A Study on the Development of Competitiveness Index for Digital Logistics City

By

KIM, Youngseon

CAPSTONE PROJECT

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

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Committee in charge:

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Executive summary

Today, countries around the world are seeking various strategies to solve the problems of the existing logistics industry due to rapid social and economic changes caused by the Fourth Industrial Revolution and to strengthen national competitiveness through technological innovation in the logistics industry. In July 2021, Korea established the 5th National Logistics Basic Plan to prepare a promotion strategy to become a global logistics leader. It aims to increase sales of the logistics industry to 140 trillion won by 2030 and to raise LPI to the top 10 globally by 2030, creating a sustainable logistics industry environment, strengthening industrial competitiveness, and improving market constitution. In addition, the government selected a digital logistics pilot city to solve the urban logistics problem and apply digital logistics technology in the design and planning stage of the city. Accordingly, this study aims to develop a competitiveness index model that can grasp the absolute level of competitiveness in digital logistics cities for the successful promotion of digital logistics cities.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. Introduction

Logistics is very closely related to the country's economy and industry, and logistics performance indicators such as customs clearance, logistics infrastructure, and cargo tracking systems of a country are significantly correlated with the competitiveness of the country as a whole as well as the trade and logistics sectors. (Jeon, H. J., & Kim, Y. M., 2019).

Recently, many countries are expanding investment in the logistics industry and improving various systems related to the logistics industry to enhance their competitiveness by reflecting social changes such as a rapid increase in daily logistics due to the development of e-commerce, reorganization of industrial structure and job change, and paradigm shift to smart society, resolving urban problems such as environmental pollution and traffic congestion caused by cargo vehicles, and lack of logistics information sharing. In the past, these investments mainly focused on the physical concentration of facilities, such as the construction and expansion of new logistics infrastructure such as ports, roads, and railroads. However, in recent years, many countries have focused on smarting and digitizing the logistics industry by utilizing advanced technologies in the era of the 4th industrial revolution such as robotics, big data, the Internet of Things, and unmanned transportation.

Accordingly, the Korean government also established the 5th National Logistics Basic Plan to become a global logistics leader through smart and digital innovation in the logistics industry. According to this policy, in order to grow the logistics industry, six promotion strategies were proposed, including the establishment of a logistics system based on advanced smart technology and the establishment of shared infrastructure and networks. In addition, the Korean government designated Song-san Green City and Busan Eco Delta City, which are being implemented in K-water, as "digital logistics pilot cities" in June 2021 so that they can build smart logistics infrastructure at the stage of planning and designing new cities to apply and utilize various advanced logistics technologies. Because these cities are under construction, it is very easy to apply and utilize various advanced logistics technologies.

This study introduces various prior studies and evaluation indicators related to the smart city and logistics industry for the successful implementation of this pilot project, and presents components for the development of indicators to evaluate the competitiveness of digital logistics cities through various changes in logistics-related conditions and policy analysis.

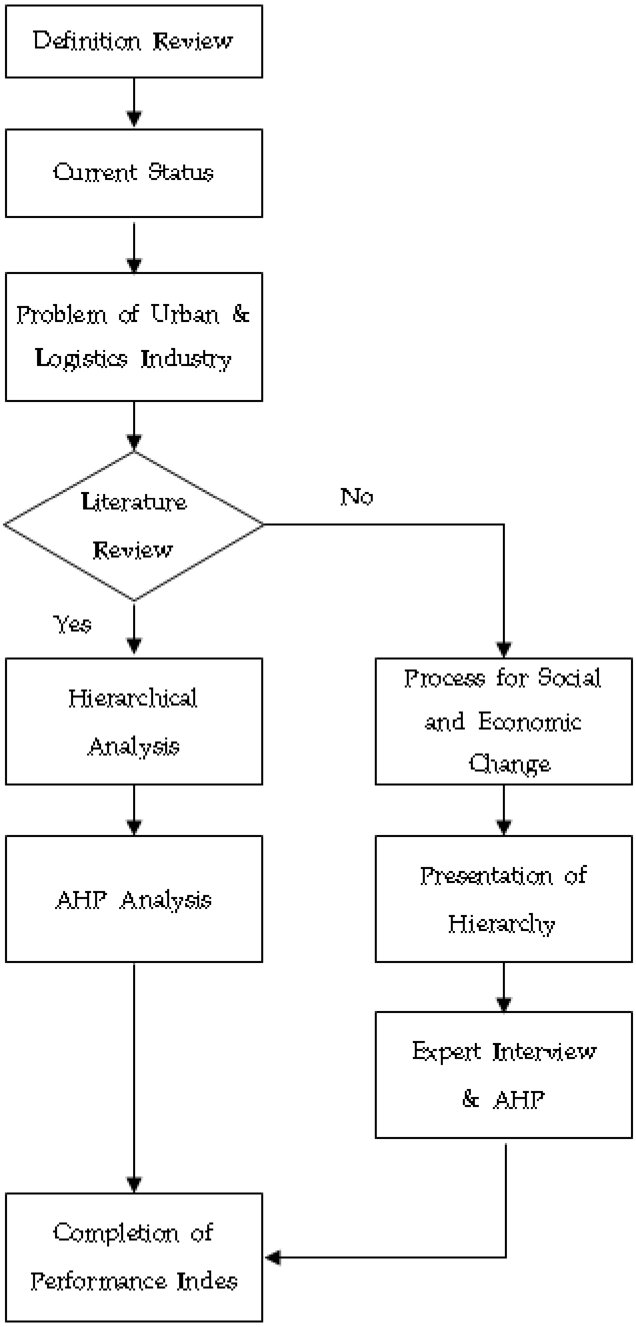
2. Research Questions and methods

The Korean government has proposed various institutional improvement methods and strategies to improve the competitiveness of the logistics industry. One of them is the digital logistics city. The digital logistics city is to apply highly advanced logistics technology closely related to the Fourth Industrial Revolution from the planning stage of a new city. It will be able to solve various problems of logistics in the city and improve and develop the competitiveness of the logistics industry.

