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Exploring the determinants of information systems performance: A case of Korean SMEs

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Abstract

The performance of informatization differs depending on its utilization, investment and construction methods. This study analyzed the key factors affecting the performance of informatization based on a public survey on the information system operation of small and medium-sized companies in Korea. Through structural equation modeling and one-way ANOVA, the study identified the pathways leading to performance. As a result of the analysis, it was confirmed that higher levels of top management support are associated with increased information system use and performance. Similarly, higher levels of information system use are correlated with better performance of information systems. This research is significant as it investigates and reveals how top management support and information system usage work in the cases of SMEs in South Korea, which is a leading country in manufacturing. The findings of this study will provide valuable insights for SMEs, whether they have already developed an information system or plan to do so, in their efforts to enhance corporate competitiveness.

Key words: *Information system use, information systems performance, top management support, Korean SMEs*

1. Introduction

The concept of information systems was introduced in the 1960s[1-3]. Departments using information systems started to appear in companies, and efforts were made to apply them to actual business [2]. Along with the rapid development of information technology (IT), information systems have advanced at a rapid rate[1]. Nowadays, information systems are used for many purposes, including cost reduction, quality and productivity improvement, the creation of business opportunities, strengthening firm competitiveness, decision-making, and communication[4]. Production and operations management is one of the areas where

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information systems have been actively incorporated (e.g., Enterprise Resource Planning (ERP) [5, 6], Supply Chain Management (SCM) [7-10], and Customer Relationship Management (CRM) [11]). The technology and strategy of production and operations management has significantly expanded through the use of information technology and systems[12].

Although information systems were first introduced a few decades ago, there are still opportunities for Korean small and medium sized enterprises (SMEs) to improve their production and operations management by increasing the use of information systems such as ERP and Manufacturing Execution Systems (MES) [13, 14]. According to Korea Statistical Information Service[15], of the 71,825 manufacturing companies in Korea in 2020, 50,596(70.45%) uses the ERP information system, 8,498(11.83%) companies uses the CRM information system, 6,493(9.04%) companies uses the SCM information system, and 25,752(35.85%) uses the Radio-Frequency Identification (RFID) system. Referring to the history of information system development for production and operations management in Figure 1, these statistics indicate that only a limited number of Korean SMEs have adopted new information systems for production and operations management. Many Korean SMEs are still hesitant to introduce new information systems due to various challenges and difficulties[18, 19].

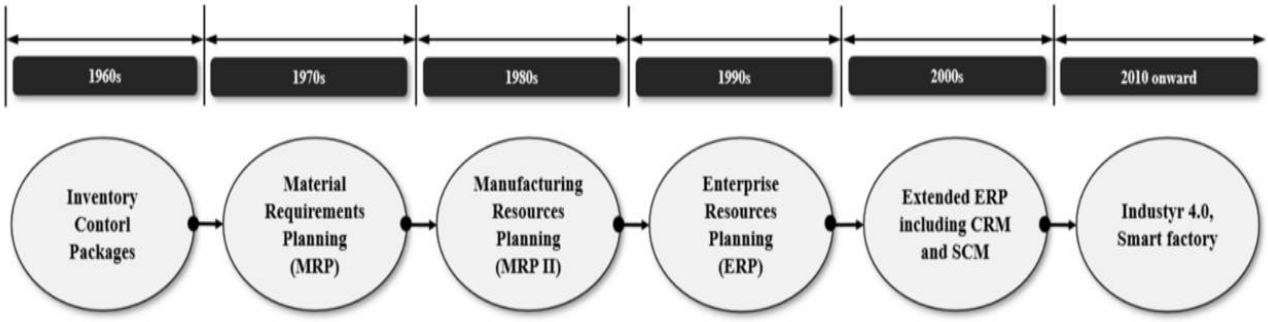

Figure 1. Evolution of production and operations management system (Adjusted from [16, 17, 20])

Implementing information systems is costly[21]. Thus, information systems have been selectively adopted by Korean SMEs due to the limited resources that they can invest[22,23]. Despite many studies proving the improvement of firm competitiveness[24,21] and performance[25, 26],Information systems are underutilized by many Korean SMEs when it comes to managing operations and production. The mature use of information systems is necessary not only to improve firms competitiveness and performance, but also to convert to a smart factory system[27, 28]. Therefore, this situation should be improved quickly.

