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Logistics Service Supply Chain Model

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Abstract. This study aimed to specifically identify and modelize the service supply chain architecture of the logistics industry, which is difficult to be explained in the form of the traditional manufacturing supply chain. This research methodology used in this study is inter-industry analysis. According to the results, this study found that the types of supply chain entities and the direction of relationship between entities in the traditional manufacturing-oriented supply chain architecture are different from that of the logistics service supply chain architecture. This study was able to use the results of the inter-industry analysis to explain B2B architecture. Moreover, based on prior research and general service characteristics, this study proposed LSSCM (logistics service supply chain model) by adding final consumer to both the supply line (upstream) and delivery line (downstream). The academic contributions of this study are as follows. First, this study expanded the concept of the traditional manufacturing supply chain to a service perspective to modelize the logistics service supply chain architecture. Second, originality is shown in this study as it applies inter-industry analysis as research methodology to the service supply chain architecture. Finally, the multi-disciplinary nature of the study makes it meaningful from the perspective of service science.

Keywords: Logistics, Service Supply Chain, Service Science, IO Analysis

1. Introduction

Service management and service supply chain management have captured great attention from both academia and industry due to the rise of the service economy, the process of globalization, and the introduction of the concept of service science by IBM in 2004. However, comparing to manufacturers and suppliers that have successfully implemented SCM (supply chain management), the implementation of supply chain management for the service industry is still at the initial stage (Kwon, 2010). Because the service industry does not have any systematic model like the manufacturing industry due to its various characteristics, lack of studies applied the concepts and theories of supply chain to the service industry.

Armistead & Clark (1993) was the first to apply supply chain to the service industry, in which the concept called value chain was applied to the service industry. Zhang et al. (2009) stated that research on supply chain should shift the focus from manufacturing supply chain that emphasizes transport of tangible goods to the service industry.

The majority of previous studies on service supply chain gave their attention to the role of service in the traditional manufacturing-oriented supply chain and the ways to improve the effectiveness of the service. Kim (2021), Ellam et al. (2004), Baltacioglu et al. (2007), Zhang et al. (2009), and Lin et al. (2010) are representative studies on service supply chain architecture.

The purpose of this study is to specially identify and modelize the service supply chain architecture of the logistics industry, which is difficult to be explained in the form of the traditional manufacturing-oriented supply chain. Namely, this study intends to investigate the supply chain architecture, which is the core of the service industry but still remains on a conceptual level. This study targets the logistics industry, which plays a subsidiary role in strengthening the relationship management of entities in the existing manufacturing-oriented supply chain.

This study uses inter-industry analysis as its research methodology to link the forward and backward industrial architecture of logistics service to the concept of service supply chain, in order to identify the service supply chain architecture.

2. Literature Review

Armistead & Clark (1993) is one of the first to highlight the need of studying service supply chain and developing a concept of supply chain in the service industry. Service started to be viewed from the perspective of supply chain, as the concept of supply chain in the manufacturing industry was applied to the service industry. Nie & Kellogg (1999) stated that there is a limitation when applying the traditional supply chain management theory to the service industry because the focus of it was on the manufacturing industry. Youngdahl & Loomba (2000) suggested to apply the concept of service factory to the global supply chain.

Sampson (2000) studied the supply chain architecture of service companies, and Ellram et al. (2004) adopted the traditional supply chain management model to the field of specialized service to propose the service supply chain management. Baltacioglu et al. (2007) addressed the characteristics of service in light of the SCOR model and established a comprehensive framework for service SCM. However, the studies of Baltacioglu et al. (2007) and Ellram et al. (2004) were limited to specialized service, and the conceptual service supply chain architecture presented in their studies followed the traditional manufacturing-oriented supply chain.

Lin et al. (2010) presented different types of supply chains in the service industry in view of the traditional supply chain management. Thereafter, Lin et al. (2012) identified the service supply chain architecture from the perspective of operating mechanism of the service supply chain to study the operating mechanism of service supply chain according to the service dominant logic view. The results demonstrate that service supply chain is made up of different types of modules. Sakhuja & Jain (2012) presented the conceptual framework of service supply chain. Liu et al. (2017) examined the difference between the manufacturing and the service industry and proposed SSSCM (sustainable service supply chain management). Wang et al. (2015) reviewed the definition of service supply chain, and classified service supply chain into SOSC (service only supply chain) and PSSC (product service supply chain). The most recent study on the service supply chain structure is the study of Kim (2021). He proposed GSM (generalized service supply chain model) as shown in Fig. 1 through exploratory research from the perspective of service science. Table 1 summarizes previous research on the types of service supply chains.