However, the government, civic groups, and companies cannot focus everything on the construction of a digital logistics city in terms of time, economy, and space. They set the ultimate goals that the digital logistics city pursues, such as solving the problems of the city, improving the competitiveness of the logistics industry, and introducing high-tech technologies, and they should focus only on them. In other words, we have to think about which parts of the city and logistics should be focused on for the successful promotion of the digital logistics city. In addition, on what criteria can we judge the success of the completed digital logistics pilot city? We have to figure out whether the pilot city is successful and what to supplement and create a better shape in the follow-up projects. Therefore, this study aims to present evaluation indicators that can be the goals and standards that the government, businesses, and civic groups should have in the process of promoting the digital logistics pilot city.

This study proposes indicators to present areas to be focused on in the digital logistics pilot city planning and development process. And this study intends to propose the indicators through the following process.

[Figure 1] Research Methods



3. Current Status and Problems of the Logistics Industry

3.1 Definition of Logistics and Digital Logistics

The concept of logistics is defined differently by scholars and institutions, and the definition used in the field of marketing and production management in the United States, where logistics in the modern sense occurred, is mainly cited. The American Marketing Association defines logistics as "a process for planning and distribution control of funds and human resources for material distribution, manufacturing assistance, purchase, etc." (A single logic to guide the process of planning, allocating, and controlling financial and human resources committed to physical distribution, manufacturing support, and purchasing operations)

In Korean legal terms, logistics is a concept that includes a series of all operations, including transportation, storage, and unloading, until goods are produced by suppliers and delivered to consumers or recovered from consumers and discarded. It includes processing, assembly, classification, repair, packaging, trademarking, sales, information and communication that are added to this process to create value. (Basic Act on Logistics Policy). In addition, logistics refers to integrated management of individual financial, production, and marketing sectors, and supplying goods and services demanded by consumers in perfect condition at the place and time desired by consumers while maximizing corporate profits. (Yoo, C. K., & Yoo, C. W., 2012).

Meanwhile, smart logistics has a very close relationship with a new trend called the Fourth Industrial Revolution. The term was first used at the Davos Forum in January 2016. In the era of the 4th industrial revolution, new technologies such as artificial intelligence, robotics, the Internet of Things, and autonomous vehicles are created and developed rapidly, and their speed, scope, and depth develop at an exponential speed, not a linear speed, unlike the 1st, 2nd, and 3rd industrial revolutions. It involves changes in systems across countries, businesses, industries and society as a whole.

Smart logistics is a complex fusion of new IT technologies and logistics technologies of the 4th Industrial Revolution and has six characteristics: Traceability, Environment Friendly, Green Logistics, Interface Oriented, Human Centered, and Asset Management between various logistics tasks such as transportation, packaging, storage/unloading, information/security. (Jeong, S. Y., & Jeong, G. Y., 2012). The goal of smart logistics is to provide comprehensive IT-based logistics services beyond infrastructure-oriented logistics to reduce logistics costs and achieve efficient operation of logistics required by logistics companies. (Lee, E. J., 2022). As such, smart logistics are playing a role in creating value by sharing information on production and consumption by utilizing IT technologies such as big data, artificial intelligence, and automation, away from the past role of intermediating products and services.

3.2 Definition and Problems of Urban Logistics

3.2.1. Definition of Urban Logistics

In order to evaluate the competitiveness of digital logistics cities and propose their indicators, this study needs to focus a little more on urban logistics, not the overall logistics part. Since the logistics industry is very comprehensive, if this study focuses on the entire logistics industry, the results of this study may be distorted. Urban logistics refers to all logistics activities in which logistics activities are spatially limited to cities.

Noh et al. (2021) defined urban logistics as a daily logistics service activity based on a courier service that delivers cargo through processes such as collection and classification using a cargo vehicle. As such, there are many cases in which urban logistics are limited to daily logistics due to the rapid growth of daily logistics. However, Meyberg (1974) presented urban logistics in a more expansive sense, such as classifying them into not only daily logistics but also cargo entering the city in macroscopic terms, home delivery cargo with limited origin and destination into the city, and cargo passing through or through the city. In other words, since urban logistics has existed for a long time in terms of manufacturing-based corporate logistics, it would be reasonable to expand and approach the concept from traditional corporate logistics (B2B) to daily logistics (B2C). (Kwon, H. G., 2020).

3.2.2 Problems with Urban Logistics

Digital logistics cities are a concept introduced to solve various problems of urban logistics, and the purpose of this study is to develop indicators to evaluate the competitiveness of digital logistics cities, so it is necessary to first look at the problems of urban logistics to develop evaluation indicators. Wood et al. (1982) divided the perspective of urban logistics problems into interest groups such as society, citizens, shippers of carriers, and local governments, suggesting that each group's views on truck regulations, environmental issues, traffic congestion, fares, and services are different.

[Table 1] Perspectives on Urban Logistics by Stakeholders

Stakeholders	**Regulation & Control**	**Environmental Prob.**	**Traffic congestion**	**Freight Charge**	**Services**
Society	Forcing Control	Maintenance & Improvement	Reduction	low	No quality change
Citizen	Urban Trucking Regulation	Improvement	Urban Trucking Regulations	low	No quality change
Carrier	Unregulated	Internal Policy	Deregulation of freight vehicles	Keep it as low as possible	No quality change
Shipper	Be irrelevant	Be irrelevant	Congestion & parking space	Lower the actual cost	No quality change
Government	Specify Truck Route	Responding to the needs of Citizens	Allow truck traffic on limited roads	be irrelevant	regardless.

