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IMPACT OF SCM SYSTEM OPERATION STRATEGY ON SCM PERFORMANCE AND MEDIATING EFFECT OF PROCESS INNOVATION

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ABSTRACT

This study aims to identify the influence of the supply chain management (SCM) system operating strategy on process innovation and SCM performance. To this end, this research empirically investigated a total of 243 small and medium businesses in South Korea that executed a process innovation program. The introduction of SCM systems and process innovation positively impacted SCM performance. Furthermore, a positive impact in the mediating effect of process innovation on SCM performance was validated. The results indicate that introducing and applying systems for optimized logistics management, as in supplier-initiated stock management and enterprise resource planning, boosted innovation between different processes, which ultimately positively impacted SCM and simultaneously contributed to improving logistics management functions and performance enhancement. This finding empirically proved that applying an integrated logistics between each system—rather than isolated synching and application in a single system, as was the case in the past—could develop an interlinked synergy effect, thereby promoting innovation in logistics between different processes and subsequently improving SCM performance.

Keywords: *Supply Chain Management, Operation, Strategy, Process Innovation, Performance*

1. INTRODUCTION

Supply chain management (SCM) is a management paradigm that triggered a widespread response in the 2000s. Interest in SCM is increasing today because competition is intensifying because of informationization and globalization, thereby forcing companies to simultaneously pursue two different goals of customer satisfaction. This approach has resulted in the introduction of enterprise resource planning (ERP) systems and more interest in optimizing business environments connected internally and externally to the businesses [1].

SCM, a set of approaches also known as a logistics network that aims to meet customers' service expectations and minimize the overall system cost by providing products in precise quantities at precise locations (in terms of production and distribution) through the effective integration of manufacturers, suppliers, warehouses, storage service providers, and retailers.

However, integrating a supply chain is very difficult for several reasons. First, facilities in a supply chain may be different and have colliding purposes. Suppliers generally want their manufacturers to purchase numerous products with a benign delivery schedule. Production decisions are made without precise information on customers' demands. Therefore, balancing supply and demand is difficult for manufacturers. Manufacturers traditionally prefer mass production, which may increase transportation costs [2]; by contrast, logistics centers aim to reduce stocks.

A supply chain is a dynamic, evolving system, and customers want more diversity and personalization in products. Even without changes in the customers' demand for a specific product, backorders over the entire supply chain and stock volumes can change significantly. In a traditional supply chain, the order volume from the distributor to the factory is more susceptible to fluctuations than the order volume of retailers issued to a distributor.

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However, simply sharing information has only a limited effect in saving costs and reducing stocks. Therefore, some of the most representative techniques used by companies to increase supply chain efficiency are collaborative planning, forecasting, and replenishment (CPFR); vendor-managed inventory (VMI); and warehouse management system (WMS).

CPFR has been recognized as a tool that helps businesses respond to the changes in demands more effectively based on a collaborative customer demand and order prediction system of the partners in a supply chain [3].

Based on the precise prediction of demands, introducing CPFR can reduce the whip effect on a supply chain, thereby reducing excessive stocks or out-of-stock products when enhancing the quality of services provided to customers to provide more benefits. CPFR's customer response capabilities show better performance in the whip effect or backlogs than the existing SCM techniques, such as sharing POS information or VMI [4,5]. However, an official, cooperative relationship between CPFR participants is a prerequisite to achieving the intended performance, depending on the cooperation and trust between these parties. The partners must share their goals and visions and have the will and take action to share information and conduct predictions to ensure the realization of the intended outcomes of CPFR.

A WMS is a logistics system that contributes to faster decision-making for warehouse management by obtaining related information, such as parking, order placement, intake, and release of materials in real time; processing such information efficiently; and managing the materials in the warehouse. For any system, having accurate data is crucial for optimizing decision-making. The WMS is a decision-making support system providing warehouse information as needed in real time [6].

For efficient SCM integration, the company's management must ensure the successful operation of CPFR, ERP, VMI, and WMS, whereas the actual conditions between the supply chain must be understood. The effect of this integration can be enhanced based on the trust earned through forming a partnership for this very purpose [7].

