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The Effects of R&D Researchers' Quality Management System Application on their Work Performance in Korea

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ABSTRACT

This paper is intended to examine a relationship regarding whether innovation, interactivity, system quality and information quality, extended variable, has an effect on R&D researcher's work performance through the mediation of ease of use and usefulness after applying an extended technology acceptance model to quality management system in Korea. A total of 300 questionnaires were distributed through face-to-face interview, and 212 questionnaires were used for statistical analysis. In order to prove the validity of results of testing a hypothesis, the validity and reliability of measurement instrument was tested in advance. In order to prove the validity of results of testing a hypothesis, the validity and reliability of measurement instrument was tested in advance. And to this end, an exploratory factor analysis of measured variables was made by using SPSS 18.0 K after being divided into convergent validity and discriminant validity. And with regard to confirmatory factor analysis, AMOS 18.0, measurement model, was used after being divided into exogenous variable and endogenous variable. It is possible to consider that this study empirically and theoretically contributes in that this study provides contents for evaluating the technology acceptance model and characteristics of quality management system through the test of extended technology acceptance model regarding the quality management system. It is thought that the results of study can be utilized to prepare for effective system development, establishment and design through the quality management system work performance of R&D researchers at the point of contact for quality management that company pursues.

Keywords: R&D Researchers, Quality Management System, Work Performance
JEL Classifications: L1, O3

1. INTRODUCTION

To survive in the infinite competition era, it is necessary to make ceaseless efforts to achieve excellent business performance and have a competitive edge. As a result, research institutions of manufacturers work hard to address various issues, such as technology innovation, interaction, and quality management in order for work performance and competitive edge. In the case of quality management, it is emphasized that the quality of service or product is a potential strategic weapon to have an edge (Park, 1994).

In other words, manufacturers need to establish and operate the best quality management system based on innovation in consideration of their characteristics in order to improve their competitiveness that contributes to their excellent business performance. The purpose of quality management system application is to better organizational competitiveness, effectiveness, and flexibility through the continuous improvement in business process and to positively influence organizational innovation (Ahire et al., 1996). Researchers of R&D institutes fail to establish the quality management system fitting corporate conditions in order for better work performance, because of their poor understanding of the application of quality management system.

Therefore, this study tries to analyze relevant variables with the use of technology acceptance model to see how R&D researchers' direct application of quality management system is related to their work performance. However, there is free research on the extended technology acceptance model that includes not only manufacturing and service quality, but the quality factors of quality management system, a documentation information system helpful at work consistency and improvement.

For the reason, this study applies the extended technology acceptance model to quality management system to choose innovation and interactivity as extended variables and system quality and information quality as quality factors; investigates how the variables influence R&D researchers' work performance in the mediation of ease of use and usefulness to provide theoretical and practical examination and discussion; and thereby lays the foundation for reviewing quality management system for R&D researchers.

2. THEORETICAL BACKGROUND

2.1. Usefulness and Ease of Use

Technology Acceptance Model is the representative theory of information system introduced first by Davis (1989). The decisive factors influencing the use intention of technology are perceived ease of use and usefulness. Ease of use is referred to as a degree of expectation that a potential user can use the technology without many efforts. Usefulness means a degree of a potential user's subjective belief that the user can improve productivity if using the technology (Davis, 1989). The technology acceptance model is a developed type of theory of reasoned action in which an actual action is influenced by behavior intention which is influenced by subjective norm and personal attitude which is influenced by the result of the performing action and a personal belief of evaluating the result (Fishbein and Ajzen, 1975). This model developed in line with the acceptance of computer based technology adjusts variables depending on the objects to analyze and has been applied through a diversity of expansion. DeLone and McLean (1992) suggested that quality factor is important as the success factor of information system. Regarding to the studies on the extended technology acceptance model on the basis of the quality factor, a study was conducted with antecedent variables as the quality factors of information system. Various studies proposed the modified and extended models in consideration of the characteristics of technology and group. Also, the model has been applied and researched in order to prove its usefulness in the way of researching the acceptance action of a new technology (Sohn et al., 2011).