In addition, Ogden (1984) defined urban logistics problems by classifying costs related to urban cargo transportation into social costs: transportation costs, congestion costs, traffic accidents and environmental costs, community costs: costs incurred in connection with facility construction and maintenance, policy execution, urban and regional structure costs: costs related to transportation and location correlation.

In order to establish urban logistics problems more systematically, this study synthesized the aforementioned perspectives and divided them into macro perspectives and micro perspectives. Logistics from a macro perspective focuses on the ripple effects of social perspectives such as traffic congestion and environmental pollution rather than the influence of carriers and shippers directly related to actual logistics activities as public logistics. On the other hand, the microscopic perspective focused on the position of carriers and shippers who supply goods, and this study described the major problems of urban logistics facing our society from a macro and public perspective.

[Table 2] Classification of Urban Logistics

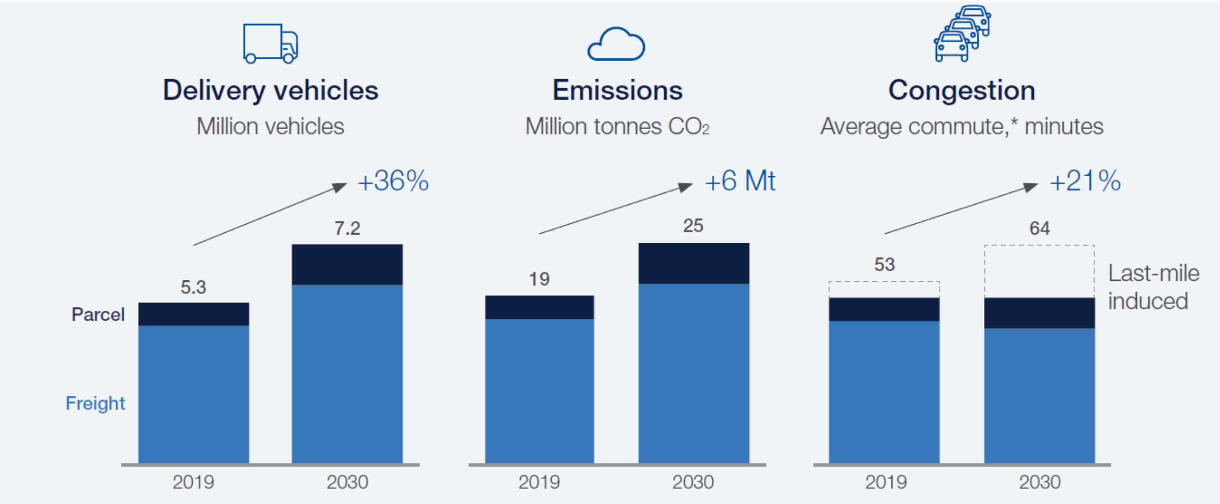
Perspective	Stakeholders	Cost and Objectives	Problems
macroscopic	Government Citizens	Minimizing social costs	✓ Arrangement of logistics facilities ✓ Expansion of infrastructure such as roads ✓ Securing operating parking spaces at truck bays, ✓ Restriction of cargo traffic and Overloading control
microscopic	Carrier Shipper Supplier	Minimize transportation costs Minimize inventory costs Maximize the level of logistics service	✓ Joint delivery ✓ Route determination and schedule planning, ✓ Strategic inventory management

3.2.2.1. Road congestion and lack of parking space intensified

The characteristic of urban logistics such as courier service is door-to-door service. It is a system that delivers various small cargoes to many customers, so the delivery network is very vast and detailed than other cargo transports. Therefore, the delivery service naturally led to an increase in small freight cars. The increase in the number of delivery vehicles in the city leads to the invasion of the movement and space of various vehicles operating in the city. Increased traffic creates traffic congestion and increases the driving time of existing vehicles. The World Economic Forum (WEF) predicted that last-mile delivery demand, such as courier services in 100 major cities around the world, will grow 78% between 2019 and 2030. (WEF,2020).

As a result, the World Economic Forum predicted that freight vehicles would increase by 36% over the same period, increasing commuting time by 21% and individual commuting time by 11 minutes.

[Figure 2] 2030 Base Scenario (WEF, 2020)



In addition, due to the increase in courier services, parking spaces are becoming scarce in residential complexes, and because there is no parking space for delivery vehicles in residential complexes, and parking spaces are very narrow or absent, delivery vehicles often park illegally on roads near residential areas, which can also cause traffic congestion.

[Figure 3] Illegal Parking of Delivery Vehicles (KIM, B. H., 2019)

3.2.2.2. Traffic Safety Issues

The most important competitive factor among companies in urban logistics can be said to be the delivery speed. The industrial structure of fast delivery of soaring delivery volumes has increased the working hours of delivery workers, caused traffic safety problems such as increased cargo vehicles and speeding. The number of accidents involving freight vehicles (1 ton) increased by an average of 31.5% annually to 4,512 in 2017, 7,288 in 2018, and 10,264 in 2019. (Samsung Fire & Marine

Insurance, 2020). As such, traffic accidents in freight vehicles are increasing with the growth of urban logistics.

