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A Study on the Effect of CEO Support and Government Support on the Information System Quality and User Satisfaction in Smart Factory.

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Smart factories are intelligent factories based on ICT and are recently being considered as an effective alternative to manufacturers that suffer from difficulties. However, it is not getting as much effect as expected in the real industry field. This study aims to help these manufactures by improving the efficiency of their smart factory based process by identifying the factors that affect the system quality and user satisfaction level. The main subject of this study was collected from the survey through the management and executive officers of small and medium-sized manufacturers that have introduced smart factories. A questionnaire was produced, and the survey was conducted by both a direct interview or e-mail. The questionnaire was composed of 27 questions, including CEO support, government support, information system quality and user satisfaction. Technical statistics, reliability analysis and exploratory factor analysis were conducted by using SPSS 22.0. Additional confirmed factor analysis, structural model analysis and mediation effect test were conducted by using AMOS 22.0. The results of the study are as follows. First, the conclusion was reached that the chief executive elicits the system application problem through active internal communication and that the information system quality improves when reflected in the system design. Second, government support policies indicated that smart factory deployment awareness should be improved through promotion and education, which have a positive impact on the quality of information systems. Third, it was concluded that the reliability and accuracy of the information provided by the information system should be fundamental and that users' satisfaction would be improved when the information provided was organized easily to understand.

Fourth, the quality of information system is shown to have a direct and indirect effect between CEO support and government support and user satisfaction. The questionnaire used in this study shows the degree of subjective measure. Therefore, there may be a difference from the actual situation. If we analyze the objective output information generated by smart factories, it would give a more accurate result. In addition, a comparative analysis of the application levels of smart factories could provide more meaningful research results. These would be analyzed through the further study.

Key words: *Smart Factory, CEO Support, Government Support, Information System Quality, User Satisfaction.*

Introduction

Smart factories are manufacturing solutions that provide flexible and adaptable production processes to solve problems arising from production facilities under an increasing complexity, dynamic and rapidly changing business environment (Radziwon et al., 1994). In Korea, the value addition of the manufacturing industry to GDP exceeds 30%. The employment induction coefficient is high and the dependency on the manufacturing industry is higher than that of major competitors (Kim, 2018). However, recent global economic recession has limited resource depletion and aging population which is weakening manufacturing competitiveness. To address this issue, smart factory has become a rising alternative. According to recent news related to smart factories, the government has a smart factory dissemination program for small and medium-sized manufacturers by 2020. The number of companies that have adopted smart factories has increased but many companies are still showing a low introduction performance. This could be because of the low level of smart factory itself and the lack of readiness for the participants. Some previous research on smart factories suggested that top management level's support affects user satisfaction. Some other research has verified that the government support affects system introduction performance. However, there is little research that considers the information system quality. It is required to verify how these key factors such as CEO support and government support affects the quality of the information system and how the information system quality affects user satisfaction. To address this issue, this study aims to verify the impact of CEO's support and government support on the information system quality and finally on user satisfaction.

Materials and Methods

CEO Support

Hirschheim (1985) argued that the support of the top executives affects the quality of the information system design and that the top executives adjust the design process through contact with the system design team while taking personal interest in the system development project. (Hirschheim, 1985). Nah et al. (2003) also suggested the interest and support of the CEO as the necessary elements for the successful construction of the ERP system (Nah et al., 2003). Looking at domestic studies, Lee Seok-jun (2001) found that top management's education support and active participation are important as key success factors that affect the performance of ERP systems (Lee, 2001). As such, the CEO can control key issues both inside and outside the organization by making strategic decisions and affects the entire organization, including the formation and design of an organizational culture and structure (Nahavandi, 1997). In summary, these studies have shown the support of CEO has an overall impact on the introduction of smart factories and has a significant impact on system design.

Government Support

Korea's smart factory support business has been playing a role in supporting and managing the establishment of smart factories since 2017 at the ministry of small and medium-sized venture. In the Kim Ho & Kim Byung-geun (2012) study, the government-sponsored companies indicated they had a positive effect on SMEs by reducing their R & D investment, increasing their intensity and sales and increasing their private R & D investment (Kim and Kim, 2012). In the study of companies participating in the support project, government support had a positive effect on the construction of smart factories, and it was found that policy support was suitable for the size and environment of the company was needed (Choi and Choi, 2017). However, Yang Dong-woo (2011) found that the higher the proportion of government support, the lower the performance of the technology and thus the need to come up with measures to reduce moral hazards to companies (Yang, 2011). It has been found there is a significant difference between satisfaction and management performance for companies that receive government support from the U.S. Small and Medium Business Administration (Nahavandi and Chesteen, 1988). To summarize the preceding research, there were some critical studies of smart factory support projects, but most of the findings were positive. In addition, companies that received government support had positive effects on their satisfaction and management performance.

