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A Study on the Countermeasures of Shipping and Port Logistics Industry in Responding to the Progression of Fourth Industrial Revolution

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Abstract : *The presence of the Fourth Industrial Revolution is omniscient, led by full force emergence of technologies that make biological, physical, and digital worlds borderless. All industries which jump on the bandwagon, can observe convergence and merging of bushiness happening within, between and across industries. As the shipping and port logistics industry is said to be in eye of this storm, the purpose of this study is to investigate the shipping and port logistics industry's awareness regarding 4th IR, as well to identify necessary countermeasures in responding to progression of this trend. Analytic Hierarchy Process (AHP) methodology was then used to compare the importance of four phases of countermeasures, reviewed by experts in the field. Results showed that countermeasures should be first orchestrated to the 'Merging and Integration of Inter-industry', then followed by 'Preemptive Introduction of Advanced Technology', 'Expansion of Intra-industry Businesses', and eventually 'Automation, Unmanned Technology'. Last but not least, four phases of countermeasures which should be introduced and executed one phase after another, are outlined for the shipping and port logistics industry to boost its competitiveness in addressing this progressive trend.*

Key words : *Fourth Industrial Revolution, Shipping and Port Logistics Industry, Countermeasures, AHP, Comparing Importance*

1. Introduction

At the World Economic Forum (WEF) held in Davos in January 2016, the concept of the Fourth Industrial Revolution (hereinafter referred to as 4th IR) was proposed as the concept of the future led by new technologies such as Artificial Intelligence(AI), Virtual Reality(VR), Augmented Reality(AR), Big Data and Internet of Things(IoT)(Kim, 2016). Since then, Korea and many other major countries have been busy tailoring various strategies based on own respective industrial strengths in order to come out with countermeasures that could best serve the future prospect of industry-academia-university.

Korean government has also set forth the 4th IR as the main policy trend, and 4th IR Committee was also formed to be trusted with responsibility of responding to 4th IR. Meanwhile, Korea's domestic industry is trying to develop new business model by combining intelligence based on automation and autonomy based on hyper-connection which is also among the characteristics of the 4th IR in the existing industry(Mac-Net, 2018).

Especially, the shipping and port logistics industry, which is competitive in the world, is pursuing various attempts to gain competitive advantage through the 4th IR and expand into new business area. In Korea, after the bankruptcy of Hanjin Shipping, we are actively seeking strategic countermeasures for the industrialization of shipping, port and logistics sectors.

However, few studies have been conducted on how the 4th IR is actually perceived and applied to shipping and port logistics companies in practice. And neither much research has been done regarding what could be the resulting effects and relevant changes in shipping and port logistics industry as the 4th IR progresses. In view of that, this study sought to investigate the awareness and needs for changes in the shipping and port logistics industry following 4th IR; as well as to propose how the appropriate countermeasures should be directed and planned.

Further into details, the concept of the 4th IR and the relevant leading technologies are first summarized in this

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study for better preparation of the countermeasures against the 4th IR in the shipping and port logistics industry.

Then, we look into the actual status of industry's awareness regarding 4th IR and propose countermeasures for practical application in Korea's domestic shipping port logistics industry.

2. Theoretical Background

2.1 Concept of the 4th IR

The 4th IR is mainly discussed as 'Industrial Revolution based on fusion of physics, digital and biological technology'. As a result, we expect that everything will be connected, more intelligent, and will change society to velocity, scope, impact(Schwab, 2016).

The 4th IR Committee defines the intelligent revolution based on hyper-connection triggered by digital technology such as AI and Big Data. And the rapid development of Information and Communication Technology (ICT) is combined with and linked to all industries and societies, including manufacturing and service industries, thereby transforming the production structure and social structure and defining the revolution as a center of emphasis(Hwang, 2017). There is no clear conceptual arrangement yet.

