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A Study on the Development Priority of Smart Shipping Items—Focusing on the Expert Survey

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Abstract: As smart technology in the shipping industry accelerates, demand for technology development, which aims to increase competitiveness by utilizing the latest smart technologies, is increasing. The shipping industry in each country is pushing for developing its smart technologies at a rapid pace, and it is urgent to prioritize the demand for smart technologies in the shipping industry for sustainable industry growth. The purpose of the present study is to verify the importance and urgency of smart technologies in the shipping industry, and the present study surveys 74 domestic and foreign shipping industry officials, covering shipping companies, brokers, governments, etc. The importance and urgency of each smart technology item in the shipping industry are questioned in a survey. It is necessary to focus investment on specific smart shipping items under a limited budget, and, since the priorities presented in this study were derived through comprehensive collection of opinions from 74 shipping experts, the priorities presented in this study are expected to be effective reference values when implementing sustainable shipping investment policies. According to an interview analysis on importance and urgency, both "autonomous ships" and "blockchain" items show high importance and urgency. Since both importance and urgency are high, strategic priorities are the highest, and it is expected to contribute effectively to enhancing the smartness of the shipping industry when it focuses its investment capabilities in those fields.

Keywords: shipping industry; sustainable growth of shipping industry; smart shipping technology

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1. Introduction

According to the "*Leading through the Fourth Industrial Revolution Putting People at the Centre*" [1] published by the World Economic Forum in 2019, many studies have been conducted to analyze the impact of the fourth Industrial Revolution on the introduction and application of technologies in various industrial fields. Afolalu et al. [2] predicted that the technology development by the fourth Industrial Revolution will affect various fields, such as economy, industrial structure, and labor market, and that new technologies, such as Internet of Things (IoT), artificial intelligence (AI), and big data, will expand rapidly. Klaus Schwab [3] noted that the fourth Industrial Revolution, which is referred to as an innovative technological revolution, would accelerate industrial and economic structural changes through the evolution of related industries in the future. Treude [4] explained that new digital technologies can make a smart city that has various advantages for its citizens, roughly in line with the demands of sustainable development. He predicted that smart technologies could ultimately lead to strengthening industrial competitiveness through productivity improvement.

The first Industrial Revolution was based on steam power to automate production, and the second utilized electric power to produce mass production. The third used

electronics and information technology to automate production. Now, the fourth Industrial Revolution is developing, based on the third, the digital revolution that has been occurring since the later part of the last century. The fourth Industrial Revolution can be characterized by a fusion of technologies blurring the lines between the physical, digital, and biological spheres. The fourth is developing at an exponential rather than a linear pace, and it is influencing almost every industry in every country. Wang et al. [5] raise several questions for forthcoming research, including the relationship between policy priorities, scientific research, and academic research. They mentioned that urban development using IoT, AI, digitalization, and so on, which are smart technologies related to the fourth Industrial Revolution, is accelerating. The following Table 1 explains the development of the industrial revolution.

Table 1. Development of the Industrial Revolution.

	The 1st Industrial Revolution	**The 2nd Industrial Revolution**	**The 3rd Industrial Revolution**	**The 4th Industrial Revolution**
Period	18th century (1760–1840)	the early 19th and 20th centuries	the late 20th century	21st century
Characteristics	increased productivity based on steam engine	mass production based on electric energy	digital revolution based on computer and internet	ultra-intelligent revolution based on IoT, AI and big data
Impact	massive manufacturing industries	electricity production lines and mass production systems	global IT revolution with the internet	revolution of social systems through automation, intelligence, etc.

Source: authors referring the Klaus [3].

Meanwhile, the fourth Industrial Revolution is also appearing in the shipping industry. The EU, Japan, and other major shipping industries are pushing for the development of autonomous ships, blockchain, etc., using IoT and AI, aiming to improve safe sailing and improving operating efficiency. Brenner [6], Maiolini et al. [7], and Colglazier [8] explained that innovative improvement of business models is inevitable for sustainable development, and a complete reorganization of the business structure using digital technologies, IoT, etc., should be accompanied. These papers argued that the spread of smartization technology is urgent to improve current stagnant productivity. The fourth Industrial Revolution in the shipping industry is due to broadband telecommunication facilities in the early 2010s. Yang et al. [9] highlighted that, despite the urgent need to introduce smartization in the shipping industry, there are no previous studies that suggested smartization items that can be introduced. As a result, the growth of IoT, AI, and big data information processing algorithms, as well as high-level operation monitoring and remote operation, are coming to reality. As smartness in the shipping sector accelerates, demand for technology to increase competitiveness by utilizing various new technologies is increasing. Shipping industries and shipping companies in each country are pushing to smarten their shipping businesses at a rapid pace. It is urgent to prioritize the demand for smart technology development in the shipping sector to advance in competition with major global shipping countries and promote sustainable competitiveness in the shipping sector. In summary, leading by the EU, Japan, and other major shipping countries around the world are actively pushing for the smartness of shipping, and it is necessary to conduct a demand survey on shipping's smart technology and derive items that need development most urgently. If the smart shipping technologies are developed, it is expected that this will benefit shipping-related agencies, such as shipping companies, shipbuilders, trading companies, and also society, which means the national economy.

Amid the smartening revolution in the shipping industry, smartening is expected to bring various advantages, such as improving operational efficiency and upgrading safety sailing. Shipping, which accounts for more than 90% of worldwide exports and imports,

has a huge impact on society as a whole, and it is highly essential to draw a priority on smart technology development and strategy implementation, given that smartening can contribute to the development of the national economy as well as major players in the shipping industry. Pfeifer et al. [10] argued that the introduction of smartization technology in the shipping industry is slower than in other manufacturing industries, and that which technology should be introduced first should be suggested. Ichimura et al. [11] explained that the spread of smartization items in the shipping industry should promote sustainable industrial development, but opinions have not yet been collected on what smartization items need to be introduced and developed. The present study argues that it is necessary to focus investment on specific smart shipping items under a limited budget, and, since the priorities presented in this study were derived through a comprehensive collection of opinions from 74 domestic and overseas shipping industry experts, the priorities presented in this study are expected to be practical reference values when implementing shipping policies for sustainable industry growth.

The composition of the present study is as follows. Section 2 introduces preceding studies that analyzed the development of smart technologies in the shipping industry. Section 3 reviews the latest overseas smart shipping technologies being developed by major shipping countries. In Section 4, the present study first introduces multiple smart shipping technology items that are finally selected based both on preceding studies in Section 2 and overseas cases in Section 3. Subsequently, chapter IV explains the results of the demand survey, which was sent to the 74 shipping industry officials for the selected smart shipping items, and shows the importance and urgency of each smart shipping technology item. In Section 5, the primary conclusion of the present study is summarized and suggestions are presented.

2. Review of Prior Studies

2.1. Research Methodology

This study examined previous studies that analyzed shipping smartization technology in Section 2 and reviewed overseas shipping smartization technology cases in Section 3, described later. By reviewing several previous studies and overseas cases, it is possible to grasp the smartization technology of the shipping industry emerging around the world. In short, this study attempted to identify major shipping smartization technologies to be included in the questionnaire before surveying shipping experts. To this end, the present study conducted a wide range of prior studies and overseas case reviews.

