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Self-management of greenhouse gas and air pollutant emissions in Taichung Port, Taiwan

Ying-Tsai Tsai[a], Chen-Jui Liang[b,*], Kuo-Hui Huang[a], Kuo-Hsin Hung[a], Ciao-Wun Jheng[c], Jeng-Jong Liang[c]

[a] *Pot of Taichung, Taiwan International Ports Corporation, Taichung 43501, Taiwan, ROC*
[b] *International School of Technology and Management, Feng Chia University, Taichung 40724, Taiwan, ROC*
[c] *Department of Environmental Engineering and Science, Feng Chia University, Taichung 40724, Taiwan, ROC*

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ABSTRACT

A self-management approach and committee were established in Taichung Port to facilitate the control of the total quantity of greenhouse gas (GHG) and air pollutant emissions from various sources in the port district. This self-management approach was the first approved case by the Environmental Protection Bureau of Taichung City. The district has a land area of 37.93 km^2 and a sea area of 2035.75 km^2, and it is divided into various zones, namely heavy industry, export processing, and harbor zones according to the difference of based on differences in land use. The approach includes an inventory and actions to reduce carbon levels and air pollutants. The year 2014 was defined as the base year of emissions; however, some of the emission benchmark values were changed in 2015 or 2016 because more accurate inventory results became available during those years. A self-management committee comprising a general manager, departmental directors, and experts/scholars was formed in 2015. In the self-management approach, nine main reduction strategies and three actions to offset GHG and air pollutants were continually enforced. The results demonstrate that the environmental protection to facilitate the development of a green port is workable. Following the successful experience of Taichung Port, the self-management method was adopted in other industries and areas in Taichung City, a special municipality.

1. Introduction

The “green port” concept is now widely implemented worldwide (Barnes-Dabban et al., 2017). The terms of green port and eco-port are identical, and these ports represent those with environment friendly operations. Sustainable or green freight systems serve to mitigate negative effects on the environment and human health (Iannone, 2012). To facilitate the full implementation of the green port policy, many environmentally friendly strategies were enforced by many ports. The environmentally friendly strategies of Los Angeles Pore compose of alternative maritime power, CEQA/EIR projects and public notices, clean air action plan, clean truck program, ocean-going vessel emission reduction, etc. The sustainability strategies of Rotterdam Port include carbon capture and storage, LED lighting, heat alliance, CO_2 footprint, clean vessels via real discount, future land, mobile e-nose, truck stops, and solar power.

Taichung Port is the second-largest port in Taiwan. It received eco-port certification from the European Sea Port Organization (ESPO) in November 2015 and November 2017. In 2016, the “Taichung Port area greenhouse gas and related air pollutant emission

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[*] Corresponding author.
E-mail address: cjliang@fcu.edu.tw (C.-J. Liang).

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sources management and reduction of self-management method" was enforced and approved by the Environmental Protection Bureau (EPB) of Taichung City, Taiwan. The year 2014 was defined as the base year of greenhouse gas (GHG) and air pollutant emissions; however, some of the emission benchmark values were changed in 2015 or 2016 because more accurate inventory results became available in these years. These changes were also approved by the EPB. The self-management method includes the establishment of a special committee that is empowered to undertake various actions to ensure the full implementation of the green port policy. These actions are assigned to various departments in the Taichung Port sector, and the committee then regularly supervises and reviews the results. The self-management method was successful and has now been adopted in other industries and areas.

2. Literature review

To achieve green status, some previous studies provided various strategies such as improving regulations and management systems (Ying and Yijun, 2011), promoting ecological footprint analysis (Erdas et al., 2015), integrating coastal management, developing sustainable port infrastructure and networking initiatives, promoting the regionalization of ports, ensuring urban and landscape connectivity, facilitating the social integration of ports (Nebot et al., 2017), implementing quantitative analysis using the Driver–Pressure–State–Impact–Response framework (Wan et al., 2018), improving the environmental performance of hinterland transport (Aregall et al., 2018), and revitalizing port activities and the port cluster (Woo et al., 2018).