Our research aims to help Korean SMEs further implement information systems for production and operations management. For this purpose, this study identified two major antecedents affecting information systems performance to clarify the dynamics of information systems in Korean SMEs. Using data from more than 2,000 Korean manufacturing SMEs, it verifies the relationship among top management support (TMS), information system use (ISU), and information systems performance (ISP). Finally, these companies were classified into four groups according to the level of TMS and ISU, and the path of improving ISP was explored. Our analysis will help Korean SMEs identify key components affecting information systems performance and understand the evolution path to achieve higher performance.

This paper is structured as follows. Section 2 presents how the hypotheses were developed based on previous studies. Section 3 explains the data collection process and relevant variables with corresponding

measurement items. Section 4 presents the main findings of the study. Finally, Section 5 discusses the theoretical and practical implications of the study along with the limitations and future research directions.

2. Theory

2.1. Top management support and information systems performance

Generally, top management support is defined as the degree to which top management understands information systems and supports related activities[24, 29, 30-31]. Information systems performance is defined as the degree to which an information system improves the current process[24, 30]. This definition emphasizes the soft, qualitative benefits of information system use.

In many studies, top management support has been recognized as a key component positively affecting information systems performance[24, 30, 32]. Lack of top management engagement and commitment is a critical obstacle to achieving high performance[33, 34]. Saunders and Jones[21] identified key dimensions for evaluating information systems performance and their measures using the Delphi, and they discovered that top management support is an important factor in determining the importance of each dimension. Sohal et al.[32] mentioned that insufficient top management support is a major obstacle to the successful use of information technology and the improvement of firm performance. Similarly, Ragu-Nathan et al.[24] verified that the performance of information systems is directly impacted by top management support and indirectly by the effectiveness of information system functions. Furthermore, Jitpaiboon and Kalaian[4] confirmed that top management support positively moderates the relationship between user support and information systems performance. Khan et al.[30] examined the effect of top management support on information performance considering five users' mindfulness factors, and empirically verified that top management support affected information systems performance indirectly through the sensitivities to information system operations.

Based on above studies, the following hypothesis was developed to describe the relationship between top management support and information systems performance.

H1. Top management support positively affects information systems performance.

2.2. Top management support and information system use

In general, information system use is defined as an individual's behavior of using information systems and their efforts put into the system[31, 35]. Delone and MacLean[36] summarized the empirical measures of information system use after reviewing 27 studies which are considering information system use as a measure of successful information systems. These measures have been selectively employed in several subsequent studies[37-40].

Prior studies verified that top management support can enhance the level of information systems use. Representatively, Sabherwal et al.[31] verified a direct, positive effect of top management support on the use of the information system as well as an indirect, positive effect by affecting users' exposure and favorability toward the systems. In empirical study based on the data from 145 companies in Singapore, Bardi et al.[41] examined the relationship between top management support and information system use. It was confirmed that top management support was crucial for the development, implementation, and use of logistics information systems. Furthermore, Lin[42] verified that the quality of information system and top management support can promote the use of the ERP system. Top management support has a direct effect on the ERP system usage as well as an indirect effect through users' satisfaction and perceived usefulness of the

information system. It was also found that top management can encourage the use of information systems by allocating resources required for active system use[38].

Especially, SMEs' top management has a bigger influence on firm's decision-making[13, 43-45]. Therefore, in case of SMEs, the relationship top management support and information system use will be further strengthened. These studies led to the following hypothesis about the positive relationship between top management support and information system use.

H2. Top management support positively affects information system use for production and operations management.

2.3. Information system use and information system performance

Earlier studies supported the positive association of information systems uses with information systems performance. Ragu-Nathan et al.[24] verified that the greater the application range of information systems, the better its performance, indicating that information systems performance was positively associated with information system use. Chang and King[46] discovered that if information system functions were actively used by multiple departments of a company after information system resources were adequately equipped, information system functional performance and business process efficiency would be improved, positively affecting the firm's performance. Aydiner et al.[25] argued that information system capabilities are a firm's abilities to implement and use information systems effectively. They also validated the positive relationship between information systems capabilities and a firm's performance. Other studies examined similar relationship, especially for SMEs[38, 47].

