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IMPACT OF KOREAN SMALL- AND MEDIUM-SIZED MANUFACTURERS' SUPPLY CHAIN TECHNOLOGY STRATEGIES AND TECHNOLOGY INNOVATION COMPETENCE ON CORPORATE PERFORMANCE

ROK LEE[1], SU SUNG JEON[2,*], BYEONG CHUL LEE[3]

[1]Smart Manufacturing Engineering Project Organization, Changwon National University, Changwon 51140, Korea
[2]Department of Business and Administration, Graduate School of Gyeongsang National University, Jinju 52828, Korea
[3]Department of Job Industry, GEPA, Gumi 39393, Korea
Email: [1]roklee@changwon.ac.kr, [2]jss9999@gnu.ac.kr, [3]bclee@gepa.kr

ABSTRACT

This empirical study aims to identify the influence of supply chain technology (SCT) strategies and organizational capabilities of Korean small- and medium-sized manufacturers, adopting and operating SCT strategies, on corporate performance. SCT strategy factors of small- and medium-sized manufacturers were considered independent variables, while corporate performance variables were considered dependent variables. Both exploratory factor and reliability analyses for the SCT strategy metrics were employed. Results showed that SCT strategies, the impact of technology innovation competence on corporate performance, influence of SCT strategies on corporate performance, and the mediating effects on SCT strategic factors and corporate performance were significant and adopted. Generally, these results imply that the introduction of Vendor Managed Inventory, Enterprise Resource Planning, Collaborative Planning Forecasting and Replenishment, Warehouse Management Systems, and Order Management System as SCT strategic factors are directly related to enhanced corporate performance. In the context of technology innovation competence, the factors are closely linked with capabilities in strategic planning, research and development, manufacturing, and marketing. In the context of SCT strategic factors of small- and medium-sized manufacturers, if technology innovation competence is combined, enhancing corporate performance is possible.

Keywords: *Supply Chain Technology, New Product Development Performance, Financial Performance, Manufacturing Firms, Korea*

1. INTRODUCTION

Korean small- and medium-sized manufacturers are key in the national industry development and economy. Additionally, they have undergone tremendous changes in recent years in a rapidly changing socioeconomic environment. As a result of selective and intensive resource allocation, while focusing on large companies selected for achieving rapid economic growth in a short period, small- and medium-sized manufacturers have witnessed relative contraction. To improve the corporate performance of such businesses, various management strategies are being implemented to achieve competitive advantage. Moreover, there has also been effective management of the supply chain along with expansion of the global market, intense competition,

and increased product innovation speed. Additionally, many businesses strive to communicate with their supply chain management (SCM) partners, strengthening market competitiveness, and create corporate value, through such supply chain technology (SCT) such as Enterprise Resources Planning (ERP), Vendor Managed Inventory (VMI), Collaborative Planning Forecasting & Replenishment (CPFR), Warehouse Management Systems (WMS), and Order Management System (OMS) [1-3]. SCT can be defined as a technology that makes systematically recognizing the importance of management and strategic implementation of various flows in the supply chain throughout the enterprise possible [4-6]. Through the introduction of SCT, companies want to reduce transaction costs and inventory costs, improve cash flows, and create transaction values, by rationally maintaining the logistics and distribution systems.

Particularly, one of the fields frequently mentioned among the application fields of SCT is the production or manufacturing function. Various studies suggest the need to utilize SCT more actively, for effective and efficient management, and improved performance of production or manufacturing processes [7-9]. This is because those related to production and sales, and decision-makers are all gathered through SCT, to understand future demand and supply, inventory forecast, profit and loss, maximizing performance by enhancing the relationship between SCM partners [10]. Basically, the reinforced strategies formed within the supply chain become a key factor in the supply chain, and the SCT strategies seek to enhance corporate performance and competitiveness through strategic linkage [11].

According to Punniyamoorty et al. [12], optimizing the delivery date, price, and quality of supply materials while sharing information through the interconnected IT system, via collaboration between suppliers and customers, is possible.

Technologies such as just-in-time delivery/inventory systems require close partnerships to improve manufacturing efficiency and delivery, and secure quality [13].

Furthermore, owing to the lack of flexibility in production and supply, limits on demand forecasting exist, and supply cannot be delivered on time. Maximizing this flexibility is the essence of SCT [14].

SCT strategies are introduced to maximize utilization of all corporate resources [15]. Thus, the improved efficiency of SCT can act as the driving force in strengthening management's corporate competitiveness [16].

Particularly, the introduction of the ERP system not only efficiently supports and manages enterprise resources but can also be considered the core system of SCT encompassing corporate SCM activities [17].

Additionally, Collaborative Planning Forecasting Replenishment (CPFR) is a strategic collaboration system between suppliers and sellers, through which sellers and suppliers can respond flexibly to market changes. Basically, by operating the consensus-based forecast that reflects supply constraints and minimizing the differences between planning and implementation through consultation, ultimately reducing shortages, logistics costs, and inventory shortages is possible [18]. Further, there is the advantage of reducing inventory in the supply chain and optimizing the logistics network through data collected from OMS and WMS.

This is because close collaboration between partners participating in the recent supply chain, the establishment of compatibility of information technology that connects the supply chain, and risk and change management, have not been considered simultaneously [19]. Therefore, it is a crucial issue for companies that implement supply chain management to improve corporate performance through the operation of SCT, by simultaneously considering situational factors (e.g., environmental, organizational, and information system factors), and both management and information system strategies [20].

The Fourth Industrial Revolution has recently led to internal and external changes in a huge industry based on the complete adoption and diffusion of core technologies (e.g., big data and artificial intelligence). In the context of rapid changes, companies should first introduce ideas to survive and grow with their own unique strategies for corporate performance. Therefore, in this study, considering the crisis of Korean companies, we try to suggest alternatives by finding SCT strategies for improving corporate performance through implementing SCT strategies and strengthening new product development competencies via technology innovation. Basically, considering that corporate competition has shifted to competition between supply chains in a rapidly changing corporate management environment, this study aims to understand the impacts of corporate internal capabilities, SCT strategies, and technology innovation competence on performance. Moreover, it attempts to empirically identify the structural causal relationship of mutual relations through surveys on Korean manufacturing companies.