3.2.2.3. Environmental pollution problem

The increase in freight vehicles due to the growth of urban logistics is intensifying the air pollution problem from an environmental perspective. The increase in the inflow of freight vehicles into residential areas can adversely affect the air quality of residential areas by air pollutants generated from freight vehicles. Air pollutants that can occur in freight vehicles include carbon monoxide (CO), nitrogen oxides (NOx), sulfur oxides (SOx), and fine dust (PM10, PM2.5). In particular, small freight cars often operate at low speeds when operating in the city center or idle after stopping, resulting in more serious air pollution emissions due to incomplete combustion gas emissions.

As such, the increase in the inflow of freight vehicles into the city is undermining the public's health by lowering air quality, and it is predicted that an additional 6 million tons of carbon dioxide will be emitted by 2035 due to the increase in the inflow of freight vehicles into the city in the world's 100 major cities. (WEF, 2020)

3.3. Digital Logistics City

A digital logistics city can be defined as a city that introduces digital innovation technology and smart logistics technology to the overall urban logistics and urban environment to respond to the paradigm shift in logistics and solve the problems of urban logistics systems.

Digital logistics cities can be organized into five keywords: human-centered, convergence innovation, job transition, eco-friendly, and stable. For its success, it is necessary to review various factors such as logistics infrastructure, logistics network, logistics service, safety and environment, public goods, reflection of the characteristics of the city, and demonstration and implementation. In addition, it is necessary to reflect various design factors that take into account new issues such as last mile, common property, fusion logistics, life safety, underground logistics, and digital logistics that reflect changes in socioeconomic and logistics conditions and characteristics of the city. In addition, it suggested that digital logistics cities should be able to cover both corporate and daily logistics, and that the participation and activities of private companies should be maximized. (Kwon, H. G., 2020).

[Table 3] Changes in Logistics Paradigm

As - Is	**To - Be**
✓ Provider-centric, dependent on government financial support ✓ Export-import support logistics focused on companies aiming for economic growth ✓ Independent/division of labor based on single department, single industry ✓ Support logistics led by manufacturing and distribution ✓ Regional-oriented logistics	✓ Consumer-oriented logistics ✓ Aiming for the convenience of people's living, the national economy and logistics closely related to life ✓ Convergence logistics for sharing, collaboration, and win-win ✓ Leading logistics leading the manufacturing and distribution industries ✓ Global Linked Logistics

[Table 4] Components and Design element of the Digital Logistics City

Components	Design element
✓ Logistics infrastructure, network, service and safety ✓ Regional development and specialization ✓ Public logistics, Demonstration and implementation	✓ Autonomous delivery using robots, etc. ✓ Sharing means of transportation and storage space ✓ Convergence between industries ✓ Digital logistics safety equipment and technology development ✓ Logistics management using underground space ✓ New transportation service using tube technology ✓ Introduction of new logistics service based on digital technology

[Figure 4] Example of Digital Logistic City Construction (Kwon, H. G., 2020)

4. Literatures Review

4.1 Current status of prior research and indicators related to logistics

This study is to derive components that can evaluate the competitiveness of digital logistics cities. Therefore, prior studies related to this were examined and the applicability of this study was reviewed. The Logics Performance Index (LPI), the most useful tool for grasping a country's logistics competitiveness, is surveyed and published by the World Bank to evaluate each country's logistics competitiveness, and surveys of import and export logistics companies every other year on six items, including customs clearance, logistics infrastructure, international transportation, and timeliness.

Furthermore, domestic and international prior studies on logistics competitiveness indicators focus on deriving the components that can evaluate the competitiveness of ports or port background complexes, and transportation logistics, which are key elements of international logistics, or developing their evaluation indices. In particular, there have been quite a few studies on port competitiveness, which can be divided into a study on port selection and a study on port competitiveness analysis.

4.1.1. Literatures on Port Selection

Before competition between ports began in earnest, many studies were conducted on the choice of port of call by shipping companies. However, research on the analysis of port competitiveness has been active since competition between ports has emerged as an important issue as port management independence is strengthened and large-scale capital has begun to be invested.

In this regard, the study of Kim, C. W et al. (2005) focused on analyzing the determinants of terminal selection located in a specific port from the perspective of the shipping company. Location and facilities, timeliness, terminal operational capabilities, informatization of terminals, convenience provision to customers, and cost were considered as major determinants of terminal selection, and the relative importance between them was analyzed. Meanwhile, Heo, Y. S. (2006) analyzed the competitiveness of Busan Port only from the perspective of the shipping company and showed a study of a concept similar to the choice of a shipping company's port of call. It was analyzed through ANOVA verification of port preference, growth potential, and port competitiveness of shipping companies for eight major ports. In addition, Park, J. A. and Park, M. S. (2007) analyzed the selection factors of Mokpo Port by dividing the port users' selection factors into four factors: port characteristics, logistics costs, interregional networks, and services, and presented the development strategy of Mokpo Port.

[Table 5] Reviewing of Literature on Port Selection Determinants

	Kim, C. W. et al. (2005)	Heo, Y. S. (2006)	Park, J. A & Park, M. S. (2007)
Target Port	Terminal in Busan Port	Busan, Tokyo, Shanghai, Shenzhen, Hong Kong, Kaohsiung, Singapore, Rotterdam	Mokpo Port,

Determinants	Location and facilities timeliness Terminal Operations Convenience for customers	Port facilities, port rates, port services, ship ports, geopolitical locations, port background economy scale, political and social stability, and background linkage systems	Port characteristic factors, logistics cost factors, inter-regional network, service factors

4.1.2. Literatures on Port Competitiveness

Recently, more research has been conducted on the analysis of the competitiveness of the port itself rather than on the subject of research on port selection, and most of the research aims to select competitiveness determinants to compare them with the ports to be compared and to suggest ways to supplement the competitiveness of the ports to be studied.