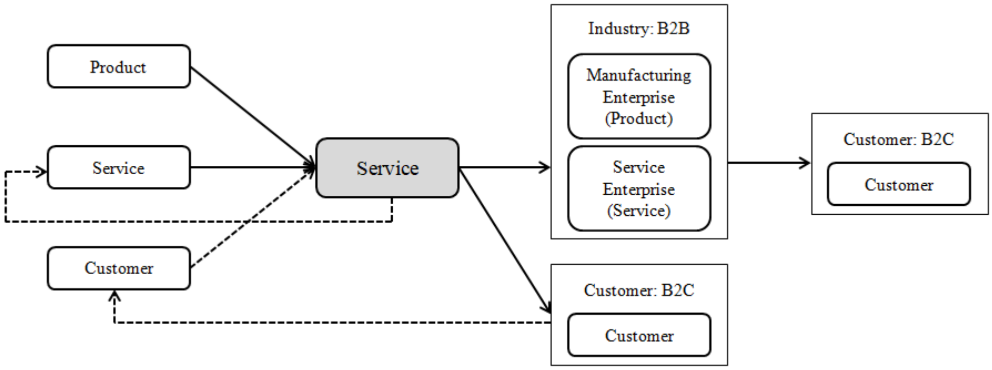

Fig. 1: GSM (Generalized Service Supply Chain Model)

Table 1: Previous Studies on the Service Supply Chain Types

Researcher	Study Subject
Kim (2021)	An exploratory study on the service supply chain architecture: an approach to service dominant logic in service science
Liu et al. (2017)	A framework of sustainable service supply chain management: a literature review and research agenda
Hussain et al. (2016)	A framework for supply chain sustainability in service industry with confirmatory factor analysis
Wang et al. (2015)	Service supply chain management: a review of operational models
Lin et al.(2012)	Service supply chain: configuration structure and operations mechanism
Sakhuja & Jain (2012)	Service supply chain: an integrated conceptual framework
Giannakis (2011)	Management of service supply chains with a service-oriented reference model: the case of management consulting
Lin et al. (2010)	Service supply chain: nature, evolution, and operational implications
Meier & Völker (2008)	Industrial product-service-systems - typology of service supply chain for IPS2 providing

Most research on service supply chain focused on the service functions in terms of relationship management between entities within a manufacturing-oriented supply chain. Studies have also been conducted on a particular service industry, by applying the concept of manufacturing supply chain to the service process. Few research suggested the types and models of supply chains correspond with the characteristics of the service industry without considering the traditional manufacturing industry-oriented supply chain. The reason may be that it was difficult to generalize the types of service supply chains due to the diversity of the service industry and the characteristics of services that are different from tangible products. It was also difficult to apply the methodology to scientifically distinguish service supply chain to the traditional supply chain.

According to the previous studies that proposed the types of service supply chain, Ellam et al. (2004) suggested seven key service processes of service supply chain based on the eight supply chain business processes identified by Lambert and Cooper (2000). Baltacioglu et al. (2007) divided service into core service (service to be delivered to consumers) and supporting service (service to support core service). They stressed the characteristics of services and evolved the comprehensive framework of service supply chain on the basis of the SCOR model. Thereafter, Zhang et al. (2009) proposed the conceptual model of service supply chain. They presented key companies as service integrators and providers, and modelized the relationship between service providers and customers. Lin et al. (2010) described service suppliers act as key companies in a traditional supply chain. They suggested that when these companies deliver services to customers, product suppliers participate in the service supply chain by delivering partial service to customers. Kim (2021) proposed a generalized service supply chain structure from the perspective of service dominant logic. Although the studies of Ellam et al. (2004), Baltacioglu et al. (2007), Zhang et al. (2009), Lin et al. (2010) and Kim (2021) all identified the architecture and types of service supply chains, the proposed conceptual models of the service industries follow the concept of flow and relationship management in the traditional manufacturing supply chain. Therefore, there is a limitation on proving the systematic industrial architecture of the service-focused service supply chain.

3. Research Design and Methodology

3.1. Research Design

This study used inter-industry analysis as the research methodology. Inter-industry analysis was first introduced in 1936 by Leontief of the United States. Leontief took Walras' general equilibrium theory as his point of departure by turning the attention from an abstract theory model to an empirical inter-industry analysis that combines the theory with empirical economic events. (Leontief, 1941; Leontief, 1970; Leontief, 1986; Miller & Blair, 2009).