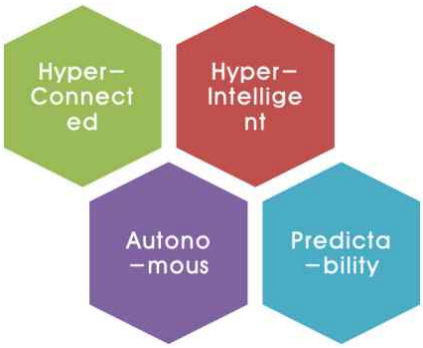

Fig. 1 Four characteristics of the 4th IR
Source: Summarized and schematized by the author

The characteristics of the 4th IR can be summarized as follows: Hyper-Connected, Hyper-Intelligent, Autonomy, and Increased predictability as shown in Fig 1. In particular, super connectivity means that everything is connected and interacted between people-objects, objects-objects through advanced technology(IoT, cloud, sensor, etc.). Hyper-Intelligent means that artificial intelligence can make autonomous evolution based on Big Data, perform proper judgment and autonomous control, identify a certain pattern through deep learning, and create new value. The emergence of Hyper-Connected, Hyper-Intelligent and Autonomous systems had promoted the early-stage Predictability through data analysis of the Third Industrial Revolution to a higher level.

2.2 Technology of the 4th IR

The 4th IR is also spearheading the scientific revolution that changes the quality and environment of our lives, such as industrial automation and bio-revolution, by playing a central role as General Purpose Technology (GPT). Changes in these key technologies can be seen in Table 1, where innovative technologies around the world change around the ICT technology each year, as reported by MIT Technology Review.

Table 1 MIT 10 breakthrough technologies(2015-2018)

No.	2015	2016	2017	2018
1	Magic Leap	Immune Engineering	Reversing Paralysis	3D Metal Printing
2	Nano-Architecture	Precise Gene Editing in Plants	Self-Driving Trucks	Artificial Embryos
3	Car-to-Car Communication	Conversational Interfaces	Paying with Your Face	Sensing City
4	Project Loon	Reusable Rockets	Practical Quantum Computers	Cloud-based AI services
5	Liquid Biopsy	Robots That Teach Each Other	The 360-Degree Selfie	Duelling Neural Networks
6	Megascale Desalination	DNA App Store	Hot Solar Cells	Babel Fish earbuds
7	Apple Pay	SolarCity's Gigafactory	Gene Therapy 2.0	Zero-carbon Natural Gas
8	Brain Organoids	Slack	The Cell Atlas	Perfecting Online Privacy
9	Supercharged Photosynthesis	Tesla Autopilot	Botnets of Things	Genetic Fortune Telling
10	Internet of DNA	Power from the Air	Reinforcement Learning	Materials' Quantum Leap

Source: MIT Technology Review, 2018

The key technologies of the 4th IR being described by other organizations are as following: The World Economic Forum has been promoting the technology that leads the 4th IR such as mobile Internet, cloud technology, Big Data, IoT and AI(WEF, 2016). Meanwhile, Career Industry Council of Australia presented Cloud Services, IoT, Big Data, AI and Robotics as change drivers(CEDA, 2015). General Electric(GE) proposes cloud data, automation technology, predictive analytics, and smart systems for proactive control with technology that will increase productivity in the future. And GE is predicted to be a

technology that satisfy customer needs, such as mechanical sensor, communication technology, and 3D printing technology.

2.3 Structure of the 4th IR

The structure of the 4th IR, which is distinguished from the third industrial revolution, has the same structure as in Fig 2. First, data is collected using IoT and Internet of Biometry(IoB)(STEP1). Then the data is saved through storage and analysed via the cloud system(STEP2). Following that, AI is used to create value(STEP3) and continuous feedback in which optimization is performed(STEP4)(Lee, 2017).

Most of the industrial cases in which the 4th IR is applied are pertaining to data collection via IoT, data storage and analysis using cloud as well as Big Data technology, continuous optimization process using real time analysis and control based on AI. As a practical case, we can see its characteristics in Siemens's smart factory, GE's Predic Platform, Carterpillar and Komats's heavy equipment management system and Amazon's logistics system.