2.2. Research on Innovation

Innovation is presented in diversified ways depending on subjects. This study applied the consumer innovation which is defined as a trial of new things or a trend of accepting a new product (Tellis et al., 2009). Midgley and Dowling (1978) said that one's purchasing or accepting a new product faster than others is implemented innovation, and reported that such action is influenced by situational factor and one's intrinsic innovation which is a unique personality like psychological and social factor not influenced by others. Hirschman (1980) argued that consumers without innovation would habitually respond to the products without changes, and therefore innovation acts as a big role for dynamic market. According to Hoffmann and Soyez (2010), to turn intrinsic innovation into implemented innovation, an interest in product category has a big influence, and innovation occurs differently depending on products. In this sense, if people have a lot of interest in a specific product and have the experience of use, they tend to accept related new products and thereby their intrinsic innovation can lower.

2.3. Research on Interactivity

Blattberg and Deighton (1991) said that interactivity is the direct communication between groups or individuals regardless of time and space. Kollock and Smith (1995) argued that members' cooperation, interaction, information sharing and exchange are important for technology development and thought of ceaseless interaction as the significant factor to improve cooperation and keep constant relation. It means that members' communication, information sharing and exchange are significant interaction. Therefore, firms are able to pay attention to their members' opinions and solve problems through the interaction process and its effect.

2.4. Research on System and Information Quality

Quality management system is used to systemize and use a lot of information organically to improve quality. System quality represents the quality of information system. Bailey and Pearson (1983) suggested the variables to measure system quality. Seddon and Kiew (1994) proposed the successful model of improved information system. Based on the previous studies on the success of information system, DeLone and McLean (1992) found the items for successful evaluation of system and made systematic arrangement. Information quality is referred to as the quality of the contents and information resulting from information system. Seddon and Kiew (1994) said that it is possible to evaluate information quality on the basis of timeliness, adequacy, and clarity, and Shannon and Weaver (1949) said that it was meaningful for success measurement.

2.5. Work Performance

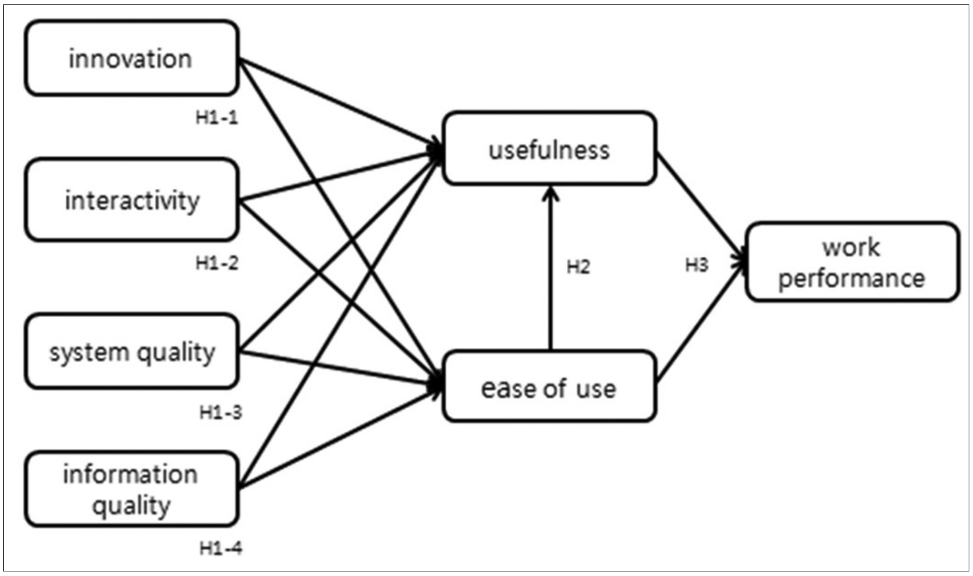
Work performance includes the concept of effectiveness or efficiency for organizational goal and objective, representing the achievement or accomplishment of jobs that shows an employee's job performance ability or efficiency, such as work process speed and ability accuracy. Dutta et al. (2003) argued that the factors of improving corporate performance are the ability of price setting and the ability of product development. However, it is not easy to define and measure performance. If performance is conceptualized in unidimensionality, it is easy to clarify and measure it. But, the concept of performance can be defined differently depending on a measurement point, priority, or a measurement group's interest. According to the previous research on work performance, reward, training, and management are important indexes of organization and its manager. Performance measurement and members' ability are factors to provide significant information, and have been used as important indexes in marketing and personnel areas of corporate management.