2. THEORETICAL BACKGROUND

2.1. SCT Strategies

In modern times, achieving a competitive advantage solely through innovation of corporate internal processes is difficult [21]. It was suggested that companies need to develop new capabilities to quickly respond to changes and uncertainties in the market environment [22]. SCT aims to maximize corporate performance through integrated management of corporate internal and external activities [23]. Goldsby and Zinn [24] argued that businesses can adapt to changes in the market environment and grow by strategically introducing SCT and developing technology innovation competence. Additionally, by introducing SCT strategies, companies can increase profits, improve service levels, and thus increase customer satisfaction, by innovating corporate production and logistics processes, reducing storage, transportation costs and inventory maintenance costs, and then increasing inventory turnover rates [25].

Hence, many companies need changes to adapt to fluctuations in the market environment and strengthen their competitiveness, and they can cope with those issues through ICT strategies. Additionally, the introduction of the SCT strategies can provide consumers with the products and services desired by the market at a lower price and faster speed than can be provided by other suppliers. As facilitators in improving corporate performance in SCT strategies, VMI, ERP, CPFR, WMS, and OMS are reported to be highly related [26-29].

Basically, effectively reduce operating costs of suppliers and alleviating risks under VMI is possible [30]. Based on cases of Korean small- and medium-sized parts manufacturers, VMI was found effective in reducing inventory and logistics costs and improving services [31]. ERP is a comprehensive resource management system integrating all sectors within a company to efficiently manage resources [32]. Introducing the ERP system enables rapid decision-making processes based on information, various simulations, and planned management activities. It also improves cost reduction and material management efficiency [33].

Furthermore, although basic order information is collected in ERP, OMS is required as ERP cannot completely manage all the order information required by companies [34]. OMS is key in managing various information until delivery of the order [35].

In SCM, CPFR has been conducted for general manufacturing companies [36]. CPFR, which emphasizes collaboration between companies, aims to increase operational efficiency and increase sales [37]. CPFR aims to establish joint business plans targeting specific markets between trading partners. A key factor for making CPFR successful is consensus between trading partners to share business processes and information [38].

Conversely, WMS aims to maximize corporate value such as accurate inventory management, efficient supply of raw materials, and customer satisfaction in the supply chain [39]. Companies aim to manage inventory in an integrated manner at the enterprise level through the establishment of WMS and aims to operate efficient processes by identifying the flow of information in real-time [40]. Therefore, SCT is currently considered a critical corporate management strategy.

2.2. Technology Innovation Competence

Corporate technology innovation competence can be defined as an activity strategically managing the entire innovation cycle, from the creation of new technologies to the utilization of existing technologies, to enhancing competitiveness [41]. Technology innovation competence can be regarded as a core competence to secure corporate competitiveness [42]. Hence, a company's technology development capability generally refers to the ability to build its own core capabilities through differentiated service and product development from its competitors [43]. Such technology innovation competence can be defined as a myriad of technical competencies related to service, product development, and production [44]. Moreover, it comprehensively includes knowledge and techniques necessary for acquiring, improving, and utilizing technologies [45].

Supply chain management is a basic activity requiring collaboration and information sharing [46]. The introduction of SCT strategies is the complete optimization technique for managing technology innovation processes through innovative products and services in an integrated manner, via collaboration and swift information sharing [47].

Regarding SCM competencies in previous studies related to technology innovation competence [48-49], recent studies have conceptualized supply chain competencies in three dimensions such as strategic integration, organizational integration, and information integration [50-53].

Therefore, to understand the relationship between internal or external integration and other variables in more detail, this study attempts to reflect on research and development (R&D), technology cooperation, manufacturing, and marketing capabilities, as variables related to technology innovation competence.

2.3. Corporate Performance

In the context of new product development, supply chain integration and corporate performance are interrelated [54]. Particularly, new product development performance is evaluated as the most critical factor in corporate success [55]. Companies can obtain a sustainable competitive advantage only when they possess unique capabilities that cannot be easily imitated [56]. These achievements are conceptualized as operational strengths that pursue technology innovation through corporate R&D. Moreover, they are mainly measured regarding performance improvement, customer satisfaction, development of new technologies, and shorter development period [57].

Sun [54] argued that companies can successfully derive new product development outcomes by establishing internal and external resources or cooperative relationships based on supply chain integration. Improved innovation competence between businesses, and higher efficiency of corporate operation can also influence corporate performance.

Particularly, integration strategies in the supply chain significantly affect new product development performance [54, 58-61], and it was confirmed that they also indirectly affect financial performance.

Comprehensively considering the results of these studies, supply chain management independently has a positive effect on corporate performance. However, when combined with SCT, financial performance such as cost reduction and profit increase can also be expected. Given that, we assume that corporate performance variables will be different depending on new product development factors and financial factors, and we intend to measure these factors by reflecting them as dependent variables.

3. RESEARCH METHOD

3.1. Study Design

3.1.1 Research model

In this study, we designed SCT strategy factors of small- and medium-sized manufacturers as independent variables, and corporate performance variables were designed as dependent variables. Additionally, to investigate the mediating effects in the causal relationship between these variables, the technology innovation competence variable was set as a mediating variable. As for SCT strategies, subfactors were composed of VMI, ERP, CPFR, WMS, and OMS, based on the research of Lee (2021). Regarding technology innovation competence, subfactors consisted of capabilities in strategic planning, R&D, manufacturing, and marketing, based on the study of Kim (2017). Furthermore, as corporate performance factors in previous studies, new product development performance and financial performance factors were categorized as performance. These variables were analyzed using a structural equation model using AMOS (Figure 1).