The present study attempts to forecast the change of the shipping industry caused by the fourth Industrial Revolution utilizing the "futures wheel" method among various future prospecting techniques. The futures wheel technique is regarded as the past case basis technique that predicts the future through empirical knowledge of events that have occurred in the past. This technique is recognized as a scientific and objective way to predict the future based on the review of prior studies without special equipment or software, especially when it is impossible to predict the future due to a lack of quantified data. The present study reviews several prior studies analyzing smart shipping technologies emerging in the global shipping industry and attempts to show the latest smart shipping technology items in the shipping industry introduced by prior studies. The following Figure 1 shows the research methodology.

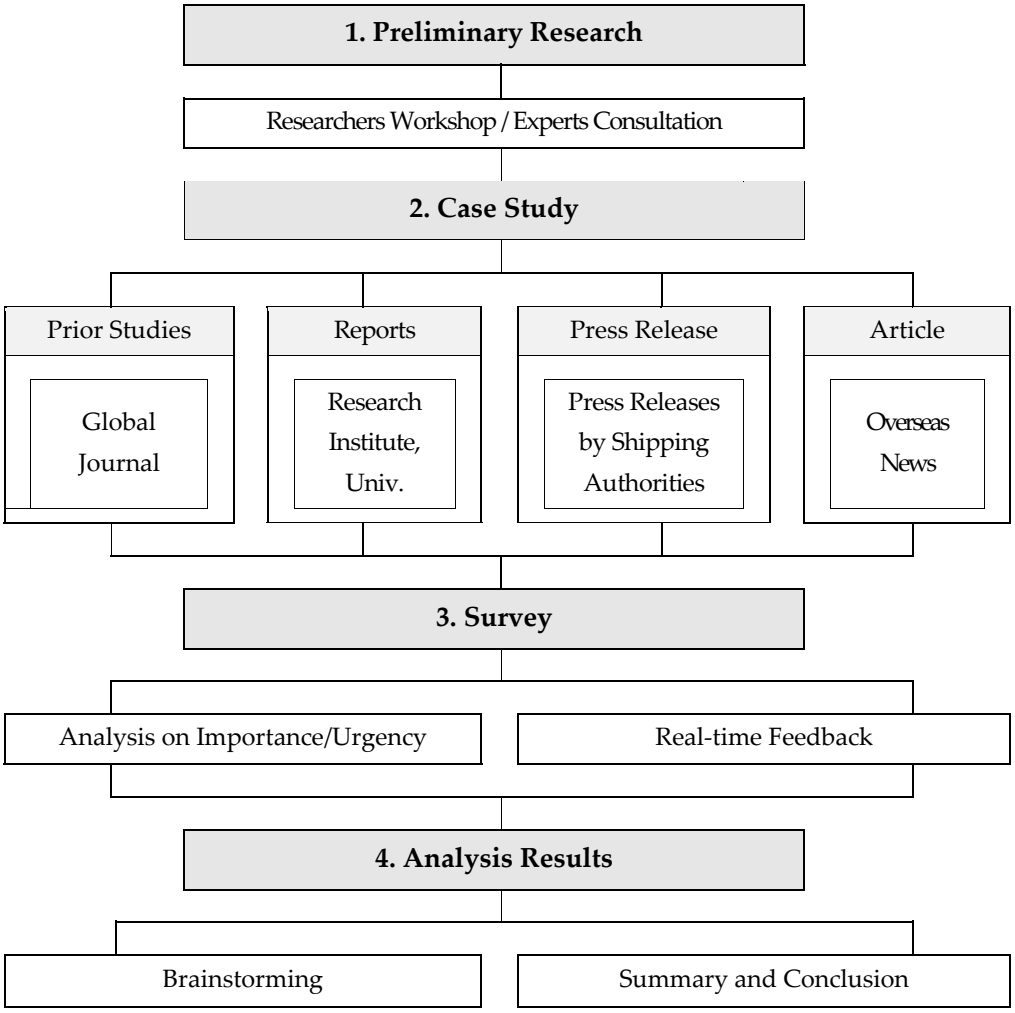

Figure 1. Research methodology.

2.2. Prior Studies Related to Smart Shipping Technology

2.2.1. Autonomous Ships (Remote Control Technology)

Zarzuelo et al. [12] noted that competition for automation in major container ports worldwide is intensifying. The automated terminals are based on AI, which are also called robotic ports because machines carry out all the tasks of loading, unloading, and transporting containers by using, for example, cranes and yard tractors without people. Their study said that, if a terminal is automated, operating costs, such as labor and power costs, can be greatly reduced compared to existing terminals, and the labor costs could be reduced by 85% if terminals achieve complete full automation even in cranes and yard tractors. In addition, fully automated terminals have the advantage of not emitting air pollutants by using electricity as the power of all loading and unloading equipment. Their study presented an automated terminal as an emerging smart shipping technology.

Papanikolaou et al. [13] introduced several cases of the development of autonomous ships and remote control technologies, enabling enhancement of the productivity of the shipping industry fundamentally. Their study explained that the shipping industry could reduce costs on a large scale with autonomous ships, which can contribute to improving the profits of shipping companies. They emphasized autonomous ships as the most urgent item to promote new smartness in the shipping industry and predicted that it would be possible to commercialize autonomous shipping vessels by 2030~2050. In short, Zarzuelo et al. [12] and Papanikolaou et al. [13] emphasized the feasibility of automatic operation through the development of remote control technology and explained that environmental pollution and cost reduction could be expected through automated technology.

2.2.2. Blockchain

Savrul and Incekara [14] showed several examples of the shipping industry in response to the EU's fourth Industrial Revolution, introducing remote control technology and blockchain technology development. Their study explained that remote control technology could reduce the number of crew members on board and, most of all, improve the welfare of shipping workers by converting onboard work to land work. They noted that the development and application of blockchain technology enable real-time tracking of cargo moving at sea, preventing delays in transportation. Their research suggested that long-distance remote control technology and blockchain are urgent items to promote new smartness in the shipping industry. If new technologies are developed in response to the fourth Industrial Revolution, the shipping industry can achieve cost reduction and productivity improvement.

Sikorski et al. [15] introduced overseas cases where blockchain technology, one of the leading technologies in response to the fourth Industrial Revolution, is applied in various industries, such as the shipping industry, chemical industry, etc. Their study predicted that blockchain technology could improve the efficiency of supply chain management (SCM) by visualizing container information, improving transport efficiency, and providing door-to-door services faithfully. According to their study, blockchain technology can manage not only the location of container, but also the temperature, humidity, vibration, etc., of the container. If the container is visible, the efficiency of the entire SCM and the transport safety can be increased, and shipping companies can respond more appropriately to delays in transportation. In addition, container information obtained in advance through blockchain can be used for customs clearance. Their study explained that blockchain is an urgent item to promote new smartness in the shipping industry, and real-time tracking of containers can be a future image of the shipping industry.