This study used the industrial linkage effects for inter-industry analysis, the leading methodology for identifying the industrial architecture of logistics service supply chain. That is to say, the methodology is capable for analyzing the linkage architectures of forward and backward industries of any specific industry, and it can be utilized in studies on industrial architecture of service supply chain, which is conceptual and unclear until now, with considerable mathematical persuasion. This study uses production inducement coefficients to evaluate industrial linkage effects, identifies the linkage architectures of forward and backward industries, and combines with logistics service supply chain to derive results.

This study is conducted as an extended study of the service supply chain model proposed in the study of Kim (2021). Data analysis uses the results of input-output analysis of the first stage calculated for the logistics industry in the study of Kim et al. (2021). In order to identify the industrial linkage architecture of the logistics service supply chain, additional analysis is conducted by expanding it to three stages. The overall research framework and analysis procedure are illustrated respectively in Fig. 2.

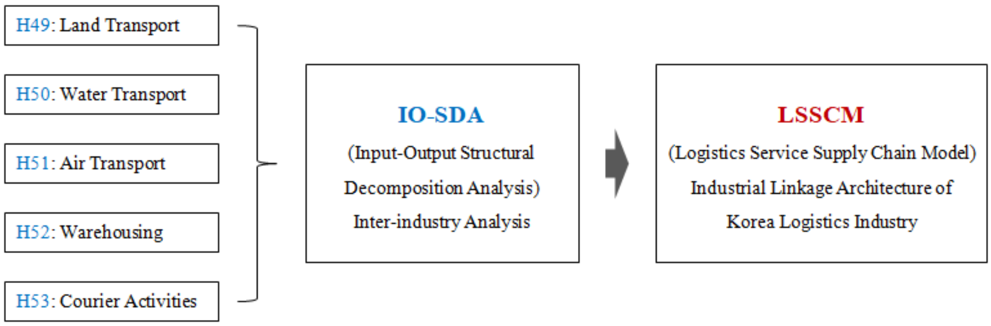

Fig. 2: Research Framework

3.2. Analysis Model

Inter-industry analysis model is a linear model that determines output levels according to the interdependencies between different sectors. The model represents the successive changes in demand in all sectors induced by the change in production level of a particular sector. Similar to the general equilibrium model, inter-industry analysis emphasizes the relationship between sales and purchases of inputs, so it has been recognized as a useful method to analyze and predict the overall economic impact (Miller & Blair, 2009). In the context of an economy is divided into n industries, products are used both as final goods and as intermediate goods for the production in other industries. Intermediate good is noted with z_{ij}, meaning the amount of intermediate goods in sector i supplied to sector j.

Intermediate demand (z_{ij}), final demand (Y_i), import (M_i) and total output (X_i) of sector i are displayed in the input-output table to show the output structure of sector i. The model of output structure is expressed in Formula (1).

$$X_i = \sum_{j=1}^{n} z_{ij} + Y_i - M_i = \sum_{j=1}^{n} a_{ij}X_j + Y_i - M_i \qquad (1)$$

The input coefficient a_{ij} corresponds to the aggregate intermediate good i used by sector j $(a_{ij} = z_{ij}/X_j)$. This ratio indicates the relationship between input and output, meaning the outputs in sector i that are used as intermediate inputs to generate one unit of production in sector j. The total outputs of a particular industry equals to the total required inputs in sector i due to the production of outputs, consumption expenditures, exports, investments, and government expenditures in order to generate one unit of production in entire industries.

One the other hand, the input structure of sector j, which includes intermediate input (z_{ij}), value-added (w_j), and total input (X_j), is shown in a row in the input-output table, as presented in Formula (2).

$$X_j = \sum_{i=1}^{n} z_{ij} + W_j = \sum_{i=1}^{n} r_{ij} X_i + W_j \qquad (2)$$

The output coefficient r_{ij} is obtained by dividing intermediate input (row vector) by total input $(r_{ij} = z_{ij}/X_i)$. It means that the total output of a particular sector equals the sum of the sector's basic input factors/value-added and payments for purchases from other industries and for imports.

3.3. Research Methodology

This study conducts inter-industry analysis that applies industrial linkage effects as the main methodology to achieve the research aim, and focuses on computing forward and backward linkage effects of the logistics service industry.

Power of influence and sensitivity of dispersion are methodologies widely used for identifying key sectors in an economy. This methodology was suggested by Rasmussen and Hirschman in late 1950s, using the production inducement coefficients table to measure forward and backward production inducement effects of each sector relative to the average of the entire industry.

