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Corporation's Characteristics and LIS(Logistics Information System) Strategies

Soo Wook Kim*
Seoul National University
Seoul, Korea

Abstract

Logistics Information System(LIS) is known as a critical factor in achieving logistics competitiveness. Most corporations, however, do not seem to have clear strategies in meeting the information systems requirements of this decade. This is partly due to a lack of understanding about the causal relationship between a corporation's characteristics and logistics information system priorities. In this paper, a set of advisable strategies for LIS utilization is derived from a relationship analysis conducted by means of LISREL.

From the analysis on 244 sample firms, this study finds that the utilization of LIS most directly affects logistics performance, while the utilization of LIS indirectly may affect performance by using a corporation's characteristics as an intermediate mechanism, and that such indirect utilization of LIS has greater influence on logistics performance than the direct utilization of LIS. Based on the above finding, this study suggests that the utilization strategy of LIS should be established in the direction of Support function LIS Primary function LIS → Connection function LIS.

Keywords: Logistics Information System, Support Function LIS, Primary Function LIS, Connection Function LIS.

1. Introduction

With a recent rise in the importance of logistics rationalization as the last measure in strengthening corporate competitiveness,

* Assistant Professor of Operations Management, College of Business Administration, Seoul National University(Kimsoo2@snu.ac.kr).

the construction of integrated LIS has been in keen demand in order to effectively achieve logistics rationalization. Many corporations, however, are not adequately meeting this demand. One of the main reasons for this is that the construction and utilization strategy of LIS do not take into consideration a corporation's goals and specifications. This is partly because managers often do not realize that the utilization performance of LIS can differ according to corporate characteristics such as the corporation's strategy, the type of logistics organization, and the level of logistics technology and logistics administration ability. Therefore, the accurate understanding on the relationship between LIS utilization and various corporate characteristics is very meaningful. In this respect, this study suggests an advisable LIS utilization strategy through an examination of the relationship between LIS utilization, logistics performance, and a corporation's characteristics.

This paper is organized as follows. Section 2 refers to the necessity of relationship analysis between LIS and a corporation's characteristics, and in section 3, research model components of this study and related studies are introduced. In section 4, after establishing the model setting and outlining hypotheses, research methodology used for testing the above hypotheses is presented. Section 5 analyzes the relationship model by means of LISREL, and characterizes a set of advisable strategies for LIS utilization through additional experiment. Finally, concluding remarks are given in section 6.

2. The Necessity of Relationship Analysis between LIS and Corporation's Characteristics

According to Moon(1994), a corporation's decision making on logistics is based on the following three concepts: The first is the *total cost* concept in which a decision is made through an analysis of the trade-off relation between service level and logistics cost. Second is the *scalar decision making* concept, where short- and long-term characteristics of decision making on logistics are considered by classifying whether such decisions have characteristics that are long-term and strategic or short-term and tactical. The third is the *integrated logistics*

management concept covering all processes related to logistics from raw material supply to final product delivery. This concept refers to logistics system from the viewpoint of supply chain management.

The above three concepts provide the fundamental bases for examining the significance of LIS utilization and the direction in which LIS should be utilized. The first decision-making concept proposes that LIS should be used to maximize logistics performance such as logistics cost and customer service. The second concept suggests that decision making on the utilization of LIS should be made by sufficiently considering the scalar fit relation between LIS and a corporation's characteristics, including its general and functional characteristics related to logistics. Finally, the third concept dictates that the utilization of LIS should be made in a direction in which logistics functions are integrated and rationalized in terms of supply chain management through an efficient connection between the internal supply chain and external entities such as suppliers and customers as well as among a corporation's internal functions.

With respect to hierarchical congruent relations between LIS utilization and a corporation's characteristics, the scalar concept in particular can be regarded as the most important part of LIS utilization. This is because the direction for integration and operation by function of LIS as well as the effect of LIS utilization on logistics performance may vary depending on the type of relationship between the utilization of LIS and a corporation's characteristics, and also a corporation's characteristics affecting the effective utilization of LIS can be accurately analyzed and managed through this relationship (Stock and Lambert 1993).

3. Research Variables

A corporation's characteristics that influence the relationship between LIS utilization and logistics performance can be divided into company-level characteristics representing the overall structure of a corporation and functional characteristics representing the company's logistics capability. The strategic

capability of a corporation and the status of its logistics organization can be considered company-level characteristics, while logistics technology and logistics administration ability can be regarded as functional characteristics.

3.1. LIS Utilization

Managing logistics functions through information technology makes it possible to attain higher efficiency and performances than the existing effectiveness-oriented logistics management system. This is because LIS utilization ultimately provides an incentive for growth through the strengthening of overall competitiveness as well as simply the benefits of cost reduction and high quality(Groover and Wiginton 1984, Kaeli 1990, Kaltwasser 1990, Kaplan 1986, Shull 1987 Sullivan 1985). Previous authors claim that LIS utilization is essential in generating competitiveness and plays a crucial role in the development of logistics as a management discipline(Stenger 1986, Stock and Lambert 1993). Bowersox(1990) and Germain (1989) verified empirically that logistics performance is higher for corporations more susceptible to the innovation of logistics information technology, while Bardi, Raghunathan and Bagghi (1994) assert that LIS determines the efficiency and competitiveness of a company in the marketplace, as well as its ability to optimize logistics costs and service levels. Williams, Nibbs, Irby and Finley(1997) insist that LIS utilization can make both suppliers and buyers more cost, product, and process efficient, which translates into advantages over their competitors.