According to Jansen et al. [8], innovation types can be divided into product, marketing, process, and organizational. Product and process innovation can be classified as technological innovations, whereas organizational and marketing innovations are nontechnological. In particular, product innovation and marketing innovation are business innovation activities that consider external environments. By contrast, organizational and process innovations are business innovations from the inside of the company and a macro-environmental approach for process innovation.

Dyer et al. [9] investigated business people who successfully returned after experiencing business failure caused by failure to innovate. They found that the causes of failures originated from factors within the company, and those who successfully returned were able to do so because they were aware of such factors [10]. The importance of securing behavioral capabilities based on process innovation must be highlighted based on the operation of special management systems and the awareness of the importance of process innovation [11]. However, in contrast to businesses seeking process innovation, the majority of business innovation efforts were stalled or ineffective. Understanding the factors that hinder innovation became vital [12]. Some well-known studies on the factors that held back process innovation included Mani & Chouk [13], who considered that innovation was not accepted because of the subjects' psychological resistance. At the same time, Choi & Williams [14] indicated that cynicism in the organization originated from cynical attitudes toward the organization itself. That is, they did not like innovation being widespread.

For this reason, the existing innovation factors tend to focus on narrow perspectives on specific phenomena without a comprehensive approach to improve factors undermining process innovation. The systematic management of the supply chain for small and medium-sized businesses (SMBs) and efficiency enhancement are further important [15,16], whereas introducing and operating SCM systems are crucial. Therefore, this study examines CPFR, ERP, VMI, and WMS in an SMB influence process innovation and SCM performance.

1.1 Theoretical Background

1.1.1 Strategy for operating an SCM system

SCM integrates more functions, such as product development, marketing, and customer services, enabled by advanced and computerized decision-making support systems, communication, and education.

SCM is an essential tool for e-commerce and is expected to continue its growth, with the ultimately

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integration of CFPR, ERP, VMI, and WMS with SCM at the center.

The most profound effect of introducing CPFR is that it enables precise replenishment planning and innovative logistics to provide competitive advantages based on communication and information sharing relying on trust among partners [17]. CPFR aims to enhance the competitive advantages of not a single company but all participating businesses considering the relationship with partners and the estimated de-mand while emphasizing the establishment of a mutually cooperative system. Cases at Procter & Gamble and Walmart showed that introducing CPFR more efficiently solves the vertical supply chain issues, thereby allowing participating businesses to operate with higher efficiency [18].

Numerous studies have reported the desirable effects of CPFR [19–21]. In such studies, CPFR im-proved key performance indicators to enhance the supply chain's competitive edge, including but not limited to, advancing partnerships, cost reduction, real-time information sharing, upgrading customer services, and enhancing information credibility.

VMI is "one of SCM processes which allows sharing of the inventory and intake/release information of the purchaser so that the supplier can take over the inventory management function of the purchaser, which can then enjoy reduced stocks and stable provision of products" [22]. VMI can be understood as a scheme where the order placement process is omitted between a purchaser and supplier on the supply chain. One of the factors crucial for operating SCM is to eliminate unnecessary steps in a supply chain, which can have potential benefits, such as removing the delaying factors in the flow of information and decision-making at a higher level in the supply chain [23].

When a product is required, the traditional process involves placing a purchase order to the supplier. Here, the purchaser determines the volume and frequency of these orders based on its inventory management. In VMI, the supplier uses the Internet or EDI to monitor the purchaser's inventory information and purchasing information. The supplier may access POS information and the entirety of the information related to the products supplied by it and held at the purchaser. The gathered information can be used as a basis to estimate the demand. Furthermore, such a sales analysis and estimation of demands serve as a basis to determine the supply volume used to create purchasing orders and provide the purchaser with products [24].

A WMS is a system developed to ensure more a precise management of inventory. Therefore, it cannot be operated independently and is related closely to other systems. A company manufacturing and selling its products must establish a consumption plan for its materials based on volume, types, and time in production plans to ensure that it can order, purchase, and intake the shortfalls in inventory. The sales or accounting system shows the inventory intakes status and allows monitoring the number of items available for sale. Moreover, when an order enters the system from sales activities, the sales system sends information to the WMS as the pending release information, which is followed by the release activities from the WMS. Once the product release is completed, the results are returned to the sales, accounting, and pro-duction systems [25].