Dombrowski and Wagner [16] examined the fourth Industrial Revolution in the shipping industry, focusing on the EU, China, and Japan. Their study emphasized blockchain and predicted that the activation of IoT logistics, especially containers logistics, could be expected through blockchain utilization. Their research argued that collecting and utilizing container data from all over the world through blockchain can reduce time spent at congestion ports or customs. The blockchain is also expected to increase efficiency at the overall level of the supplier chain. Their study highlighted the blockchain as an urgent item to develop in the shipping industry and expected to provide high-quality information to customers by utilizing blockchain, a type of IoT technology, and to enable significant growth in the shipping industry. In summary, Savrul and Incekara [14], Sikorski et al. [15], and Dombrowski and Wagner [16] selected blockchain as a promising future smartization technology among various shipping smartization technologies. The advantages of blockchain technology presented by their papers include real-time tracking, reduced transportation time, and improved customer satisfaction.

2.2.3. Market Forecast with Big Data

Chun et al. [17] introduced several IoT and big data use cases, such as autonomous cranes and automated container terminals, to respond to the fourth Industrial Revolution. It is necessary to develop autonomous cranes and automated container terminals through internet advancement, which can solve the problem of labor shortage in the port industry caused by being recognized as a 3D (difficult, dangerous, and dirty) industry. Their research also argued that big data could predict the seasonality of the shipping industry, thereby hedging a certain range of market fluctuations. They emphasized the autonomous cranes, the automated container terminals, and the prediction of the market conditions using big data as the most urgent items to promote new smartness in the shipping industry.

Zhang and Wang [18] examined whether big data in the stock market can enhance the forecast of oil prices. Their study employs four high-frequency stock market data to forecast Brent and West Texas Intermediate (WTI) prices. The high-frequency stock data have certain power over the lower-frequency data to predict more correctly. The

MIDAS (mixed-data sampling) method using high-frequency indices is demonstrated to be superior to the ordinary manner. In short, their results show that the high-frequency stock market data have evident power over the lower-frequency stock market data in forecasting monthly oil prices, and the MIDAS model using high-frequency indices proves superior to ordinary regression models. Their study argued that future price forecasts using big data reduce the fluctuations in prices within the industry, ultimately enabling continued growth of the industry. In short, Chun et al. [17] and Zhang and Wang [18] explained that the shipping industry has an industry-specific market cycle, so it is necessary to stabilize industrial–economic fluctuations. They emphasized that market forecasting services should be provided because shipping companies suffer from frequent economic fluctuations. According to their research, using big data, which have recently emerged for all industries, can help predict freight fluctuations in the shipping industry.

2.2.4. Digitalization

Wang and Sarkis [19] predicted the current digitalization trends of shipping and logistics industries and the future direction of progress. They noted that digital transformation is becoming a hot topic in all industries, and shipping and logistics industries are no exception. They predicted that digitalization is an area where various stakeholders participate through complex stages and transparent information, securing safety, etc., caused by digitalization, which can make both the shipping companies and shippers beneficiaries. This paper suggests that digitization is the latest smart technology emerging in the shipping industry, and the level of digitization can dominate the competitiveness of the industries or countries in the future.

Aiello et al. [20] indicated that digitalization is emerging as a key competitive factor for shipping companies as non-face-to-face transactions that are also active in the shipping industry due to COVID-19. Digitalization, which focuses on closely connecting shipping companies and shippers, is now leading to changes in the global shipping market. Their study defined that digitization as use of digital technologies to change a whole business model and provide new value-producing possibilities. Digitalization basically refers to taking analog information and encoding it into zeroes or ones so that computers can store, process, and transmit such digital information. They argued that it is possible to increase logistics efficiency by standardizing and sharing data and predicted that digitalization would ultimately improve customer service quality and competitiveness of the shipping industry.

Ahn and Kim [21] presented various smart shipping items within the shipping industry and derived investment priorities for each item. As smartization in the shipping and logistics sectors accelerates, the demand for technology development in Korea, which aims to increase competitiveness by utilizing various new technologies and gain an advantage in domestic and international competition, is increasing. Global shipping companies and countries' shipping and logistics industries are pushing for smartening their own shipping and logistics industries rapidly. They emphasized the need for industrial digitalization, which can strengthen the ripple effect of information and improve logistics efficiency. Sharing information through digitalization increases transaction transparency and ultimately enables cost reduction. This study is similar to the present study in that they conduct a survey and present investment priorities for each smart item. In summary, Wang and Sarkis [19], Aiello et al. [20], and Ahn and Kim [21] are paying attention to digitalization among various shipping smartization technologies. Their research findings reveal that digitalization can improve logistics efficiency and transparency, through standardizing and sharing data, and reduce logistics costs. In addition, they assure in common that digitalization can ultimately improve the shipping industry and national economic power.

2.2.5. Online Booking System

Zeng et al. [22] predicted that the ability to absorb smart technology would determine whether small and medium-sized companies will survive or not in the shipping industry.

They argued that small and medium-sized carriers should be able to secure stable cargo through online booking systems and should increase their ability to collect small cargoes through the development of e-commerce platforms if there is not much mass cargo. Their study highlighted an online shipping reservation system and e-commerce platform as the smart technology urgently needing to be develop in the shipping industry.

Meng et al. [23] mentioned that the aim of revenue management (RM) is to maximize revenue growth for a firm by optimizing product/service availability and prices based on micro-level predicting of customer behavior. Seat/cargo capacity control and cargo pricing are two critical RM study issues that have yielded various models and solutions, especially for seaborne transportation, which have been taken up most of the global trade. Their study concluded that the online booking system allows shipping companies to predict customers' behavior more accurately, which enhances the efficiency of the ship's operations. The common goal of most companies is to maximize profits, and a company can maximize its gain by optimizing its utilization rate. Their study emphasized that the online ship booking system can maximize corporate profits by increasing utilization rate. In short, the online booking system is also one of the emerging smart items in the shipping industry. Zeng et al. [22] and Meng et al. [23] are paying attention to the online booking system, which can facilitate cargo reservations and provide stable work, especially for small and medium-sized shipping companies. In addition, the online booking system provides future predictive power for shipping companies to perform their management more stably. According to their research, shipping companies attempt to maximize profits, and the online booking system can help achieve the goal of maximizing profits.

2.2.6. Human Resources with Smart Technologies

Jo and D'agostini [24] analyzed the importance and scale of the fourth Industrial Revolution and examined how interactions among economies, societies, and individuals have been changed. They mentioned that the shipping industry is no exception, and the growing maritime autonomous surface ships (MASSs) are foreseen to be a main growth generator for the next-generation shipping industry. Nevertheless, MASSs may also negatively affect numerous fields, one of which might be potential loss of maritime works. Their research argued that automation had been rapidly progressing in each sector within the shipping industry recently, which could lead to a decrease in the size of future job openings. They proposed the need to systematically implement human resources training to handle smart technologies proficiently concerning the fourth Industrial Revolution, such as IoT, AI, and big data.

Wadley [25] explained that advanced agriculture, construction, shipping, etc., are cutting their workforces, manufacturing has even been hollowed out, and the service industries, including the shipping industry, are frequently capital-intensive. Accelerated economic and technological change impacts firm investment and can influence labor demand weakly. From a deductive presentation that led to the societal scope of innovations, this study analyzed seven interacting operators of capital/labor substitution or labor displacement. This study expressed concern that future unemployment may increase due to advances in smart technologies and suggested that it is necessary to train personnel with the emerging fourth Industrial Revolution technologies, such as IoT, AI, etc., to prevent large-scale unemployment at once. In short, Jo and D'agostini [24] and Wadley [25] suggested that, while smart technology is rapidly spreading in the shipping industry, it is important to foster human resources that can handle these technologies skillfully. According to their paper, with the development of smart technology, the development of manpower must be accompanied. However, they also raise concerns that unemployment could increase against the backdrop of the development of shipping smart technology. If it is not accompanied by fostering human resources, which are familiar with IoT and AI, the unemployment of unskilled workers in shipping smartization technology could increase.