The element (i, j) of the production inducement coefficients table that is in the *i*-th row and *j*-th column is denoted as r_{ij}, which indicates the growth in production of sector i induced when final demand in sector j increases by one unit. Thus, the production inducement coefficient of each sector is denoted by the column total $\mathrm{BL}_j^R = \left(\frac{1}{n}\sum_{i=1}^{n} r_{ij}\right) / \left(\frac{1}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n} r_{ij}\right)$. This equation measures how much production will be ultimately induced, both directly and indirectly, in the entire industry (sectors 1-*n*) when a unit of final demand is generated in sector j. Again, higher production inducement coefficients in a sector means that an increase in final demand on the sector will induce a larger amount of production in all industries. Therefore, using BL_j^R can estimate backward linkage effects, which indicate how much production will be induced in other industries by the demand in a certain industry.

The row total in a production inducement coefficients table is denoted by $\mathrm{FL}_i^R = \left(\frac{1}{n}\sum_{i=1}^{n} r_{ij}\right) / \left(\frac{1}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n} r_{ij}\right)$, indicating the production increase units in sector i when one unit of final demand is generated in sector 1-*n*. Therefore, using FL_i^R can estimate forward linkage effects, which indicate how much production will be induced in a certain industry by the demand in other industries.

3.4. Data Collection and Industry Scope

This study utilizes the National IO Tables released in 2016 by WIOD to conduct the analysis. The reason of using WIOD is that the industrial classification of 56 sectors is more specific. Especially, data of the logistics industry, which is the research object of this study, are presented in 5 sectors. In addition, performing time series analysis with data of 15 years can improve the reliability of the results. In contrast, ICIO data are classified into only 36 sectors, and only one sector belongs to the logistics industry. Furthermore, this study used world input-output table instead of regional input-output table to raise public trust, and to allow future research to expand the research scope to inter-country comparison.

This study analyzes data in National IO Tables (Released November 2016) from WIOD. This study analyzes the time-series data of the logistics industry in the input-output tables of the Korea economy for the period 2000-2014, which includes sectors H49-H53.

The data analysis extends the analysis step with reference to the previous study of Kim et al. (2021). This study identified stage 1 of the industrial linkage architecture by analyzing the 10% of (4 out of the 5 logistics sectors, because the one being studied is excluded) the forward and backward industries of the logistics sector with the highest production inducement coefficients. This study in turn examined stage 2 of the industrial linkage architecture based on the selected forward and backward industries in stage 1, and examined stage 3 of the industrial linkage architecture based on the selected forward and backward industries in stage 2. This study selected the two industries with the highest production inducement coefficients throughout the study period as the forward and backward industries in stage 2 and 3. Therefore, a total of 3 stages of the industrial linkage architecture were analyzed.

4. Results

4.1. Analysis Results of Linkage Effects by Industry

This study examined the forward and backward linkage effects of the logistics industry, and the results denote that the backward linkage effect of all logistics sectors, which indicates the purchase of intermediate goods by the logistics industry from other industries, are all on the average level. On the other hand, the forward linkage effects of the five logistics sectors, which indicates the output of the logistics industry that are used as intermediate goods by other industries, are not alike.

This study investigated the backward industries of the logistics industry in stage 1, which supply outputs to be used as intermediated goods by the logistics sector in its production. Based on the results, the related backward industries in stage 2 and 3 were examined in turn, and the results were presented in the following Table 2.

Table 2: Backward Linkage Industry of Logistics Industry

Section	Linkage Industry of Stage 1	Linkage Industry of Stage 2	Linkage Industry of Stage 3
H49	C19, C29, H52, K64	B, C20, C24, K64, L68, N	H49, C19, D35, C20, N, L68, I, K64, F
H50	C19, H52, N, K64	B, C20, K64, N, I, L68	H49, C19, D35, C20, N, L68, I, C10-C12, A01, K64, F
H51	C19, H52, C30, N	B, C20, K64, N, C24, C28, I	H49, C19, D35, C20, N, L68, I, C24, C25, C10-C12, A01
H52	N, K64, L68, D35	C20, I, N, L68, K64, F, C19	C19, D35, C10-C12, A01, C20, I, K64, F, N, L68, C24, C25, B
H53	N, G47, C26, K64	C20, I, L68, K64, C27, N	C19, D35, C10-C12, A01, K64, F, N, L68, C24, C20, I