Information System Quality

The better the quality of the information systems introduced to the organization or the more suitable for the enterprise's work characteristics, the higher the performance will be (DeLon and McLean, 1992). DeLone and McLean's information system success model is divided into system, user and organization areas. Among them, the system area is classified as the dependent variable of system quality and information quality. In a study related to information system quality, it was found that system quality affects perceived ease of use and perceived usefulness (Freeze et al., 2010). Pitt, Watson & Kavan (1995) found that system quality, information quality and service quality affect the use of information systems and user satisfaction (Pitt et al., 1995). Kim Jun-ho (2002)'s study said that system quality and quality of information each have a significant definition effect on system satisfaction. (Kim, 2008). In summary, the measurement factors for information system quality used in smart factory are divided into system and information quality. In addition, these measurement factors were found to affect user satisfaction.

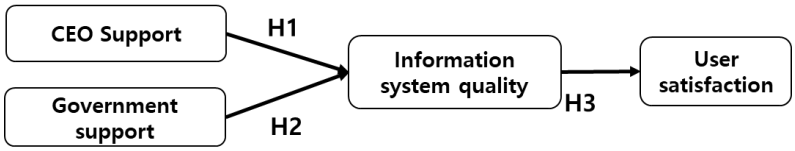
User Satisfaction

To measure the effectiveness of information systems, a user satisfaction measurement has been widely used since the 1970s. Power & Dickson (1973) found that user satisfaction is the most important criterion for measuring the success and failure of information systems (Powers and Dickson, 1973). Heo & Han (2003) found that high user satisfaction had a positive effect on personal and organizational performance (Heo and Han, 2003). Kim Kab-tae (2004) found that the quality factors (system quality, information quality) of the ERP system affect the degree of use and user satisfaction of the information computed by the ERP system (Kim, 2008). In other studies, measuring user satisfaction is also used as a common factor for measuring information system effectiveness.

Research Models and Hypothesis
Research Models

The previous study showed the CEO's support has a significant impact on the smart factory system design and the government support factors affect the user's satisfaction and performance. However, there is a lack of comprehensive research on how CEO support and government support factors affect information system quality and user satisfaction. Therefore, the purpose of this study was to analyze the extent of CEO's support and the extent of the impact of government support factors on user satisfaction by using information system quality as a medium effect shown in Figure1. In this study, independent variables are the CEO's support and government support factors, dependent variables are user satisfaction and parameters are information system quality.

Figure 1. Research model



Research hypothesis

Hypothesis 1(H1): CEO support has a positive impact on information system quality.
Hypothesis 2(H2): Government support has a positive effect on information system quality.
Hypothesis 3(H3): Information system quality has a positive effect on user satisfaction.
Hypothesis 4(H4): Information system quality have a positive mediating effect between CEO support and user satisfaction.
Hypothesis 5(H5): Information system quality have a positive mediating effect between government support and user satisfaction.

Operational definition of variables

The operational definition of each variable is summarized in Table 1 below:

Table 1: Operational definition of variables

Measurement variable	Operational definition	A leading researcher
CEO support	The degree to which the CEO of the system Introduction enterprise is interested in, support for and the importance of implementing the system.	(Umble et al., 2003)
Government support	The degree of governmental and institutional support and effectiveness needed to disseminate and spread smart.	(Kuan and Chau, 2001)
Information system quality	System stability, high speed, system failure, availability when needed, degree of error free, accuracy of information, Needed, reliable, degree of easy to understand.	(DeLon and McLean, 1992; Lee and Chung, 2009)
User satisfaction	The degree of effectiveness and satisfaction in the performance of personal tasks resulting from the use of the system.	(DeLon and McLean, 1992; Han et al., 1999)

Results and Discussion

Empirical Result

Demographic characteristics analysis

57% of the respondents were over 40 years old and 43% of them were under 40 years of age. The distribution of the respondents was 71% for men and 29% for women. The distribution of sales was 48.9% less than 3 billion, 23.7% between 3 ~ 5 billion, 10.2% between 5 ~ 10 billion, 9.1% between 10 ~ 30 billion, 8.1% between 30 ~ 50 billion and the number of employees The distribution was less than 20 persons 46.2%, less than 50 persons 34.4%, less than 100 persons 14.5%, more than 100 persons 4.8%. The industrial classification was 5.9% for other industries, 51.1% for machinery / metals, 19.9% for electricity / electronics, 14.5% for information carriers and 8.6% for chemicals and materials. The Business operation period was 16.7% under 3 years, 19.4% under 5 years, 29.0% under 10 years, 33.9% under 20 years and 1.1% over 20 years.