The WMS is closely related to sales, production, and accounting systems and is operated as information and physical inventories move. The interface between the WMS system and the ERP, where sales, accounting, and production systems are combined, is essential.

1.1.2 Process innovation

Cleff & Rennings [26] divided innovation into process and product innovations depending on the scope of innovation. This aspect of innovation is related to planning production activities based on a product; it depends on the changes in the market environment and reflects the principle of the production ecosystem, wherein a product must be updated or planned on a continued basis. Process innovation is closely related to the company's product life cycle (PLC), with a regulating function reducing the frequency of new product development or prolonging the period. Process innovation can further be deemed a limiting device that prevents excessive spending in R&D or reduces the likelihood of a failure in product development.

In a practical sense, tendencies in the manufacturers' operations include extending the product ecological environment to consider the product's life cycle and maximizing the efficiency in production processes. Most companies with such competitive advantages manifest innovative operations based on PLM operations. PLM is a PLC management system based on information technologies. It is a comprehensive management system covering a product's entire life cycle, starting from the designing phase to production,

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sales, maintenance, and more. It is also a system capable of managing the processes at the corporate level and monitoring the information on products, workers, technologies, and processes [27,28].

Especially in the case of process innovation, it can be interpreted from the perspective of technological innovation, which requires improvement or complementation to enhance process efficiency for the company's products. The organizational and functional innovation of a company is sought after to invigorate this kind of innovation. Also, process innovation is, according to Ettile & Pavlou [29], is more focused on dynamic aspects, such as developing a new product or expanding to a new market, based on new inventions, improvement, expansion, or other technological changes in production methods. So, the process innovation of a company is an essential part of business innovation that a business must secure [30].

For this reason, companies with competitive advantages have been utilizing their resources and capabilities in seeking process innovation and developing them into the dynamic competencies of the business. Regarding this perspective, Seong & Kim [31] applied design thinking for factory logistics innovation based on specialty steel production processes and established the principles of innovation for identifying logistical issues and root causes to achieve desirable results. For example, Lee et al. [32] established a cell system based on the assembly process of electronics to overcome the existing process operations with limitations: assembly works were performed manually by workers in each process in the past. They selected a production method, where a worker was responsible for multiple processes to enhance efficiency in process operations. Moreover, Lee [33] applied a Six Sigma process innovation system to a capacitor (CAP) production line, with a focus on S company (a South Korean SMB), to reduce the processes' defect rate by 61.6%, reduce overall equipment efficiency by 28.1%, and increase production volume by 51.6%.

1.1.3 SCM performance

SCM integration is a collaborative practice of managing the processes between companies or within a company. This means the degree of strategic collaboration between the partners in a supply chain. SCM integration intends to reduce cost while promptly providing customers with the highest value by creating an efficient and effective flow for products, information, fund, service, and decision-making. With the integration of the supply chain, the lead time is reduced, and coordination capabilities are increased. This also reduces the cost while the interdependent decision-making process is streamlined, enhancing the participants' overall performance in the supply chain [34].

The integration of the supply chain is, in its structure, divided into the three aspects of supplier integration, internal integration, and customer integration. Internal integration is the level of synchronization of the organizational processes, execution, and actions for meeting a customer's requirements and organizing them into collaborative and manageable processes. Supplier integration is the collaborative process and interactions to ensure an efficient supply flow between suppliers and the organization. Customer integration is the collaborative process and interactions to ensure an efficient supply flow between customers and the organization.

Close interactions with the customer are required to achieve a high level of customer integration. Therefore, a shift from a product orientation to customer orientation is essential. According to preceding studies, customer integration has been found to impact the performance of a business.

Hendricks et al. [35] argued that SCM alone is not enough to maximize business performance, and they emphasized the need for additional internal processes, including innovation or operating competencies. In the relationship between the performance of a business and SCM, designing the SCM to ensure proper utilization of operating competency is essential. In addition, preceding studies found that CRM and SCM, the activities to secure relational assets with the outside, impact the performance of a business.

Flexibility is defined as the ability of a business, key suppliers, and consumers to respond quickly to changes in the market. Flexibility is crucial, as an organization with flexibility can respond efficiently to a sudden change in supply or demand or sudden turmoil in the supply chain.

