use a technology. This model predicts the acceptability of a tool and identifies the modifications that must be brought into the system in order to make it acceptable to users [25]. According to the TAM, actual system use is influenced directly or indirectly by the user's behavioral intentions, attitude, perceived usefulness, and perceived ease of using the system. The model also suggests that the acceptability of an information system is determined by two main factors—perceived usefulness and perceived ease of use. The perceived usefulness is the user's subjective view of the probability of increasing one's work performance when employing a specified information system in an organization. Perceived ease of use is measured as the degree that any user expects the target system to be free of additional effort on their part [26]. Davis [27] added that the TAM was created through the identification of primary variables that have been suggested by existing research that deals with affective and cognitive determinants related to IS acceptance. The original version of the TAM is outlined in Fig. 1.

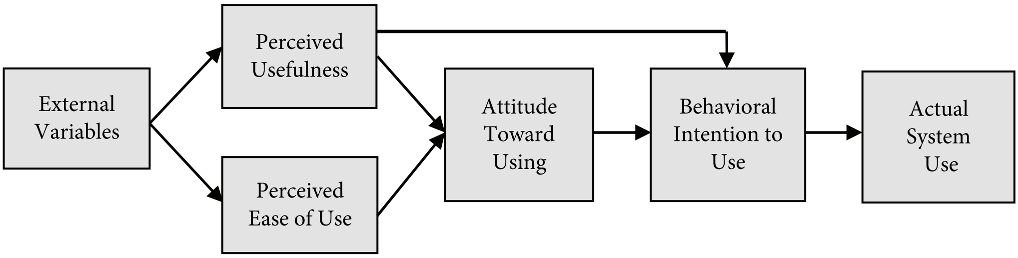

Fig. 1. Technology Acceptance Model, original version [27].

The TAM had been continuously tested with different samples and extended to the original TAM. Moon and Kim [28] advocated extending the model to include extension factors specific to the problem set being investigated.

These extended factors included general context and target technology factors, and they took into consideration the main users of the new system. Venkatesh and Davis [29] extended the original TAM by introducing the second generation of the model TAM2 to explain how subjective norms and cognitive instrumental processes affect perceived usefulness and intentions. The new elements in TAM2 are outlined in Fig. 2.