Fig. 2 Structure of the 4th IR
Source: Author improvised based on Lee, 2017

2.4 Status of the Introduction of 4th IR

2.4.1 Shipping Industry

All stakeholder of shipping industry are competing to take lead in leveraging technologies of 4th IR for securing competitive advantages such as optimal operation, cost - effective and ultimate transparency of the value chain. Following is the summary of the development trend :

Table 2 The 4th IR in shipping industry

NO.	Technology	Country/Carrier	Achievement
1	Autonomous ship	Rolls-Royce	Autonomous ship navigation by 2020
		Kongsberg	First electric-powered autonomous craft in partnership with Yara
		Norway	The world's first autonomous navigation commissioning site at Trondheim Fjord
		Japan	Realize autonomous merchant vessel by 2025
2	Big Data	Hapag - Lyod's in partnership with XVELA	Real-time information sharing solution for transportation supply chain
		Maersk in partnership with Ericsson	Real time end-to-end container tracking solutions for vessels and containers via floating DSM and single GSM antenna
		CMA CGM in cooperation with Traxens	Real-time container monitoring technology
3	Block chain	Maersk and IBM	Digital resolution for cross - border shipping logistics process
		IBM	IBM's high-security business network through IBM Cloud and IBM Bluemix based on the Linux Foundation's open-source Hyperledger Fabric platform

Source: The author summarized from latest news and reports

2.4.2 Port Industry

The global automation container terminal market including semi-automation terminals will grow at a CAGR of 25% from 20.4 billion USD in 2016 to USD 6.22 billion in 2021. Of these, fully unmanned automation terminals accounted for 51.47% of all automation terminals in 2016, and are expected to increase to 55.31% in 2021(Technavio, 2017). Table 3 indicates the technological developments introduced at different terminals in the global nations.

In the era of the 4th Industrial Revolution, the reason for the construction of an automated terminal with a high initial investment cost is to secure competitiveness through economic operation and to operate environmentally friendly ports(Korea Maritime Institute, 2017). Recently, Busan Port has been selected as the "10th Port Contaminated Particulate Matter" with 7 Ports in China, Dubai and Singapore, and the introduction of environmentally friendly ports in Korea has become a big social issue(Wan at al., 2016). So the government of Korea is promoting the introduction of smart port which can secure competitiveness and operate environmentally friendly through the autonomous and intelligent ports.

Table 3 The 4th IR in port industry

No.	Country	Robotic Ports or Terminals	Technology Applied
1	Netherlands	Unmanned automation terminal in 1993 and unmanned pier cranes in 2015 at Rotterdam Port, State-of-the-art APM terminal and Rotterdam World Gateway(RWG) followed in 2015	Automated Guided Vehicle (AGV), Automated Stacking Crane (ASC), ship automatic anchoring, automatic cone detaching system and lifting buffer platform operation
2	China	Full operation of unmanned automated terminal at QQCTN of Qingdao Port in May 2017	
3	United States	Fully automated unmanned Long Beach Container Terminal (LBCT) in April, 2016	
4	Singapore	Fully unmanned automation for all of TUAS's 65 berths (partially in 2020 and completely in 2040)	
5	Germany	Smart port, Port of Hamburg that integrates four infrastructure systems including ports, roads, railways, and customs clearance	Movable bridges with various traffic management systems such as SmartROAD Solution, structural and environmental sensors, smart lighting scheme (Follow Me Lighting)

Source: The author summarized from latest news and reports

2.4.3 Logistics Industry

E-commerce companies have been actively involved in developing platforms that integrates the three modes of transportation for optimum delivery speed and coverage. Following table shows the development led by two main 'game changers' in logistics field :

Table 4 The 4th IR in logistics industry

No.	E-commerce Company	Achievement
1	Amazon	Fulfillment by Amazon (FBA)
		Introduction of thousands of its own brand of trucks
		Development of dispatching applications
		Beijing Century Joyo Courier Service
		Amazon One, cargo aircraft
		Patent awarded for Amazon Prime Air, a conceptual drone-based delivery system via parachute
		Patent awarded for beehive-like tower as fulfillment center with drones
		KIVA robot
2	Alibaba	Digital partnership with Maersk Line and CMA CGM to introduce 'Online Container Booking System' through OneTouch

Source: The author summarized from latest news and reports

Besides, there are also various applications and business intelligent systems used in logistics industry such as VANET Systems, Warehouse Management Systems (WMS), Enterprise Resource Planning (ERP), Transportation Management Systems (TMS), Intelligent Transportation Systems (ITS), Radio-Frequency Identification (RFID) tags and sensors for availability of more accurate information and better linkage among wide range of autonomous lifting vehicles, smart warehouses and other relevant operations. These systems acquire real-time information from the existing logistics system and apply superintelligence control as well as regulatory control processes based on AI to address various industrial problems and improve efficiency.