2.2.7. E-Commerce Platform

Sun et al. [26] analyzed on dual-channel sales strategy the decision of container slots considering shipping e-commerce platforms. A two-case game model is employed to verify the purchasing contract under each sales case. A win–win case for both the shipping company and the shipper could be found based on several conditions in their study, and the impacts of some parameters on the optimal balances are estimated under the win–win case. The conclusions serve as managerial recommendations for container shipping companies to design effective shipping e-commerce platforms. In short, their study regarded the e-commerce platform as the most urgent item for the shipping industry to be smart.

Balci [27] introduced the online shipping reservation service and e-commerce models in response to the fourth Industrial Revolution. It explained that satisfaction and trust in digital products in shipping affect customer loyalty, and trust impact digital satisfaction. It predicts that, as the size of e-commerce continues to spread globally, how much shipments are secured through e-commerce could be a major factor in determining the management performance of the shipping industry. It suggests online ship booking services, e-commerce models, etc., as an urgent item to promote new smartness in the shipping industry, and mentioned that digitalized operations in a business-to-business (B2B) industry affect overall customer loyalty. That is, successful digitalization of shipping and logistics services impacts customers' satisfaction. In short, Sun et al. [26] and Balci [27] mentioned that e-commerce could provide new works to shipping companies. As non-face-to-face purchases increase, the size of the e-commerce industry is overgrowing, which increases the demand for sea transport services. As e-commerce is expected to continue to expand, business partnerships between companies that operate e-commerce and those that provide seaborne transport services will be important. These B2B businesses will eventually accelerate with the development of smart technology. Table 2 explains the major smart shipping items in prior studies.

Table 2. Major smart shipping items in prior studies.

Major Items	Title	Journal
Autonomous ships (remote control technology)	Industry 4.0 in the port and maritime industry: A literature review	*J. Ind. Inf. Integr.* (2020) [12]
	Energy Efficient Safe Ship Operation (SHOPERA)	*Transp. Res. Proc.* (2016) [13]
Blockchain	The Effect of R&D Intensity on Innovation Performance: A Country Level Evaluation	*Procedia Soc Behav Sci.* (2015) [14]
	Blockchain technology in the chemical industry: Machine-to-machine electricity market	*Appl. Energy* (2017) [15]
	Mental Strain as Field of Action in the 4th Industrial Revolution	*Procedia CIRP.* (2014) [16]
Market forecast with big data	Deep reinforcement learning-based collision avoidance for an autonomous ship	*Ocean Eng.* (2021) [17]
	Do high-frequency stock market data help forecast crude oil prices? Evidence from the MIDAS models	*Energy Econ.* (2019) [18]
Digitalization	Emerging digitalisation technologies in freight transport and logistics: Current trends and future directions	*Transp. Res. E: Logist. Transp. Rev.* (2021) [19]
	Towards Shipping 4.0. A preliminary gap analysis	*Procedia Manuf.* (2020) [20]
	A Study on the demand for technology development to lead the smartization of the shipping industry	*Korea International Commerce Review* (2021) [21]
Online booking system	The adoption of open platform for container bookings in the maritime supply chain	*Transp. Res. E: Logist. Transp. Rev.* (2020) [22]
	Revenue management for container liner shipping services: Critical review and future research directions	*Transp. Res. E: Logist. Transp. Rev.* (2019) [23]
Human resources with smart technologies	Disrupting technologies in the shipping industry: How will MASS development affect the maritime workforce in Korea	*Mar. Policy.* (2020) [24]
	Technology, capital substitution and labor dynamics: global workforce disruption in the 21st century?	*Futures* (2021) [25]
E-commerce platform	The dual-channel sales strategy of liner slots considering shipping e-commerce platforms	*Comput Ind Eng.* (2021) [26]
	Digitalization in container shipping: Do perception and satisfaction regarding digital products in a non-technology industry affect overall customer loyalty?	*Technol. Forecast. Soc. Change.* (2021) [27]

3. Review of Overseas Case Studies

3.1. Autonomous Technology (Ships, Remote Control, Terminals, and Cranes)

According to Yara [28], the Norway manufacturer is developing to build autonomous container ships. The electric autonomous container ship, named Birkeland, was completed in the second half of 2020, making it the world's first electric autonomous container vessel. Birkeland is operated entirely on electricity, and the purpose of the development of this vessel is to reduce emissions of environmental pollutants. Yara uses the trucking method to transport manufactured chemicals and fertilizers from its manufacturing plant Porsgrunn to Brevik port for export, to which about 40,000 trucks are needed annually. The problem with exports is that air pollution and noise caused by about 40,000 trucks damage residents. To reduce this damage to residents, Yara has been working with Kongsberg, a research institute specializing in ship electronics and offshore engineering, to develop autonomous ships since 2015. Yara intends to dramatically reduce emissions of environmental pollutants, such as noise, carbon dioxide, nitrogen compounds, etc., by utilizing container ships operated by electric batteries. Yara plans to pre-emptively respond to the fourth Industrial Revolution by developing "Pollution Free" ships that do not emit any environmental pollutants by utilizing electronic engineering technology.

In July 2017, Rolls-Royce [29] and Svitzer, a British tugboat company, recently conducted a pilot operation of the world's first remote-controlled ship, Svitzer Hermod, in Copenhagen, Denmark, which operated reliably through remote control. The captain of Svitzer Hermod on land remotely controlled that 28-m-long tugboat. This pilot operation was an experiment of a ship departing from the inner wall with remote control from the headquarters on land, then moving it 360° again, and then returning to the inner wall. Through IoT and AI technologies, it achieved stable remote adjustment, even from a location about 400 m away from its headquarters on land. The Svitzer Hermod by Robert Alan's ship design was built in 2016 at the Sanmar shipyard in Turkey. With the successful launch of the world's first remote-controlled vessel through the utilization of broadband networks, the growth of remote-controlled vessels is expected, along with the rapid development of IoT technology.

China's development of automated container terminals utilizes IoT technology, which is a critical technology of the fourth Industrial Revolution, and China is trying to reduce labor costs and vessel congestion by the development of automated systems using broadband internet. The fourth terminal in Yangsan port, completed on 10 December 2017, is the world's largest automated container terminal through several performance tests. The annual cargo processing capacity was developed at 4 million TEUs; it plans to expand to 6.3 million TEUs in the future, and it can handle several large container ships simultaneously. The development of the automated terminals in China was driven by China's Ministry of Transport of the People's Republic of China, and this is an example of China's government-led introduction of smart technologies to the shipping industry [30].