The business ecosystem never stops changing, and flexibility, which is a concept that is being discussed strategically, is a necessary factor for a business's decision-making or when seeking mutual understanding and compromise between organizations [36].

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2. MATERIALS AND METHODS

2.1 Research Model

CFPR, ERP, VMI, and WMS were used in this study as independent variables. Process innovation was used as the mediating variable to verify the impact of the operating strategy of the SCM system of an SMB upon process innovation and SCM performance through empirically verifying the impact on SCM performance through a study model, as shown in Figure 1.

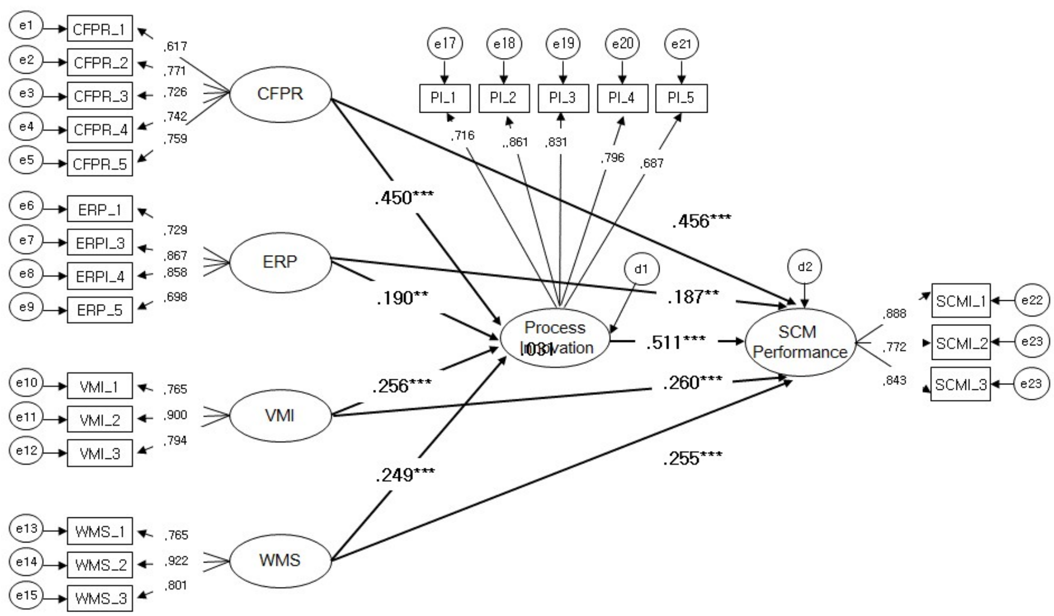

Figure 1: Research model

2.2 Questionnaires

The questionnaire used in this study was composed as shown in Table 1.

Table 1: Questionnaire Composition

Item	Number of questions	Reference	Measure
CFPR	8	Jung & Jung [37]; Min et al. [38]; Lee [7]	5 Likert
ERP	8		
VMI	6		
WMS	6		
Process innovation	7	Yam et al. [39]; Lee [15]	
SCM Performance	5	Sun et al. [41]; Lee & Kim [42]	
General Characteristics	5	-	Nominal scale

2.3 Hypothesis Setting

Because of the limitations in a quantitative study themed on integrated logistics, there are limitations in explaining the direct relationship for this study's hypotheses. However, it was possible to indirectly infer the possibility of a significant impact on a company's process innovation, based on the examination of the technical aspects that are required to introduce/establish a successful system of logistics from many pre-ceding studies in the process of classifying process innovation factors of integrated [43].

Fengque et al. [44] also emphasized a smart factory's core technologies, technical elements, and structural diagram. Furthermore, in the final application stage, various applications and devices impact innovative performances through their

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successful introduction, including direct involvement in production. Therefore, because the application of integrated logistics can lead to improvement and innovation, the following hypotheses were established:

H1. CFPR would have a positive impact on SCM performance.

H2. ERP would have a positive impact on SCM performance.

H3. VMI would have a positive impact on SCM performance.

H4. WMS would have a positive impact on SCM performance.

H5. CFPR would have a positive impact on process innovation.

H6. ERP would have a positive impact on process innovation.

H7. VMI would have a positive impact on process innovation.

H8. WMS would have a positive impact on process innovation.