Lee, H. G. and Ryu H. G. (2007) developed a competitiveness index that can grasp the absolute level of competitiveness of ports through hierarchical analysis and calculated and compared the competitiveness index of Busan Port, Gwang-yang Port, and major ports in Northeast Asia to examine the applicability of this competitiveness index.

[Table 6] Absolute Evaluation of Port Competitiveness Level (Lee, H. G., Ryu, H. G. (2007))

Higher Factor		Lower Factor	
Items	Weights	Items	Weights
Service Requirements	0.166	Immediate response to user needs	0.421
		24-hour, 7-day service	0.273
		Immediate berth loading and unloading service	0.306
Convenience level	0.166	Level and Utilization of Port Information System	0.571
		stability of port labor	0.429
Availability Degree	0.152	availability of berths	0.567
		a port ship	0.433

Background conditions	0.138	Size and level of utilization of free trade zones in port background areas	0.499
		Total Container Volume	0.501
Regional connectivity	0.147	Distance to major cargo destination	0.572
		Efficient background network	0.428
regional centrality	0.115	Port Accessibility	0.574
		Location of the main route	0.426
Logistics-related costs	0.117	inland transportation freight	0.508
		Costs related to vessel/cargo entry/exit	0.492

Kim, W. H. et al. (2008) adopted an input-output-result model to compare and evaluate port competitiveness using the competitiveness index calculated by composing each evaluation item and evaluation index. Evaluation items and indicators considered measurability, improvement, controllability, relative importance, and sufficiency, and a total of 11 evaluation items and 19 indicators were extracted by reflecting expert surveys.

[Table 7] The Results of Deriving Weights of Comprehensive Port Competitiveness Indicator (Kim, W. H. et al. (2008))

Index	Items	Weights
Input index	The size of the economy behind port	0.236
	Port Location Conditions	0.298
	Port investment	0.257
	port governance	0.209
Sub-total		1.000
Output index	Infrastructure level	0.342
	Rate level	0.342
	Service Level	0.316
Sub-total		1.000

Result Index	Port volume	0.261
	Customer satisfaction	0.266
	Community contribution	0.226
	Contribution to the national economy	0.246
Sub-total		1.000

4.1.3. Other Literatures Related to Logistics

Kim, J. K. (2009) used AHP to extract factors that evaluate the competitiveness of the logistics complex behind the port through prior research and expert research and to derive the importance and priority of each factor. Using the proposed indicators, the competitiveness of the logistics complexes behind the ports of Busan New Port, Gwang-yang Port, Shanghai Port, and Kobe Port was evaluated to identify major strengths and suggest ways to compensate for the weaknesses of domestic ports.

[Table 8] Competitiveness Evaluation Index of Logistics Complex behind Port (Kim, J. K. (2009))

Factor	Indicater	Shipping and terminal operators	Shippers	Academics and port authorities	Totals
Cost factor	Rent	0.531	0.499	0.492	0.507
	tax benefits	0.275	0.339	0.332	0.315
	incentives	0.194	0.162	0.177	0.178
	Subtotal	1.000	1.000	1.000	1.000
	Total	0.370	0.451	0.270	0.363
Facility factors	Quality of site security	0.476	0.545	0.354	0.458
	Infrastructure	0.292	0.235	0.235	0.254
	Logistics network	0.232	0.220	0.411	0.288
	Subtotal	1.000	1.000	1.000	1.000
	Total	0.204	0.173	0.195	0.191
Labor system	Flexible labor system	0.498	0.531	0.475	0.501

	Labor environment	0.169	0.174	0.276	0.206
	Technical manpower	0.333	0.295	0.249	0.293
	Subtotal	1.000	1.000	1.000	1.000
	Total	0.127	0.120	0.173	0.140
Market factors	Economic scale	0.750	0.693	0.714	0.719
	Political & social stability	0.250	0.307	0.286	0.281
	Subtotal	1.000	1.000	1.000	1.000
	Total	0.300	0.257	0.362	0.306

Joo, J. H. et al. (2017) selected mobility and accessibility, transport scale, green transportation, and safety as indicators of the country's transportation logistics competitiveness, and determined weights through AHP techniques and expert surveys. And the calculated weight was verified using the Bootstrap technique.

[Table 9] National Transport Competitiveness Indicator using AHP (Joo, J. H. et al. (2017))

Higher Indicator	Weights	Type	Lower Indicator	Individual indicator weight
Accessibility	0.346	Road	0.403	0.141
		Railways	0.300	0.105
		Aviation	0.132	0.047
		Shipping	0.166	0.061
Transport Scale	0.173	Road	0.381	0.070
		Railways	0.309	0.057
		Aviation	0.153	0.029
		Shipping	0.156	0.032
Green Infrastructure	0.137	Road	0.434	0.061
		Railways	0.241	0.032
		Aviation	0.176	0.029
		Shipping	0.149	0.025
Safety	0.343	Road	0.517	0.156
		Railways	0.199	0.058
		Aviation	0.154	0.051
		Shipping	0.131	0.045

Smart logistics is a concept that has emerged recently, and there are relatively few prior studies on the competitiveness of smart logistics. Park, H. K. (2017) developed a strategic selection model that allows new logistics businesses to succeed according to innovative advances in information and communication technology networks using pairwise comparison and AHP techniques. The main evaluation factors were logistics smart service, logistics smart ecosystem environment, logistics smart platform, and logistics smart implementation.