NYK [31], a Japanese shipping company, explains that autonomous ships can collect and interpret data, such as weather, sea depth, and sea obstacles, in a short time using IoT, where all objects are connected to the internet. Based on these data analysis results, AI automatically finds the most efficient route while considering fuel efficiency. Furthermore, the development of autonomous ships can increase the possibility of avoiding sea accidents by receiving data subject to navigation or predicting vessel equipment malfunctions. In June 2017, NYK announced plans to develop the autonomous ship through co-operation with Japanese shipbuilding companies and Japan's Ministry of Land, Infrastructure, Transport and Tourism (MLIT). In short, the development of autonomous ships is a project to pre-emptively respond to the fourth Industrial Revolution through co-operation among shipping companies, shipyards, and the government. NYK planned to develop an automatic operation system that uses AI to designate optimal routes and install this system on 250 newly built Japanese national ships by 2025.

According to IKNOW Machinery [32], a Japanese port facility manufacturer, the autonomous crane equipped with remote condition monitoring and management system

(RCMS) facilitates automatic unloading for cargos, utilizing the IoT. When an autonomous crane is introduced, it is possible to decrease expenses by reducing labor costs significantly. IKNOW Machinery, a subsidiary of Oshima Shipyard, announced in 2017 its plan to develop autonomous cranes as its mid- to long-term business plan. The Oshima Shipyard predicted that autonomous cranes in ports would determine whether ships will call at the port. IKNOW Machinery is conducting operational testing of autonomous cranes in co-operation with NYK. The autonomous crane is an example of smarting in response to the fourth Industrial Revolution through a partnership between shipping and shipbuilding as with autonomous ships.

3.2. Blockchain

Maersk Line [33,34], a Danish shipping company, announced a plan for a blockchain technology alliance with IBM in March 2017. The Maersk Line began a partnership with other industries, including the IT industry, to respond quickly to the fourth Industrial Revolution, and is most actively responding to the fourth Industrial Revolution among shipping companies. What Maersk Line is paying attention to is IoT technology that can be applied to the container box. If containers are operated using blockchain, it is possible not only to reduce time in the congestion port or customs, but also to increase efficiency at the total supplier level. Maersk predicted that the era of connecting sea, land, and aviation will come by digitization soon and is pushing for the operation of a "comprehensive transportation platform" that connects trucks and air with vessels as axes. Maersk's next partners to incorporate big data into the container industry are international logistics companies, such as FedEx and UPS. In short, Maersk Line is planning to push for comprehensive transportation of containers equipped with blockchain through co-operation with companies related to IoT and AI, not just with co-operation among existing partners, such as shipping and shipbuilding companies. The ultimate goal of Maersk Line is to identify the real-time location of cargoes on time by applying blockchain and reduce transport time to improve customer satisfaction.

3.3. Digitalization

MOL [35] and Mitsui Engineering & Shipbuilding (MES), a Japanese shipping company and a shipbuilding company, announced plans to develop next-generation ship management systems in June 2017 jointly. MOL will install a data collection device to its vessels provided by Mitsui Shipbuilding, which accumulates data subject to vessel conditions in real time to pre-diagnose a malfunction of ships and ultimately promote operation efficiency of vessels. The joint development plan for a digital ship management system between these two companies is to make the most of ICT technology. MOL and MES apply their knowledge of broadband communication technologies and digital shipping systems. The developed digital system combines chosen risk information, including past incidents and lessons acquired, displays of dangerous sea areas, and regions subject to particular regulations announced by the International Maritime Organization (IMO).

3.4. Online Booking System

YunQuNa [36], the Chinese online freight booking service provider that has developed the online platform, signed a contract with CMA-CGM in 2017 and provided an online booking system service. The online booking system, developed by YunQuNa and CMA-CGM includes six European routes and four Mediterranean routes, including major Mediterranean ports, such as Italy, Britain, Spain, Germany, and France. Service routes have been continuously expanded, and online booking services have been provided for 15 routes as of the first half of 2021. Online booking services jointly offered by YunQuNa and shipping companies have similar characteristics to airline booking services. Through the online booking system, shippers can request the seaborne transport services based on the shipping schedule and freight rate announced by the shipping company, which allows them to receive one-stop international logistics services. Through the online booking

system, shipping companies can quickly grasp shippers' needs, which can adjust their fleet to routes and reduce operating costs. Shippers can complete their online fleet reservations within 30 min after submitting the order online. In addition, a shipper can also book additional services, such as customs declaration, packaging, and warehouse, through YunQuNa's online booking system.

3.5. Human Resources with Smart Technologies

In the shipping industry, corporate social responsibility (CSR) tends to be emphasized. In recent years, there has been a shortage of human resources in the shipping industry, such as crews. The Japanese shipping industry aims to transform the contents of shipping industry work, which have emphasized physical labor in the past, into one of the professionals requiring high technical skills, such as IoT, to relieve the atmosphere that the shipping industry work is a 3D job and foster human resources in the shipping industry with smart technology in the mid to long term. As safety in terms of ship operation is required higher than ever in the past due to the emerged large size of ships, demand for crews who cultivate high technical skills and safety awareness is increasing. In particular, the demand for crews who are familiar with new technologies, such as IoT and AI information analysis is increasing. The MLIT is introducing a new training system to promote human resources proficient in innovative shipping technologies, such as IoT, AI, etc. For example, as the importance of education related to smart shipping technology spreads, new departments of universities subject to shipping and shipbuilding are being established throughout Japan. These new departments are planning to foster specialists who have acquired fourth industrial technologies and will continue to supply high-end shipping personnel to respond to the fourth Industrial Revolution [37].

3.6. E-Commerce Platform

Evergreen [38], a Taiwanese shipping company, announced in June 2017 that it would partner with Alibaba, which is conducting electronic commerce (EC) business worldwide based in China, and provide an e-commerce platform service for products sold by Alibaba. Taiwanese Evergreen signed an alliance agreement with China's Alibaba, which is uncommon for an MOU between Taiwanese and Chinese companies. Customers who purchase products from the Alibaba website can choose how to transport them (air transport, sea transport, etc.), and Evergreen is in charge of seaborne trade. Evergreen first provides e-commerce platform services only to Chinese consumers and later expands to customers worldwide. When the customer completes the service selection, the freight rate will be fixed to the past rate at the time of the selection, even if the rate changes later. The fixed freight rate makes it easier to manage logistics costs and establish a more stable transportation system through co-operation with Evergreen. The Chinese government is driving the development of e-commerce platforms. The e-commerce platform utilizing Alibaba's information and communications technology (ICT), which has the world's highest sales volume, reflects the Chinese government's intention to strengthen the competitiveness of the domestic shipping industry further. The following Table 3 describes the overseas emerging smart shipping items.

Table 3. Overseas emerging smart shipping items.