H9. Process innovation would have a positive impact on SCM performance.

H10. Process innovation would have a mediating effect on the relationship between CFPR and SCM performance.

H11. Process innovation would have a mediating effect on the relationship between ERP and SCM performance.

H12. Process innovation would have a mediating effect on the relationship between VMI and SCM performance.

H13. Process innovation would have a mediating effect on the relationship between WMS and SCM performance.

2.4 Samples and Data Collection

This study prepared questions for each variable and conducted an online survey from August 11 to September 30, 2021. The data was gathered from South Korean SMBs, where SCM was performed. A total of 420 questionnaires were distributed, and after removing incomplete or missing results, 243 responses were used in the analysis. After gathering the data through a survey, IBM SPSS 24.0 and AMSO 24.0 programs were used to conduct frequency analyses. The data credibility and validity were checked, and a structural equation analysis was performed. The results indicated that 36.5% of the participants were in the automobile industry, 41.0% in the shipbuilding/aviation/heavy equipment industry, 18.7% in electronics/electricity, and 3.8% in other industries.

3. RESULTS

3.1 Verification of Validity and Reliability

3.1.1 Exploratory factor analysis and verification of reliability

Exploratory factor analysis was conducted to verify the validity of this study's CFPR, ERP, VMI, and WMS measurements. Principal component analysis was conducted in factor analysis, and the rotation of the factor was varimax. Cronbach's α value, which indicates the internal consistency between items that constitute the factors extracted through factor analysis, was also calculated for reliability verification. In general, a Cronbach's α value above 0.60 can be considered reliable.

First, the results of exploratory factor analysis and reliability analysis on the measurement items of CFPR, ERP, VMI, and WMS are shown in Table 2. Factor analysis removed three measurement items with low factor loading or high load on factors with different research concepts. The Kaiser–Meyer–Olkin (KMO) value for determining sample fit was 0.871. Bartlett's sphericality verification results showed significant values; thus, the collected data and measurements are suitable for factor analysis. The factor analysis extracted three factors, with a total explanation of variance of 69.248%. Factor 1 is a "CFPR" factor, and the dispersive explanation is 27.339%. Factor 2, an "ERP" factor, is 23.567%; Factor 3, a "VMI" factor, is 18.342%; and Factor 4, a "WMS" factor, is 18.342%. These factors confirm the validity of measured items.

Table 2: Factor Analysis and Reliability Verification of CFPR, ERP, VMI, and WMS

Factor	Item	Factor Loading				Cronbach's α
		Factor 1	Factor 2	Factor 3	Factor 3	
CFPR	CFPR_2	.863	.118	.139		.883
	CFPR_3	.847	.167	.188		
	CFPR_5	.765	.205	.128		
	CFPR_1	.720	.066	.246		
	CFPR_4	.710	.232	.226		
ERP	ERP_2	.120	.847	.024		.845
	ERP_1	.144	.790	.104		
	ERP_6	.270	.750	.095		
	ERP_5	.276	.736	.061		
	ERP_3	.384	.674	.022		
VMI	VMI_1	.142	.146	.856		.877
	VMI_2	.293	.011	.856		
	VMI_3	.217	.033	.844		
WMS	WMS_1	.142	.146	.156	.840	.840
	WMS_3	.293	.011	.256	.829	
	WMS_2	.217	.033	.244	.788	
Eigen Value		3.554	3.064	2.384		
Variance(%)		27.339	23.567	18.342		
Total Variance(%)		27.339	50.906	69.248		
KMO(Kaiser–Meyer–Olkin) =.871 Bartlett's Sphericity: Approximated $\chi 2$ = 2,247.479 (df = 78, p =.000)						

Further, the reliability of the items that make up the CFPR, ERP, VMI, and WMS was verified, as Cronbach's α values were CFPR .883, ERP 0.845, VMI 0.877, and WMS 0.840, indicating that all factors are internally consistent.