3.2. Samples and Data Collection

For the empirical analysis of this study, questionnaires were directly collected, and e-mails were used for SCM practitioners of small- and medium-sized manufacturers that were introducing and operating SCT, among small- and medium-sized manufacturers participating in the supply chain in Korea. The questionnaire was distributed and collected between September 6th to October 29th, 2021. A total of 325 copies were distributed, and the final 300 copies were used for the analysis by excluding some copies with incomplete answers and missing values. Respondents showed the following distribution: automobile/shipbuilding (34.8%), aircraft/heavy equipment (37.0%), electronics/semiconductor (26.0%), and others (2.2%).

3.3. Measurement of Variables

3.3.1. SCT strategy

All of the variables used in this study were partially modified to fit the situation of the study, based on the measurement tools tested in previous studies, so as to create metrics. Therefore, as for the main variables of the SCT strategies assumed to have an impact on corporate performance, we used five main strategies of VMI, ERP, CPFR, WMS, and OMS, as independent variables of this research model, based on the study of [62]. The survey between each construct and the corresponding indicator was composed of a Likert 5-point scale.

3.3.2. Technology innovation competence

Based on a study by Hwang and Sung [63], capabilities in strategic planning, R&D, manufacturing, and marketing were selected, as technology innovation competence variables are assumed to have a huge impact on corporate performance. They also argued that the manpower directly invested in R&D, the ability to incorporate external technologies, and the ability to promote active technology cooperation with external factors are important. The indicators used in the study were partially modified to suit this study. Our questionnaire consisted of items regarding R&D capability, technology accumulation ability, and technological innovation system, and we constructed a 5-point Likert scale.

3.3.3. Corporate performance

Corporate performance is the core competence of small- and medium-sized manufacturers through the introduction of strategic SCT. To understand the efficiency of corporate operations that leads to the service development of customer-oriented and differentiated products, and the resultant increase in product sales and decrease in logistics costs, we classified corporate performance into new product development performance and financial performance. New product development performance is formed according to the effects of the related new product development, while financial performance [64]. In this study, both new product development and financial performances were evaluated on a 5-point Likert scale for corporate levels.

4. EMPIRICAL ANALYSIS

4.1. Verification of Validity and Reliability

4.1.1. Exploratory factor analysis and reliability verification

Each item measuring the variables used in this study is based on previous studies, and exploratory factor analysis was performed to verify the construct validity of such metrics as SCT strategy, technology innovation competence, and corporate performance. Concerning factor analysis, principal component analysis was performed for each study variable, and the varimax method was used for factor rotation. The exploratory factor analysis in this study attempts to secure validity by refining variables based on the following criteria. First, when items with a factor loading of .50 or lower, and items with a factor loading of .50 or higher were loaded, they were subsequently removed because they were conceptually opaque. The items of the loaded factors lacked theoretical justification, and the inappropriate items were removed. Next, to verify the reliability of the items with an internal consistency constituting factors extracted from factor analysis, Cronbach's α value was calculated. Generally, if the value of Cronbach's α is between .60 and .70, or higher, it can be seen that reliability is secured.

First, Table 1 shows the results of the exploratory factor analysis and reliability analysis for the SCT strategy metrics used in this study. As a result of factor analysis, there were no metrics with low factor loading or high loading for factors with different research concepts. The Kaiser-Meyer-Olkin (KMO) measure that judges the sample fit was .914; the result of Bartlett's sphericity test, which verifies the existence of unit matrix for the correlation matrix between metrics for factor analysis, was approximated χ^2=2,446.761(df=190, p<.001). This is significant, and the collected data and metrics were suitable for performing factor analysis. As a result of factor analysis, five factors were extracted as predicted, and the total variance explanatory power was 70.132%. Specifically, Factor 1 was the "VMI" factor, which had a variance explanatory power of 40.581%; Factor 2 was "ERP" factor with a variance explanatory power of 11.797%; Factor 3 was the "CPFR" factor with a variance explanatory power of 6.809%; Factor 4 was the "WMS" factor with a variance explanatory power of 5.880%; Factor 5 was the "OMS" factor with a variance explanatory power of 5.065%; the construct validity was confirmed. As a result of verifying the reliability of the metrics constituting the SCT strategy factors, Cronbach's α value was .884 for "VMI" factor, .775 for ERP factor, .887 for CPFR factor, .828 for WMS factor, and .847 for OMS factor, respectively. Reliability was secured as factors were composed of internally consistent items.

Table 2 illustrates the results of exploratory factor and reliability analyses on technology innovation competence metrics. As a result of factor analysis, the KMO measure was .942. Bartlett's sphericity test had the result of Approximated χ^2=3,404.201(df=153, p<.001), which indicates significance. It was then found that the collected data and metrics were appropriate for performing factor analysis. As a result of factor analysis, four factors were extracted without removing any items, and the total variance explanatory power was 78.230%. Factor 1 was "Strategic planning capability" with a variance explanatory power of 55.130%, Factor 2 was "R&D capability" with a variance explanatory power of 8.879%, Factor 3 was "Manufacturing capability" with a variance explanatory power of 8.543%, and Factor 4 was "Marketing capability" with a variance explanatory power of 5.677%. As a result of verifying the reliability of components of technology innovation competence, Cronbach's α value was .880 for Strategic planning capability, .928 for R&D capability, .945 for Manufacturing capability, and .911 for Marketing capability, respectively; the reliability was secured as they consisted of internally consistent items.

Table 3 shows the results of exploratory factor analysis and reliability analysis on corporate performance metrics. As a result of factor analysis, the KMO measure was .903, and Bartlett's sphericity test had the result of approximated χ^2=1,282.554 (df=45, p<.001), which indicated significance. Collected data and metrics were appropriate for performing factor analysis. As a result of factor analysis, two factors were extracted without any items removed, and the total variance explanatory power was 69.770%. Factor 1 was "New product development performance" with a variance explanation power of 52.854%, and Factor 2 was "Financial performance" with a variance explanation power of 16.917%. As a result of verifying the reliability of components of corporate performance, Cronbach's α value was .855 for New product development performance, and .911 for Financial performance, respectively; the reliability was secured as they were composed of internally consistent items.