Items	Major Contents	Expectation
autonomous technology	world's first electric autonomous container vessel (Yara) [28]	reduce emissions of environmental pollutants, such as noise, carbon dioxide, nitrogen compounds, etc.
	world's first remote-controlled ship (Rolls-Royce & Svitzer) [29]	enhance productivity, reduce labor costs
	automated container terminals utilize IoT technology (Yangsan) [30]	reduce labor costs and vessel congestion

Table 3. *Cont.*

Items	Major Contents	Expectation
autonomous technology	ships equipped with automatic operation system using AI (NYK) [31]	increase the possibility of avoiding accidents by receiving data subject to navigation or predicting vessel equipment malfunctions
	crane equipped with Remote Condition Monitoring & Management System (IKNOW Machinery) [32]	decrease expenses by reducing labor costs
blockchain	containers equipped with blockchain (Maersk Line) [33,34]	reduce time in the congestion port or customs, increase efficiency at the total supplier level
digitalization	system combines chosen risk information, including past incidents and displays of dangerous sea areas (MOL) [35]	pre-diagnose a malfunction of ships, promote operation efficiency of vessels
online booking system	complete the online fleet reservations within 30 min after submitting the order online (YunQuNa) [36]	quickly grasp shippers' needs, reduce operating costs
human resources with smart technologies	specialists who have acquired smart technologies (MLIT) [37]	increased demand for high-end shipping personnel to respond to the smart shipping technologies
e-commerce platform	platform for connecting goods purchased through e-commerce to seaborne transport services (Evergreen) [38]	easier to manage logistics costs, establish a more stable transportation system

4. Development Strategy for Smart Shipping Technologies

4.1. Selected Smart Shipping Items for Expert Survey

This study examined the latest smart shipping technology items in the global shipping industry through reviewing prior studies in Section 2 and overseas cases in Section 3, respectively. Since then, the present study has conducted several brainstorming meetings attended by shipping officials and researchers from the present study and selected the final smart shipping technology items. (Date of meetings: September 2020, October 2020, March 2021, June 2021, November 2021, February 2022, etc.) The smart shipping technology items of the present study, which were finally selected through the brainstorming meetings, are the following: ① automatic ships, ② blockchain, ③ market forecast with big data, ④ digitalization, ⑤ online booking system, ⑥ human resources with smart technologies, and ⑦ e-commerce platform.

This study intends to conduct interviews with experts in the shipping industry in relation to the aforementioned seven shipping smartization items, and summarize the survey results. In short, this study used the Delphi technique to derive the investment priority of shipping smart items. The Delphi technique is one for problem solving and future prediction through expert empirical knowledge, and is also called the expert consensus method. It can be defined as a series of procedures that induce and synthesize experts' views on a problem and organize them into a collective judgment by solving the problem through a top-down opinion method through repeated feedback. This is based on the principle of quantitative objectivity that "the majority's opinion is more accurate than one's opinion" and the democratic decision-making principle that "the majority's judgment is more accurate than the minority's judgment" when there is no accurate information on the problem to be estimated. The next Table 4 explains the major smart shipping items in prior studies and overseas cases.

Table 4. Major smart shipping items in prior studies and overseas cases.

Prior Studies/ Overseas Cases	Autonomous Ships	Automated Terminal	Autonomous Cranes	Remote Control	Block Chain	Market Forecast with Big Data	Digitali-Zation	Online Booking System	Human Resources with Smart Technologies	E-Commerce Platform
Zarzuelo et al. (2020) [12]		V	V							
Papanikolaou et al. (2016) [13]	V			V						
Savrul and Incekara (2015) [14]				V	V					
Sikorski et al. (2017) [15]					V					
Dombrowski and Wagner (2014) [16]					V					
Chun et al. (2021) [17]		V	V			V				
Zhang and Wang (2017) [18]						V				
Wang and Sarkis (2021) [19]							V			
Aiello et al. (2020) [20]							V			
Zeng et al. (2020) [22]								V		
Meng et al. (2019) [23]								V		
Jo and D'agostini (2020) [24]									V	
Wadley (2021) [25]									V	
Sun et al. (2021) [26]										V
Balci (2021) [27]								V		V
EU [28,29,33–35]	V			V	V					
China [36,38]		V						V		V
Japan [31,32,37]	V		V				V		V	

Note: V means that each prior research & the country corresponds to those smart items

The present study excludes the automatic cranes because there were opinions that those are secondary items that are not critical. The automated terminals are excluded because there were opinions that those are subject to port industry rather than shipping industry. In addition, the present study excluded remote control technology because there were opinions that it was a similar item to automatic ships. Table 5 represents the selected final smart shipping items in the present study for expert survey.

Table 5. Selected final smart shipping items in the present study for expert survey.

Selected 7 Items
① autonomous ships
② blockchain
③ market forecast with big data
④ digitalization
⑤ online booking system
⑥ human resources with smart technologies
⑦ e-commerce platform

4.2. Expert Survey

4.2.1. Overview of the Survey

The purpose of the present study is to verify the importance and urgency of smart technologies in the shipping industry, and the present study surveys 74 shipping industry officials covering shipping companies, brokers, governments, etc. Among the 74 respondents, several respondents engaged in overseas shipping companies, such as Maersk Line, NYK, MOL, etc., were included; the present study could consist of responses from domestic and overseas shipping industry officials. The present study attempted to secure the representation of the survey results by receiving several responses from shipping industry officials belonging to Korea and major shipping countries. The importance and urgency of each of the seven smart technology items in the shipping industry are questioned in a survey. In short, this survey is to determine the priority of the strategy of smarting the shipping industry.

The survey included not only shipping company employees, but also shipping brokers, shipping policy authorities, etc., so that the opinions of respondents working at various sites could be appropriately reflected. And the present study attempted to increase the reliability of the survey results by including the policymakers of the shipping policy authorities in charge of actually drafting and implementing the shipping smartening policy in the survey respondents. In addition, shipping company employees were classified

into large/medium/small companies, and a sufficient number of female employees in the shipping industry were included in the survey respondents. In short, this study focused on the balanced composition of the respondent sample of the survey, and the respondents' samples secured in this study were allowed to represent the shipping industry by covering shipping company workers, shipping brokers, shipping policy authorities, etc.

It will be possible to increase the competitiveness of the shipping industry more effectively if research and development (R&D) can be concentrated in areas of high importance and urgency. The present study expects that the survey results of the present study will be useful references in establishing shipping strategies to contribute to the technological advancement of the global shipping industry. The survey respondents' features are shown in the following table. The following Table 6 explains the features of survey respondents.

Table 6. Features of survey respondents.

Division		Number of Surveys	74
		Number of Respondents	45
Response Rate		60.8%	
Respondents' gender	Male	(33)	73.3%
	Female	(12)	26.7%
Firm size	Large	(23)	51.1%
	Medium and small	(15)	33.3%
	Others	(7)	15.6%
Main business	Seaborne transportation	(26)	57.7%
	Brokers	(6)	13.3%
	Governments	(2)	4.4%
	Others (association, university, etc.)	(11)	24.6%

4.2.2. Questions in Survey

As mentioned above, the present study surveys 74 shipping officials in Korea. Our survey consists of two questions to set the strategic direction for smart technology items in the shipping industry. In short, there are two questions about the importance and the urgency of strategies subject to smart shipping technology items in the shipping industry. The present study utilizes the Likert scale for quantitative surveys of preferences. The Likert scale is one of the most frequently used as response measures for surveys and others, and respondents reply to the level at which they agree with the questions presented. There is a relative hierarchy in the response category, and the respondent selects the relative strength that the questions mean in the survey. This study uses a five-step Likert scale. Two questions about importance and urgency are as follows: Tables 7 and 8 explain the importance and urgency of each item, respectively.

Table 7. A Question in the survey: about the importance of each item.