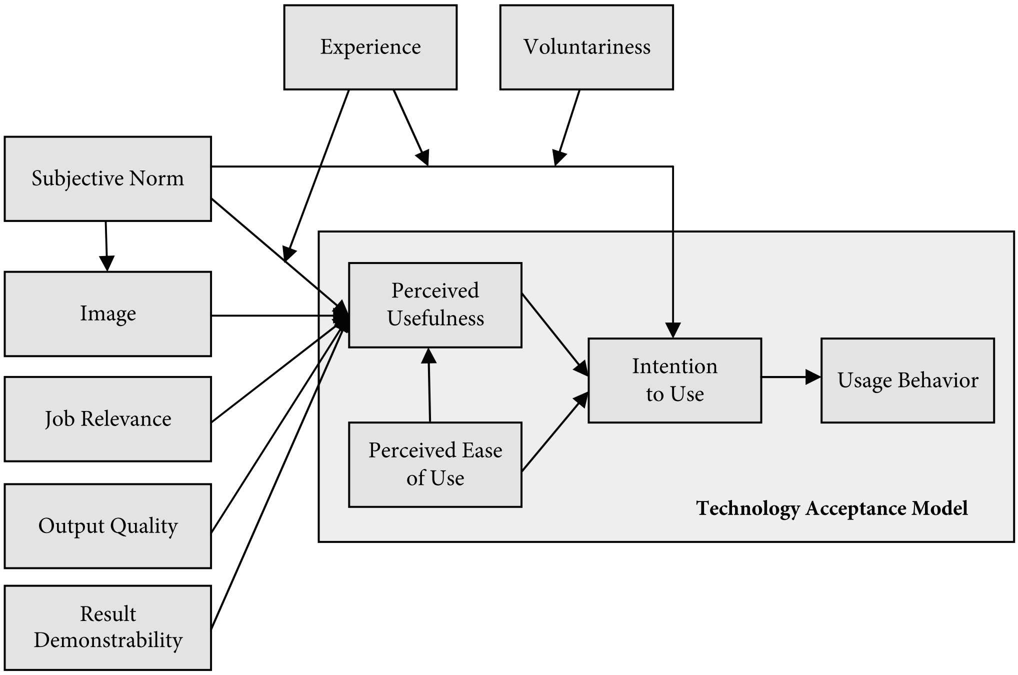

Fig. 2. Technology Acceptance Model, updated version [29].

2.2 DeLone and McLean (D&M) Information Systems (IS) Success Model

DeLone and McLean [30] recognized the importance of defining success measures for IS. As a consequence, they suggested an interactive model for use with six high-level dimensions of IS success. This model involves causality and process. Six high-level dimensions of IS success were defined and assumed to be tied together, rather than as factors that operate independently. The six dimensions are 1) system quality, 2) information quality, 3) user satisfaction, 4) use, 5) individual impact, and 6) organization impact. In short, this model demonstrated that IS success is measured by how the system related to user satisfaction and its ease of use.

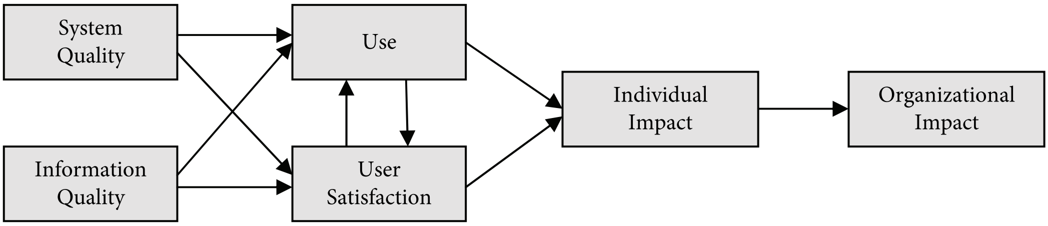

Fig. 3. Original DeLone and McLean Information Systems Success Model [30].

Finally, the model indicated that IS effectiveness also has a significant impact on organization performance [30]. The D&M IS Success Model is displayed in Fig. 3.

The D&M IS Success Model had been tested by many other studies. After reviewing the original model based on the empirical studies of their original model, DeLone and McLean created the Updated D&M IS Success Model, which appears in Fig. 4. In this model, they incorporated the concept of "Service Quality" to the original model, and combined the concepts of "Individual Impact" as well as "Organizational Impact" into the concept of "Net Benefits." The concept of Service Quality is now incorporated as a necessary component associated with IS success, especially when considering that e-commerce is an environment where attention to customer service is crucial. Choices are made to determine at what point impacts (from individuals to national accounts) should be measured. This will depend on the systems and their purposes. For the sake of brevity, DeLone and McLean combined impact measures into just one impact category labeled "Net Benefits" instead of complicating the revised model with increased success measures [31].

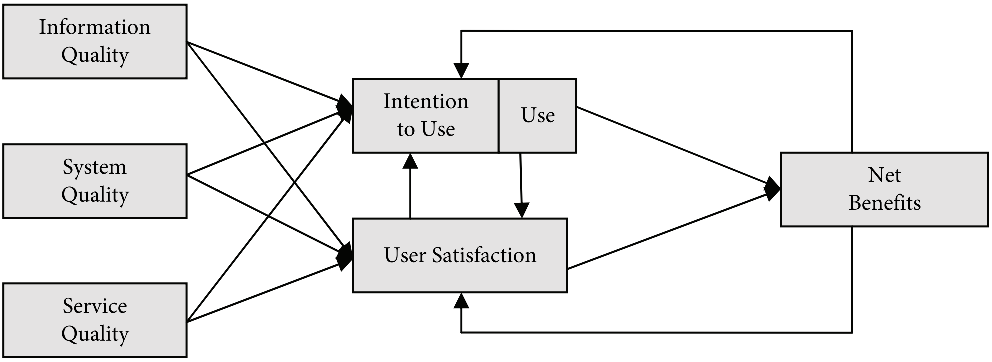

Fig. 4. Updated DeLone and McLean Information Systems Success Model [31].