3.2. Strategic Capability

The strategic capability of a corporation, which has thus far been a recurrent thesis in studies on structural relations, is a substantial characteristic in that a company's strategic characteristics are tightly bound with its functional decision-making activities(Kotha and Orne 1989). The strategic capability of a corporation indicates the corporation's competency level within its industry. The level of competition shows the corporation's competitive position and the level of competitive superiority within a specific industrial category, and competitive

status of a corporation carries significant meaning on the suggestion of strategic direction(Montanari 1978). Robertson and Gatignon(1985) also argue that adopting technical innovation is highly correlated with the competitive environment of suppliers and customers.

Therefore, from this perspective, the proliferation of logistics information technology for the effective execution of logistics activities can be seen as closely related to the competitive business climate of suppliers and customers. Lenz and Engledow(1986) back up such assertion. They contend that individual corporations gain distinct levels of competency through opportunities and risks resulting from industrial environment, and the competitive position of a corporation within an industry has much to do with the acceptance of information technology.

3.3. The Status of Logistics Organization

The problem on the status of logistics division can also be linked to LIS utilization by presenting the following two research questions. The first question is on the necessity and position of an exclusive division in charge of logistics activities within the organization, which should be dealt with in order to determine how the institution of systematic logistics organization affects the improvement of LIS utilization performance. The second question is concerned with whether the logistics division takes responsibility for the utilization of LIS, and which relationship it has with the existing information system division. This is also an important research subject in that the effective utilization of LIS may be decided upon by the clarity of authority and responsibility on LIS and organizational relationships between the two divisions.

Scholars have conflicting opinions over the effects that the level of formalization and centralization of logistics organization have on LIS utilization(Bowersox et al. 1989, Kotha and Orne 1989, Zaltman et al. 1973). Ein-Dor and Segev(1978) and Raymond(1985) assert that a formalized logistics organization leads general logistics activities and institutes regulations and procedures which facilitate daily decision-making. They also contend that more formalized corporations have more

sophisticated information systems and corporations with more advanced information systems utilize information technology more effectively.

Fredrickson(1986), on the other hand, argues that even though a high degree of formalization may eliminate the ambiguity of roles, it restricts the organization members' discretionary rights in decision-making and disturbs the pursuit of new opportunities and innovation. Webster(1970) points out that a strict and extremely formalized mechanical organization cannot accept innovation, whereas Sapolsky(1967) states that although an organization with a low degree of formalization and centralization is far more open to and accepts innovation, it is difficult to actually put into practice. Kennedy(1983) also comments that the effects of formalization depend upon the stage of innovation process, and that an organization is more susceptible to innovation when it is less formalized in its beginning stages. Germain, Droge and Daugherty(1989) discovered that corporations with decentralized organizational structures utilize computers less than do those with centralized structures, through studies on logistics-related computer software and information variables. Their study indicates that centralization may increase the possibility of accepting and seeking innovation in logistics information technology. On the other hand, Fredrickson(1986) claims that centralization, in general, delays the initiation of decision-making. Moch and Morse(1977) and Kennedy(1983) also claim that centralization has a negative effect on the acceptance of technology innovation.

3.4. Logistics Technology Level and Logistics Administration Ability

Logistics technology can be considered as the infrastructure of logistics to support the efficient execution of logistics activities. Logistics administration ability is defined as the level of basic activities that are prerequisites for the implementation and control of logistics activity(Lynagh and Poist 1984). Bowersox (1990) classifies logistics management into logistics management as a technology, which stresses traditional logistics management concept as a logical experiment on logistics management techniques, and logistics management as a system, which adjusts and manages logistics service improvement activities

from top management with respect to integrated management. Ballou(1985) defines logistics management as "logistics activities implemented to meet demands of customers or a method and system used to economically realize services".

Viewed in the above perspectives, logistics technology and logistics administration ability are essential elements that should be dealt with on a comprehensive, company-wide level rather than on an individual or sectional dimension in that the systemization and rationalization of those two factors may independently affect logistics performance and LIS utilization.

3.5. Logistics Performance

Performance measurement in logistics is critical because of the following two reasons: First, performance measurement makes it possible to implement trade-off analysis on logistics cost and customer service(Tyworth 1992). Second, performance measurement is directly related to a corporation's overall business activities such as profitability or market share. Accordingly, a study on which criteria should be used to measure logistics performance and how it should be used can be treated as the most critical issue in promoting logistics efficiency (Kearney 1985).

Among the theories on logistics performance measurement, Germain(1989) developed a measurement matrix of logistics performance by dividing subjects into performance focus and strategic focus, further classifying performance focus into internal performance and external performance and classifying strategic focus into cost access and differentiation access. Kearney(1985) presents productivity, utility, and performance as the three categories to evaluate the functionality of logistics, where productivity is defined as the ratio of output to actual input, utility as the ratio of actual used capacity to available capacity, and where performance is measured by the ratio of actual output to base output.