One of the widely used concepts related to information systems performance is information system success. It is clearly defined in Delone and McLean's[36] research where information system use is one of the six critical constructs for success. After analyzing further studies conducted throughout the decade following 1992, Delone and McLean[37] updated their work. More proof of the beneficial correlation between information system use and system performance was discovered.

Some studies attempted to examine the positive effects of information system use for production and operations management on firm's performance. Jayaram et al.[8] verified the positive effect of the use of information systems infrastructure to improve SCM time-based performance. Other studies also confirmed the role of information system use for production and operation management in improving SCM performance and efficiency[9, 48].

Referring to these studies, we posit the following hypothesis that information system use positively affects information systems performance.

H3. Information system use for production and operations management positively affects information systems performance.

Figure 2 describes the steps undertaken to conduct the systematic research. In stage 1, the relationship among top management support(TMS), information system use(ISU), and information systems performance(ISP) was identified by reviewing previous studies, and the key dynamics was verified through structural equation modeling. In stage 2, Korean SMEs were classified into four groups according to the level of top management support and information system use. Next, a comparative analysis was conducted to explore the evolution path to achieve higher information systems performance.

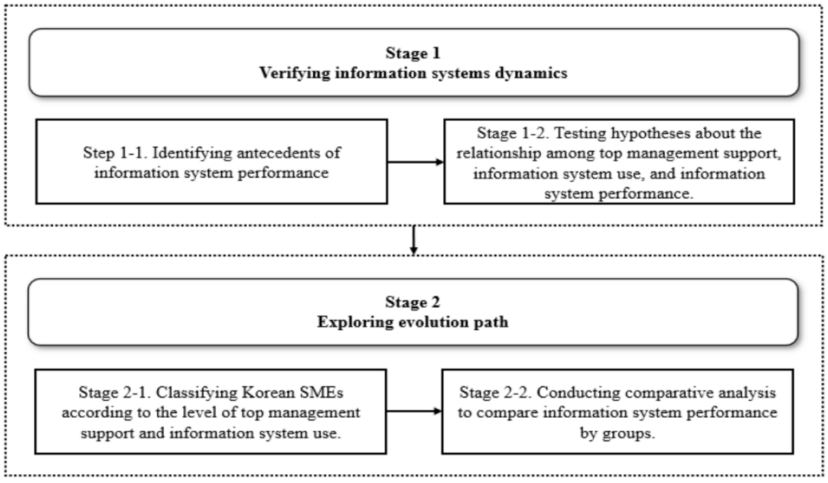

Figure 2. Research framework

3. Research Model

3.1. Data Collection

This study utilizes the results of the 2019 SME Informatization level survey conducted by the Korea Technology and Information Promotion Agency for SMEs. This survey is an annual survey conducted by a Korean institution that supports and manages the level of informatization of SMEs and can be said to be reliable and reliable data. Of the total 4,600 responses, only 2,367 data corresponding to the manufacturing industry with tasks in the production/logistics field were extracted to be suitable for interpreting the performance of the information system utilization of production and logistics process. Table 1 summarizes the detailed sample characteristics. Due to the characteristics of SMEs, the number of workers is mostly distributed between 10-300, and sales are relatively even in a wide range.

Table 1. Sample Characteristic

General Information		Frequency (n=2367)	Percentage (%)
Industry	Manufacturing	2367	100
Establishment date	Before 1990	422	16.8
	1990s	618	25.5
	2000 - 2004	434	18.4
	2005 - 2009	379	16.5
	After 2010	514	22.8
Number of workers	1 - 9	287	14.2
	10 – 19	355	16.3
	20 - 49	614	25.7
	50 - 99	486	19.3
	100 - 299	491	19.4
	300 - 999	119	4.5
	> 1000	15	0.6
Annual Sales	< KRW19.99 billion	308	15.2
	KRW20 – 49.99 billion	334	15.2
	KRW50 – 79.99 billion	248	10.3
	KRW80 – 119.99 billion	210	9.0

	KRW120 – 199.99 billion	265	10.8
	KRW200 – 499.99 billion	493	19.5
	> KRW500 billion	509	20.0

3.2. Research variables and measurements

As previously mentioned, the purpose of this study was to determine the empirical effects of Informatization on the performance improvement of the firm based on constructs from previous studies.