2.3 Ferratt et al. Success Factors for ERP Implementation

Defining what comprises a big project is relative. It even depends on factors that can include duration, complexity, budget, and the project quality. Complexity in ERP projects can be defined by the amount of business functions and how much the ERP implementation is expected to affect business processes. Some researchers developed new sets of project success factors, which have both risks and best practices, as they are related to IS projects [32,33].

Researchers can adhere to known project management principles to achieve the goal of achieving successful ERP implementation. Some researchers developed new sets of fundamental project success factors, which have the potential to improve the success of project implementation chances in a significant way. Additionally, some researchers found both risks and best practices as they are related to IS projects. Ferratt et al. [24] re-identified questions related to best practices and grouped them into four success factors for use in ERP implementation. These best practice questions are 1) top management support, 2) software selection efforts, 3) information-systems area participation, and 4) consultant support.

2.4 Chung ERP Success Model

Chung synthesized three well-known models that have been described above. Many other researchers validated these models. Developing factors from models having a multi-level perspective makes the Chung model attractive since there have not been a lot of studies that empirically validate factors that impacts both the user's acceptance and project implementation.

Chung adopted the TAM first as a starting point for the ERP Success Model in order to investigate the relationships between success factors and success indicators. Secondly, the D&M IS Success Model was selected to identify the success indicators. Lastly, the factors that were re-defined by Ferratt et al. were included to develop the ERP Success Model.

Chung then identified three main dimensions that can be used to measure the success of ERP systems by combining the three models, which have been mentioned above. The three main dimensions are 1) success factors, 2) intermediate constructs, and 3) success indicators. Finally, Chung investigated these identified success factors and intermediate constructs to verify the relationships with the success indicators, which is the ERP success.

The Chung model is dependent on a single sample population of construction companies in both the United States and South Korea. Chung sent the invitations to participate in the data collection survey to approximately 3,000 persons, of whom 281 responded by completing the data collection questionnaire. Out of the 281 responses, 141 were from the United States (50%), 131 were from South Korea (47%), and nine responses were from other countries (3%). Chung disregarded the data collected from countries other than the United States or South Korea. He analyzed the critical ERP success factors that he defined by comparing the data collected from these two countries. Chung showed that the satisfaction rate with ERP system implementation for US respondents was higher than that from the Korean respondents. Besides the higher impact of the 'Subjective Norm' on 'Use' in the model in the US sample, there were just marginal differences existing within the two groups [15]. The Chung ERP Success Model is shown in Fig. 5.