3. RESEARCH METHOD

3.1. Research Model and Variable Setting

This study tried to analyze the effects of quality management system application on R&D researchers' work performance. More specifically, based on previous studies, it examined quality management system with the extended information technology acceptance model including information system quality, looked into any statistically significant differences in usefulness and ease of use, and investigated the statistical significance of the relation between usefulness, ease of use, and work performance. To do that, this researcher set up the research model as shown in Figure 1 and conducted a 5-point Likert scale based questionnaire survey with the use of the questionnaire items used in previous studies so as to measure the extended technology acceptance model factors

Figure 1: Research model



(innovation, interactivity, system quality, and information quality) and work performance.

3.2. Research Hypotheses

The purpose of this study is to find the effects of quality management system application on R&D researchers' work performance. The study issues are presented as follows:

Hypothesis 1: Quality management system will significantly influence usefulness and ease of use.

Hypothesis 1-1: Innovation will significantly influence usefulness and ease of use.

Hypothesis 1-2: Interactivity will significantly influence usefulness and ease of use.

Hypothesis 1-3: System quality will significantly influence usefulness and ease of use.

Hypothesis 1-4: Information quality system will significantly influence usefulness and ease of use.

Hypothesis 2: Ease of use will significantly influence usefulness.

Hypothesis 3: Usefulness and ease of use will significantly influence R&D researchers' work performance.

3.3. General Characteristics of Respondents

A questionnaire survey had been conducted with R&D researchers working in research institute of L Korean company from October 6 to October 28, 2016 for 23 days. For data collection, the study subjects were R&D researchers using quality management system. A total of 300 questionnaire copies were distributed through direct interview, and 231 copies were collected. Of them, the copies of respondents who had no experience of quality management system and answered questions insincerely or didn't answer some questions were excluded. As a result, a total of 212 copies were analyzed finally.

4. RESEARCH METHOD

4.1. Validity Analysis and Reliability Analysis of Measurement Variables

This research model is used to find the correlations between variables. The total 212 copies were analyzed. To compare with the independent and similar factors studied in previous studies and examine the construct validity of the subjective measuring tool, this research used SPSS 18.0 K and conducted factor analysis, a general analysis method to find if the measured result of measurement index fits the originally intended theoretical concept. As a method of extracting factors, principal component was applied and thereby factors with more than 1.0 of Eigenvalue which represents a quantity of distribution for factor explanation. Factor loading was judged to be more than 0.4 which is statistically significant. Varimax was applied to remove multicollinearity, the correlation between factors.

After the convergent validity examination of each measurement variable and the convergent validity and discriminant validity of potential variables, confirmatory factor analysis was conducted with exogenous variables and endogenous variables in the measurement model AMOS 18.0 K. To evaluate goodness-of-fit, goodness of fit index (GFI), adjusted GFI (AGFI), root mean square residual, normed fit index (NFI), χ^2, and P value of χ^2 were used. To measure internal consistency and reliability, Cronbach's alpha coefficient was used.

4.1.1. Exploratory factor analysis on independent variables

Factor analysis was conducted with the independent variables of this research model, which are innovation, interactivity, system quality, and information quality. As a result, the four factors were extracted as shown in Table 1. The eigenvalue ranged from 2.025 to 4.014, higher than 1.0. Therefore, all independent variables were classified clearly. cumulative distribution was 65.946% and factor loading was higher than 0.4. As a result, convergent validity and discriminant validity between measurement variables in the same factor were all examined. Cronbach's alpha value of all the four factors was more than 0.6. Therefore, the measurement tool had no problem.