Indexes for measurement used in this study are as the following. Top management support (TMS) is measured using Top management's interest in information systems and willingness to support and Top management's knowledge of information systems/IT solutions.

The following latent variable, information system use for production and operations management (ISU) is one of the general corporate business system processes (sale, purging, production/distribution, and support), and measures how well manufacturing, shipment planning, process management, quality management, warehouse and distribution management processes are used in-house work.

Finally, Information systems performance (ISP) explained how the information system used by companies affects efficiency performance with three observation variables. To find out the relationship between the three latent variables above, the survey of the 10 items was composed and measured on a 5-point scale. Indexes for measurement used in this study are as the following table 2.

Table 2. Research variables and measurements

Variables	Measurement items	Reference
Top Management Support (TMS)	Top management's interest in information systems and willingness to support them Top management's knowledge of information systems and IT solutions(e.g. which systems are suitable for company)	[24, 29-31, 49]
Information System Use for production and operations management (ISU)	The level of information system utilization for manufacturing The level of information system utilization for shipment planning The level of information system utilization for process management The level of information system utilization for quality management The level of information system utilization for warehouse and distribution management	[31, 35, 50]
Information systems performance (ISP)	Reducing the lead time to execute business process Reducing efforts to perform business process Improving the accuracy of business process	[14, 24, 30]

4. Results

4.1. Reliability and Validity

Confirmatory Factor Analysis was conducted using AMOS 22.0 to verify reliability through the internal consistency used in standardized measurement variables and to determine the overall goodness of the model fit. We obtained Chi-square = 184.338, degrees of freedom = 32, goodness of fit index RMSEA = 0.045, SRMR = 0.020, TLI = 0.982, CFI = 0.988, which were above the minimum required values[51].

Table 3 shows the reliability and validity of each variable. Like Table 3, latent variable's composite reliability and Cronbach a were both over 0.7[52-53]. As the results of the confirmatory factor analysis and convergent validity, in which all variables satisfy the validity criteria[54].

Table 3. Convergent Validity

Construct	Measurement Item	Standardized factor loading	SMC	AVE	Cronbach's α	Construct reliability
TMS	TMS1	0.902	0.814	0.794	0.884	0.885
	TMS2	0.880	0.774			
ISU	ISU1	0.791	0.626	0.667	0.908	0.909
	ISU2	0.843	0.71			
	ISU3	0.863	0.745			
	ISU4	0.876	0.768			
	ISU5	0.699	0.489			
ISP	ISP1	0.699	0.488	0.500	0.747	0.748
	ISP2	0.74	0.548			
	ISP3	0.675	0.455			

Table 4 shows the correlations between two variables alongside the square root of AVE. As the square root of AVE exceeds the correlation between each pair of variables, this confirms discriminant validity within the research model[52].

Table 4. Discriminant Validity: Correlation matrix

	ISP	TMS	ISU
ISP	0.705*		
TMS	0.295	0.891*	
ISU	0.304	0.358	0.817*

4.2. SEM analysis

Structural equation modeling (SEM) is a statistical technique widely used in social science research to validate hypotheses about the relationship between observational and latent variables[55]. Table 5 presents the results of SEM analysis to validate the research hypotheses of the relationship between TMS, ISU and Informatization performance.

Table 5. Result of the research model.

Hypothesis	Unstandardized coefficient	Standardized coefficient	S.E	C.R	P	Result
H1. TMS → ISU	0.661	0.358	0.044	15.184	***	Supported
H2. TMS → ISP	0.169	0.214	0.021	7.921	***	Supported
H3. ISU → ISP	0.097	0.227	0.011	8.592	***	Supported
Fit indices	Chi-square = 184.338 (d.f = 32, p < 0.001) RMSEA = 0.045 TLI = 0.982 CFI = 0.988 SRMR = 0.020					

* p < 0.05, ** p < 0.01, *** p < 0.001

Firstly, TMS had a significant effect on ISU with a standardized coefficient of 0.358 (C.R = 15.184, p-value = 0.001), that is, the stronger the CEO's willingness to promote informatization, the more positive the utilization of the production/logistics information system.