4.2. Hypothesis Setting

Corporate SCT strategies are affected by environmental uncertainty [65].Lee and Kim [66] argued that supply chain strategies can enhance technology innovation competence, leading to higher competitiveness of small- and medium-sized manufacturers. Furthermore, SCT strategies pursued by a company can reduce uncertainty and improve performance such as product quality and product development; based on this assumption, the following hypotheses were established [67-68].

H1. The SCT strategy of small- and medium-sized manufacturers will have a positive (+) impact on technology innovation competence.

H1-1. VMI operation of small- and medium-sized manufacturers will have a positive (+) effect on technology innovation competence.
H1-2. ERP operation of small- and medium-sized manufacturers will have a positive (+) impact on technology innovation competence.
H1-3. CPFR operation of small- and medium-sized manufacturers will have a positive (+) impact on technology innovation competence.
H1-4. WMS operation of small- and medium-sized manufacturers will have a positive (+) impact on technology innovation competence.
H1-5. OMS operation of small- and medium-sized manufacturers will have a positive (+) impact on technology innovation competence.

SCT strategy directly affects corporate performance such as product quality improvement, cost, delivery date, and flexibility, based on technology innovation competence. Sun [54] argued that SCT strategies can improve corporate performance, depending on technological innovation research, strategic planning capability, and marketing capability. Specifically, SCT strategies of a company increase the possibility of producing more successful new products, by maximizing technology innovation competence, which underpins the fact that SCT strategies are mechanisms to increase performance [54]. Therefore, based on the argument, the following hypotheses were suggested.

H2. Technology innovation competence of small- and medium-sized manufacturers will have a positive (+) impact on corporate performance.

H2-1. Strategic planning capabilities of small- and medium-sized manufacturers will have a positive (+) impact on technology innovation competence.

H2-2. R&D capabilities of small- and medium-sized manufacturers will have a positive (+) impact on technology innovation competence.

H2-3. Manufacturing capabilities of small- and medium-sized manufacturers will have a positive (+) impact on technology innovation competence.

H2-4. Marketing capabilities of small- and medium-sized manufacturers will have a positive (+) impact on technology innovation competence.

According to Oh and Lee [69], the influence of SCM on corporate profits and long-term success is growing as the global market expands and the speed of product innovation quickens. Such companies should apply the techniques that affect main SCM processes. Additionally, for efficient corporate management, it is necessary to focus on core strategies; for competitive advantage in the supply chain, shortcomings should be supplemented through selective strategies.

Such SCT strategies are highly essential for higher corporate performance, and as corporate supply chain strategies, the strategies are ultimately influenced by the higher corporate operation capabilities. Therefore, based on this argument, the following hypotheses were established.

H3. SCT strategy of small- and medium-sized manufacturers will have a positive (+) impact on corporate performance.

H3-1. VMI operation of small- and medium-sized manufacturers will have a positive (+) impact on corporate performance.

H3-2. ERP operation of small- and medium-sized manufacturers will have a positive (+) impact on corporate performance.

H3-3. CPFR operation of small- and medium-sized manufacturers will have a positive (+) impact on corporate performance.

H3-4. WMS operation of small- and medium-sized manufacturers will have a positive (+) impact on corporate performance.

H3-5. OMS operation of small- and medium-sized manufacturers will have a positive (+) impact on corporate performance.

In the recent business environment, it is difficult to accurately predict the complexity of changes in the market environment, due to market globalization and the diversification of customer needs, which also exert considerable pressure on companies. Small- and medium-sized manufacturers establish SCM strategies for efficient operation to cope with the uncertain business environment. Chun et al.[70] argue that corporate performance can differ based on technology innovation competence performing strategies. Particularly, regarding the utilization of supply chain strategies, the performance of technology innovation competence varies depending on the mediation of internal competencies such as R&D capability, technical cooperation ability, and manufacturing and marketing capability of members. This is especially true given that, management and systemization of technology innovation competence are also important. Therefore, based on the argument, the following hypotheses were established.

H4. There will be mediating effects of technology innovation competence on the relationship between SCT strategies and corporate performance of small- and medium-sized manufacturers.

H4-1. There will be mediating effects of strategic planning capability on the relationship between SCT strategies and corporate performance of small- and medium-sized manufacturers.

H4-2. There will be mediating effects of R&D capability on the relationship between SCT strategies and corporate performance of small- and medium-sized manufacturers.

H4-3. There will be mediating effects of manufacturing capability on the relationship between SCT strategies and corporate performance of small- and medium-sized manufacturers.

H4-4. There will be mediating effects of marketing capability on the relationship between SCT strategies and corporate performance of small- and medium-sized manufacturers.

4.3. Confirmatory Factor Analysis

To verify convergent and discriminant validity of research variables such as SCT strategy, technology innovation competence, and corporate performance, confirmatory factor analysis was performed on the measurement model. In this study, the goodness of fit of the model was estimated through fitness indices such as χ^2 statistics, Standardized Root Mean Square Residual (SRMR), Tucker Lewis Index (TLI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA) with confidence intervals. Regarding the goodness of fit of the measurement of model for SCT strategy, which is shown in Table 4, the results are as follows, while showing a relatively good fit and indicating that the measurement model is appropriate for the data: χ^2=221.425 (df=160, p<.001), SRMR=.0543, TLI=.969, CFI=.974, and RMSEA (90% CI)=.042 (.027～.055). Additionally, the factor loadings of all measured variables for SCT strategy factors, such as latent variables of VMI, ERP, CPFR, WMS, and OMS, were all statistically significant (p<.001).