[Table 10] Evaluation Index of Logistics Smart Strategization Plan (Park, H. K. (2017))

Factor	Weights	Detailed Factor	Detailed Weights
Logistics Smart Service	0.256	Intelligent/analytic capabilities	0.339
		speed	0.323
		customization	0.339
Logistics Smart Ecosystem Environment	0.250	Mutual reliability, , ,	0.208
		business environment connectivity	0.313
		logistics Smart Sensor supply stability	0.231
		sustainability	0.247
Logistics Smart Platform	0.237	Collaborative	0.437
		platform, convergence service platform	0.280
		, tracking platform	0.284
Implementation of Logistics Smart	0.256	Standardization	0.420
		IT security	0.295
		legal and institutional improvement	0.285

4.2 Smart City related indicators status

Digital logistics cities can be said to be part of smart cities in that they improve urban problems by utilizing the latest ICT technology. However, if smart cities improve urban problems from a macro perspective, digital logistics cities focus on the logistics sector, one of the components of the city.

As interest in smart cities increases, discussions on the concept of smart cities are actively taking place, and very interest in indicators that can compare the competitiveness of smart cities is increasing. Initially, smart city-related indicators were led by large global companies. In 2009, IBM set and operated indicators to objectively verify the achievements of smart urbanization in countries around the world. CISCO, another smart city global company, is also striving to objectify the performance of smart cities using smart city indicators. Global companies and advanced countries actively use smart city performance indicators because they can preempt the concept of smart cities, and success models can be promoted internationally to achieve standardization of smart cities.

Currently, more than 10 smart city-related indicators are being used worldwide. Smart city indicators are published in both the public and private sectors, and new indicators are continuously emerging. The details of the indicators commonly include indicators for technological sectors that measure smart city-related technologies such as information and communication technology, governance-related indicators, and indicators for measuring innovation.

[Table 11] Overview of Global Smart City Related Indicators

Public/Private Sector	Indicator (Institute)	Overview
Public	European Smart City Indicators (EU)	To compare small and medium-sized European cities and form strategic visions for the six key elements of smart cities in order to secure international competitiveness of cities and sustainable urban development
	Smart City Indicators (INTEU)	By operating 40 Living Lab cities and presenting comparative indicators, it is intended to help decision-making by providing information and knowledge necessary by local governments to other provinces.
	Smart Sustainable Cities Index (ITU-T)	Economic, social, Test ICT factors for efficiency and sustainability in responding to the present and future of environmental perspectives to ensure the validity of more than 70 metrics that can contribute to international standardization
	International City Indicators (ISO)	International Organization for Standardization presents global city indicators with the aim of evaluating international standards for urban planning
	Green City Indicators (ISO)	The International Organization for Standardization presents green city indicators with the aim of evaluating international standards for green cities
	Smart City Indicators (Saudi Arabia)	Presenting Smart City Indicators as a Means for Urban Planning

Private	Smart City Indicators (Smart City Council)	Continuously monitoring the degree of smart city construction in the world's major cities every year based on the six key elements adopted by the EU
	Navigant Smart City Indicators	To measure the complex ranking of the technological advantage of private companies leading smart cities, the activity related to smart cities, and the amount of orders, etc
	UK Smart Cities Index (Navigant)	Assessing the current smart city development status through detailed comparison of the 10 leading cities in the UK
	Mature and Potential Indicators (IDC)	It aims to reduce operating costs and improve long-term smart city sustainability through maturity and potential indicators.
	City Indicators (CISCO)	Set strategic objectives that can be reached by sector during the process of establishing strategic plans by city and indicators to understand the current status of each city
	Smart City Performance Indicators (IBM)	Identify the core attributes of a smart city with limited variables and monitor the smartization process
	Network Society Indicators (Ericsson)	Indicators created to understand how ICT development affects citizens' participation in urban development, economic performance, and cooperation among institutions
	Smart City Performance Indicators (GSMA)	Provide a strategic basis for enhancing practical use of smart mobile services

As a result of reviewing literature and similar indicators, indicators for smart cities, which are a higher concept than digital logistics cities, are actively developed and utilized, and in terms of logistics, research on the competitiveness analysis of port facilities, which are infrastructure that plays a key function of logistics, is dominated. However, it is noteworthy that the research case of Park, H. K. (2017) presents indicators on how to strategize smart logistics.

5. Development of Competitiveness Evaluation Model of Digital Logistics City

The composition of the index and the procedure for calculating the index are largely composed of three parts: the composition of the index system, the calculation of weights, and the calculation of indices. In this study, the future development direction of the logistics industry was suggested through the prospect of changes in social and economic conditions. In addition, through this, we would like to present an indicator system, which is the first step in constructing an index model for evaluating the competitiveness of digital logistics cities.

5.1 Prospects for Social and Economic Change

Future social changes include positive changes such as productivity improvement due to technological development, while negative changes such as job loss exist. Therefore, by looking closely at various changes in the future society, we will be able to find more realistic and reasonable countermeasures.

5.1.1 Changes in industrial structure

First of all, in terms of technology and industry, the 4th Industrial Revolution will change the industrial structure and create new smart business models through convergence between technologies and industries. Its important characteristics, "super-connectivity" and "super-intelligence," change the subject of the production process. Previously, mechanical facilities that make parts and products were the subject of the production process, but now it has changed to an industrial structure in which parts and products are the subject of the production process. As a result, the need for human labor in the manufacturing sector is already gradually decreasing, and the industrial structure has begun to change, such as the phenomenon of "Reshoring."

In addition, new "smart business models" such as Online to Offline (O2O) will emerge with the development of platform technology based on "super connectivity" such as the Internet of Things (IoT) and cloud. The rise of the sharing economy and the on-demand economy has made the experience of consumers important. In addition, it will create a collaborative structure between data-driven services and new types of industries. As a result, a new smart business model based on Information and Communication Technology (ICT) and 'super connectivity' is expected to emerge. In addition, considering the level of technology development such as big data, the Internet of Things, artificial intelligence, and autonomous vehicles, a new market is expected to emerge due to the full-scale commercialization of these technologies in the future.