Secondly, both ISU and TMS exhibit a significant impact on ISP. TMS demonstrates a standardized coefficient value of 0.214, while ISU exhibits 0.227. Moreover, within this model, there exists an indirect effect whereby TMS influences ISP through ISU. To ascertain the significance of this indirect effect, bootstrapping was performed 1,000 times at a significance level of 0.05. Consequently, the direct effect was confirmed to be significant at the 0.002 level. Hence, the effect of TMS on SUS encompasses a direct Effect of 0.214 (p-value = 0.001) and an indirect Effect of 0.081 (p-value = 0.002), resulting in a total effect of 0.295 (p-value = 0.002).

4.3. Post-hoc analysis

In 4.2, it was found that top management support and information system use for production and operations management have a significant effect on Information systems performance. In this section, one way ANOVA with post-host tests was conducted to find out the difference in the average of informatization performance according to top management support and information system use.

Firstly, based on the average values of each of the top management support and information system use, K-mean cluster analysis was used to classify groups. As a result of the K-means cluster analysis, ISU was clearly divided into high and low groups, and each group was also divided into high and low TMS group. Therefore, 2,367 samples were classified into a total of four groups. (Figure 3) Now we have 4 groups that group 2 is a high level for both TMS and ISU, group 3 is a low level for both TMS and ISU, group 1 is a low level for TMS, but a high level for ISU. Finally, group 4 is with a high-level TMS, and a low-level ISU.

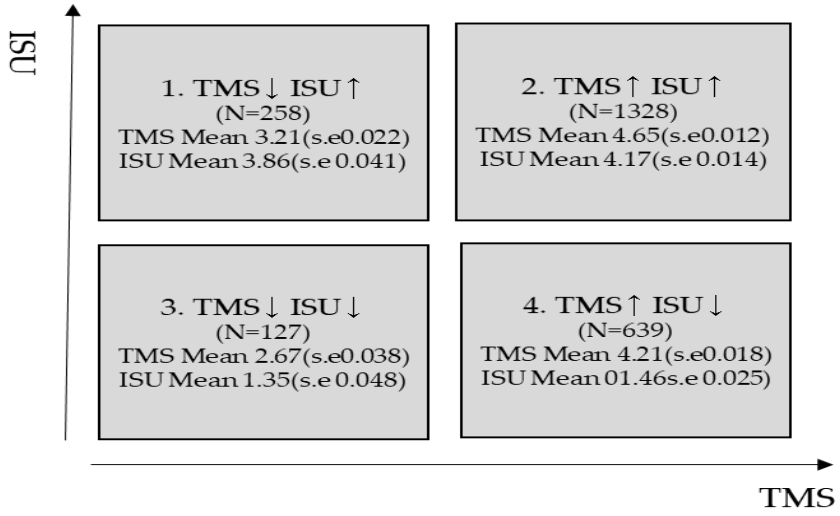

Figure 3. Sample Characteristic for ANOVA 4 groups

Secondly, to robust the cluster analysis results, the significance of the mean difference between the two groups divided by high/low for each ISU and TMS was examined. The results of the t-test are shown in Tables 6 and Tables 7 below. As a result, both ISU and TMS were significantly higher and lower at the significance level of 5%, so it was considered reasonable to classify into 4 groups and used for the analysis of differences between groups.

Table 6. Result of t-test: ISU

ISU	N	average	t(sig)
High	1586	4.12	102.667***
Low	781	1.44	

* p < 0.05, ** p < 0.01, *** p < 0.001

Table 7. Result of t-test: TMS

TMS	N	average	t(sig)
High	1985	4.50	57.585***
Low	382	3.04	

* p < 0.05, ** p < 0.01, *** p < 0.001

Finally, ANOVA with Games-Howell post-host tests assuming non-equal variances between the groups was conducted to find out the difference in information systems performance to examine in more detail the difference in performance in each group, ANOVA analysis was conducted on each of the three performance items that were observed variables of ISPs in the structural equation.