Technical statistical analysis

Statistical analysis was performed to analyze the normality of measured variables. According to the criterion for descriptive statistics, individual measurement variables with a standard deviation of 3 or less, a maximum deviation of less than 3 and a maximum of less than 3 were found to have a normal distribution.

Exploratory factor analysis

In order to verify the validity an exploratory factor analysis was conducted. The principal component analysis was used to extract all the constructive factors and the orthogonal rotation method (Varimax) was used to simplify the factorial placement. Generally, in the social science field, the selection criteria for factor items is considered to be a significant variable when the eigenvalue is above 1.0 and the factor load is above 0.4. Therefore, this study also applied the factor selection criteria of the general social science field. As a result of factor analysis, the fifth item among the five items of user satisfaction was found to be less than 0.4 for factor loading and was excluded from the analysis item The analysis was conducted by dividing a total of 20 questions into 4 factors: 4 questions for CEO support, 4 questions for government support, 8 questions for information system quality and 4 questions for user satisfaction.

Measurement model analysis
Intensive validity and reliability analysis

Used CMIN / DF (<3.0), GFI·CFI·NFI·IFI (> 0.9), AGFI (> 0.8), RMSEA (<0.8), RMR (≤0.05) to test the fitness of the data. As a result of the initial confirmatory factor analysis, the AGFI value was found to be 0.799, which failed to meet the standard. In addition, the NFI was also 0.885, which was lower than the standard and it was judged that the overall model fit was not sufficient. Therefore, in order to improve the goodness of fit of the model, the model fit was reconfirmed by removing the variables one by one in order of low SMC (Squared Multiple Correlation) value. Finally, the first of four CEO-supported questions were removed and three (1st, 2nd and 4th) of the eight information system quality questions were removed. As a result of the reliability analysis of the refined measurement variables shown in the confirmatory factor analysis, Cronbach's α value was 0.840 ~ 0.923 value (≥ 0.6) and all the factors were reliable. Next, the validity of the model was evaluated. The validity evaluation of the measurement model was carried out by dividing it into concentrated validity and discriminant validity. The concept reliability (CR) value was used to evaluate the concentration validity. The mean variance extraction value (AVE) was used to evaluate the discriminant validity. As a result, the concept reliability (CR) showed the lowest value of CEO support factor of 0.813 and all other variables showed more than 0.90. Therefore, it can be judged that concentration validity is secured based on the concept reliability value. As a result, it is shown in Table 2 below:

Table 2: Confirmatory factor analysis result table

Latent variable	Observation variable	Non-standardization factor Enemy wit	standardization factor Enemy wit	S.E	t.	SMC	AVE	CR	Cronbach's α
CEO support	CS2	1.000	.730			.533	.593	.813	.840
	CS3	1.086	.836	.104	10.458	.699			
	CS4	1.072	.827	.103	10.382	.684			
Government support	GS1	1.000	.829			.688	.709	.907	.886
	GS2	.916	.788	.076	12.092	.621			
	GS3	1.061	.843	.080	13.232	.710			

	GS4	.928	.791	.076	12.157	.626			
Information system quality	ISQ3	1	.712			.506	.644	.900	.896
	ISQ5	1.081	.808	.104	10.432	.652			
	ISQ6	1.125	.823	.106	10.627	.678			
	ISQ7	1.206	.822	.114	10.609	.676			
	ISQ8	1.084	.822	.102	10.605	.675			
User satisfaction	US1	1	.863			.744	.777	.933	.923
	US2	1.118	.939	.06	18.563	.881			
	US3	1.127	.916	.064	17.732	.839			
	US4	.956	.762	.075	12.74	.581			
Measurement model Fitness	(initial model) $\chi 2$=330.557, df=164, p=0.000, CMIN/DF=2.016 RMR=.045, GFI=.843, AGFI=.799, RMSEA=.074 NFI=.885, CFI=.938, TLI=.928 (final model) $\chi 2$= 142.937, df=98, p=0.002, CMIN/DF=1.459 RMR=.036, GFI=.910, AGFI=.875, RMSEA=.050 NFI=.935, CFI=.979, TLI=.974								