3. The Awareness and Needs of Korean Shipping and Port Logistics Industry in Responding to 4th IR

In order to examine the awareness and needs of Korean shipping and port logistics industry in responding to the 4th IR, a specialist interview survey was done with the experts of shipping and port logistics industry, particularly CEO and board members. Further into details, 6 respondents from shipping industry, 5 respondents from port industry and 6 respondents from logistics industry were involved in the interview.

3.1 Awareness Regarding 4th IR

3.1.1 Shipping Industry

In order to stay at the forefront of industrial revolutional trend, the prominent shipping companies like Maersk and CMA CGM are constantly observing the business innovation of global shipping companies towards 4th IR and responding appropriately to the emergence of relevant new technological innovations, businesses and services. Unfortunately, after the bankruptcy of Hanjin Shipping, which used to be the world's sixth largest shipping company, neither Korea nor Korea's domestic deep - sea liner shipping companies are competent to take the lead in 4th IR. Apparently, the weakening of competitiveness of Hyundai Merchant Marine had worsened the condition.

Korean shipping companies can be classified as world-wide shipping companies, Southeast Asian and offshore shipping companies depending on their corporate sizes. In this context, Southeast Asia and coastal shipping companies exclude Hanjin and Hyundai are said to be more passive in introducing the 4th IR technology or innovation by maintaining conservative corporate management. They are more focused on the strategies to provide stable

services on limited routes for securing customers. Since the market environment is comparatively stable, they are not motivated to lead rapid change nor invest aggressively for innovation. Instead, they just remain responsive to enjoy the proliferation of the 4th IR's technologies.

Meanwhile, rather than investing in new smart vessels to provide differentiated transportation services, tramp shipping companies are prone to create profit by reducing transportation costs via utilization of existing vessels which are in compliance with International Maritime Organization (IMO) standards.

In short, there is lack of specific awareness regarding innovation of 4th IR as well as necessary strategic countermeasures in responding to the upcoming challenges such as new businesses, platforms, and industrial convergence in shipping industry.

3.1.2 Port Industry

Port terminal companies have focused on enhancing the technological innovation and service competitiveness by utilizing digital revolution technologies such as automation and informatization of terminals.

Even though Korean domestic port terminal companies have been promoting port automation using Automatic Transfer Cranes (ATC), automation is not expanding due to the lack of investment by port terminal industry in technological innovation, hesitation resulted from limitations of efficiency enhancement following the application of 4th IR (stagnation of cargo volume and intensifying of competition), as well as coordination problem of human resource employment.

Although the 4th IR is attempted in the port industry through the development and operation of smart ports, it is only limited to real-time information sharing with cargo owners and shippers in addition to port automation and green ports initiatives.

3.1.3 Logistics Industry

The international logistics brokerage (forwarder) has limitation to adopt 4th IR technology respectively as most of the companies are small size enterprises and hence, they are more focused on linking the improved services of each entity in the supply chain network.

First of all, the undigitized cargo information has made it difficult to introduce the 4th IR technology because so many individual units of small warehouses will necessitate increase input of labor force for the management process of cargo information, such as labeling, input of PDA and more. Worse still, when cargo is not standardized, it limits the digitization of cargo movement within warehouse area for the relevant loading processes.

Indeed, there are more other hurdles in introducing the 4th IR technology by warehouse companies independently, for example the concern of inefficient increase in profitability due to self-investment and the difference in perception of whether the introduction of the 4th IR technology is a profit for the shippers or warehouse owners. As evident as in the case of WMS which has been developed but is not used by many companies, warehouse cargo information is always perceived as confidential information. Thus often than not, companies are reluctant to disclose the data.

Undeniably, the 4th IR will lead to a series of crisis like 3D printing technology will result in reduced cargo volume; while Information and Communication Development as well as AI Expansion that enable direct transaction between shippers and maritime carriers will weaken the role or even eliminate brokerage services and professional employment such as customs clearance.