4.1.2. Factor analysis on mediating and dependent variables

In this study, the factor analysis results of mediating and dependent variables are presented in Table 2. As the result of the exploratory

Table 1: The results of exploratory factor analysis of independent variables

Item	Component			
	1	2	3	4
System quality 4	0.912			
System quality 5	0.898			
System quality 3	0.863			
System quality 1	0.812			
System quality 2	0.801			
Interactivity 3		0.817		
Interactivity 5		0.719		
Interactivity 2		0.694		
Interactivity 4		0.633		
Interactivity 1		0.597		
Innovation 2			0.821	
Innovation 3			0.806	
Innovation 1			0.717	
Information quality 4				0.794
Information quality 2				0.732
Information quality 1				0.673
Eigen-value	4.014	2.487	2.210	2.025
Explanatory distribution (%)	24.051	15.854	13.748	12.293
Cumulative distribution (%)	24.051	39.905	53.653	65.946
Cronbrach alpha	0.912	0.748	0.803	0.701

***P<0.001

Table 2: The results of exploratory factor analysis of mediating and dependent variables

Item	Component		
	1	2	3
Usefulness 5	0.818		
Usefulness 4	0.813		
Usefulness 3	0.807		
Usefulness 1	0.774		
Usefulness 6	0.772		
Usefulness 2	0.740		
Work performance 2		0.801	
Work performance 5		0.783	
Work performance 4		0.749	
Work performance 3		0.726	
Ease of use 1			0.877
Ease of use 3			0.812
Ease of use 4			0.776
Eigen-value	4.306	2.983	2.561
Explanatory distribution (%)	32.476	22.281	20.116
Cumulative distribution (%)	32.476	54.757	74.873
Cronbrach alpha	0.913	0.856	0.898

***P<0.001

factor analysis of mediating and dependent variables, three factors-usefulness, ease of use, and work performance-were extracted. Their eigenvalue was between 2.561 and 4.306, higher than 1.0. All independent variables were clearly classified. Their cumulative distribution was 74.873% and factor loading higher than 0.4. Therefore, convergent validity and discriminant validity between measurement variables in the same factor were all examined. Cronbach's alpha value of all the three factors was more than 0.6. Therefore, the measurement tool had no problem.

4.1.3. Confirmatory factor analysis on independent variables

To measure the structural equation model for the overall causal model, this study examined unidimensionality of measurement items in each factor and conducted statistical analysis with the use of AMOS 18.0, and conducted confirmatory factor analysis on antecedent factors. According to the confirmatory factor analysis, $\chi^2 = 83.647$, df = 46, and P value of $\chi^2 = 0.001$. Compared to good-fitting model indexes, this research model had 0.917 of NFI and 0.913 of GFI, which are higher than recommended values. And Chi-square value was significant.

As the confirmatory factor analysis results of independent factors, the size of the critical ratio for structural model estimation was analyzed on the basis of the absolute value "1.96" and more. As shown in Table 3, the critical ratio of each measurement variable in this research model was far higher than 1.96, and thereby was significant at the significance level "$P < 0.001$." Given that, it is considered to be convergent validity, and this research can examine hypotheses on the basis of collected data.

4.1.4. Confirmatory factor analysis on mediating and dependent variables

Confirmatory factor analysis was conducted on mediating and dependent variables to examine unidimensionality of measurement items in each factor and statistical figures. As a result, $\chi^2 = 60.766$, df = 31, and P value of $\chi^2 = 0.002$. Compared to good-fitting model indexes, this research model had 0.917 of NFI and 0.968 of GFI, which are higher than recommended values. And Chi-square value was significant. As the confirmatory factor analysis results of mediating and dependent variables, the size of the critical ratio for structural model estimation was analyzed on the basis of the absolute value "1.96" and more. As shown in Table 4, the critical ratio of each measurement variable in this research model was far higher than 1.96, and thereby was significant at the significance level "$P<0.001$." Given that, it is considered to be convergent validity, and this research can examine hypotheses on the basis of collected data.

4.1.5. Discriminant validity analysis

As the result of discriminant validity analysis, the discriminant validity can use correlation coefficients of constructs and average variance extracted (AVE). Therefore, with the formula proposed by Fornell and Laker (1981), this study calculated the AVE. Table 5 shows the AVE of constructs used in the measurement model. The square value of the correlation coefficients of constructs didn't exceed AVE. Therefore, discriminant validity was secured.