Meanwhile, Sterling and Lambert(1985) suggest logistics cost and customer service as the most generalized standards for the evaluation of a logistics system, whereas Mentzer and Konrad (1991) assert that logistics performance should be analyzed according to effectiveness and efficiency. Collier(1977) relates

Table 1. Summary of Research Variables

Variable	Description	Literature
LIS Utilization	LIS utilization ultimately provides an incentive for growth through the strengthening of overall competitiveness as well as simply the benefits of cost reduction and high quality.	Kaeli(1990), Kaltwasser (1990), Kaplan(1986), Shull (1987) Sullivan(1985)
	Logistics performance is higher for corporations more susceptible to the innovation of logistics information technology.	Bowerso(1990) and Germain (1989)
	LIS determines the efficiency and competitiveness of a company in the marketplace, as well as its ability to optimize logistics costs and service levels.	Bardi, Raghunathan and Bagghi(1994)
	The utilization of LIS can make both suppliers and buyers more cost, product, and process efficient, which translates into advantages over their competitors.	Williams, Nibbs, Irby and Finley(1997)
Strategic Capability	A company's strategic characteristics are tightly bound with its functional decision-making activities.	Kotha and Orne(1989)
	The competitive status of a corporation carries significant meaning on the suggestion of strategic direction and on corporation's performance.	Montanari(1978)
	Adopting technical innovation is highly correlated with the competitive environment of suppliers and customers.	Robertson and Gatignon (1985)
	The competitive position of a corporation within an industry has much to do with a corporation's acceptance of information technology.	Lenz and Engledow(1986)
The Status of Logistics Organization	More formalized corporations have more sophisticated information systems and corporations with more advanced information systems utilize information technology more effectively.	Ein-Dor and Segev(1978) and Raymond(1985)
	A high degree of formalization restricts the organization members' discretionary rights in decision-making and disturbs the pursuit of new opportunities and innovation.	Fredrickson(1986)
	A strict and extremely formalized mechanical organization cannot accept innovation.	Webster(1970)

Table 1. Continued

Variable	Description	Literature
	Although an organization with a low degree of formalization and centralization is far more open to and accepts innovation, it is difficult to actually put into practice.	Sapolsky(1967)
	An organization is more susceptible to innovation when it is less formalized in its beginning stages.	Kennedy(1983)
	Centralization may increase the possibility of accepting and seeking innovation in logistics information technology.	Germain, Droge and Daugherty(1989)
	Centralization delays the initiation of decision-making.	Fredrickson(1986)
	Centralization has a negative effect on the acceptance of technology innovation.	Moch and Morse(1977) and Kennedy(1983)
Logistics Technology Level and Logistics Administration Ability	Logistics technology and administration ability are prerequisites for the implementation and control of logistics activity.	Lynagh and Poist(1984)
	Logistics management could be classified into logistics management as a technology and logistics management as a system.	Bowersox(1990)
	Logistics management is activities implemented to meet demands of customers or a method and system used to economically realize services.	Ballou(1985)
Logistics Performance	Performance measurement makes it possible to implement tradeoff analysis on logistics cost and customer service.	Tyworth(1992)
	Performance focus is classified into cost access and differentiation access.	Germain(1989)
	Logistics cost and customer service as the most generalized standards for the evaluation of a logistics system.	Sterling and Lambert(1985)
	Logistics performance should be analyzed according to effectiveness and efficiency.	Mentzer and Konrad(1991)
	Logistics performance is related to the performance of new product development.	Collier(1977)
	Objective-oriented and process-oriented evaluations should be carried out concurrently in order to measure MIS performance.	Seashore and Yuchman (1967)
	Five categories for the evaluation of logistics performance: asset management, expenses, productivity, customer service, and quality.	Bowersox(1989)

logistics performance to the performance of new product development and presents performance criteria of new product development, which is based on financial criteria such as sales rate and objective criteria that determine how much new product development contributes to the achievement of profitability, sales, profit growth rate, and other non-quantified objectives. Seashore and Yuchman(1967) contend that objective-oriented and process-oriented evaluations should be carried out concurrently to measure MIS performance. Bowersox(1989) presents five categories for the evaluation of logistics performance: asset management, expenses, productivity, customer service, and quality. His research is regarded as a representative study in evaluating logistics performance by a non-financial index.

As examined above, previous studies on the measurement criteria of logistics performance do not prove to be consistent. However, if the ultimate objectives of logistics management and LIS utilization are cost reduction and customer service improvement, the measurement criteria of logistics performance should be directly related to such objectives. Therefore logistics cost and customer service, which is the trade-off relationship, can be considered the most important measurement criteria of logistics performance.

4. Methodology

4.1. Research Model and Hypotheses

Structural equation model in Figure 1 is constructed based on the variables described in the preceding section.

This study set hypotheses in the perspective of not explanatory but exploratory, because there is no research to suggest specific causal relationships between the proposed latent variables. The hypotheses in this research describe the direct relationships between variables included in the research model of Figure 1. Therefore, a total of 21 hypotheses are constructed to test the statistical significances of all possible paths between the proposed variables as shown in the figure. LISREL is used for the analysis of the proposed structural

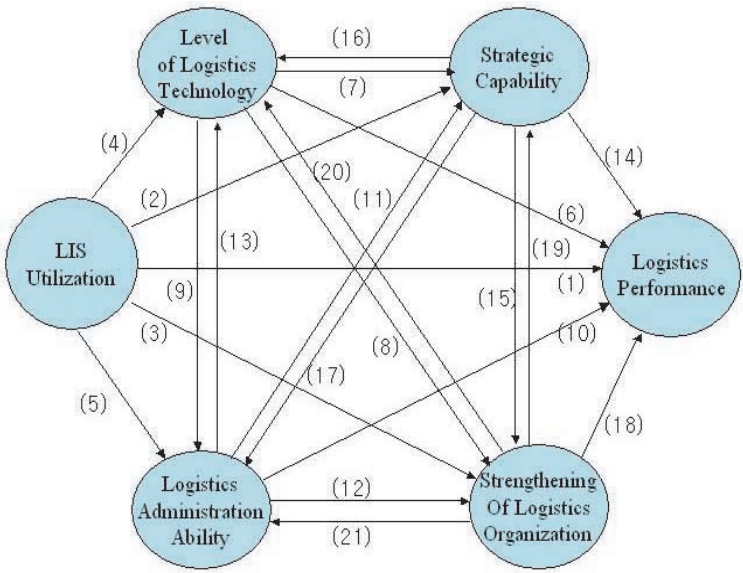

Figure 1. Research Model.

equation model.