The results of the exploratory factor analysis and reliability analysis on process innovation and SCM performance are shown in Table 3. As a result of exploratory factor analysis, KMO value, 0.864, Bartletts's sphericity, approximated χ^2 = 1,575.4420(df = 28, p < 0.001), showed that the measurement items were, therefore, suitable for performing factor analysis. Factor analysis showed that no items were removed, and two factors were extracted. The total distributed explanation power was 73.666%. Factor 1, process innovation, had a variance of 42.989%, and factor 2, SCM performance, had a variance of 30.677%; thus, construct validity was confirmed. Next, the Cronbach's α value of process innovation was 0.829, and the Cronbach's α value of SCM performance was 0.850. Therefore, it consisted of

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items with internal consistency, and the reliability was confirmed.

Table 3: Factor Analysis and Reliability Verification of Process Innovation and SCM Performance

Factor	Item	Factor Loading		Cronbach's α
		Factor 1	Factor 2	
Process Innovation	PI_1	.749	−.202	.829
	PI_3	.801	−.296	
	PI_2	.867	−.218	
	PI_4	.810	−.261	
	PI_5	.685	−.312	
SCM Performance	SCMI_1	−.394	.739	.850
	SCMI_2	−.171	.903	
	SCMI_3	−.297	.866	
Eigen Value		3.439	2.454	
Variance(%)		42.989	30.677	
Total Variance(%)		42.989	73.666	
KMO(Kaiser–Meyer–Olkin) = 0.864 Bartlett's Sphericity: Approximated $\chi2$ = 1575.442 (df = 28, p = 0.000)				

3.1.2 Confirmatory factor analysis

A confirmative factor analysis was conducted on the measurement model to verify the convergence validity of research variables: CFPR, ERP, VMI, WMS, process innovation, and SCM performance. Having an analytical basis without being sensitive to the sample's size and selecting an appropriate fit index con-sidering the model's simplicity to evaluate the fit of a measurement model are crucial [45]. This study evaluated the model's fit through goodness-of-fit indices, such as $\chi2$ value, standardized root mean square residual (SRMR), Tucker–Lewis index (TLI), comparative fit index (CFI), and root mean square error or approach (RMSEA). The revised index was reviewed through a confirmatory factor analysis, and item no. 2 from "ERP" was removed. From the fit of the measurement model in Table 4, $\chi2$ = 426.108 (df = 160, p < 0.001), SRMR = 0.047, TLI = 0.923, CFI = 0.935, RMSEA (90%CI) = 0.059 (0.051–0.067), and so on, thereby showing good fit and indicating that the measurement model is suitable. Moreover, the factor loading of all variables was statistically significant (p < 0.001), the standardized factor loading was higher than 0.50, and no negative theoretical variance was found.

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Table 4: Confirmative Factor Analysis of the Variables

Variable			Non-standardized Factor Loading	Standard Error	Standardized Factor Loading	Variance of Error	t	Construct Reliability (C.R.)	Average Variance Extracted (AVE)
CFPR	→	CFPR_1	1.000	-	.617	.344	-	.863	.564
	→	CFPR_2	1.625	.156	.771	.379	10.428***		
	→	CFPR_3	1.733	.173	.726	.571	10.000***		
	→	CFPR_4	1.420	.140	.742	.347	10.162***		
	→	CFPR_5	1.611	.156	.759	.404	10.315***		
ERP	→	ERP_1	1.000	-	.729	.573	-	.855	.604
	→	ERP_3	1.182	.083	.867	.300	14.317***		
	→	ERP_4	1.013	.071	.858	.239	14.208***		
	→	ERP_5	.896	.077	.698	.547	11.628***		
VMI	→	VMI_1	1.000	-	.765	.483	-	.846	.654
	→	VMI_2	1.201	.081	.900	.229	14.858***		
	→	VMI_3	.961	.069	.794	.369	13.858***		
WMS	→	WMS_1	1.000	-	.765	.481	-	.837	.652
	→	WMS_2	1.187	.083	.922	.231	14.857***		
	→	WMS_3	.988	.071	.801	.370	13.856***		
Process Innovation	→	PI_1	1.000	-	.716	.436	-	.903	.660
	→	PI_3	1.049	.076	.831	.227	13.756***		
	→	PI_2	1.117	.078	.861	.199	14.227***		
	→	PI_4	1.001	.076	.796	.265	13.207***		
	→	PI_5	.941	.083	.687	.455	11.404***		
SCM Performance	→	SCMI_1	1.000	-	.888	.145	-	.909	.776
	→	SCMI_2	.801	.050	.772	.234	16.013***		
	→	SCMI_3	1.035	.057	.843	.233	18.257***		