Smart Shipping Technology Items	Importance				
	Not Important at All	Not Important	Does Not Matter	Important	Very Important
Autonomous ships	①	②	③	④	⑤
Blockchain	①	②	③	④	⑤
Market forecast with big data	①	②	③	④	⑤
Digitalization	①	②	③	④	⑤
Online booking system	①	②	③	④	⑤
Human resources with smart technologies	①	②	③	④	⑤
E-commerce platform	①	②	③	④	⑤

Note: ① = Not Important at All, ② = Not Important, ③ = Does Not Matter, ④ = Important, ⑤ = Very Important.

Table 8. A question in the survey: about the urgency of each item.

Smart Shipping Technology Items	Urgency				
	Not Urgent at All	Not Urgent	Does Not Matter	Urgent	Very Urgent
Autonomous ships	①	②	③	④	⑤
Blockchain	①	②	③	④	⑤
Market forecast with big data	①	②	③	④	⑤
Digitalization	①	②	③	④	⑤
Online booking system	①	②	③	④	⑤
Human resources with smart technologies	①	②	③	④	⑤
E-commerce platform	①	②	③	④	⑤

Note: ① = Not Urgent at All, ② = Not Urgent, ③ = Does Not Matter, ④ = Urgent, ⑤ = Very Urgent.

4.2.3. Results of Survey

A survey on the strategic importance of the present study finds that 45 out of 45 respondents answered the "autonomous ships" as positive (in case of answering one of the following three: does not matter, important, very important), indicating that the shipping officials strongly recognized the importance of the development of autonomous ships. The number of respondents who answered positively to "blockchain" accounts was 45 out of 45 people, and this result implies that the shipping officials strongly recognize the importance of the development of blockchain. A total of 42 out of 45 respondents positively answered the "market forecast with big data," accounting for 93.3 percent of the respondents. The number of respondents who responded positively to the "digitalization" accounts for 42 out of 45 people, 93.3 percent of the respondents. The number of respondents who answered the "online booking system" positively is 39 out of 45 people, 86.7 percent of the respondents. The number of respondents who answered positively to the "human resource with smart technologies" accounts for 40 out of 45 people, 88.9 percent of the respondents. The number of respondents who responded positively to the "e-commerce platform" question is 34 out of 45, 75.6 percent of the respondents.

In short, the survey results of strategic importance can be described as in the order of "autonomous ships = blockchain > market forecast with big data = digitalization > human resources with smart technologies > online booking system > e-commerce platform." The following Table 9 shows the results of the survey about the importance of each item.

Table 9. Results of the survey: about the importance of each item. unit: numbers.

Smart Shipping Technology Items		Importance				
		Not Important at All	Not Important	Does Not Matter	Important	Very Important
Autonomous ships	P 45 N 0			1	27	17
Blockchain	P 45 N 0			19	13	13
Market forecast with big data	P 42 N 3		3	14	13	15
Digitalization	P 42 N 3	1	2	10	18	14
Online booking system	P 39 N 6		6	12	13	14
Human resources with smart technologies	P 40 N 5	2	3	11	17	12
E-commerce platform	P 34 N 11	3	8	16	9	9

Note: P means the number of respondents who responded positively (in case of answering one of the following three: does not matter, important, very important), and N represents the number who answered negatively (in case of answering one of the following two: not important at all, not important).

A survey on the strategic urgency of the present study finds that 43 out of 45 respondents answered the "autonomous ships" as positive (in case of answering one of the following three: does not matter, urgent, very urgent), 95.6 percent of the respondents. The number of respondents who answered the "blockchain" positively is 44 out of 45 people, 97.8 percent of the respondents, with the exception of only one respondent. The number of respondents who answered positively to the "market forecast with big data" accounts for 34 out of 45 people, 75.6 percent of the respondents, and the number of respondents who responded positively to the "Digitalization" question is 39 out of 45, 86.7 percent of the respondents. A total of 43 out of 45 respondents positively answered the "online booking System," accounting for 95.6 percent of the respondents, and the number of respondents who responded positively to "human resources with smart technologies" accounts for 45 out of 45, indicating that the shipping officials strongly recognized the urgency of the human resources with smart technologies. The number of respondents who responded positively to the "e-commerce platform" accounts for 37 out of 45 people and 82.2 percent of the respondents. In short, the survey results of strategy urgency can be described as in the order of "human resources with smart technologies > blockchain > online booking system > autonomous ships > digitalization > e-commerce platform > market forecast with big data".

Meanwhile, the survey on "urgency" included the questions "not current at all" and "not current". Meanwhile, the difference between the questions "not current at all" and "not current" may have been somewhat ambiguous and confused the respondents. This study included the "not current at all" Likert scale in the survey to induce the selection of "not current at all" if there was no urgency in the mid to long term. In short, this study attempted to influence the choice of "not current at all" when it is judged that developing the smartization item is unnecessary even for a long period. The following Table 10 explains the results of the survey about the urgency of each item.

Table 10. Results of the survey: about the urgency of each item. unit: numbers.

Smart Shipping Technology Items		Urgency				
		Not Urgent at All	Not Urgent	Does Not Matter	Urgent	Very Urgent
Autonomous ships	P 43 N 2	1	1	12	20	11
Blockchain	P 44 N 1		1	18	14	12
Market forecast with big data	P 34 N 11	3	8	19	9	6
Digitalization	P 39 N 6	4	2	19	14	6
Online booking system	P 43 N 2	2		7	17	19
Human resources with smart technologies	P 45 N 0			14	18	13
E-commerce platform	P 37 N 8	4	4	17	14	6

Note: P means the number of respondents who responded positively (in case of answering one of the following three: does not matter, urgent, very urgent), and N represents the number who answered negatively (in case of answering one of the following two: not urgent at all, not urgent).

This study conducts a cross-analysis of importance and urgency and attributes to derive strategic priorities of smart shipping technology items. Priorities derived based on the survey results of the present study to promote the smartness of the shipping industry can be useful reference materials for establishing and implementing strategies for shipping officials. Above all, it is possible to identify items on which investment should be concentrated, such as investment funds. In addition, customers' satisfaction can be expected to increase when strategies are established and implemented based on priorities.

According to an interview analysis on importance and urgency, both "autonomous ships" and "blockchain" items show high importance and urgency. Since both importance and urgency are high, strategic priorities are the highest, and it is expected to contribute effectively to enhancing the smartness of the shipping industry when it focuses its investment capabilities in those fields. Of the 45 respondents, the number of "autonomous ships" reached 27 important, 17 very important, 20 urgent, and 11 very urgent. Of the 45 respondents, "blockchain" reached 13 important, 13 very important, 14 urgent, and 12 very urgent.

The present study finds that items with high importance but low urgency are "market forecast with big data" and "digitalization" items. Of the 45 respondents, the number of "market forecast with big data" reached 13 important, 15 very important, 9 urgent, and 6 very urgent. Of the 45 respondents, "digitalization" reached 18 important, 14 very important, 9 urgent, and 6 very urgent. Due to the low urgency, it is understood as items that can strengthen the competitiveness of the shipping industry in the long term. Therefore, efforts to practice smartening are required over a long period.

The areas of high urgency but low importance were items of the "online booking system" and "human resources with smart technologies." Of the 45 respondents, the number of "online booking system" reached 13 important, 14 very important, 17 urgent, and 19 very urgent. Of the 45 respondents, "human resources with smart technologies" received 17 important, 12 very important, 18 urgent, and 13 very urgent. These items are understood to be highly urgent, highly strategic items that are likely to have strategic effects when carrying out agile strategies. They can help strengthen shipping's smartness in the short term.