4.2. Data Collection

For the purpose of this study, target corporations should be large manufacturing corporations carrying out all functions such as supply, production and distribution, as well as a continued interest and support in logistics management and LIS. Therefore, the necessary data were collected through questionnaires to logistics officers and logistics experts in comparatively large manufacturing corporations among listed and registered corporations, by making visits or mail or facsimile after phone call.

Of 1000 companies, 244 companies replied, representing a collection ratio of 24.4%. Table 2 summarizes the sample characteristics according to industry type and size. As shown in the table, sample corporations in this study have diversified industry types and scales. The diversity of the sample would strengthen the external validity of this study results.

Table 2. Sample Characteristics

		Type of Industry*						
		Consumption Industry	Basic Industrial Material Industry		Electronic and Machinery Industry			Total
No. of Firms		99(40.7%)	81(33.1%)		64(26.2%)			244
		Organization Size						
		Below 50 billion	50-100	100-200	200-500	500-1000	Above 1000	Total
No. of Firms	Sales	18	50	52	70	30	24	244
	Assets	14	34	60	64	38	34	244

* consumption industry: food processing, sweetmeats, pharmaceuticals, footwear, clothes, wood, furniture basic industrial material industry: textile, organic chemical, inorganic chemical, petrochemical, cement, paper, tire, fertilizer, fabric, pulp, metal electronics and machinery industry: computer, home appliances, communication equipment, electronic parts, automobile, automobile parts, machinery.

4.3. Measurements

LIS utilization: In this study, in order to measure the utilization level of LIS, nine categories of traditional functional LIS were identified based on previous researches(Ballou 1985, Gustin 1994, House 1985, Mentzer et al. 1990, Stenger 1986) presenting development and utilization strategies of LIS through the classification of functional LIS: plant and warehouse location selection system, automatic ordering system, procurement information system, production plan and process control system, inventory and warehouse management system, transportation management system, sale and price management system, consumer service and customer management system, forecasting system.

We also added three more sub-functional information systems (the network plan and design system, office information system, and accounting information system) that laterally support the effective utilization of the above nine major functional LIS. So, a total of 12 functional LIS were conceptualized. In order to

measure the utilization level of each of these twelve functional LIS, a seven-point scale was set up as follows by combining Nolan's research(1982) on the growth stage of information systems and Stephens' research(1989) on the integration stage of supply chain management.

No Response	Planning Stage	Initialization Stage	Extension Stage	Functional Integration Stage	Internal Integration Stage	External Integration Stage

Strategic Capability: In this study, 35 measurement variables representing strategic characteristics were constructed based on the works of Porter(1980), Miles and Snow(1978), and Miller and Roth(1989) which are the most representative studies on strategic characteristics that have undergone numerous validation processes by subsequent scholars. After the utilization degrees of these measurement variables were measured with the seven-point Likert scale, they were generalized into several strategic characteristic factors by factor analysis, and "a corporation's strategic capability", a theoretical variable for LISREL, was constructed based on these factors.

Strengthening of Logistics Organization: This study also established three measurement variables of logistics organization(i.e., the degree of complexity, the degree of decentralization, and the degree of formalization) by rearranging three organizational variables commonly dealt with in previous researches(Bowersox et al. 1989, Daft 1986, Dalton et al. 1980, Germain et al. 1989, Ein-Dor and Segev 1978, Evers et al. 1976, Fredrickson 1986, Kennedy 1983, Moch and Morse 1977, Pierce and Delbecq 1977, Pugh et al. 1969, Raymond 1985, Sapolsky 1967, Webster 1970, Zaltman et al. 1973). "Strengthening of logistics organization," a theoretical variable for LISREL analysis, was constructed based on these three variables. In order to measure the level of the above three logistics organizational variables, detailed measurement variables were constructed based on the studies of Robbins(1987), Ford and Slocum(1977), Fredrickson(1986), Bowersox and Daugherty(1987), and measured with the seven-point Likert scale.

Logistics Technology Level: This study also sets up three

Table 3. Measurement Variables

Research Variable	Measurement Items	Reference	Scale
LIS Utilization	-Plant and warehouse location selection system -Automatic ordering system -Procurement information system -Production plan and process control system -Inventory and warehouse management system -Transportation management system -Sale and price management system -Consumer service and customer management system -Forecasting system -Network plan and design system -Office information system -Accounting information system	Ballou 1985, Gustin 1994, House 1985, Mentzer et al. 1990, Stenger 1986	Twelve point scales
Logistics Technology Level	Construction of Logistics Center -The appropriateness of logistics center location -The efficiency in the operation of logistics center Logistics Automatization -Packaging standardization -Transportation mode -Digital Picking system -Unit load system -Automatic retrieval system Application of Advanced Management Technology -Just-In-Time -MRP -DRP(distribution resource planning) -PERT-CPM -CRAFT	Yang(1996), Rao, Stenger and Wu(1994), Germain, Droge and Daugherty(1994)	Seven point Likert scales(Extremely Low-Extremely High)