Note: A01 (Crop and animal production, hunting and related service activities) / B (Mining and quarrying) / C10-12 (Manufacture of food products, beverages and tobacco products) / C19 (Manufacture of coke and refined petroleum products) / C20 (Manufacture of chemicals and chemical products) / C24 (Manufacture of basic metals) / C25 (Manufacture of fabricated metal products, except machinery and equipment) / C26 (Manufacture of computer, electronic and optical products) / C27 (Manufacture of electrical equipment) / C28 (Manufacture of machinery and equipment n.e.c.) / C29 (Manufacture of motor vehicles, trailers and semi-trailers) / C30 (Manufacture of other transport equipment) / D35 (Electricity, gas, steam and air conditioning supply) / F (Construction) / G47 (Retail trade, except of motor vehicles and motorcycles) / H49 (Land transport and transport via pipelines) / H52 (Warehousing and support activities for transportation) / I (Accommodation and food service activities) / K64 (Financial service activities, except insurance and pension funding) / L68 (Real estate activities) / N (Administrative and support service activities)

And this study investigated the forward industries of the logistics industry in stage 1, which use output from the logistics industry as intermediated goods in their production. Based on the results, the related forward industries in stage 2 and 3 were examined in turn, and the results were presented in the following Table 3.

Table 3: Forward Linkage Industry of Logistics Industry

Section	Linkage Industry of Stage 1	Linkage Industry of Stage 2	Linkage Industry of Stage 3
H49	B, C23, E37-E39, G47	C19, D35, F, C26, C25, C17, J61, C21	C20, H50, C24, C17, L68, O84, C27, J62-J63, C28, C30, C18, J58, G47, G46, Q, M72
H50	H52, H53, E37-E39, H51	H50, H51, G47, K64, C25, C17, H53	H52, H53, G47, J61, C21, L68, C28, C30, C18, J58, K64
H51	G47, H53, G46, G45	J61, C21, G47, K64	G47, G46, Q, M72, J61, C21, L68, H52
H52	H50, H51, H49, B	H52, H53, G47, B, C23, C19, D35	H50, H51, G47, K64, J61, C21, C19, D35, F, C26, C20, C24, C17
H53	G47, K64, K66, G46	J61, C21, L68, H52	G47, G46, Q, M72, H50, H51

Note: B (Mining and quarrying) / C17 (Manufacture of paper and paper products) / C18 (Printing and reproduction of recorded media) / C19 (Manufacture of coke and refined petroleum products) / C20 (Manufacture of chemicals and chemical products) / C21 (Manufacture of basic pharmaceutical products and pharmaceutical preparations) / C23 (Manufacture of other non-metallic mineral products) / C24 (Manufacture of basic metals) / C25 (Manufacture of fabricated metal products, except machinery and equipment) / C26 (Manufacture of computer, electronic and optical products) / C27 (Manufacture of electrical equipment) / C28 (Manufacture of machinery and equipment n.e.c.) / C30 (Manufacture of other transport equipment) / D35 (Electricity, gas, steam and air conditioning supply) / E37-E39 (Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services) / F (Construction) / G45 (Wholesale and retail trade and repair of motor vehicles and motorcycles) / G46 (Wholesale trade, except of motor vehicles and motorcycles) / G47 (Retail trade, except of motor vehicles and motorcycles) / H49 (Land transport and transport via pipelines) / H50 (Water transport) / H51 (Air transport) / H52 (Warehousing and support activities for transportation) / H53 (Postal and courier activities) / J58 (Publishing activities) / J61 (Telecommunications) / J62-J63 (Computer programming, consultancy and related activities; information service activities) / K64 (Financial service activities, except insurance and pension funding) / K66 (Activities auxiliary to financial services and insurance activities) / L68 (Real estate activities) / M72 (Scientific research and development) / 084 (Public administration and defence; compulsory social security) / Q (Human health and social work activities)

4.2. Architecture of Logistics Service Supply Chain

Based on the analysis of the logistics industry (H49, H50, H51, H52, H53), this study computed the production inducement coefficients of each logistics sector to identify the 3-stage linkage architecture. This study then attempted to identify the forward and backward industrial architecture of the entire logistics industry in common. The results revealed that most of the industries that link to the five logistics sectors in common are backward industries, while G47 (retail) is the only forward industry.

Regarding the common backward industries, the industries in stage 1 that directly affect the transport industry (H49, H50, H51) include C19 (petroleum products), H52 (warehousing), and C29/C30 (motor vehicles and transport equipment). K64 (finance) directly affects all logistics sector except H51 (air transport), and N (administrative and support) directly affects all logistics sectors except (land transport). Common industries in stage 2 and 3 that have indirect effect were examined. In stage 2, common backward industries of all five logistics sectors are C20 (chemical products), K64 (finance), and N (administrative and support). In stage 3, common backward industries of all five logistics sectors are C19 (petroleum products), C20 (chemical products), D35 (electricity and gas), I (accommodation and food), L68 (real estate), and N (administrative and support).