$\chi2$ = 426.108 (df = 160, p =.000), SRMR =.047, TLI =.923, CFI =.935, RMSEA (90%CI) =.059 (.051–.067)

***p <.001

To further examine the convergent validity of the variables, the construct reliability (CR) and average variance extracted value (AVE) were evaluated. First, as shown in Table 5, the CR value of all variables is higher than 0.70: CFPR (0.863), ERP (0.855), VMI (0.846), WMS (0.837), process innovation (0.903), and SCM performance (0.909). The AVE values of all variables were also found to be greater than.50: CFPR (0.564), ERP (0.604), VMI (0.654), WMS (0.652), process innovation (0.660), and SCM performance (0.776). Therefore, convergent validity was identified.

Finally, the discriminant validity between the variables was examined. Comparing the squared values of the correlation coefficients and AVE values given in Table 5, the discrimination between the variables was less than the squared value (0.523) of the correlation coefficients (0.723) between the highest correlation between process innovation and SCM performance. The correlations among CFPR, ERP, VMI, and WMS showed significant positive correlations with process innovation, and it further showed a significant positive correlation with SCM performance. Process innovation showed a significant positive correlation with SCM performance.

Table 5: Correlations between the Variables

Variable	CFPR	ERP	VMI	WMS	Process Innovation	SCM Performance
CFPR	.564					
ERP	.461***	.604				
VMI	.209**	.501***	.654			
WMS	.213**	.455***	.222**	.652		
Process Innovation	.597***	.528***	.450***	.467***	.660	
SCM Performance	.698***	.380***	.297***	.312***	.723***	.776

**p <.01, ***p <.001,

Note: The values on diagonal line mean AVE

3.2 Verification of Research Hypotheses

A structural equation model analysis was conducted to validate the research hypothesis, and the parameter estimation method used maximum likelihood estimation. First, the fitness of the research model was analyzed. Table 6 shows the results indicating that $\chi2$ = 428.110 (df = 158, p < 0.001), SRMR = 0.046, TLI = 0.921, CFI = 0.933, and RMSEA = 0.057. Therefore, the research model's fit was excellent and was determined to be the best fit acceptable for the research results.

Table 6: Fitness of the Research Model

$\chi2$	df	p	SRMR	TLI	CFI	RMSEA (90%CI)
428.110	158	.000	.046	.921	.933	.057(.049～.065)

Table 7 provides the verification results of research hypotheses H1–H9 to verify the effects of CFPR, ERP, VMI, and WMS on process innovation and SCM performance and the effect of process innovation on SCM performance.

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Table 7: Verification Result of Research Hypotheses H1–H9

H	Path			Non-standardized Coefficient	Standard Error	Standardized Coefficient	t(C.R)	p
H1	CFPR	→	SCM Performance	.373	.111	.456	6.185	.000
H2	ERP	→	SCM Performance	.157	.061	.187	2.682	.006
H3	VMI	→	SCM Performance	.212	.048	.260	4.079	.000
H4	WMS	→	SCM Performance	.209	.054	.255	4.066	.000
H5	CFPR	→	Process Innovation	.381	.120	.450	6.177	.000
H6	ERP	→	Process Innovation	.160	.067	.190	2.679	.005
H7	VMI	→	Process Innovation	.230	.053	.256	4.167	.000
H8	WMS	→	Process Innovation	.204	.048	.249	4.051	.000
H9	Process Innovation	→	SCM Performance	.529	.085	.511	6.643	.000

Looking at the verification results of the research hypothesis H1–H4, which assumed that CFPR, ERP, VMI, and WMS affect SCM performance, CFPR (standardized path coefficient = 0.456, t = 6.185, p < 0.001), ERP (standardized path coefficient = 0.187, t = 2.682, p < 0.01), VMI (standardized path coefficient = 0.260, t = 4.079, p < 0.001), and WMS (standardized path coefficient = 0.255, t = 4.066, p < 0.001) have a significant positive effect on SCM performance. Therefore, research hypotheses H1–H4 were adopted. The results of the verification of the research hypothesis H5–H8, which assumed that CFPR, ERP, VMI, and WMS affect process innovation, indicate that CFPR (standardized path coefficient = 0.450, t = 6.177, p < 0.001), ERP (standardized path coefficient = 0.190, t = 2.679, p < 0.01), VMI (standardized path coefficient = 0.256, t = 4.167, p < 0.001), and WMS (standardized path coefficient = 0.249, t = 4.051, p < 0.001) have a significant positive effect on process innovation. Thus, research hypotheses H5–H8 were adopted. The verification results of research hypothesis H9, which assumed that process innovation affects SCM performance, showed that process innovation (standardized path coefficient = 0.511, t = 6.643, p < 0.001) has a significant positive effect on SCM performance. Therefore, research hypothesis H9 was also adopted.