Table 3. Continued

Research Variable	Measurement Items	Reference	Scale
Logistics Administration Capability	Systematic Construction of Logistics Plan -Documentation of logistics strategy and policy -Concurrence between management planning and logistics planning Procurement and Training of Logistics Expert -Systematic education and training on logistics management -Procurement of logistics expert Control of Logistics Outcome -Computation criteria for logistics cost -Accuracy of measurement and evaluation of logistics performance	Research report published in February 1990 by the Korea Productivity Center	Seven point Likert scales(Extremely Low Emphasis - Extremely High Emphasis)
Strengthening of Logistics Organization	Differentiation -No. of work and rank in logistics department -No. of logistics department distributed locally -Average distance between headquarter and local department -Ratio of local employees to total employees Decentralization -The degree of delegation by function -The degree of delegation by rank Formalization -The position of top manager in logistics department -The participation of logistics managers in strategic planning -The documentation of regulations and procedures of logistics related work	Bowersox et al. 1989, Daft 1986, Dalton et al. 1980, Germain et al. 1989, Ein-Dor and Segev 1978, Evers et al. 1976, Fredrickson 1986, Kennedy 1983, Moch and Morse 1977, Pierce and Delbecq 1977, Pugh et al. 1969, Raymond 1985, Sapolsky 1967, Webster 1970, Zaltman et al. 1973	Seven point Likert scales(Extremely Low Emphasis - Extremely High Emphasis)
Strategic Capability	-Extensive Sales & Distribution Ability -Advertising & Sales Promotion Ability -Rapidity of Product Supply		

Table 3. Continued

Research Variable	Measurement Items	Reference	Scale
Strategic Capability	-Utilization of Innovative Marketing Techniques -Productivity Fluctuation Ability -Product Supply Ability by the Due Date -High-quality Product Supply Ability -Sales/Distribution Network Control Ability -Low-priced Product Supply Ability -Brand Development Ability -Elaborateness Ability of Existing Products -Fund Raising Ability within a Company -Productivity and Profitability Analysis Ability -Production Cost Reduction Ability -Comparison/Control of Goal and Performance -Innovation of Manufacturing Process -Stock Holding Ability -Growth and Demand Forecasting Ability -Investment in Production -Quality Control Ability -Diversity of Manufacturing Process Technology -Raw-material Procurement Ability -Production Manpower Procurement Ability -Consistent quality Product Supply Ability -R&D Cost to Sales -Investment for New Market -Introduction Level of New Product -Analysis on Competitors and Environment -Size of Strategy-Making Team -Selling Expenses to Sales -Supply Ability of Diverse Products -Demand Focused Design Ability	Porter 1980; Miles and Snow 1978; Miller and Roth 1994	Seven point Likert scales(Extremely Low Emphasis - Extremely High Emphasis)

Table 3. Continued

Research Variable	Measurement Items	Reference	Scale
Logistics Performance	Cost Reduction -Purchasing cost -Operation cost -Inventory cost -Warehouse cost -Sales cost -Distribution/transportation cost Customer Service -On-time delivery of materials from suppliers -Percent of acceptable materials -The speed of suppliers' order processing -The reduction of response time in processing requests for materials returns -Product innovation level -Process innovation level -The accuracy of order processing for customers -The reduction degree of product return ratio -The speed of order handling -The reduction of response time in processing requests for product returns or after-service	Lummus et al. 1998; Birou et al. 1998; Tan et al. 1998; Zaheer et al. 1998	Seven point Likert scales(Worst in Industry-Best in Industry)

factors such as the degree of logistics automatizaton, the ability of construction and effective operation of logistics centers, and the utilization degree of advanced management and quantitative techniques, which have recently emerged as pivotal issues in relation to the level of logistics technology, as the measurement variables indicating the level of logistics technology. Detailed measurement variables for these three variables were constructed based on the studies of Yang(1996), Rao, Stenger and Wu(1994), Germain, Droge and Daugherty(1994), and measured with the seven-point Likert scale.

Logistics Administration Capability: Six survey questions related to logistics administration ability among ten items proposed in a research report titled "The actual states and improvement plans of the logistics management of Korean corporations" published in February 1990 by the Korea Productivity Center were extracted. These six items were measured with the seven-point Likert scale and reorganized into three new variables such as the ability to systematically construct logistics management plans, the ability to procure, educate and train logistics experts, and the ability to control logistics performance.

Logistics Performance: Logistics cost reduction and customer service improvement were selected as the measurement variables of logistics performance, where logistics cost reduction was measured by comparing logistics costs to sales figures over the last three years, while customer service improvement was measured by the accuracy of order processing, the reduction degree of product return ratio, the speed of order handling, and the reduction degree of response time in processing requests for product returns or after-service with the seven-point Likert scale.

5. Results

5.1. Factor Analyses and Reliability Test

Although measurement items presented in this study for measuring LIS utilization degree and strategic capability have been used in previous empirical studies, it is extremely difficult

Table 4. Factor Analysis

(a) LIS Utilization			
Measurement Item \ Factor	Connection Function (α=0.8356)	Primary Function (α=0.9050)	Support Function (α=0.8111)
Transportation Management System	.860		
Forecasting System	.797		
Automatic Ordering System	.733		
Procurement Information System	.685		
Plant & Warehouse Location Selection System	.655		
Production Plan and Process Control System		.829	
Sales and Price Management System		.790	
Consumer Service and Customer Management System		.760	
Inventory and Warehouse Management System		.688	
Network Plan and Design System		.786	
Accounting Information System			.666
Office Information System			.623
Eigenvalue(Pct of Var)	3.9084(.3257)	2.55(.2125)	1.398(.1165)