Regarding the common forward industries, G47 (retail) is the industry in stage 1 that has direct effect on H49 (land transport), H51 (air transport), and H53 (courier activities), meaning that the three sectors are providing intermediate inputs for the production in G47 (retail). Both H49 (land transport) and H52 (warehousing) are utilized by B (mining and quarrying). H49 (land transport) and H50 (water transport) are widely used by E37-E39 (waste management). Unlike backward industries, not many common industries are found to be the forward industries in stage 2 and 3 that have indirect effect, confirming that services provided by each logistics sector are used in diverse fields. G47 (retail) is the only forward industry in stage 3 that is related to all five logistics sectors. Table 4 and Table 5 show the common backward and forward industries in the industrial linkage architecture by stage, respectively.

Table 4: Backward Linkage Industries of Logistics Industry

Section		Total	H49	H50	H51	H52	H53
Stage 1	C19	3	○	○	○		
	C29/C30	2	○		○		
	H52	3	○	○	○		
	K64	4	○	○		○	○
	N	4		○	○	○	○
Stage 2	B	3	○	○	○		
	C20	5	○	○	○	○	○
	C24	2	○		○		
	I	4		○	○	○	○
	K64	5	○	○	○	○	○
	L68	4	○	○		○	○
	N	5	○	○	○	○	○
Stage 3	A01	4		○	○	○	○
	C10-C12	4		○	○	○	○
	C19	5	○	○	○	○	○
	C20	5	○	○	○	○	○
	C24	3			○	○	○
	D35	5	○	○	○	○	○
	F	4	○	○		○	○
	H49	3	○	○	○		
	I	5	○	○	○	○	○
	K64	4	○	○		○	○
	L68	5	○	○	○	○	○
	N	5	○	○	○	○	○

Table 5: Forward Linkage Industries of Logistics Industry

Section		Total	H49	H50	H51	H52	H53
Stage 1	B	2	○			○	
	E37-E39	2	○	○			
	G47	3	○		○		○
	H51	2		○		○	
	H53	2		○	○		
Stage 2	C17	2	○	○			
	C19	2	○			○	
	C21	3	○		○		○
	C25	2	○	○			
	D35	2	○			○	
	G47	3		○	○	○	
	H52	2				○	○
	H53	2		○		○	
	J61	3	○		○		○
	K64	2		○	○		
Stage 3	C17	2	○			○	
	C18	2	○	○			
	C20	2	○			○	
	C21	3		○	○	○	

	C24	2	○			○	
	C28	2	○	○			
	C30	2	○	○			
	G46	3	○		○		○
	G47	5	○	○	○	○	○
	H50	3	○			○	○
	H51	2				○	○
	H52	2		○	○		
	J58	2	○	○			
	J61	3		○	○	○	
	K64	2		○		○	
	L68	3	○	○	○		
	M72	3	○		○		○
	Q	3	○		○		○

Based on the results, we can recognize that the service industry and the manufacturing industry are situated as both the forward and backward industries of the logistics industry in stage 1, 2, and 3. With regard to the backward industries in stage 2 of the linkage architecture of the logistics industry, the five logistics sectors have one thing in common that in case any product was contained in the input elements in stage 1, no service was included in the input elements in stage 2. The reason is that the backward of the products in stage 1 is connected to the manufacture-oriented supply chain architecture, which can be seen in the traditional supply chain architecture. Stage 1 of the forward industrial linkage architecture of each logistics sector differed. Both services and products are included in the forward architectures of H49 (land transport) and H52 (warehousing), meaning that land transport services and warehousing and handling services are utilized in both the service and manufacturing industries. On the other hand, H50 (water transport), H51 (air transport), and H53 (courier activities) are directly connected to services, indicating that the services are primarily used by the distribution and logistics industries. The industrial linkage architecture of the logistics service supply chain is presented in Fig. 3. Finally, Fig. 4 comprehensively presents the basic industrial linkage architecture of logistics service supply chain, together with complementary relationships (a sector appeared as both the forward and backward industry), forward and backward industrial relationships between logistics sectors, and logistics sectors that appeared as their own forward and backward industries. The results proved that the nature of the manufacturing-oriented supply chain architecture and that of the service supply chain are different from the perspective of industrial architecture.