3.2 Needs in Responding to 4th IR

3.2.1 Shipping Industry

The first call is to achieve cost reduction with the application of 4th IR technology such as Big Data and AI to ship navigation and cargo management. For example, shipboard operation should be enhanced with optimal fuel system to achieve fuel minimization while empty container arrangement should be optimized for minimization of re-positioning.

The second emphasis is safe operation. Real-time tracking of vessel location and e-navigation are the fundamental ones where we have real-time access of on-board status with attachment of sensors on ship facilities and equipment. Information transmission overland and remote control of equipment made it possible for precise problem diagnosis and instant resolution support on crew's decision making from offshore. Particularly, Land-Sea Real Time Automatic Control System has enabled constant monitoring and control for refrigerated containers which are sensitive to change in temperature. Meanwhile, unmanned vessels with automation can minimize human risk factors to the least and such performance could be boosted with land control.

The next demand in responding to 4th IR would be to enhance customer service and increase customer satisfaction by utilizing the 4th IR technology. For example, developing smartphone-based booking system to enable easy transactions via direct customer interface; instant fulfillment of customers' requirements such as real-time identification and sharing of cargo information like freight location and transportation status with other shippers and logistics service providers; and automatic check-in and check-out at port entrance as well as exit so that port services can immediately stand-by to reduce port waiting time and relevant costs.

For sure, crew remains as an important asset regardless how fast things around could change. Hence, better manpower management for crew is another expectation. Improvement of the quality and ability of crew members for the application of the 4th IR such as job support, education regarding the state-of-the-art technologies which have already applied to the ship and shipping industry, re-establishment of the status of seafarer as control expert for most of the automated equipment of 4th IR in order to uphold crews' self-motivation and self-esteem as well as offshore support to overcome differences in competency of the crew (qualities, motivation, knowledge, technology) are fundamental.

3.2.2 Port Industry

In order to make expansion of port automation viable, the most urgent call is to improve the investment conditions of terminal companies (profitability enhancement), secure trade volume; as well as generalize port automation in advanced port. This should then be followed by more aggressive development or advancement of port automation technology. Real-time information analysis regarding oceanographic measures like wave height, current and sea level via sensors is desirable to achieve best safety and unloading practices which holistically consider all circumstances. Real-time information sharing on port facility, cargo and terminal yard condition (congestion situation, etc.) among shippers, freight service providers, drivers, forwarders is necessary for visibility and safety of freight while enhancement of carry-in and carry-out efficiency is vital for elimination of terminal congestion or port traffic. To a larger extent, it would be even better if automation could be expanded to cover aspects like Quality Control (QC) management.

Besides, energy efficiency via electrification of port handling or discharging facilities and equipment as well as development of utilization technology for renewable energy, solar power in port operation, would certainly be in demand. And again, we should never fail to take into account our on-site personnel or field workers. For example, risk at work could be reduced by the use of drone and proper adjustment of human resource employment.

3.2.3 Logistics Industry

The use of Big Data by the international logistics service providers for better inter-connectivity between businesses and all entities in the value chain in order to facilitate standardization of innovation and sharing of real-time logistics information is a decisive initiative now to have a big leap forward. Thus, security issues of sales know-how sharing should be addressed accordingly and laid out for discussion.

Along the way, warehouse business is promoting digital cargo management through the use of Big Data, AI, and standardization of freight. In view of that, unification and standardization of labeling to cargo or the different subjects of logistics services as well as proper enlargement or segmentation of warehouse are among the necessary moves. Specifically, we could expand automatic warehouses for standardized cargoes, subdivide specialized warehouses for unstandardized cargo according to types or link the small-medium sized warehouses to facilitate management. Then, development and operation of Big Data, AI-based warehouse management optimization system (loading area, moving distance optimization) could come into the play to enhance the chain's overall efficiency.

Apart from that, unification of Bill of Lading (B/L) style for aviation sector and quick settlement using air pool with customized B/L for maritime sector which is used unitedly by shipping carriers involved in the transaction could also facilitate better joint settlement between the two modes of transportation via integration.