(b) Strategic Capability			
Measurement Item \ Factor	Marketing & Customer Service	Cost Reduction & Defensive Control	Differentiation & Pros. Investment
Extensive Sales & Distribution Ability	.838		
Advertising & Sales Promotion Ability	.830		
Rapidity of Product Supply	.717		
Utilization of Innovative Marketing Techniques	.702		
Productivity Fluctuation Ability	.697		
Product Supply Ability by the Due Date	.625		
High-quality Product Supply Ability	.619		

Table 4. Continued

(b) Strategic Capability			
Measurement Item \ Factor	Marketing & Customer Service	Cost Reduction & Defensive Control	Differentiation & Pros. Investment
Sales/Distribution Network Control Ability	.593		
Low-priced Product Supply Ability	.580		
Brand Development Ability	.571		
Elaborateness Ability of Existing Products	.561		
Fund Raising Ability within a Company	.507		
Productivity and Profitability Analysis Ability		.828	
Production Cost Reduction Ability		.755	
Comparison/Control of Goal and Performance		.742	
Innovation of Manufacturing Process		.708	
Stock Holding Ability		.700	
Growth and Demand Forecasting Ability		.672	
Investment in Production		.661	
Quality Control Ability		.616	
Diversity of Manufacturing Process Technology		.588	
Raw-material Procurement Ability		.565	
Production Manpower Procurement Ability		.537	
Consistent quality Product Supply Ability		.525	
R&D Cost to Sales			.805
Investment for New Market			.757
Introduction Level of New Product			.709
Analysis on Competitors and Environment			.666
Size of Strategy-Making Team			.643
Selling Expenses to Sales			.634
Supply Ability of Diverse Products			.625
Demand Focused Design Ability			.561
Eigenvalue(Pct of Var)	8.8416(.2763)	7.1904(.2274)	4.672(.1460)

* Factor loadings below 0.5 were not presented

to draw generalized characteristics from previous researches on LIS functions and strategic variables. This is due to the diversity of research approaches and the complications of relations between characteristics compared with those for measuring the strengthening of logistics organization, technology level, and administration capability as aforementioned. Accordingly, factor analyses were conducted on the measurement variables of LIS utilization degree and strategic capability. Table 4 shows the results of these factor analyses.

As can be seen, LIS can be divided into three major functions. The first is the primary function LIS that focuses on the effective operation and control of related logistics functions, such as the production plan and process control system, inventory and warehouse management system, sales and price management system, and consumer service and customer management system. The second is the connection function LIS that focuses on effective link between logistics functions within and outside of a corporation, such as the plant and warehouse location selection system, procurement information system, automatic ordering system, transportation management system and forecasting system. The third is the support function LIS which laterally supports the effective operation of the primary and connection function LIS such as the network plan and design system, office information system, and accounting information system. The above classification is associated with the research of Porter and Millar(1985) in classifying information technology activities into primary and support activities.

In the factor analysis on strategic capability measurements, 32 items except three variables found to be inappropriate for grouping are categorized under three factors with an eigenvalue of 1 or higher: marketing and customer service ability, cost reduction and defensive control ability, and differentiation and prospective investment ability.

Cronbach α reliability tests were performed for all multi-item scale measures, the results of which can be found in Table 5. As shown in the table, the α value of items for connection function LIS is highest at 0.9412 and the α value of those for the differentiation level of logistics organization is lowest at 0.6228. However, because it is generally known that there is no problem in evidencing the justification of an analysis if the α coefficient is

Table 5. Reliability Test

Measurement Item		No. of Items	Cronbach α Coefficient
LIS Utilization	Primary function LIS	4	0.9389
	Connection function LIS	5	0.9412
	Support function LIS	3	0.8484
Strengthening Of Logistics Organization	Differentiation of logistics organization	5	0.6228
	Decentralization of logistics organization	12	0.8377
	Formulation of logistics organization	4	0.7238
Strategic Capability	Marketing & Customer service capability	12	0.8958
	Cost reduction & Defensive control capability	12	0.9078
	Discrimination & Prospective investment capability	8	0.8257
Logistics Technology Level	Facility Automatization	5	0.6307
	Utilization of Advanced Mathmatical Methods	11	0.9388
	Construction of Integrated Logistics Center	2	0.7305
Logistics Administration Ability	Systemical Construction of Logistics Plan	2	0.8499
	Procurement & Training of Logistics Experts	2	0.8696
	Control Ability on Logistics Activity & Performance	2	0.8052

above 0.6, measurement items can be considered to be sufficiently reliable to evidence the justification of analysis results.

5.2. LISREL Analysis: the analysis of relationship between a corporation's characteristics

LISREL analysis was performed to test 21 hypotheses which are established to examine structural relationship between a corporation's characteristics. Maximum likelihood estimation method is used(Bagozzi 1991, Boomsma 1982). On the basis of this study's latent and measurement variables that were previously mentioned, basic LISREL model is suggested as shown in Figure 2.

The GOF of the basic LISREL model is shown in Table 6.