As for the goodness of fit of the measurement model for technology innovation competence that is presented in Table 5, the results are as follows: χ^2=200.778 (df=129, p<.001), SRMR=.0405, TLI=.975, CFI=.979, and RMSEA (90% CI)=.050 (.036～.064). The results indicate a relatively good fit, presenting that the measurement model is suitable for the data. Furthermore, the factor loadings of all measurement variables for the latent variables of technology innovation competence factors, such as capabilities in strategic planning, R&D, manufacturing, and marketing, were all statistically significant (p<.001).

Meanwhile, as for the goodness of fit of the measurement model for corporate performance suggested in Table 6, the outcomes are as follows: χ^2=47.285 (df=21, p<.001), SRMR=.0413, TLI=.955, CFI=.979, and RMSEA (90% CI)=.076 (.047～.104). It shows a relatively good fit, indicating that the measurement model was suitable for the data. Additionally, the factor loadings of all measurement variables for corporate performance factors such as new product development performance and financial performance were all statistically significant (p<.001).

Construct reliability (CR) and average variance extracted (AVE) were reviewed to examine the convergent validity of latent variables. First, convergent validity indicates the degree of correlation between two or more metrics for one latent variable. Generally, it is significant if the standardized factor loading is higher than .50. If CR value is higher than .70, and AVE value is higher than .50, convergent validity is assumed. Tables 4, 5, and 6 show that the standardized factor loadings of all the metrics of all latent variables were higher than .50; in the case of CR, all of the latent variables were higher than .70, and the value of AVE was higher than .50, confirming the convergent validity.

Finally, discriminant validity among latent variables was verified. Discriminant validity indicates how different one latent variable actually is from other latent variables. As the most conservative evaluation method, each value of AVE of two latent variables is greater than the square of the correlation coefficient of the variables, indicating that discriminant validity exists. As a result of confirming discriminant validity by comparing the square of the correlation coefficient and the AVE value (Table 7), the square value (.446) of the correlation coefficient (.668) between technology innovation competence and new product development performance variables with the highest correlation was found to be lower than the value of AVE. Hence, the discriminant validity between latent variables was secured.

Regarding the correlation between research variables, both SCT strategy and technology innovation competence showed a significantly positive (+) correlation with new product development performance, and both variables showed a significantly positive (+) correlation with financial performance.

4.4. Research Hypothesis Verification

Structural equation model analysis was performed using AMOS 26.0 to verify the research hypothesis, so as to examine the structural causal relationship between such variables as SCT strategy, technology innovation competence, and corporate performance. As for the parameter estimation method, we used maximum likelihood (ML). First, regarding the goodness of fit of the research model (Table 8), their results are as follows: χ^2=96.374 (*df*=40, *p*<.001), GFI=.920, AGFI=.868, SRMR=.048, TLI=.923, CFI=.944, and RMSEA (90% CI) =.080. The results indicate a good fit. There were no difficulties in accepting the study results.

Figure 1 and Table 9 indicate the results of the research hypothesis test established to examine the causal relationship between the SCT strategy factors, and technology innovation competence and corporate performance.

First, as a result of verifying the effects of the manufacturers' SCT strategies on technology innovation competence, the SCT strategy factors had the following results: VMI (standardized path coefficients=.398, *t*=4.850, *p*<.001), WMS (standardized path coefficients=.279, *t*=3.532, *p*<.001), and OMS (standardized path coefficients=.212, *t*=2.822, *p*<.01). This indicates that a significantly positive effect on technology innovation competence exists. Such factors as ERP (standardized path coefficients=.057, *t*=.751, *p*>.05), and CRFR (standardized path coefficients=.110, *t*=1.544, *p*>.05) failed to show a significant effect on technology innovation competence. Therefore, the hypotheses of 1-1, 1-4, and 1-5 were adopted, but the hypotheses of 1-2 and 1-3 were rejected.

Next, as a result of verifying the effects of manufacturers' technology innovation competence on corporate performance, such technology innovation competence factors as R&D capability (standardized path coefficients=.296, *t*=4.099, *p*<.001), manufacturing capability (standardized path coefficients=.405, *t*=5.575, *p*<.001), and marketing capability (standardized path coefficients=.495, *t*=6.397, *p*<.001) showed a significantly positive (+) impact on corporate performance. Strategic planning factor (standardized path coefficients=.133, *t*=1.544, *p*>.05) did not have a significant effect on corporate performance. Therefore, hypotheses 2-2, 2-3, and 2-4 were adopted, but hypothesis of 2-1 was rejected.

Finally, as a result of verifying the effect of SCT strategies of manufacturers on corporate performance, such SCT strategy factors as VMI (standardized path coefficients=.185, *t*=2.424, *p*<.05), WMS (standardized path coefficients=.356, *t*=4.357, *p*<.001), and OMS (standardized path coefficients=.483, *t*=5.838, *p*<.001), had a significantly positive (+) impact on corporate performance. The factors of ERP (standardized path coefficients=.103, *t*=1.274, *p*>.05), and CRFR (standardized path coefficients=.077, *t*=1.032, *p*>.05), did not have a significant effect on corporate performance. Therefore, the hypotheses of 3-1, 3-4, and 3-5 were adopted, whereas hypotheses of 3-2 and 3-3 were rejected.

Next, to verify research hypothesis 4, predicting that technology innovation competence will have mediating effects on the relationship between SCT strategy factors and corporate performance, bootstrapping was performed on the indirect effects of these paths. Bootstrapping estimates the distribution of parameters based on sample data without knowing the distribution of the population. When 0 is not included in the 95% confidence interval (CI), it is considered significant at the significance level of .05, and Table 10 shows the verification results.