In addition, the rapid rise in global average temperatures is raising awareness of climate change around the world. Accordingly, major countries around the world are pursuing various policies to cope with climate change, and future industries are expected to gradually change into eco-friendly structures that curb carbon emissions as much as possible.

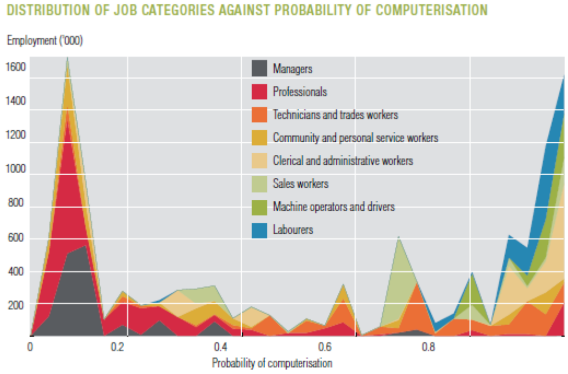
5.1.2 Changes in employment structure

Major changes in science and technology are expected to change the employment structure of the future society. In particular, the improvement of automation technology and computer computational technology is expected to directly affect jobs related to simple and repetitive office administration jobs or low-skills tasks, reducing employment rates. Oxford Univ. (2013) conducted a study on jobs that are likely to disappear in the future due to computerization and automation, with 47% of current jobs likely to disappear within 20 years. In particular, jobs related to simple and repetitive tasks such as telemarketers, librarians, accountants, and taxi drivers are expected to disappear due to automation technology (Oxford Univ., 2013).

However, there is not only a negative outlook regarding the change in the job landscape. There is also a prediction that new jobs will emerge in the technical and industrial fields related to the Fourth Industrial Revolution, and the demand for high-skilled workers will increase. In particular, there is a prospect in the industry that 2 million new jobs will be created in technology fields that are highly related to major drivers of change in the Fourth Industrial Revolution, such as artificial intelligence, 3D printing, big data, and industrial robots, 65% of which will be new jobs (GE, 2016).

[Figure 5] Computerisation by Occupation (Oxford Univ., 2013(Left), CEDA, 2015(right))

Computerisable				
Risk	Probability	Label	SOC code	Occupation
687	0.98		43-4151	Order
688	0.98		43-4011	Brokerage Clerks
689	0.98		43-9041	Insurance Claims and Policy Processing Clerks
690	0.98		51-2093	Timing Device Assemblers and Adjusters
691	0.99	1	43-9021	Data Entry Keyers
692	0.99		25-4031	Libray Technicians
693	0.99		43-4141	New Accounts Clerks
694	0.99		51-9151	Photographic Process Workers and Processing Machine Operators
695	0.99		13-2082	Tax Prepaerers
696	0.99		43-5001	Cargo and Freight Agents
697	0.99		49-9064	Watch Repairers
698	0.99	1	13-2053	Insurance Underwriters
699	0.99		15-2091	Mathematical Technicians
700	0.99		51-6051	Sewers, Hand
701	0.99		23-2093	Title Examiners, Abstrsctors, and Searchers
702	0.99		41-9041	Telemarketers



5.1.3 Changes in consumption patterns

Consumers share information in real time through social media on various channels such as offline, online, mobile, virtual reality, and augmented reality, and purchase products and services suitable for them at optimal purchase conditions. In addition, consumers will be able to check basic information about the product, such as function, quality, price, and follow-up management, as well as compliance with environmental and labor ethics. It is predicted that consumers in the future will evolve beyond "smart consumers," which means "smart consumers," to become consumers with as much knowledge as professional engineers. To respond to the increasingly smart consumer demands, production will evolve into a smart form that investigates and utilizes demand data and flexibly adjusts the process, rather than simply inputting and processing production factors from a supply-driven perspective. Sensors and memories will be attached to mechanical facilities or materials and parts to self-diagnose and optimize the production process, and product management by life cycle will be possible as all life cycles of products can be tracked through the Internet of Things. Various evolving consumer products make consumer life smarter.

The 4th Industrial Revolution will further expand the production of products and services optimized for individual demand. In the past, consumers had to be satisfied with purchasing a decent product within a limited range of choices because easy products that the average person would like were mass-produced. However, as connectivity has increased significantly due to network development, consumers can access more diverse brands and make a wide range of choices. The on-demand economy, in which producers and consumers are constantly connected and can meet even small demands, is expanding (Kim et al., 2017). The on-demand economy is a system in which demand determines everything, not supply-oriented, and provides customized products and services immediately to meet consumer demand through ICT infrastructure. Consumer demand has been subdivided, and the development of big data, IoT, and 3D printing technologies has made production flexible, closely linking production and consumption, and providing an opportunity for personalized production to expand. The paradigm is changing from production based on a mass production system to individual production that broadly meets various demands (Marsh, 2013). In the past, personalized demand existed, but customized products were relatively expensive because they had to be produced manually. However, as the fourth industrial revolution digitized design and production systems and connected to each other made it easier to change the structure or production method of products, general consumers also benefit from personalized production at a low price (Kim, 2016)

5.1.4 Changes in demographic structure

The global population growth and the acceleration of urban concentration are causing various urban problems such as urban resource and infrastructure shortages, traffic congestion, and energy problems. The Korea Institute of Science and Technology Planning and Evaluation (2018) predicts that the global population will be 10 billion in 2050, and the concentration of the city's population will accelerate due to technological advances, with about 6.3 billion people living in the city from 4.2 billion in 2018. Smart cities are actively being promoted around the world to solve various problems in cities and proactively respond to the Fourth Industrial Revolution.