Bootstrapping was performed to analyze the indirect effects of CFPR, ERP, VMI, and WMS on SCM performance by mediating process innovation to verify research hypotheses H10–H13, which assumed the mediating effects of process innovation in the relationship between CFPR, ERP, VMI, WMS, and SCM performance. Bootstrapping is a method of estimating the distribution of parameters based on sample data without knowing the distribution of the sample data. When the 95% confidence interval (CI) does not contain zero, it is considered significant at the level of 0.05. Table 8 shows the bootstrapping results.

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Table 8: Verification Result of Research Hypothesis H10–H13

H	Path					Indirect Effect (bootstrapping)				
						Non-standardized Coefficient	Standard Error	Standardized Coefficient	95%CI	*p*
H10	CFPR	→	Process Innovation	→	SCM Performance	.364	.088	.227	(.223∼.564)	.00
H11	ERP	→	Process Innovation	→	SCM Performance	.085	.041	.092	(.019∼.174)	.008
H12	VMI	→	Process Innovation	→	SCM Performance	.326	.067	.288	(.245∼.664)	.000
H13	WMS	→	Process Innovation	→	SCM Performance	.334	.078	.274	(.235∼.598)	.000

*bootstrapping sampling (N=2,000)

After verifying the mediating effect of process innovation, CFPR→ process innovation→SCM per-formance (standardized path coefficient = 0.227, 95%CI: 0.223–0.564, p < 0.001), ERP→process innovation→SCM performance(standardized path coefficient = 0.092, 95%CI: 0.019–0.174, p < 0.01), VMI→process innovation→SCM performance (standardized path coefficient = 0.288, 95% CI: 0.245–0.664) and VMI→process innovation→SCM performance (standardized path coefficient = 0.274, 95% CI: 0.235–0.598) showed that no zeroes were included in the 95% confidence interval. These results validate that CFPR, ERP, VMI, and WMS affect SCM performance by mediating process innovation. Therefore, research hypotheses H10–H13 were adopted. Combining the aforementioned results, CFPR, ERP, VMI, and WMS affect SCM performance and SCM performance by mediating process innovation; therefore, the partial mediating effect has been confirmed.

4. CONCLUSION

This study's findings supported Siagian et al. [40] and Dey et al. [46], where the interactions between producers and consumers can increase values. This is an empirical study based on statistical analyses to reprove the existing studies explaining the causal relationship between process innovation and integrated logistics. This study further supports the conclusion that applying the technologies discussed herein can be an essential factor in a successful SCM's innovation performance. Moreover, the results of the empirical study verified preceding studies [42] that emphasized a technological system related to integrated logistics, which again highlighted its importance. Therefore, based on such findings, setting future directions and enhancing awareness on process innovation in small or medium-sized manufacturers are essential for integrated management in an SMB.

Additionally, promotion of the needs market should be preceded by industrial sync efficiency, busi-ness model, and development of logistics standards. Furthermore, it is necessary to re-establish a master plan to realize integrated logistics for small- and medium-sized manufacturing businesses and develop a road map to follow up and accelerate the government's commercialization and development promotion policies. Further developments include the domestic industrial–academic–research community study projects to develop technology-based devices, platforms, and software.

Therefore, applying an integrated model from order placement to shipping to develop a manufacturing innovation mindset and applying technologies by using systems are crucial to ensure that SMBs can apply and improve optimized and integrated logistics solutions.

Finally, this study used a limited survey, and the findings cannot be generalized across the country. Therefore, future studies must use diversity samples reflecting the technological factors of various smart factories, thereby going beyond the existing limitations.

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