4.2. Goodness-of-fit Evaluation of Research Model

This model has seven important variables: Innovation, interactivity, system quality, information quality, usefulness, ease of use, and work performance. These are the factors extracted by explanatory factor analysis in this research model. To examine the validity of the factor variables, confirmatory factor analysis was conducted. To examine construct validity, goodness-of-fit evaluation indexes, including GFI (more than 0.9 means excellent; more than 0.8 good), AGFI (more than 0.9), Chi-square (the less the better), and P value of Chi-square (more than 0.05 means proper) were applied.

Figure 2 illustrates variance structure equation model which was created on the basis of research model with the exception of the variables removed by validity and reliability analyses. The examination results are χ^2 = 211.187, df = 135, and P value of

$\chi^2 = 0.000$. Given the overall GFI, this model is considered to be acceptable overall and has the results of the structure equation as shown in Table 6.

The indirect effects of the independent variables of this study-innovation, interactivity, system quality and information quality-were examined. The results are shown in Table 7. Therefore, innovation, interactivity, system quality, and information quality had statistically significant indirect effects on work performance.

Table 3: The results of confirmatory factor analysis of independent variables

Type	Estimate	S.E.	C.R.	P
System quality 1←System quality	0.729	0.051	11.132	***
System quality 3←System quality	0.874	0.049	14.754	***
System quality 5←System quality	0.902	0.042	16.345	***
System quality 4←System quality	0.989			
Interactivity 2←Interactivity	0.628	0.081	6.265	***
Interactivity 5←Interactivity	0.727	0.098	6.117	***
Interactivity 3←Interactivity	1.000			
Innovation 1←Innovation	0.993			
Innovation 3←Innovation	1.124	0.112	7.363	***
Innovation 2←Innovation	1.102	0.120	7.401	***
Information quality 2←Information quality	9.994			
Information quality 4←Information quality	1.697	0.375	4.224	***

***P<0.001. S.E.: Standard error

Table 4: The results of confirmatory factor analysis of mediating and dependent

Type	Estimate	S.E.	C.R.	P
Usefulness 4←Usefulness	1.048	0.072	11.804	***
Usefulness 3←Usefulness	1.055	0.072	11.770	***
Usefulness 1←Usefulness	1.027	0.067	11.804	***
Usefulness 6←Usefulness	0.998			
Work performance 4←Work performance	0.757	0.064	7.735	***
Work performance 5←Work performance	0.917	0.061	11.752	***
Work performance 2←Work performance	0.992			
Ease of use 4←Ease of use	1.000			
Ease of use 3←Ease of use	0.979	0.042	14.278	***
Ease of use 1←Ease of use	0.905	0.041	13.303	***

***P<0.001. S.E.: Standard error

5. CONCLUSION AND DISCUSSION

This study tried to approach the relation between quality management system used by R&D researchers and their work performance in the empirical perspective. It has three purposes. The first one is to find the effects of R&D researchers' quality management system on usefulness and ease of use. The second one is to find the effect of the ease of use on usefulness. The third one is to empirically analyze the effects of the ease of use and usefulness on the work performance of R&D researchers using quality management system. To achieve the purposes, this study used the extended technology acceptance model of Davis (1989) to examine the structural influence relation and conducted exploratory and confirmatory factor analyses to prove the validity and goodness-of-fit of measurement variables. The analysis result indicates that the measurement variables can be used also in the future research.