As a result of verifying the mediating effects of technology innovation competence on the relationship between SCT strategy factors and corporate performance, the indirect effect of the path from SCT strategy, technology innovation competence to new product development performance (standardized path coefficients=-.055, 95% CI: -.288～.144, p>.05) was reviewed. The indirect effect of the path from SCT strategy, technology innovation competence to financial performance (standardized path coefficients=.013, 95% CI: -.082～.172, *p*>.05) was also reviewed. It was found that 0 was not included in the 95 % confidence interval, thus verifying the significance of the mediating effects. Based on the result, SCT strategy was found to have a positive impact on companies' new product development performance and financial performance, via technology innovation competence. Therefore, the research hypotheses of 4-1 and 4-2 were all adopted.

5. DISCUSSION

In summary, first, the influence of SCT strategy on technology innovation competence was significant and then adopted. Second, as the impact of technology innovation competence on corporate performance was significant, both were fully adopted. Third, the effect of SCT strategy on corporate performance was also found significant and adopted. Fourth, the mediating effect of technology innovation competence on the relationship between corporate performance and the SCT strategy factor was found significant and adopted.

This result indicates that using of VMI, ERP, CPFR, WMS, and OMS as SCT strategy factors is directly related to new product development and higher financial performance. Like technology innovation competence, a close relationship exists among capabilities in research development, technology cooperation, manufacturing, and marketing. Particularly, this can be evaluated by suggesting that new product development and financial performance can be promoted by combining technology innovation competence as an SCT strategy factor of these small- and medium-sized manufacturers.

Lee and Park [71] revealed that the collaboration and information sharing with companies related to the supply chain, as strategic measures of small- and medium-sized enterprises, had significant impact on corporate performance. This study is useful as it underpins their research findings.

Additionally, the strategic factors of the supply chain, corporate technology competence, and the components of corporate performance were classified in detail, and their interrelationships were identified. Beyond this, research focused on existing internal integration and additional integration with external customers and supplier partners. The study raised the need to improve the support and planning processes of information systems and the responsibilities for the SCM organization [72-73]. Considering the above, this study has industrial implications.

As for practical implications, integrating internal and external work processes and data, including customers and suppliers, is important for improving SCM performance for small- and medium-sized manufacturers that are planning to introduce SCT. This SCT strategy has implications in that it can replace clear decision-making in the operation process.

In an uncertain environment, greater attention has been paid to the sharing of operation information that is provided based on SCT capabilities for decision-making among supply chain partners. The utilization methods of corporate resources can improve SCM performance and continuously strengthen competitiveness [74]. This means that small- and medium-sized companies should prioritize the expansion of the value of the entire supply chain by enhancing the information technology capabilities, via the utilization of the SCT strategy, as well as the reinforcement of internal core competencies. Basically, efforts should be made to operate efficiently in the short term and create superior customer value in the long term by improving the existing supply chain. Additionally, efforts should be made to discover new opportunities by securing competitive advantage.

Hence, no company is standalone, as it is operated by integrating and creating internal and external resources and capabilities within the company. Participating companies in the supply chain interact with each other while creating chains with each stage of processes from raw material procurement to product delivery in a dependent relationship. Therefore, to enhance SCT competencies of small- and medium-sized manufacturers, as a strategy, technology innovation competence should be maximized strategically to strengthen corporate financial performance.

Finally, as this study only targeted 135 Korean small- and medium-sized manufacturers, there may be limitations in generalizing the research findings. In the case of small- and medium-sized manufacturers, there may be differences in many environments, such as the current status of competitors and national support and surrounding business environments. Therefore, follow-up studies should be comprehensive, while including manufacturers in other countries, which have different external conditions from Korean small- and medium-sized manufacturers' conditions. This will help generalize the research results.

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Table 1: Factor Analysis and Reliability Verification of SCT Strategy Metrics

Factor	Item	Factor loading					Cronbach's α
		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	
VMI	VMI_3	*.806*	**.139**	**.116**	**.152**	**.247**	.884
	VMI_4	*.810*	.061	.102	.240	.121	
	VMI_1	*.856*	.086	.052	.215	.167	
	VMI_2	*.681*	.262	.282	.183	.237	
ERP	ERP_1	**.084**	*.729*	**.157**	**.211**	**.264**	.775
	ERP_2	**.108**	*.793*	**.092**	**.057**	**.147**	
	ERP_4	**.343**	*.663*	**.041**	**.096**	**.235**	
	ERP_3	**.304**	*.617*	**.043**	**.247**	**.034**	
CPFR	CPFR_2	**.187**	**.155**	*.731*	**.110**	**.047**	.887
	CPFR_1	**.075**	**.273**	*.841*	**.118**	**.094**	
	CPFR_4	**.059**	**.276**	*.825*	**.213**	**.089**	
	CPFR_3	**.129**	**.226**	*.813*	**.240**	**.129**	
WMS	WMS_4	**.320**	**.214**	**.163**	*.652*	**.267**	.828
	WMS_1	**.139**	**.196**	**.141**	*.748*	**.210**	
	WMS_2	**.174**	**.178**	**.117**	*.746*	**.096**	
	WMS_3	**.311**	**.131**	**.279**	*.675*	**.199**	
OMS	OMS_2	**.120**	**.188**	**.257**	**.247**	*.618*	.847
	OMS_3	**.145**	**.228**	**.134**	**.067**	*.806*	
	OMS_1	**.078**	**.261**	**.124**	**.166**	*.814*	
	OMS_4	.140	.279	.137	.143	*.742*	
Eigen Value		8.116	2.359	1.362	1.176	1.013	
Variance %		40.581	11.797	6.809	5.880	5.065	
Cumulative variance %		40.581	52.379	59.187	65.067	70.132	
KMO measure(Kaiser-Meyer-Olkin)=.914 Bartlett's sphericity test: Approximated χ^2=2446.761 (*df*=190, *p*=.000)							

Table 2: Factor Analysis and Reliability Verification of Technology Innovation Competence Metrics

Factor	Item	Factor loading				Cronbach's α
		Factor 1	Factor 2	Factor 3	Factor 4	
Strategic	SPC_2	***.702***	.307	.250	.130	.880

