Transportation Research Part A 118 (2018) 480–493

Contents lists available at ScienceDirect

Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

Impact of the smart port industry on the Korean national economy using input-output analysis

Wang Ki Jun[a], Min-Kyu Lee[b], Jae Young Choi[a,*]

[a] Graduate School of Technology & Innovation Management, Hanyang University, Seoul, Republic of Korea
[b] Graduate School of Management of Technology, Pukyong National University, Busan, Republic of Korea

ARTICLE INFO

Keywords:
Input-output analysis
Smart port
Economic impact analysis

ABSTRACT

Recently, state-of-the-art technologies such as the Internet of Things and information and communications technology have been applied to the port logistics field in accordance with the advent of the fourth industrial revolution globally. In line with this trend, developed countries are developing and applying smart port technology in the port industry. However, few studies have investigated the economic impact of this activity. Thus, by reviewing the various definitions and policies of the smart port industry and applying a modified hybrid methodology combining Delphi surveys and input-output analysis, this study estimates the economic impact of the smart port industry on the Korean economy with a sophisticated yet reasonable range of values. The smart port industry is dominated by the forward linkage effect, which means the smart port industry is used as an intermediary material or process in other industries. Furthermore, compared with the port industry, the smart port industry has an especially large impact on productivity, value added, and employment.

1. Introduction

Smart port technology is a major issue for many developed countries. Specifically, it is improving the efficiency and automation of the maritime transportation industry through the integration of various information and business processes (Ferretti and Schiavone, 2016). Maritime transportation, which accounts for 90% of the world's cargo volume, plays a major role in national economies, and ports as the base of maritime transportation represent infrastructure facilities closely related to national competitiveness (Chang et al., 2014; Cullinane and Song, 1998; UNESCAP, 2005; Rodrigue and Notteboom, 2009). Thus, by recognizing the importance of the smart port, highly developed countries have been actively investing capital in developing smart port technologies and applying them to traditional port areas.

Smart port technology can be explained as the convergence of new technologies such as the Internet of Things (IoT), Big Data, automation, and environmentally-friendly technology. Specifically, IoT technology, which indicates an intelligent infrastructure that connects wired and wireless networks to surrounding objects such as electronic equipment and sensors, and exchanges collected information between them (Ferretti and Schiavone, 2016), has recently evolved rapidly and is making a big difference in the logistics and transportation industries. For instance, DHL, the international express company, predicts that 50 billion devices will be connected to the Internet by 2020. When the IoT is applied to the field of logistics, including freight transportation and warehouse management, their costs will be reduced, whereas the sales effect will be increased. Moreover, such technology will create an economic value of USD 1.9 trillion in logistics and supply chain by 2025 (Macaulay et al., 2015).

* Corresponding author.
E-mail address: boogalooaz@gmail.com (J.Y. Choi).

https://doi.org/10.1016/j.tra.2018.10.004
Received 9 April 2018; Received in revised form 31 July 2018; Accepted 3 October 2018

Particularly for developed countries in the port industry, efforts to adapt smart technology at ports have been steadily progressing. In 2010, Germany launched the Smart Port Logistics project in its Hamburg port: IoT sensors were installed throughout the port to establish a system to exchange data from every part of the port, including the ships, trucks, and transformation system. Thus, smart port technology has improved the flow of traffic and cargo in the Hamburg port (Ferretti and Schiavone, 2016; Heilig et al., 2017). Similarly, Rotterdam Port in the Netherlands, which opened the first automated container terminal, the core of the smart port, back in 1993, continued to lead the smart port industry by opening the APM terminal and Rotterdam world gateway in 2015. In the US, Long Beach Container Terminal (LBCT), a completely automated container terminal applying smart port technology, was opened in 2016. Lastly, China, which has ports handling the largest cargo volume in the world, also opened Qingdao Qianwan Container Terminal (QQCTN) in Qingdao Port, the first fully automated container terminal. It is expected that the efficiency of the port will be improved by 30% and the labor cost will be reduced by 85%.