As shown in Table 6, the basic LISREL model in Figure 2 does not meet the criteria of GOF, which indicates that it is inappropriate to accept this model as a theoretical model. This is because the model in Figure 2 itself is very complicated and does

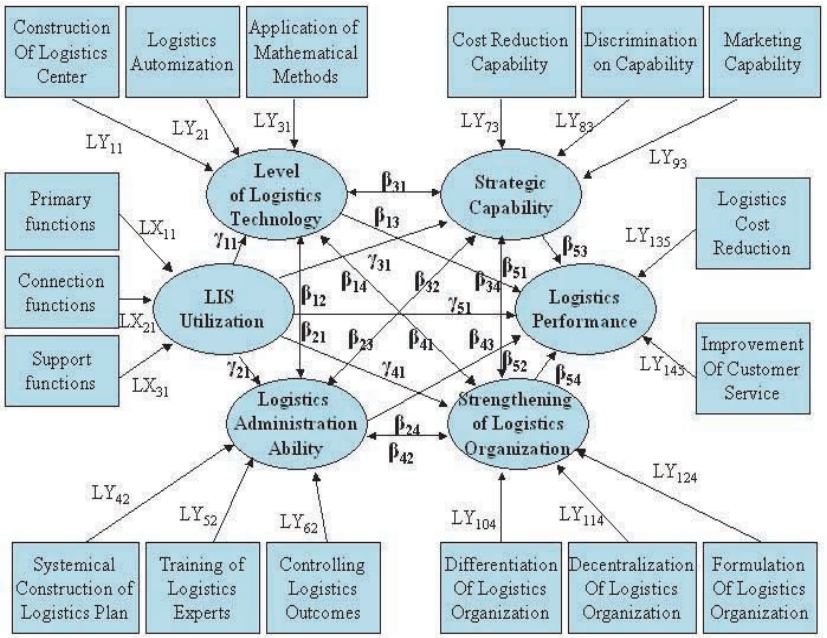

Figure 2. Basic LISREL Model.

Table 6. The Goodness of Fit of this research's LISREL model

	χ^2 Value	Degree of Freedom	GFI	AGFI	Standard Residual
Basic LISREL Model	496.42 (P = 0.000)	98	0.775	0.648	0.172
Adjusted LISREL Model	111.45 (P = 0.377)	108	0.935	0.909	0.048

not correspond with actual data. To solve this problem, the paths found to be insignificant at 95% significance level in the first LISREL analysis are removed and the adjusted LISREL model is constructed as shown in Figure 3, on which LISREL analysis was repeated.

As shown in Table 6, the adjusted LISREL model satisfies all of the criteria which determines the concordance of the model, and it implies that the above adjusted LISREL model can be accepted. Therefore, the hypotheses of this study were tested

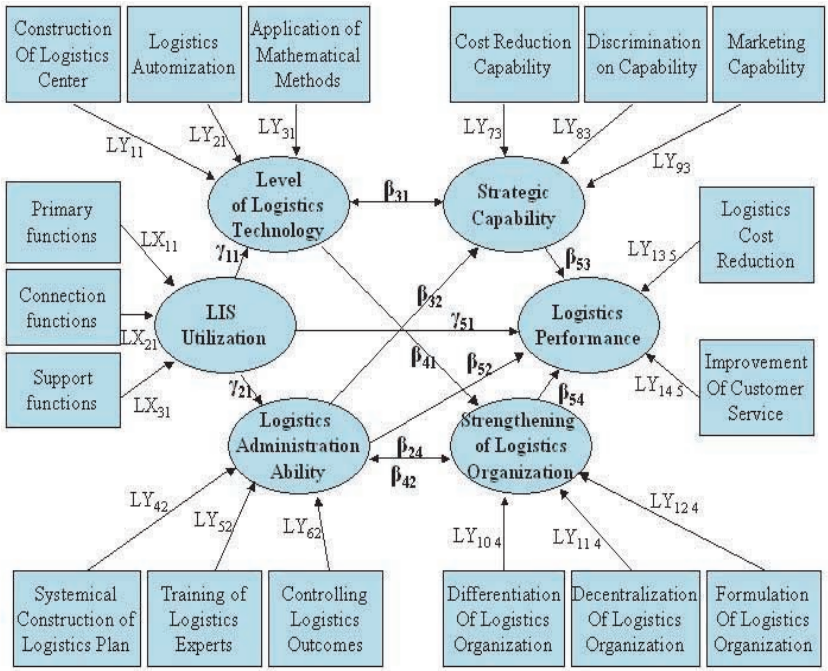

Figure 3. Adjusted LISREL Model.

based on the analysis results of the adjusted LISREL model, which are exhibited in Table 7.

Figure 4 demonstrates only the paths proven to be statistically significant at 95% significance level from the above hypothesis test.

If paths indicated as having significant relations between variables in Figure 4 are connected, four different routes through which LIS affects logistics performance can be suggested as follows.

- LIS Utilization → Logistics Performance
- LIS Utilization → Logistics Technology Level → Strategic Capability → Logistics Performance
- LIS Utilization → Logistics Administration Ability → Strategic Capability → Logistics Performance
- LIS Utilization → Logistics Technology Level → Strengthening of Logistics Organization → Logistics Administration Ability → Strategic Capability → Logistics

Table 7. Hypothesis Test Results

Hypothesis	Basic Model	Adjusted Model		LISREL
	T Value	T Value	Indirect Effect	Result
LIS Utilization → Logistics Performance	5.301	2.487	0.314	Accept*
LIS Utilization → Strategic Capability	-1.293			Reject
LIS Utilization → Organization Intensification	-1.78			Reject
LIS Utilization → Technology Level	6.472	7.519		Accept
LIS Utilization → Administration Ability	4.664	3.203	0.094	Accept
Technology Level → Logistics Performance	1.114			Reject
Technology Level → Strategic Capability	5.311	3.401	0.082	Accept
Technology Level → Organization Intensification	7.333	4.546	-0.084	Accept
Technology Level → Administration Ability	-1.429			Reject
Administration Ability → Logistics Performance	2.218	0.870	0.574	Reject
Administration Ability → Strategic Capability	15.932	3.738	-0.044	Accept
Administration Ability → Organization Intensification	0.87	1.469	0.045	Reject
Administration Ability → Technology Level	0.522			Reject
Strategic Capability → Logistics Performance	11.563	2.862		Accept
Strategic Capability → Organization Intensification	0.408			Reject
Strategic Capability → Technology Level	-1.776			Reject
Strategic Capability → Administration Ability	1.02			Reject
Organization Intensification → Logistics Performance	2.571	1.429	0.148	Reject
Organization Intensification → Strategic Capability	-1.632			Reject
Organization Intensification → Technology Level	1.259			Reject
Organization Intensification → Administration Ability	7.941	2.546	-0.055	Accept

*Statistically significant at 95% significance level.