Several researchers have explored the effectiveness of green port strategies. For example, Chang and Wang (2012) evaluated the effectiveness of strategies designed to reduce pollutants in port areas, and Roh et al. (2016) explored the main factors influencing sustainable port development. Woo et al. (2018) investigated environmental policy issues in ports from both economic and environmental perspectives and explored the extent to which an environmental policy affects the cost–benefit structure. Park and Yeo (2012) used a fuzzy set approach to evaluate the greenness of five Korean ports. Davarzani et al. (2016) examined past and present research on green ports and maritime logistics and concluded that the findings obtained from the evolution of seminal research areas can help the field grow in several dimensions. By integrating Weick's sense-making properties with Weber and Glynn's affiliated institutional mechanisms, Barnes-Dabban et al. (2017) explained the dynamic interplay between institutions and sense-making in the greening of the Freeport of Monrovia. Kavakeb et al. (2015) investigated the impact of using automated guided vehicles on the performance and total cost of a port. Longo et al. (2015) provided a decision support system with 20 strategies for the managerial and policy implications of a port. The simulation and comparison of design alternatives in terms of 20 strategies were accomplished. Di Vaio and Varriale (2018) proposed the Balanced Scorecard and Tableau de Bord as managerial accounting instruments for developing competitive green ports. Additionally, the work of strengthening employee education in the direction of environmental sustainability was also suggested. Aregall et al. (2018) conducted a global review of green port strategies to identify ports with improved environmental performance of hinterland transport.

Various externalities in shipping and port can reduce the negative impact of port operations on the environment. Urbanyi-Popiołek and Klopott (2016) explored how the growing turnover of container units has affected port cities. Dooms et al. (2013) found no relationship between economic and environmental performance at the individual inland port level. Marín et al. (2017) described the impact of aerosol particles, composed of black and brown carbon, emitted from the Valparaiso port on the human population and local environment. Esmer et al. (2016) proposed an analytical nonprice competition framework to reduce the effect of various competition-based factors on the port sector. Acciaro et al. (2014) argued that active energy management can offer substantial efficiency gains, be used to develop new alternative revenue sources, and improve the competitive position of the port.

3. Research methodology with emission inventory and framework of total quantity control

3.1. Boundary and description of the self-management area

Fig. 1 shows the geographical location and boundary of the self-management area. Taichung Port is located in central Taiwan (Fig. 1), which has wharves of 58, terminal length of 14,695 m, and shipping routes of 15. In 2017, the annual container and cargo handling capacities of Taichung Port reached 1.66 million TEU and 127.86 million metric tons. The self-management area is the operation area of Taichung Port, which encompasses statutory land and sea territories covering a total of 2073.68 km^2. The land territory is 37.93 km^2, including a land area of 28.20 km^2 and a harbor basin area of 9.73 km^2. The sea territory is 2035.75 km^2 and comprises a semicircular sea area of radius 20 nmi (37 km). The center of the sea area is located at the main channel exit. The sea areas are divided into three zones (Zones 1, 2, 3) situated within two boundaries of 15- and 10-nmi lines (dotted lines in Fig. 1), enabling the calculation of the average vessel speed in the 20-nmi contiguous zone. The self-management area does not contain the Wuqi Fishing Harbor.

The principles of division management and responsibility adopted in the self-management area are based on land use and industrial characteristics; therefore, the area is divided into regions of heavy industry (A1), export-processing (B1), and harbor (B2) areas (Fig. 2). A 5824-MW coal-fired power plant and a 6-MMT yr^{-1} crude steel plant are located in the A1 area. The power plant is the largest coal-fired power station worldwide. The steel plant is the second-largest steel plant in Taiwan. Their GHG and air pollutant emission regulatory works are directly controlled by the EPB of Taichung City. The B1 area is an export-processing zone that belongs to the Industrial Development Bureau (IDB) at the Ministry of Economic Affairs of Taiwan, and this area contained 76 factories in 2016. Because both A1 and B1 areas are governed by their own competent authorities, their management of GHG and air pollutant emissions is not included in the self-management approach. However, including their emission data in the annual self-management report is necessary to provide a clear understanding of the pollution situation of the entire port area. The B2 area is composed of