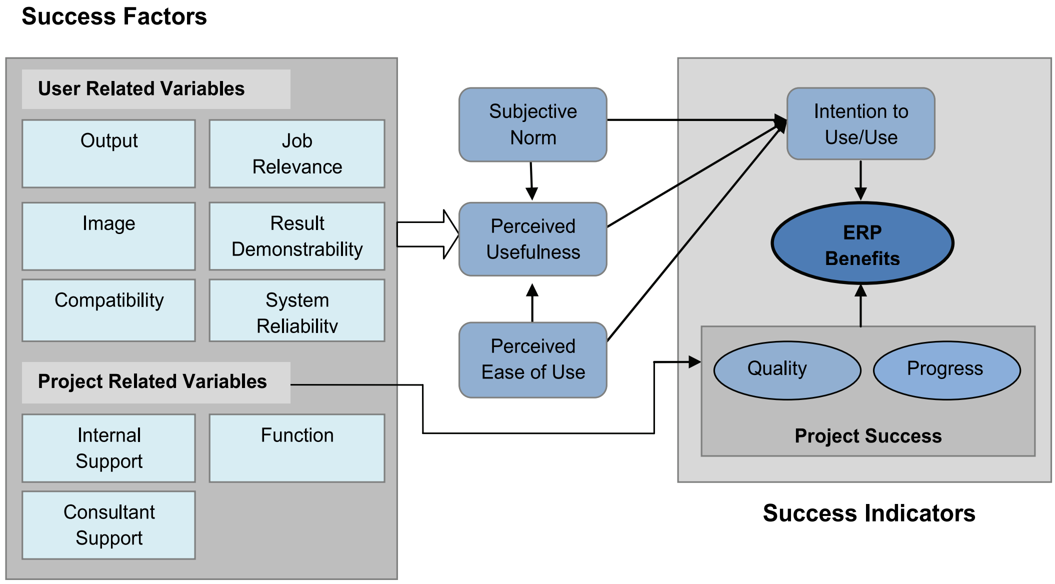

Fig. 5. Chung Enterprise Resource Planning (ERP) Success Model [15].

3. Research Methods

The major goal of the research that was performed as a part of this study was to validate Chung's findings related to the applicability of the ERP Success Model to cross-industry sectors. This goal was pursued by replicating Chung's findings based on data collected from a new sample in a cross industry sector.

A second research goal was to assess the significance of any differences between Chung's findings based on data collected from a sample of engineering and construction companies and the findings of this study that were based on data collected from different industry fields.

The success factors that explain the nature of the outcomes were variables that were either: 1) user-related or 2) project-related. There are six user-related variables and three project-related variables in the Chung model. This study intended to adhere to these user-related variables through the validation process.

The objective of this study was to investigate the validity of the existing ERP Success Model so as to offer a possible explanation for the unique nature of the implementation process associated with ERP systems across various industry sectors. In order to achieve this objective, this research used a data collection from a survey instrument, validated the data with Structural Equation Modeling (SEM) analysis.

3.1 Terms and Definitions of Variables

Chung defined 16 variables to validate the ERP Success Model. There are nine variables for success factors, two intermediate constructs, and five variables for success indicators. Table 1 represents the terms and definitions of each variable.

Table 1. Terms and definitions of variables in the model

Terms	Definition
Output	Quality of the system output including management and performance report
Job Relevance	An individual's perception regarding the degree to which the target system is applicable to his or her job
Image	The degree to which use of the system is perceived to enhance one's image or status in one's social system
Result Demonstrability	The tangibility of the results of using the system, including their observability and communicability
Compatibility	Quality of the system in exchanging data with other systems
System Reliability	The degree to which the system ensures the delivery of data to the users
Internal Support	The degree of the company's internal support for the ERP implementation project (top management support, training, and project planning)
Function	The functionality of the ERP software and its matching with the company's necessary business functions
Consultant Support	The degree to which consultant support helps to make ERP implementation successful
Subjective Norm	The person's perception that most people who are important to him think he should or should not perform the behavior in question
Perceived Ease of Use	The degree to which a person believes that using an ERP system would be free of effort, clear and understandable, as well as being easily applied
Perceived Usefulness	The degree to which a person believes that using an ERP system would enhance his or her job performance, improves the productivity and effectiveness of the organization
Intention to Use / Use	User behavior in intention to use, supervisors and subordinates use the ERP system routinely as needed
ERP Benefits	The degree of user satisfaction with the ERP system and individual & organizational impacts from the ERP system
Project Success - Progress	The degree to which the implementation project was completed on time, and within the budget as initially planned
Project Success - Quality	The degree of the quality of the ERP system and matching the scope of the ERP system with the company's needs
GICS	Global Industry Classification Standard

ERP=Enterprise Resource Planning.

4. Data Analysis and Findings

In this section, data collection, structured equation modeling analysis, and the results of the analysis are presented.