Performance

These four routes show that the utilization path of LIS affecting logistics performance can be categorized into two types. The first is the structure through which LIS utilization directly affects logistics performance, and the second is the structure through which LIS utilization indirectly affects logistics performance by using a corporation's characteristics as a utilization mechanism. In other words, LIS utilization not only directly affects logistics performance, but also may indirectly affect it through the utilization of a corporation's characteristics.

As shown in Figure 4, the T-value is 2.487 when the utilization of LIS directly affects logistics performance.

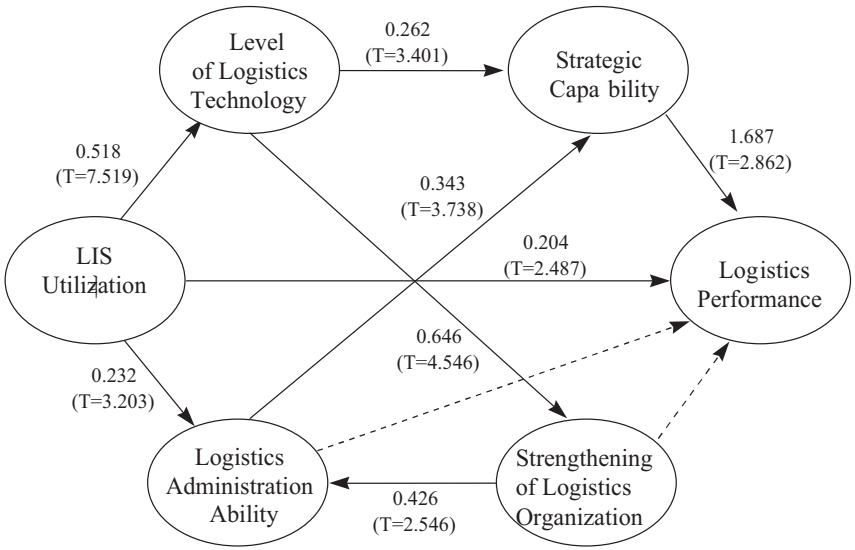

Figure 4. Structural Model Test Results

Meanwhile, T-values of all related paths are spread from a minimum of 2.546 to a maximum of 7.519, when it indirectly affects logistics performance. The analysis of relationship between variables except LIS indicates that three paths(β_{42} (logistics administration ability → strengthening of logistics organization), β_{52}(logistics administration ability → logistics performance), β_{54}(strengthening of logistics organization → logistics performance)) are not statistically significant. This means that organizational and administrative factors such as the strengthening of logistics organization or logistics administration ability do not directly affect logistics performance. However, as shown in Table 7, the indirect effects of these variables on logistics performance are very high (β_{52}: 0.574, β_{54}: 0.148).

In conclusion, it can be determined that even though the strengthening of logistics organization and logistics administration ability do not directly affect logistics performance, they indirectly affect logistics performance through a process in which the strengthening of logistics organization affects logistics administration ability and such logistics administration ability subsequently affects strategic capability.

The fact that the three paths(β_{24}: strengthening of logistics organization → logistics administration ability, β_{32}: logistics administration ability → strategic capability, β_{53}: strategic capability → logistics performance) have statistical significance as shown in Figure 4 proves the validity of the above analysis.

6. Conclusion

The results of empirical test above mentioned indicate that in order to maximize logistics performance, decision-making on LIS utilization should be made by sufficiently considering the scalar fit relation with a corporation's general characteristics and logistics related factors, and in a direction where the integration of logistics is accomplished through the efficient connection of each logistics function.

The result of relationship analysis between LIS utilization and a corporation's characteristics by LISREL demonstrates that LIS utilization most directly affects logistics performance, while LIS utilization indirectly affects performance through the improvement of logistics technology/logistics administration ability and the strengthening of logistics organization, and such indirect utilization of LIS has greater influence on logistics performance than the direct utilization of LIS.

Therefore, the utilization strategy of LIS should be established in the direction where, on the basis of support function LIS, primary function LIS which can influence directly on logistics performance is used to realize the automation within each logistics function and efficient linkage between related functions in the short-term, and connection function LIS which can affect indirectly logistics performance is utilized to accomplish the integration of all internal functions within a company and the external integration with suppliers and consumers in the long-term. This is a significant contribution in this paper in that it suggests a set of concrete and advisable strategies for LIS utilization, which have rarely been studied in spite of their noteworthy importance, from the three-dimensional analyses on the relation structure between a corporation's characteristics by means of LISREL.

However, this study also has limitations as follows. First, only

quantified characteristics were introduced as theoretical variables because not only it is extremely difficult to quantify qualitative variables, but multi-colinearity may also exist in such a complicated LISREL model. Second, this study does not suggest a detailed connection algorithm between logistics information systems by function because this paper places the focus on the suggestion of advisable LIS utilization directions. These issues will undoubtedly be addressed in future research.

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