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planning capability	SPC_3	***.674***	.324	.175	.101	
	SPC_4	***.840***	.057	.133	.251	
	SPC_1	***.723***	.152	.265	.268	
	SPC_5	***.725***	.176	.272	.353	
R&D capability	R&D_4	.191	***.831***	.313	.197	
	R&D_3	.146	***.806***	.304	.302	.928
	R&D_2	.197	***.789***	.290	.300	
	R&D_1	.184	***.795***	.208	.198	
Manufacturing capability	MC_3	.244	.300	***.748***	.320	
	MC_1	.164	.285	***.832***	.296	
	MC_2	.210	.257	***.805***	.232	.945
	MC_5	.259	.293	***.761***	.326	
	MC_4	.187	.214	***.801***	.209	
Marketing capability	MAC_1	.300	.280	.128	***.764***	
	MAC_3	.249	.226	.195	***.809***	.911
	MAC_2	.243	.198	.136	***.812***	
	MAC_4	.310	.260	.269	***.760***	
Eigen Value		9.923	1.598	1.538	1.022	
Variance %		55.130	8.879	8.543	5.677	
Cumulative variance %		55.130	64.009	72.553	78.230	
KMO measure (Kaiser-Meyer-Olkin)=.942 Bartlett's sphericity test: Approximated χ^2=3404.201 (df=153, p=.000)						

Table 3: Factor Analysis and Reliability Verification of Corporate Performance Metrics

Factor	Item	Factor loading		Cronbach's α
		Factor 1	Factor 2	
New product development performance	PDP_1	***.794***	.045	.855
	PDP_3	***.843***	.161	
	PDP_4	***.706***	.330	
	PDP_5	***.661***	.416	
	PDP_2	***.788***	.225	.911
Financial performance	FP-2	.393	***.748***	
	FP-1	.177	***.855***	
	FP-5	.169	***.875***	
	FP-3	.193	***.848***	
	FP-4	.195	***.810***	
Eigen Value		5.285	1.692	
Variance %		52.854	16.917	
Cumulative variance %		52.854	69.770	
KMO measure (Kaiser-Meyer-Olkin)=.903 Bartlett's sphericity test: Approximated χ^2=1282.554 (*df*=45, *p*=.000)				

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Table 4: Confirmatory Factor Analysis Result for SCT Strategy

Category			Non-standardized factor loading	Standard error	Standardized factor loading	Error variance	*t*	Construct Reliability (CR)	AVE (AVE)
VMI	→	VMI 1	1.064	0.083	**0.84**	.309	**12.882*** **	.886	.661
	→	VMI 2	0.994	0.083	**0.786**	.400	**11.959*** **		
	→	VMI 3	1.036	0.079	**0.854**	.260	**13.108*** **		
	→	VMI 4	1	-	**0.769**	.452	-		
ERP	→	ERP 1	1.155	0.143	**0.737**	.332	**8.054*** **	.778	.469
	→	ERP 2	1.188	0.16	**0.648**	.577	**7.41*** **		
	→	ERP 3	1.194	0.148	**0.741**	.345	**8.081*** **		
	→	ERP 4	1	-	**0.606**	.509	-		
CPFR	→	CPFR 1	1.125	0.094	**0.803**	.542	**11.927*** **	.893	.679
	→	CPFR 2	0.952	0.09	**0.719**	.207	**10.594*** **		
	→	CPFR 3	0.848	0.09	**0.646**	.163	**9.418*** **		
		CPFR 4	1	-	**0.782**	.199	-		
WMS	→	WMS 1	0.774	0.081	**0.648**	.349	**9.566*** **	.827	.547
	→	WMS 2	1.012	0.086	**0.781**	.425	**11.795*** **		
	→	WMS 3	1.087	0.085	**0.85**	.504	**12.844*** **		
		WMS 4	1	-	**0.782**	.319	-		
OMS	→	OMS 1	**0.846**	**0.08**	**0.648**	.312	**10.619*** **	.851	.590
	→	OMS 2	**1.099**	**0.066**	**0.873**	.248	**16.57*** **		
	→	OMS 3	**1.11**	**0.064**	**0.897**	.172	**17.267*** **		
		OMS 4	**1**	-	**0.856**	.241	-		
χ^2=221.425 (df=160, *p*=.000), SRMR=.0543, TLI=.969, CFI=.974, RMSEA (90% CI)=.042(.027～.055)									

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Table 5: Confirmatory Factor Analysis Result for Technology Innovation Competence

Category			Non-standardized factor loading	Standard error	Standardized factor loading	Error variance	*t*	Construct Reliability (CR)	AVE (AVE)
Strategic planning capability	→	Strategic planning1	1.074	0.11	0.747	0.514	9.808***	0.881	0.599
	→	Strategic planning2	1	-	0.671	0.686	-		
	→	Strategic planning3	1.198	0.117	0.788	0.493	10.261***		
	→	Strategic planning4	1.116	0.108	0.795	0.408	10.338***		
R&D capability	→	R&D 1	1.192	0.108	0.859	0.284	10.993***	0.929	0.766
		R&D 2	0.962	0.045	0.884	0.141	21.555***		
	→	R&D 3	1	-	0.931	0.132	-		
	→	R&D 4	0.995	0.048	0.874	0.19	20.913***		
Manufacturing capability	→	Manufacturing 1	0.977	0.043	0.9	0.363	22.676***	0.946	0.779
	→	Manufacturing 2	0.905	0.05	0.821	0.196	17.921***		
	→	Manufacturing 3	1	-	0.835	0.116	-		
	→	Manufacturing 4	1.068	0.068	0.861	0.23	15.64***		
	→	Manufacturing 5	0.965	0.069	0.803	0.17	14.057***		
Marketing capability	→	Marketing 1	1.049	0.064	0.891	0.299	16.468***	0.910	0.719
	→	Marketing	1	-	0.916	0.318	-		
	→	Marketing	1.02	0.045	0.923	0.291	22.774***		
	→	Marketing	0.949	0.047	0.882	0.375	20.297***		