In addition, in Korea, the working-age population is decreasing significantly due to the aging population caused by low birth rates. The total domestic population is expected to decrease from 51.84 million in 2020 to 37.66 million in 2070, and the proportion of the working-age population to the total population is expected to decrease from 72.1% in 2020 to 46.1% in 2070. (Statistics Office, 2021)

5.1.5 Changes in global economic conditions

Recently, protection trade has been strengthened due to various international issues, and the low growth of the global economy continues. In order to sanction China's unfair trade practices, the United States began a trade dispute in July 2018 by imposing a high tariff of 25% on Chinese imports. In addition, this trade dispute has expanded to security issues such as the U.S. restriction of semiconductor exports to Huawei, human rights issues in Xinjiang and Inner Mongolia, and the resolution of the Hong Kong Security Act.

In addition, due to the prolonged Russia-Ukraine war, Western countries are gradually tightening economic sanctions against Russia, and Russia is responding by suspending natural gas supplies to Europe. A recession is expected in Europe, where energy dependence on Russia is high, and this, coupled with austerity measures such as interest rate hikes to curb inflation, is a factor in the economic downturn.

5.2. Presenting an indicator system for the development of a competitiveness evaluation model of digital logistics cities

This study summarized the implications for digital logistics cities by predicting changes in social and economic conditions such as industry, population structure, consumption pattern, and employment structure as follows.

The first is innovation in the logistics industry based on smart technology. The paradigm to a smart society is shifting based on the development of the fourth industrial revolution technology, in which technology and industrial structure are hyperconnected and hyperintelligent due to artificial intelligence, big data linkage, and convergence. With the development of these technologies, the global e-commerce market is growing rapidly. Amid these changes, as the demand for customized services for each consumer expands, a new type of smart logistics technology and service that combines digital technology and logistics service innovation is starting. These technologies and services require cost reduction and accuracy in the entire logistics process. The second is the creation of a logistics environment from the ESG perspective. The international community's demand for responding to climate change is increasing, and the transition to an energy-independent society and a sustainable circular economy society is accelerating. Domestic and foreign logistics companies are actively proposing measures to respond to climate change and carbon neutrality throughout the logistics process in line with the eco-friendly trend. And finally, the importance of life-oriented logistics. Global population growth and acceleration of urban concentration are causing various problems such as urban resources and infrastructure shortages, traffic congestion, and energy problems, and smart cities are accelerating as a solution. In addition, changes in the demographic and social structure, such as an aging population and an increase in single-person households, are bringing about the development of various logistics services. Therefore, a systematic living logistics system that can effectively and efficiently respond to the demand for living logistics in the city center should be actively reflected in urban planning

In this study, through the three implications of changes in social and economic conditions for digital logistics cities, detailed indicators of key indicators that should be reflected in digital logistics cities are presented as shown in the table below.

[Table 12] Implications of Changes in Social, Economic Condition for Digital Logistics City

✓ Innovation in logistics industry based on smart technology ✓ Creating an ESG-Perspective Logistics Environment ✓ Increasing the importance of logistics in close-to-life logistics	⇨	✓ High Quality Living Delivery Service System ✓ Logistics infrastructure and network for uninterrupted logistics services ✓ Safety and Supplementation of Logistics Industry ✓ Establishing an Innovative Transportation System ✓ Establish an integrated monitoring system

[Table 13] The Competitiveness Evaluation Index of Digital Logistics City

Key Indicators	Detailed indicators
High-quality household goods delivery	Service satisfaction of daily logistics delivery
	Delivery Leadtime
Logistics Infrastructure and Network	Logistics Infrastructure Automation Rate
	Introduction of incentives, appropriateness of incentives
	Degree of reduction in logistics costs
	Urban Planning for Innovative Logistics Infrastructure
Safety and Security of Logistics Industry	Labor environment of logistics industry workers (disaster rate, etc.)
	Accidents caused by freight vehicles, air pollution
Establishing an Innovative Transportation System	Utilization of Renewable Energy
	Volume of new transportation systems such as robots and drone delivery
Establishing an Integrated Monitoring System	Delivery and reliability of integrated monitoring services
	Air Pollution Control System due to Cargo Vehicle

6. Conclusion. & Future Research

Recently, it is necessary to reflect social changes such as the rapid increase in daily logistics due to the development of e-commerce, the reorganization of industrial structure and job change due to the emergence of the 4th Industrial Revolution technology, and the paradigm shift to smart society, and to solve essential problems in the logistics industry such as urban problems such as environmental pollution and traffic congestion caused by cargo vehicles, and lack of logistics information sharing. In order to solve these problems and apply various advanced logistics technologies, Korea is promoting a digital logistics pilot city, and it is necessary to establish an evaluation model for the successful promotion of a digital logistics pilot city.

This study derives three implications for digital logistics cities by predicting changes in social and economic conditions in global society. The first is innovation in the logistics industry based on smart logistics, the second is the creation of a logistics environment from an ESG perspective, and finally the importance of life-oriented logistics. Through these three implications, this study presented key and detailed indicators to be pursued by digital logistics cities. There are five key indicators, including high-quality daily logistics delivery, mud infrastructure and networks, safety and security of the logistics industry, the establishment of an innovative transportation system, and the establishment of an integrated monitoring system. In addition, 12 detailed indicators were presented at the bottom of the key index. The core indicators and indicator composition system presented in this study need to be supplemented by advice of expert and surveys in the future, and additional research such as AHP analysis to calculate weights for each indicator is needed.

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