As a result of the ANOVA test (Table 8), we get F = 31.128 ~ 40.334, p-value = 0.001, which was statistically significant. Therefore, the null hypothesis was rejected, and the alternative hypothesis was adopted, so it can be said that there is a difference in information systems performance between the 4 groups. Group 2 (both TMS and ISU are high) had the highest ISP average score of 3.29 ~ 3.41 for all performance items. Group 1 (TMS is low, ISU is high ranked second except for sharing work and business knowledge, Group 4 (TMS is high, ISU is low) ranked third except for sharing work and business knowledge, and Group 3 (both TMS and ISU are low) showed the lowest average of 2.76 ~ 2.91.

Table 8. ANOVA results

	1.TMS↓ISU↑ (N=258)	2.TMS↑ISU↑ (N=1328)	3.TMS↓ISU↓ (n=124)	4.TMS↑ISU↓ (n=657)	F
Reducing work process lead time					
Mean	3.16(2***,3*)	3.41(1***,3***,4***)	2.91(1*,2***)	3.11(2***)	39.109***
S.E	0.05	0.02	0.079	0.026	
ranking	2	1	4	3	
Reducing in work process performance effort					
Mean	3.01(2***)	3.29(1***,3***,4***)	2.81(2***)	2.96(2***)	40.334***
S.E	0.051	0.021	0.074	0.028	
ranking	2	1	4	3	
Improving work process accuracy					
Mean	3.11(2**,3***)	3.31(1**,3***,4***)	2.76(1***,2***,4**)	3.05(2***,4**)	31.128***
S.E	0.049	0.022	0.073	0.028	
ranking	2	1	4	3	

* p < 0.05, ** p < 0.01, *** p < 0.001

5. Discussion

5.1 Conclusions and Implications

The study of informatization has received increased attention in recent years. Information systems have come a long way since they were first proposed in the 1960s; today, they are essential to a company's ability

to survive rather than just an option. The fast growth of information and communication technologies, as well as the global competition system on which they are built, have become an environmental force that no corporation can overlook. In today's business environment, the development and utilization of information systems are not only considered essential for survival but also critical sources of competitive advantage[56, 57, 58].

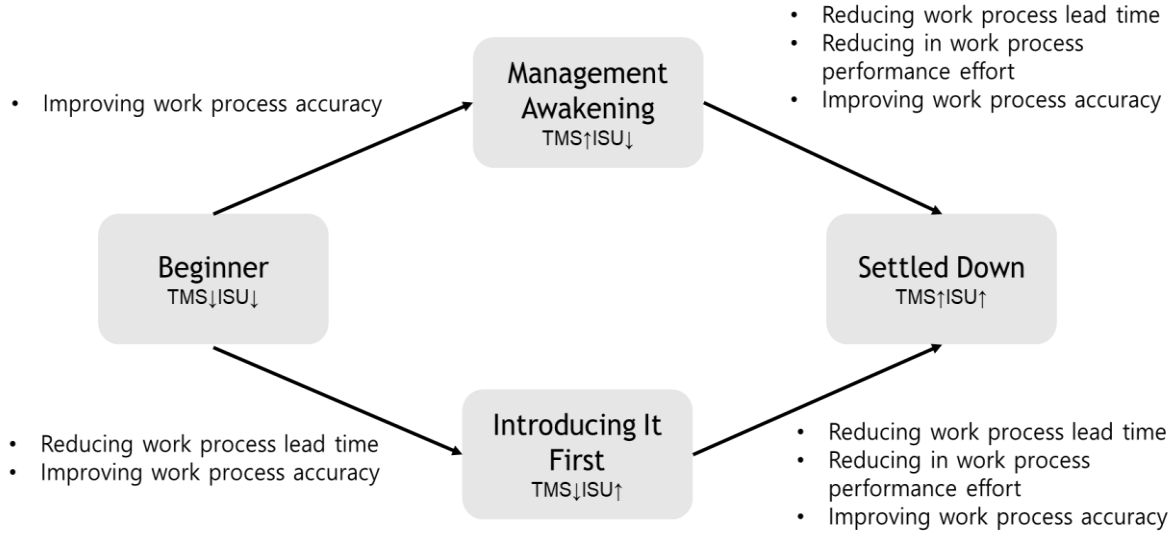

Figure 4. Performance Improvement Path Map

Scholars have studied applying information technology and systems to production and operations management [12, 13, 14]. This study attempted to clarify the preceding factors for obtaining a company's success in informatization and to provide directions on what efforts companies make to achieve information performance by grasping the causal relationship and linkages with performance between them. We used a structural equation model to examine the direct and indirect causal linkages among top management support, information system use, and information systems performance, which are three crucial variables, to study these interactions more practically and especially in Korea. We also divided the sample companies into four clusters based on their performance in two leading factors: top management support and information system use, and compare the differences in information systems performance for each group using one-way ANONA to better understand the situation and characteristics of individual companies.