This study that examined research model and hypotheses has the following meanings:

First, there was positive influence between innovation, ease of use, and usefulness of quality management system. It means that the more R&D researchers use and get used to latest technologies and their work performance is influenced, the better there was ease of use and usefulness of quality management system. Secondly, interactivity and information quality didn't influence usefulness and ease of use. It indicates that users fail to communicate with each other for quality management system, the system fails to update information constantly, and there is no effort to improve quality. Thirdly, the quality of quality management system positively influenced usefulness and ease of use. It means that system quality is a significant antecedent variable to improve ease of use and usefulness. Fourthly, there were structural influential relations between usefulness, ease of use, and work performance of R&D researchers using quality management system. It

Figure 2: The results of analyzing a research model (on the basis of C.R value)

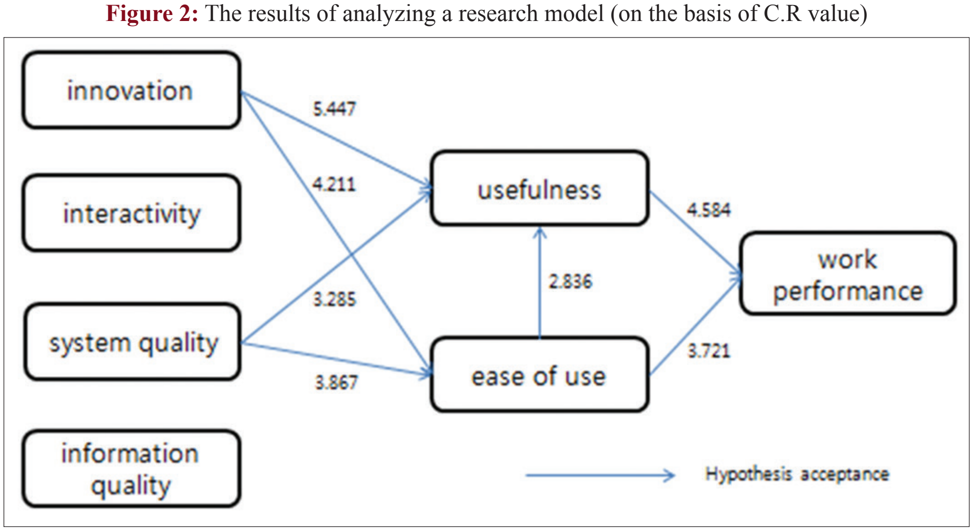


Table 5: The results of analyzing discriminant validity

Factor name	Innovation	Interactivity	System quality	Information quality
AVE	0.568	0.426	0.633	0.515
Construct reliability	0.794	0.684	0.862	0.668

Factor name	Usefulness	Ease of use	Work performance
AVE	0.636	0.661	0.456
Construct reliability	0.862	0.843	0.711

AVE: Average variance extracted

Table 6: The results of analyzing a research model structural equation

Type	Estimate	S.E.	C.R.	P	Hypothesis acceptance
Usefulness←Innovation	0.742	0.130	50.447	***	Acceptance
Usefulness←Interactivity	0.051	0.052	0.977	0.323	-
Usefulness←System quality	0.217	0.061	30.285	***	Acceptance
Usefulness←Information quality	−0.001	0.054	−0.105	0.785	-
Ease of use←Innovation	0.389	0.086	40.211	***	Acceptance
Ease of use←Interactivity	0.048	0.061	0.812	0.367	-
Ease of use←System quality	0.312	0.073	30.867	***	Acceptance
Ease of use←Information quality	0.058	0.060	0.994	0.372	-
Usefulness←Ease of use	0.240	0.084	20.836	0.005**	Acceptance
Work performance←Usefulness	0.539	0.101	40.584	***	Acceptance
Work performance←Ease of use	0.407	0.084	30.721	***	Acceptance

***P<0.001, **P<0.01, *P<0.05. S.E.: Standard error

Table 7: The test of indirect effect

Type	Coefficient value	P
Work performance←Innovation	0.098	***
Work performance←Interactivity	0.071	0.013*
Work performance←System quality	0.089	0.004**
Work performance←Information quality	0.069	0.011*

***P<0.001, **P<0.01, *P<0.05

indicates that usefulness and ease of use are significant factors of presenting the work performance of R&D researchers using quality management system and are decision variables to mediate external variables in the extended technology acceptance model and work performance.

Therefore, this study suggests the direction of improving and establishing quality management system that can help to improve R&D researchers' work performance and makes a suggestion in the point that it emphasizes the importance of the system from users' point of view.

Nevertheless, this study has the limitation in the aspect that its study subjects were R&D researchers working in one company in a specific industry. It will be necessary to conduct a study with researchers in various industries.

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