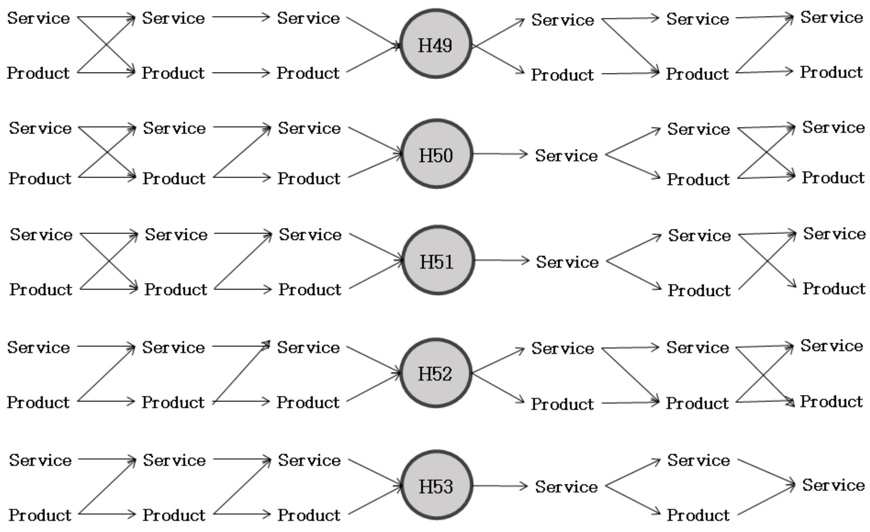

Fig. 3: Industrial Linkage Architecture of Logistics Services

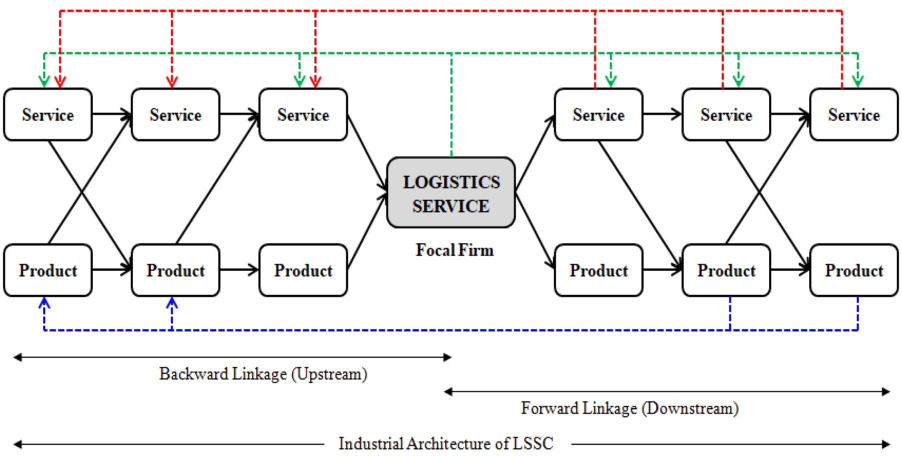

Fig. 4: Industrial Architecture of Logistics Service Supply Chain

4.3. Logistics Service Supply Chain Model (LSSCM)

The service industry is made up of a wide range of fields and has various characteristics. Within the logistics industry, the forward and backward industrial architecture of each sector is different based on the characteristics of each logistics service, including transport, warehousing, handling, etc. The characteristics of the service industry are expected to be more diverse and complicated depending on the tangibility spectrum or servitised degree of the combination of tangible products and intangible services. According to the results, remarkable differences were shown between the type of the traditional manufacturing-oriented supply chain and that of the logistics service supply chain in respect of industrial architecture and direction of the entities in the supply chain. Although the characteristics of the entities in each logistics sector's supply chain are different, the types of the logistics service supply chain could be summarized within the framework as follows.

This study investigated the forward and backward industrial architecture of the logistics industry, and the results indicate that the service and manufacturing industries are involved in both the service supply line (backward industry; upstream) and the service delivery line (forward industry; downstream). In addition to the basic industrial linkage architecture of logistics service supply chain, complementary relationships (a sector appeared as both the forward and backward industry), forward and backward industrial relationships between logistics sectors, and logistics sectors that appeared as their own forward and backward industries were also found. Such findings confirmed that the nature of the manufacturing-oriented supply chain architecture and that of the service supply chain are different from the perspective of industrial architecture.

Additionally, the entity 'final consumer' suggested by Ellam et al. (2004), Baltacioglu et al. (2007), Zhang et al. (2009), Lin et al. (2010) and Kim (2021) in their studies on service supply chain architecture can be added to the back of the supply chain. Furthermore, according to Lin et al. (2010) and Kim (2021), the distinct attribute of service is that the service supply chain is basically a two-level bidirectional (dual-directional) supply chain. While the two directions indicate physical product and information in a traditional supply chain, they indicate service delivery and customer participation in a service supply chain. Thus, the bidirectional architecture is reinforced by customer participation. Besides, service companies, which are focal in a supply chain, also act like their own suppliers. This part was confirmed by the analysis results in this study, too. It is identical to the concepts of customer participation and co-creation in service science proposed by Maglio & Spohrer (2008), Vargo & Lusch (2008) and Maglio et al. (2009).