Discriminatory Feasibility Analysis

The results showed that the correlation coefficient did not exceed the AVE square root for all variables. Therefore, it can be judged that the discrimination validity is secured. As a result, it is shown in Table 3 below:

Table 3: Measurement model discrimination feasibility evaluation result

Variable name	CEO support	Government support	Information system quality	User satisfaction.
CEO support	0.770			
Government support	0.641	0.842		
Information system quality	0.701	0.643	0.803	
User satisfaction.	0.607	0.671	0.692	0.882

Test of hypothesis

The hypothesis presented in this study was carried out using structural equation model analysis in the AMOS 22.0 program. As a result of the analysis, the proposed model showed overall acceptable data suitability. Table 4 below shows the results of structural equation model analysis.

Table 4: Hypothesis test result table

hypothesis	Pass	Standardization factor	C.R.	P value	Result
Hypothesis 1 (H1)	CEO support → Information system quality	0.486	4.926	***	Adopted
Hypothesis 2 (H2)	Government support → Information system quality	0.362	4.028	***	Adopted
Hypothesis 3 (H3)	Information system quality → User satisfaction	0.72	8.496	***	Adopted
Measurement model Fitness		CMIN=165.832, df=100, p=.000, CMIN/DF=1.658, RMR=.059, AGFI= .863, TLI=.962, CFI=.969, NFI= .925, RMSEA=.060			

Hypothesis 1 (H1): CEO support has a positive effect on information system quality. The structural model analysis showed that the Standardization factor was .486, C.R. was 4.926 and the P value was .000.

Hypothesis 2 (H2): Government support has a positive effect on information system quality. The structural model analysis showed that the Standardization factor was .362, C.R. was 4.028 and the P value was .000.

Hypothesis 3 (H3): Information system quality has a positive effect on user satisfaction. The structural model analysis shows that the Standardization factor was .720, C.R. was 8.496 and the P value was .000.

Mediating effect analysis

The information system quality, which is a parameter between exogenous variables (CEO's support and government support) and the endogenous variable user satisfaction, has a mediating effect which was verified. To verify the mediation effect, structural model analysis was performed using AMOS 22.0 Bootstrap. As a result of analyzing the mediating effects of information system quality between exogenous and endogenous variables, it was verified that all the mediating effects of information system quality were significant. The mediated effect verification results are shown in Table 5 below:

Table 5: Table of mediation effect analysis table

hypothesis	Pass	Indirect effect		Result
		Standardization factor	P-value	
Hypothesis 4 (H4)	CEO support → Information system quality→ User satisfaction	0.192	0.002	Adopted
Hypothesis 5 (H5)	Government support → Information system quality→ User satisfaction	0.128	0.007	Adopted

Conclusion

As a result of this study, it was found that the level of support of the CEO and the level of government support affect the quality of information system. The quality of information system affects user satisfaction. In addition, information system quality was found to have a mediating effect between the support of the CEO and user satisfaction and it was also found to have a mediating effect between the government support and user satisfaction. These results implicate that the CEO should recognize the necessity of smart factory and much discussion with the team members of smart factory construction project in order to improve the quality of information system to increase user satisfaction. These discussions will be the basis for accurately diagnosing the problems of system application and user requirements of companies which want to introduce smart factories.

The government should strengthen education and promotion in supporting the smart factory pervasiveness. Smart factories will have to reduce initial deployment burden by benefiting companies that are absolutely necessary. The information system of the smart factory should provide the accurate and reliable information for the user. For this, the information provided

should be configured easy for the user to understand. Without the credibility or accuracy of the information, building a smart factory would be meaningless. Even if the information is accurate and reliable, the users will stop using or switch systems if they cannot understand it. There are some limitations in this study and it is as follows: First, the survey questionnaire used in this study may be somewhat different from the actual one because it is not an objective measure but a subjective measure. In the future, more accurate analysis would be possible by analyzing the objective output information generated by smart factories. Second, the level of introduction to companies that introduced smart factories was not considered. Therefore, if a comparative analysis is made by dividing each stage of introduction of smart factories in the future we expect that the more meaningful research results could be generated.

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