4.1 Data Collection

The main survey was conducted for 50 days, and a total of 231 fully completed responses were collected. This was an adequate amount to begin the data analysis using SEM. The 231 responses received were categorized by industry sectors, as shown in Table 2. In Table 2, it is apparent that most of the respondents (40) were from the Industrial (17.3%) sector, the second largest group of respondents (34) was from the Consumer Discretionary sector (14.7%), and the smallest group of respondents (16) was from the Utilities sector. This ratio is almost consistent with the number of listed companies per industry sector on the Korea Stock Exchange. In other words, because not many companies in the Utilities sector are publicly listed in the Korea Stock Exchange, it was assumed that the number of respondents from the Utilities sectors would be the fewest among the industry sectors, which proved to be the case.

Table 2. Number of responses per industry sector

Sector	No. of responses (%)
1) Energy	19 (8.2)
2) Material	18 (7.8)
3) Industrial	40 (17.3)
4) Consumer Discretionary	34 (14.7)
5) Consumer Staples	18 (7.8)
6) Health Care	17 (7.4)
7) Financials	20 (8.7)
8) Information Technology	32 (13.9)
9) Telecommunication Services	17 (7.4)
10) Utilities	16 (6.9)
Total	231 (100)

4.2 Structured Equation Modeling Analysis

SEM, as a confirmatory technique, specifies two models—a full and a trimmed model. In order to obtain the best-fit model with the data from the cross-industry sectors, both the full and the trimmed models with the goodness-of-fit indices were compared first. Using the obtained best-fit model, path analysis was performed. Table 3 shows the fit indices for both the full and the trimmed models in the sample.

Table 3. Goodness-of-fit indices for SEM models

SEM model	χ^2	DF	χ^2/DF	CFI	TLI	SRMR	AIC
Full	149.856	50	2.997	0.891	0.836	0.069	2631.965
Trimmed	119.770	41	2.921	0.923	0.903	0.058	2233.051

SEM=structural equation modeling.

In the path diagram, comparison and investigation took place in three levels. First, the effect of success factors on Perceived Usefulness and Intention to Use were investigated. Second, the relationships between the project-related variables and the success indicators, specifically, the effect of factors on Progress and Quality, were investigated. Third, the effect of Intention to Use, Progress, and Quality on ERP Benefits was investigated.

As shown in Fig. 6, significant differences were found between the Chung model and the data from cross-industries. These differences indicated the relationships between the success factors and the success indicator of Progress. Chung defined the three project related variables of Internal Support, Function, and Consultant Support as critical success factors that have an impact on Progress. However, in this study it was found that only Function had an impact on Progress.