The architecture of logistics service supply chain architecture is strikingly different from the traditional manufacturing (supply) - manufacturing (product) - distribution (sale) - customer architecture. Especially, the delivery line of logistics service can be classified into B2B and B2C. That is, the results of the inter-industry analysis in this study explains the B2B architecture, and B2C could be further added to this in accordance with the characteristics of service and service supply chain mentioned in previous studies. Despite that most relationships of logistics services are B2B, relationships of courier services are mainly B2C. It would be useful to apply the type of logistics service supply chain proposed in this study to each service industry to identify the concrete service supply chain architecture.

This study applied inter-industry analysis in economics to identify the industrial architecture of service supply chain, in order to analyze the industrial architecture of the logistics industry (H49, H50, H51, H52, H53). Based on the structured results, this study proposed the LSSCM (logistics service supply chain model), as presented in Fig. 5.

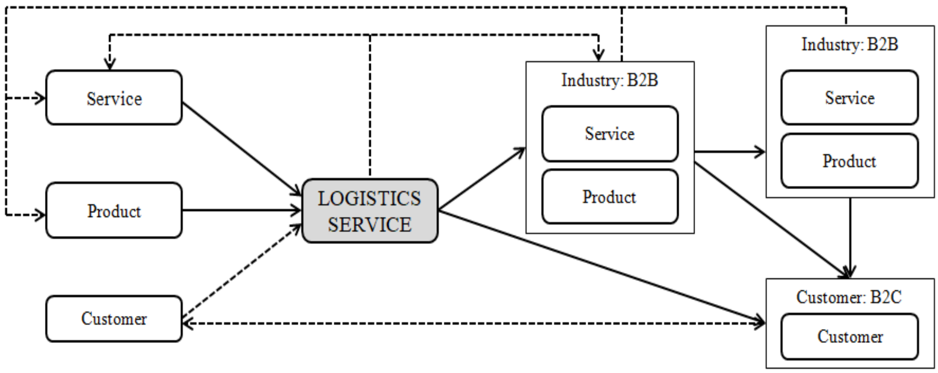

Fig. 5: LSSCM (Logistics Service Supply Chain Model)

5. Conclusion

The results of this study demonstrate that the types of the supply chain entities and the direction of the relationships in the traditional manufacturing-oriented supply chain architecture are different than those in the logistics service supply chain architecture. Although the attributes of the entities in each logistics service sector's supply chain are different, a logistics service supply chain model could be proposed within the framework based on the results. Considering logistics services as the center of logistics service supply chain, both the service supply line (backward industry; upstream) and service delivery line (forward industry; downstream) are composed of manufacturing an service. In addition to such industrial linkage architecture of logistics service supply chain, complementary relationships (a sector appeared as both the forward and backward industry), forward and backward industrial relationships between logistics sectors, and logistics sectors that appeared as their own forward and backward industries also exist. Thus, it should be recognized that the logistics service supply chain architecture and the general manufacturing-oriented supply chain architecture are different. Especially, the delivery line of logistics service can be classified into B2B and B2C. That is, the results of the inter-industry analysis in this study cloud explain the B2B architecture, and final consumers were added to both the supply line (backward) and the delivery (forward) based on previous studies and the general characteristics of service in order to construct the model. It is identical to the concepts of customer participation and co-creation in service science. This study analyzed the industrial linkage architecture of logistics service supply chain of the logistics industry (H49, H50, H51, H52, H53) by using inter-industry analysis, and proposed the logistics service supply chain model based on the analysis.

Based on the findings of this study, the research contributions and implications were summarized. This study extended the concept of the traditional manufacturing-oriented supply chain to service, in order to identify the industrial linkage architecture of logistics supply chain and modelize the logistics service supply chain architecture. Based on the analysis, this study was able to provide the foundation for future research on the architecture and type of service supply chain. Second, this study shows originality in terms of convergence by integrating forward and backward linkage effects in inter-industry analysis to investigate the service supply chain architecture. Third, meaningful from the service science perspective, this study followed the philosophical foundation of research to approach the research questions in a service-oriented way of thinking about service dominant logic, and showed a multi-disciplinary nature by applying methodology of economics. Therefore, if the logistics service supply chain model and inter-industry analysis proposed in this study are applied to different service industries, a variety of service supply chain architectures can be estimated.

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