χ^2=200.778 (df=129, p=.000), SRMR=.0405, TLI=.975, CFI=.979, RMSEA (90% CI)=.050 (.036～.064)

Table 6: Confirmatory Factor Analysis Result for Corporate Performance

Category			Non-standardized factor loading	Standard error	Standardized factor loading	Error variance	*t*	Construct Reliability (CR)	AVE (AVE)
New product development performance	→	New product 1	0.564	0.106	0.82	0.649	5.318***	0.881	0.598
	→	New product 2	0.952	0.109	0.686	0.528	8.763***		
	→	New product 3	0.964	0.114	0.818	0.469	8.472***		
	→	New product 4	1.149	0.114	0.747	0.327	10.049***		
	→	New product 5	1		0.789	0.382	-		
Financial performance	→	Finance 1	1.116	0.092	0.48	0.466	12.149***	0.842	0.523
	→	Finance 2	0.936	0.104	0.716	0.551	8.982***		
	→	Finance 3	1.044	0.086	0.74	0.413	12.109***		
	→	Finance 4	0.953	0.082	0.844	0.758	11.636***		
	→	Finance 5	1		0.785	0.467	-		

χ^2=47.285 (df=21, p=.000), SRMR=.0413, TLI=.955, CFI=.979, RMSEA (90% CI)=.076 (.047～.104)

Table 7: Correlation Between Research Variables

Category	SCT strategy	Technology innovation competence	New product development performance	Financial performance
SCT strategy	**.599**			
Technology innovation competence	.592*** (.350)	**.766**		
New product development performance	.595*** (.354)	.668*** (.446)	**.779**	
Financial performance	.425*** (.180)	.520*** (.270)	.511*** (.261)	**.719**

***p<.001, the diagonal value is AVE, ( ) is the square of the correlation coefficient.

Table 8: Goodness of Fit of the Research Model

χ^2	df	p	SRMR	GFI	AGFI	TLI	CFI	RMSEA
96.374	40	.000	.048	.920	.868	.923	.944	.080

Table 9: Research Hypothesis Verification Result (Direct Effects)

Path			Non-standardized path coefficients	Standard error	Standardized path coefficients	*t(C.R)*	*p*
VMI	→	Technology innovation competence	.293	.060	.398	4.850	.000
ERP	→	Technology innovation competence	.064	.085	.057	.751	.453
CRFR	→	Technology innovation competence	.087	.057	.110	1.544	.123
WMS	→	Technology innovation competence	.237	.067	.279	3.532	.000
OMS	→	Technology innovation competence	.205	.073	.212	2.822	.005
Strategic planning	→	Corporate performance	.097	.054	.133	1.790	.073
R&D capability	→	Corporate performance	.186	.045	.296	4.099	.000
Manufacturing capability	→	Corporate performance	.252	.045	.405	5.575	.000
Marketing capability	→	Corporate performance	.318	.050	.495	6.397	.000
VMI	→	Corporate performance	.140	.058	.185	2.424	.015
ERP	→	Corporate performance	.117	.092	.103	1.274	.203
CRFR	→	Corporate performance	.062	.060	.077	1.032	.302
WMS	→	Corporate performance	.303	.070	.356	4.357	.000
OMS	→	Corporate performance	.467	.080	.483	5.838	.000

$^{*}p<.05$, $^{**}p<.01$, $^{***}p<.001$(standardized path coefficients).

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Table 10: Verification Results of Mediating Effects of Technology Innovation Competence in SCT strategy

Path					Indirect effects (bootstrap)				
					Non-standardized path coefficients	Standard error	Standardized path coefficients	95% CI	p
SCT strategy	→	Technology innovation competence	→	New product development performance	.742	.123	.602	(.400 ~ .853)	.000
SCT strategy	→	Technology innovation competence	→	Financial performance	.643	.173	.522	(.230 ~ .931)	.000

* 2000 bootstrap sampling

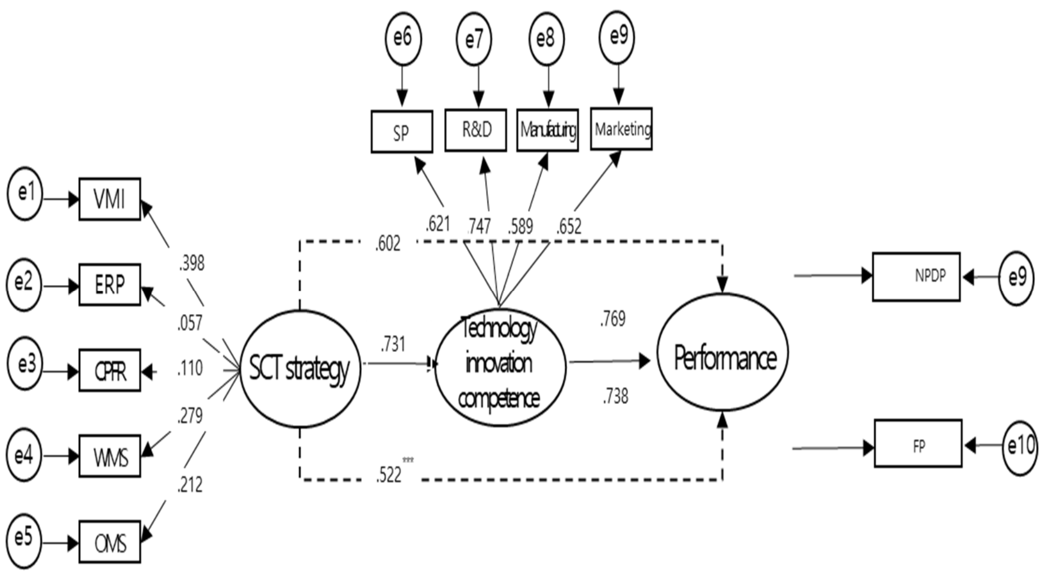

Figure 1: Research Model