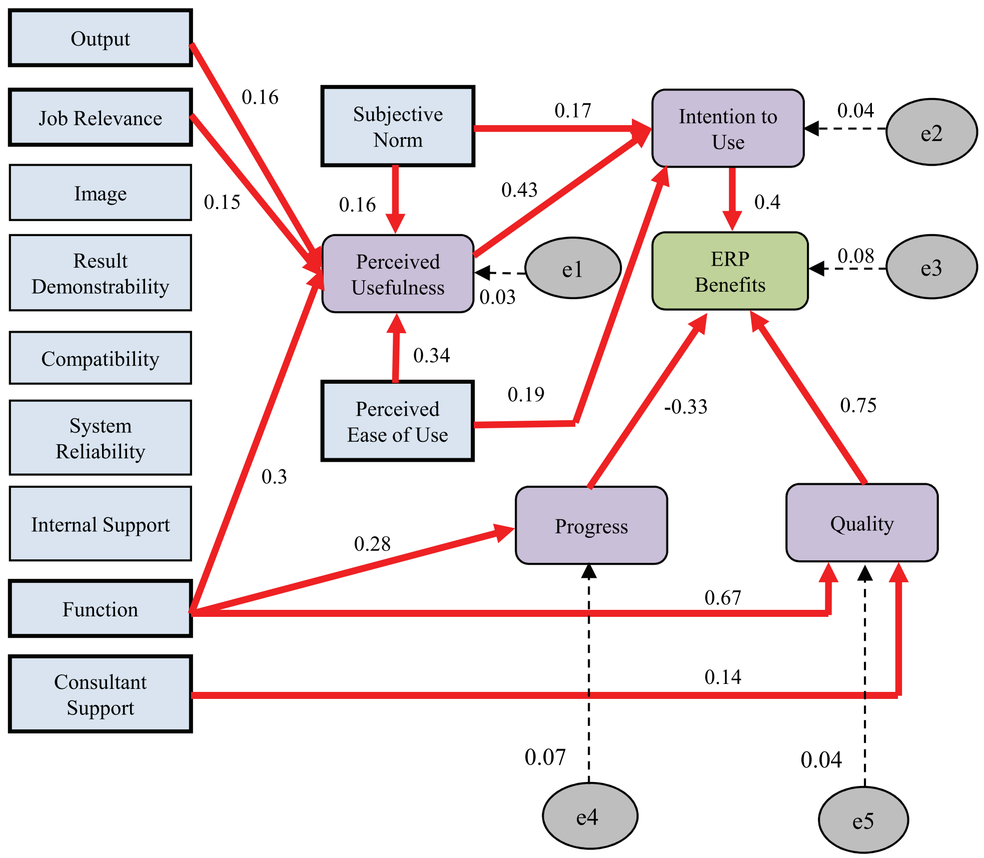

Fig. 6. Path diagram of structural equation modeling (SEM) analysis.

Overall, the relationships among success indicators in the Chung model were identical to those in the cross-industry sector data. Furthermore, the relationships between intermediate constructs and the success indicators were also the same. However, the success factors that were expected to have an impact on both Perceived Usefulness and Progress were very different from the data collected from cross-industry sectors. In short, the Chung model validated the causal effects on ERP Benefits, in regards to the success indicators and intermediate constructs. However, the effects of the success factors on the success indicators of Perceived Usefulness and Progress were invalidated. This implies that the success factors that constitute the ERP Success Model could be industry specific.

5. Conclusions

This study found that not all the factors in the Chung model were applicable for the successful ERP implementation in cross-industry sectors. This indicates that the applicability of the Chung model, in terms of its critical success factors, only works in the engineering and construction companies.

In detail, the 11 critical success factors that Chung identified in the model that had a significant impact on Perceived Usefulness did not work in terms of the applicability across industry sectors. In fact, the five factors of Output Quality, Job Relevancy, Compatibility, Function, and Perceived Ease of Use had a significant effect on Perceived Usefulness when the data consisted of ten different industry sectors. Moreover, Progress, one of the three success indicators, which indicates the completion of a project on time and within budget, had no effect on the success of the ERP in two industry sectors. The remaining two, Intention to Use and Quality, remained consistent with the Chung model.

Thus, this study concludes that the factors that had an impact on Perceived Usefulness are significantly varied by industry classifications. In other words, the critical success factors defined by Chung cannot be sustained when subjected to a broader set of data. Thus, it is not helpful in predicting ERP implementation success for other industry sectors. Surprisingly, the category of Project Progress did not have a measurable effect on the success of the ERP system since it was not found in every industry sector. This is a key finding as one would expect that on time and within budget considerations would be a minimum requirement for a project's success. Even other studies revealed that Project Progress is the most significant factor that indicates the success of an IS-related project. However, we found that this factor does not have a significant effect on ERP benefits that lead to the success of an ERP project.

Most importantly, we found that the diversity of the non-construction industry sectors has a relevant influence on factors that directly or indirectly effect ERP success. Each industry sector differs from other sectors in terms of what factors indicate success when examined sector by sector. However, even if taking into account industry-specific differences, the various industry sectors yield different results from the Chung model. In essence, this study has marginally validated the applicability of the Chung ERP model and generated new findings that can better explain the factors that go into making an ERP system successful.

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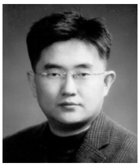

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