In line with this trend, Korea has steadily invested a huge sum of money in port areas being activated.[1] Because of the trade structure of export-led Korea, it is believed that the smart port industry will play a pivotal and significant role in the Korean economy. In particular, as its smart port industry is in the early stage, Korea has been focusing on building an expanded smart port infrastructure. In August 2016, the Korean government formulated the National Logistics Master Plan (2016–2025) to create a roadmap for the next generation of futuristic smart port construction to lead the next generation of port logistics technology (Ministry of Land, Infrastructure and Transport, 2016). In addition, until 2019, the Korean government will carry out research and development projects related to shipping port logistics and invest approximately KRW 100–200 billion over five years to develop smart port technology and foster entrepreneurship in maritime port logistics.

Although there have been active and large-scale investments in developing smart port technologies in these countries, few studies have investigated the economic impact of the smart port industry on the national economy. Admittedly, the smart port is a complex platform including port technology, the IoT, Big Data, automation and eco-friendly technology, and it is very difficult to accurately estimate economic impacts on the country level with few arguments due to its blurred definition.

Thus, this study attempts to estimate the accurate and unbiased economic impacts of the smart port industry on the Korean economy by adopting a hybrid methodology combining the Delphi survey and input-output (I-O) analysis. In fact, I-O analysis mostly adopts the industrial classification method to formulate a new target industry[2] that normally accompanies researchers' arbitrary selection of traditional industries. To overcome this drawback of I-O analysis, this study conducted the Delphi survey with 10–12 experts to minimize the risks of arbitrary selection by objectively classifying the smart port industry and improving the reliability of the research results.

Moreover, this study differs from previous studies using I-O analysis in that the estimates resulting from I-O analysis such as the production inducement coefficient, value-added inducement coefficient, and employment inducement coefficient are presented with a range of economic impact vis-à-vis four industrial classification methods–broad, narrow, associative, and complex classification–by imposing diverse weights on the selected industries reflecting expert opinions. Previous studies using I-O analysis for new industries faced the risk that the inducement coefficients were over-estimated according to the industrial classification of the new industry. By adopting the four industry categories of the smart port industry, this study seeks to calculate an economic impact that is closer to reality than the previous studies.

The rest of this paper is organized as follows. Section 2 examines the definition of the smart port, smart port industry trends and previous studies analyzing the economic impact of the port industry and new industries. Section 3 explains the classification and industrial linkage analysis methods of the smart port industry. Section 4 presents the analysis results from the perspective of the I-O model of the smart port industry. Finally, the necessity of smart port industry investment and policy implications for smart ports are suggested in Section 5.

2. Understanding the smart port

2.1. Definition of the smart port

Smart ports have also been called intelligent ports, robotic ports, and autonomous ports in several studies. Although there are some differences in the definitions of the smart port by researchers, the smart port is generally related to the improvement of port productivity and efficiency by adopting an automated system using a high level of technology such as the IoT, Information and Communication Technology (ICT), Big Data and environmentally-friendly technology (Botti et al., 2017; Buiza-Camacho-Camacho et al., 2016; Ferretti and Schiavone, 2016; Yang et al., 2018). Cho and Won (2014) defined the smart port as a port with automation, high productivity and greening facilities such as a port operation system, port logistics equipment and port logistics infrastructure.[3] Meanwhile, according to Sakty (2016) and Buiza-Camacho-Camacho et al. (2016), the smart port is specialized in the areas of operation, energy and environment. The operation seeks to improve port productivity by increasing the size of container ships and to

[1] In fact, Korea has the world's 5th largest container port, Busan Port.

[2] In fact, most previous studies arbitrarily defined the scope of the new industry in accordance with standard industry classification and related laws (Chang et al., 2016).

[3] Namely, smart ports can be summarized as two words: smart and green, where smart means completely autonomous and high productivity, and green implies operating systems and related facilities such as cargo handling, transporting and storage equipment in ports to reduce carbon dioxide emissions.