Undoubtedly, the application of Big Data, AI technology for computerization of customs clearance business has threatened the role customs duties and business of relevant services. However, the need of advice on logistics and customs clearance in response to dynamic changes of world trade environment and Free Trade Agreement (FTA) expansion creates demand for consulting and education services regarding the use of new system. There will also be demand for development of new businesses such as tool development for 4th IR in order to meet the future demand

of shippers and logistics service providers.

4. The Countermeasures of the Shipping and Port Logistics Industry in Responding to 4th IR

4.1 Prospects for the Countermeasures

The direction of countermeasures in responding to 4th IR Project should be selected based on the consideration of its importance and contribution to the continuous industrial development. Particularly, the introduction of 4th IR is expected to strengthen shipping and port logistics industry by realizing economic value enhancement of existing businesses, new market creation to accommodate future demands, market leading capability for securing competitive advantages and more.

As the 4th IR progresses, the shipping and port logistics industry is earnestly introducing advanced technology; as well as promoting automation and unmanned trends, integration and fusion of inter-industry and convergence of intra-industry businesses for the sake of innovating new businesses development in the current industry. These four evolutionary stages of 4th IR progression were derived from interview survey with experts of shipping and port logistics industry in Chapter 3.

Hence, in deciding towards which direction we should march ourselves, the experts of shipping and port logistics industry have reached consensus on 4 phases, namely technological leadership by passionately introducing cutting edge technology to improve economic performance such as enhanced productivity, reduced cost and risk through automation and unmanned technologies, ability to create new markets through the convergence and integration of inter-industries, as well as to innovate new industries through the cross-border expansion of intra-industry businesses such as tourism, education, and well-being.

Following table shows the illustration of the aforementioned 4 aspects of countermeasures :

Table 5 The Phases of countermeasures

Phases of Countermeasure	Illustration
Preemptive Introduction of Advanced Technology	Plays a leading role in the market of advanced technology by preemptively introducing advanced shipping port technology; as well as being able to lead Korea's shipping port industry and enhance competitiveness of global shipping and port logistics industry
Automation, Unmanned technology	Focusing on productivity improvement, cost and risk reduction and safety enhancement through automation and unmanned technology of shipping and port logistics industry
Collaboration and Integration of nter-industry	Creation of new business and market by integrating sub-industries of shipping and port logistics industry as well as strengthening inter-connectivity between relevant service industries such as maritime, aviation, land transportation, port, logistics, trade, finance, shipbuilding etc.
Cross-border Expansion of Intra-industry Businesses	By combining the functions of the shipping and port logistics such as education, experience, leisure, tourism, and well-being, the company expands the industrial area and provides diverse services to industrial users, port visitors, and ordinary citizens.

4.2 Comparing the Importance of 4 Proposed Countermeasures

AHP analysis was conducted to compare the relative importance perceived by Shipping and Port Logistics companies with respect to the evolutionary stages of the 4th IR. The four evolutionary stages were set as a single hierarchy of AHP and single-layer comparative analysis was done.

To illustrate, a survey based on experts of the field was conducted from August 7, 2017 to August 19, 2017 in order to compare the relative importance of the aforementioned countermeasures of shipping and port logistics industry in responding to 4th IR. A total of 41 questionnaires were distributed to shipping and port logistics experts including shipping and port logistics industry executives, university professors and professional researchers via e-mail. Effective response questionnaire of 41 sets were then received and analyzed (100% recovery rate).

Table 6 Result of comparing the importance of the 4 phases of countermeasures

Phases of Countermeasure	Importance	Consistency Rate
Preemptive Introduction of Advanced Technology	0.265	0.000
Automation, Unmanned technology	0.168	
Collaboration and Integration of Inter-industry	0.389	
Expansion of Intra-industry Business	0.177	

The result of analysis using AHP showed that the reviewed countermeasures should be first directed to, 'Collaboration and Integration of Inter-industry', followed by the 'Preemptive Introduction of advanced technology' and 'Cross-border expansion of Intra-industry Businesses'; and eventually 'Automation, Unmanned technology'.