Many previous studies revealed about the general relationship between top management support, information system use, and information systems performance. Top management support has been identified as a critical element favorably affecting information system performance[24, 30, 32, 33, 34]. Several studies also proved that top management support had a positive effect on information system use[31, 38, 41, 42]. The positive relationship between information system use and information system performance has also been confirmed through many studies[37, 46, 47]. The relationship between these variables, which was hypothesized in earlier studies, was supported similarly in this study.

However, the current state of companies, particularly in terms of top management support and information system utilization, and how these factors affect information system performance, are highly dependent on the

competitive environment and industry in which each company is located[59]. It is difficult to predict a company's performance path based solely on general theory due to variations in industry structure and market conditions. Therefore, in this study, specific performance dimensions (1. Reducing work process lead time, 2. Reducing in work process performance effort, 3. Improving work process accuracy) were individually checked for an exploratory approach.

This analysis led to the suggestion of the performance improvement path, which is depicted in Figure 4. The figure sequentially expresses the operational benefits that a company obtains in the process of adopting information systems based on the one-way ANOVA results. With TMS, even if the actual system introduction has not yet been made, a significant improvement in work process access can be expected. On the other hand, even without TMS, if ISU is equipped, performance improvement in two aspects can be expected: work process lead time and work process accessibility. Of course, if both TMS and ISU are equipped, meaningful performance improvement in all three areas is presumed: work process lead time, work process performance effect, and work process access.

The key findings derived from this study are summarized as follows. Firstly, top management support is a critical antecedent factor in information systems performance, affecting it not only directly but also indirectly through information system use. Secondly, the information system use exerts a more direct and great impact on the information systems performance than the top management support by mediating the process in which the increase in the top management support leads to the improvement of the information systems performance. This is supported by the results of the SEM study, as well as the cluster analysis and ANOVA analysis. The group with a comparatively high information system use value had a higher information systems performance value than the group without top management support and information system use values among the four clusters based on top management support and information system use values.

This research provides valuable implications for industry practitioners as it investigates how top management support and information system use, identified as performance factors in many previous studies on the establishment and operation of information systems, are working within small and medium-sized enterprises engaged in Korea, a leading country in manufacturing. Notably, it enhances previous understanding of how the use of information systems mediates the relationship between top management support and system performance. The findings of this study will be a valuable source for many small and medium-sized businesses, whether they have developed or are considering establishing an information system to enhance corporate competitiveness. Additionally, this study highlights the need for strong leadership and support from top management to promote the successful implementation and utilization of information systems. Moreover, this research is significant in that it can help to grasp the reality of the existing level of informatization achieved by companies and recommend a path for progress.

5.2. Limitations and Future research

Despite its contributions, this study has several limitations. Firstly, due to data limitations, only data from small and medium-sized manufacturing businesses were used. The reliability of research was enhanced by utilizing the vast amount of data provided by the government to understand the current status of information systems of SMEs. However, the research findings do not reflect the situation of large businesses with more advanced information systems. It is widely recognized that small and medium-sized enterprises differ from large companies in terms of their approach to information systems[23]. Additionally, it was not possible to examine the use of information system in the service industry. The research also focuses solely on Korea, which may limit the generalizability of the findings to other contexts. While Korea, with its advanced

manufacturing industries, provides an appropriate environment to study the performance of information system, it was challenging to draw diverse discussions by comparing it with countries in different situations.

Secondly, the study primarily focuses on examining the roles of top management support and information system use, neglecting other potential factors influencing information system performance. Although these two variables were identified as key factors, the inability to incorporate additional variables limits a more comprehensive structural analysis. Future studies could address these limitations by integrating variables such as system management, users' understanding of the system, and financial support for system usage. This would provide a more comprehensive understanding of the determinants of information system performance. Furthermore, conducting an international comparative study to examine how these factors vary across different countries could offer insights into the effective development and operation of information systems.

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