The present study concludes that the "e-commerce platform" item, which showed relatively low importance and urgency, is expected to help the shipping industry to smarten up indirectly. It is understood that "e-commerce platform" does not need to be established or implemented as a strategy immediately because both importance and urgency are low. Of the total 45 respondents, the number of "e-commerce platform" reached only 9 important, 9 very important, 14 urgent, and 6 very urgent. It is understood that it is not necessary to immediately policy because both importance and urgency are low for "e-commerce platform".

Cost competition among shipping companies is intensifying, and cost reduction can eventually offer lower freight rates to shippers than competitors, so it is urgent to secure operating competitiveness through cost reduction. Shipping smartization is expected to help secure operating competitiveness by reducing costs by enhancing industrial competitiveness. The purpose of shipping companies' business is to generate profits. In order to create and expand profits as a continuing company, cost reduction is inevitable in the end, and the smartization of the industry can finally reduce corporate costs and enables securing of profits. This is why intensive R&D is needed for important and urgent priority items surveyed and presented in this study. Table 11 explains the results of the survey about the priorities of strategies.

Table 11. Results of the survey: priorities of strategies.

Priorities	Items
High importance and high Urgency	autonomous ships/blockchain
High importance and low Urgency	market forecast with big data/digitalization
Low importance and high Urgency	online booking system/human resources with smart technologies
Low importance and low Urgency	e-commerce platform

4.2.4. Statistical Analysis

This study conducted a simple statistical analysis to visualize the importance and urgency of each smart item. This study gave 5 points to very important (very urgent),

4 points to important (urgent), 3 points to do not matter, 2 points to not important (not urgent), and 1 point to not important at all, and created a bar graph reflecting these points. The basic statistics for importance and urgency in this study are shown in the following table. Figure 2 describes the point of each smart item, and Table 12 shows the basic statistics for importance and urgency.

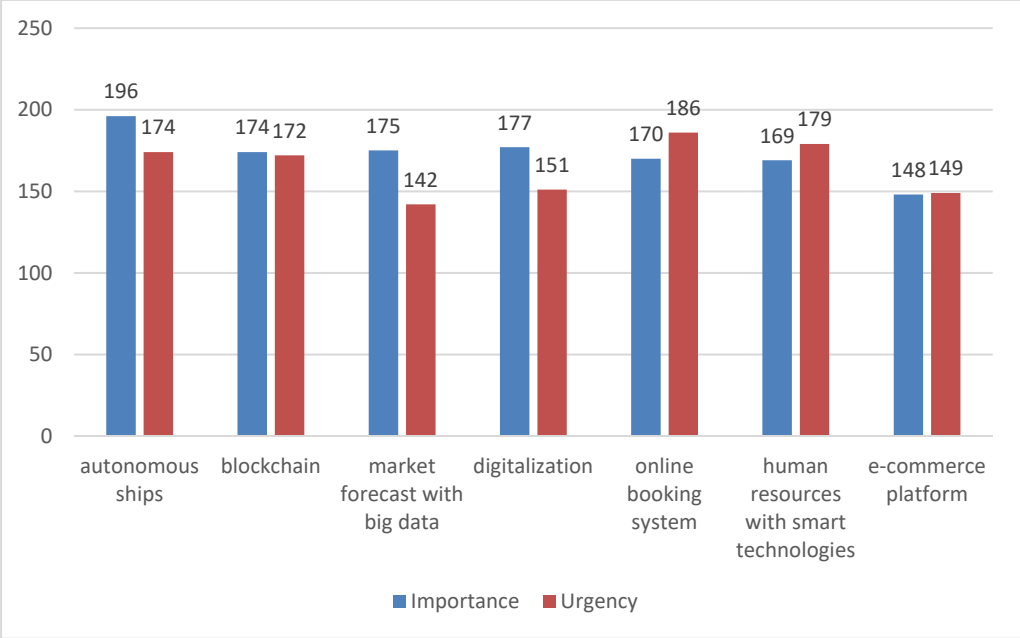

Figure 2. Point of each smart item (importance/urgency). unit: numbers.

Table 12. Basic statistics for importance and urgency.

	Importance	Urgency
Total	1209	1153
Average	172.71	164.71
Standard Deviation	14.13	17.06
Max/Min	196/148	186/142

5. Conclusions

The fourth Industrial Revolution is also appearing in the shipping industry. Major shipping countries, such as the EU, China, and Japan, are seeking to develop autonomous ships or blockchain by utilizing IoT and AI, which are aimed at improving safe operation and operating efficiency. As smartness accelerates in the shipping industry, demand is increasing to increase industrial competitiveness by utilizing various smart shipping technology items and gain the upper hand in domestic and foreign competition. Major shipping countries and global shipping companies are pushing to smarten up shipping at a rapid pace. To improve sustainable competitiveness in the shipping sector, it is urgent to prioritize development demand in smart shipping technology items.

Based on these backgrounds, the present study examined prior studies and overseas cases and derived several smartening items in the shipping industry. Afterward the derived items by prior studies and overseas cases were consulted by shipping industry experts. The final seven items selected through consultation by shipping officials are as follows: ① automatic ships, ② blockchain, ③ market forecast with big data, ④ digitalization, ⑤ online booking system, ⑥ human resources with smart technologies, and ⑦ e-commerce platform. Since then, this study conducts a survey of 45 shipping industry officials engaged in the shipping field on the final seven selected smart shipping technology items. Through

a survey, the importance and urgency of each of the seven items are analyzed. According to survey results, the autonomous ships and the blockchain shows the highest importance and urgency. The higher the importance and urgency indicate the higher the strategic priority, and it is expected that those items showing high importance and urgency can effectively contribute to enhancing the smartness of the shipping industry more than other items.

In summary, the present study examines rich prior studies and conducts a survey of 45 shipping industry officials. By conducting a survey, the present study can derive the development priorities for each smart shipping technology item. Most of the prior studies are limited to introducing the latest smart shipping technologies, and none of the studies have prioritized the development priorities of smart shipping items. It is necessary to focus investment on specific items under a limited budget, and, since the priorities presented in this study were derived through comprehensive collection of opinions from several shipping experts, the priorities presented in this study are expected to be effective reference values when implementing shipping investment policies.

According to an interview analysis on importance and urgency, both "autonomous ships" and "blockchain" items show high importance and urgency. Since both importance and urgency are high, strategic priorities are the highest, and it is expected to contribute effectively to enhancing the smartness of the shipping industry when it focuses its investment capabilities in those fields.

If the development of smart shipping technologies is activated, various positive effects are expected, such as improving productivity, reducing environmental loads, and increasing flexibility in the labor market. The present study is likely to contribute to the sustainable growth of the shipping industry, as it presents development priorities for major smart shipping technology items that are urgently needed for development. Meanwhile, this study derived the urgent priority of smartization through an expert survey. However, this study did not analyze the development level and future investment plan of each smart item in Korea, EU, Japan, etc. If the follow-up study suggests the development level and future development plan of each major shipping country, it is expected to be a useful reference value for finding smart shipping items that are urgent to develop in future.

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