4.3 Direction of the Countermeasures in Responding to the 4th IR in Shipping and Port Logistics Industry

Desirable countermeasure should be first based on innovation of new businesses from existing ones, then developing new business models within the industry and later on, convergence and integration across industry.

Firstly, shipping company, ship management, forwarder, container terminal, warehouse business, customs clearance business and other port logistics business providers should apply hyper-connected and hyper-intelligent technology of Big Data, AI, robot, drone and more to increase added value to their existing business by enhancing productivity and efficiency; while reducing cost and risk. Promoting the application of the 4th IR Technology by every business is vital so that later on, the synergy effect of integration within the sub-sectors or across the industries could tap to maximize outcome results. In this context, the subject of technological investment considering the investment potential or power of respective entities in the chain and human resource structure adjustment problem should also be properly addressed.

Secondly, we should take initiatives to create new business models through the introduction of the 4th IR technology by connecting, integrating and merging existing services, business types as well as functions within shipping and port logistics industry. Ship owners, liner shipping companies, freight forwarding companies, forwarders, shipping agencies, vessel management, container terminals, customs clearance companies, warehouse companies, land transportation companies, and port service companies should be linked through massive information sharing, real-time monitoring and controlling, remote control via e-navigation platform, as well as standardization and unification of settlement.

Thirdly, shipping and port logistics industry and the related industries are expected to integrate and convergent to come under a same rubric led by hyper-connectivity and super intelligent oriented network. Hence, establishment of convergence platform for shipping and port logistics industry with manufacturing, trade, finance, education, information network industry is critical. However, to apply the 4th IR Technology to the shipping and port logistics industry at the macro level appears to be the most challenging task.

5. Conclusion

This study examined the awareness of Korean shipping and port logistics industry regarding 4th IR and investigated the needs of the industry in responding to 4Th IR. The importance of proposed 4 phases of countermeasures were also compared in order to direct a systematic step-by-step response in reacting to the progress of the 4th IR.

The study found that the awareness level of the Korean Shipping & Port Logistics industry regarding 4th IR was very low despite that the introduction of 4th technology is so fundamental to enhance economic efficiency and improve competitiveness for each sector of the industry. Meanwhile, the result of AHP analysis regarding evaluation of the importance of countermeasures in responding to 4th IR indicated that the helm should be first steered to the promotion of convergence among sub-sectors within shipping and port logistics industry, followed by preemptive introduction of new technologies, cross-border expansion of intra-industry businesses, and finally, automation and unmanned technology. Desirable response in introducing and developing the 4th IR should be should be weighed and conducted in phases according to their relative importance, starting from innovation of new businesses from existing ones, then progress to developing new business models within the industry and later on, convergence and integration across industry.

This study is meaningful in accurately identifying the current state of the 4th IR in shipping and port logistics industry by examining and presenting the actual awareness level and needs of Korean Shipping & Port Logistics industry in reacting to 4th IR.

In addition, this study also contribute to the innovation and industrial competitiveness enhancement of Korean Shipping & Port Logistics industry by enlightening the appropriate response direction in reacting to the progressive development of 4th IR in the worldwide Shipping & Port Logistics industry .

The emergence of 4th IR is omniscient in each field, but the impact may still be sluggish or there might be sudden

change. In order to successfully respond to the 4th IR, the shipping and port logistics industry should continuously develop new businesses by integrating sub-sectors in the field and connecting shipping and port logistics industry with other industries such as manufacturing, trade, finance and information to form cooperative.

The developed phases of response should then be commercialized (this research proposed 4 phases) by having these businesses adopted throughout the industry. This could lead to increased global industrial competitiveness as the pioneering new business markets and high value-added businesses will improve productivity, safety, and economic efficiency of every sector. By doing so, the completeness of the 4th IR will be enhanced.

Establishment of cooperation schemes between industry and academia, as well as integrating government for the establishment of paradigm, technological development, systematic policy delegation and execution is also fundamental. Operating a permanent organization, arranging professional personnel (organization) and running an expert advisory committee are also necessary to monitor the impact of the 4th IR and respond proactively to the changes. Continuous monitoring, checking, and evaluating countermeasures as well as eliciting feedbacks are critical in taking advantage of opportunities in the 4th IR.

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