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Green port and maritime shipping

Dan Zhuge [a], Maxim A. Dulebenets [b], Kjetil Fagerholt [c], Shuaian Wang [d]

[a] *School of Management, Shanghai University, Shanghai, China*

[b] *Department of Civil & Environmental Engineering, Florida A&M University-Florida State University, Tallahassee, United States*

[c] *Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Trondheim, Norway*

[d] *Department of Logistics and Maritime Studies, The Hong Kong Polytechnic University, Hong Kong, China*

Air emissions from the shipping industry have received widespread attention from the academia and industry. Frequent shipping activities consume nearly 240 million tons of marine fuel per year as reported by the International Maritime Organization (IMO). Therefore, considerable ship emissions will be generated, including sulfur dioxide (SO_2), nitrogen oxide (NO_x), carbon dioxide (CO_2) and particulate matter (PM). Most of these emissions occur within 400 km of the coastline, which have caused severe environmental problems. The emissions at ports are mainly generated from the activities of ships berthing and navigating as well as the activities of cargo loading, unloading, transshipment, storing and internal container transfer operations within the terminals. To ensure environmental sustainability at ports, operators need to balance port operations efficiency and emission control, while it is challenging to introduce the green target into the traditional port operations problems (e.g., berth allocation, quay crane scheduling, and yard crane assignment). With the aim of energy saving and emission reduction in the shipping industry, the port management system should be further optimized and green port technologies deserve to be widely explored and discussed. To promote the research on green port and maritime shipping, a special issue on “Green Port and Maritime Shipping” was hosted. The special issue collected eight research papers, with the topics regarding the internal truck renewal, the berth and yard allocation, the stocks allocation, the construction of an environmental management system, the control of marine greenhouse gas emission, the assessment of container terminals competitiveness, the construction of a multi-criteria decision support framework, and the analysis of maritime transportation research capability. Several papers were selected from IFSPA (International Forum on Shipping, Ports, and Airports) 2022.

The effective management of port traffic can mitigate the environmental problem in ports. Zhen et al. (2022) addressed an internal truck renewal problem in container ports, where the internal trucks are used to transport containers between quay cranes and storage yards. The authors analyzed three types of internal trucks that are usually adopted in container ports (i.e., diesel-driven internal trucks, electric-driven internal trucks, and liquefied natural gas (LNG)-driven internal trucks) and three modes of renewal (i.e., purchasing, retrofitting, and chartering). A two-stage stochastic mixed integer programming model was proposed to determine the internal truck composition and the selection of renewal modes. To solve the proposed model, a tailored Benders decomposition algorithm accelerating by Pareto-optimal cuts was developed. Extensive numerical experiments on Shanghai Yangshan Deep Water Port were conducted to

validate the effectiveness of the mathematical model and the efficiency of the solution approach, and managerial insights on the renewal of internal trucks in green ports were provided.

The effective allocation of resources, especially the allocation of berths and yard spaces, can also contribute to the development of green ports. Lin et al. (2022) focused on the allocation of berths, quay cranes, and yard spaces for tidal ports considering channel constraints and carbon tax policy. The authors presented a mathematical model for this allocation problem with the aim of minimizing the total cost, which consists of the ships' waiting and delay penalty costs and the carbon emission costs caused by ships in channel, ships during mooring, trucks during loading of containers, and trucks during unloading of containers. They also developed a heuristic algorithm based on the sequential method to solve the model efficiently. Numerous computational experiments were performed and valuable management implications were drawn. Yu et al. (2022) investigated a stocks allocation problem in automated container terminals. The choice of clustering strategies for yard space management was discussed. A mixed integer linear programming model was proposed to achieve a trade-off between the transportation distance and the allocation dispersion among blocks. They performed numerical experiments on the real-world operations from Yangshan phase IV automated container terminal. A yard area with 18 non-cantilever blocks was analyzed during a planning horizon of 7 days. The results reported that it is suitable for the automated container terminal to choose the stack-based allocation with multi-batches in the same bay. The effect of the automated rail-mounted gantry crane and the berthing time on the total transportation distance for the container allocation was also identified.

Jeevan et al. (2022) attempted to construct an environmental management system based on the concept of green port. With the characteristics of significant container throughput, congestion issues, emissions, and pollution, Port Klang, the largest port in Malaysia, was selected for the analysis on the green port concept. Using the Analytic Hierarchy Process, the authors analyzed the factors most relevant to the implementation of the green port concept and the effect of green port applications on the future competitiveness of the port. They discussed the criteria of green port (including environmental quality, the use of energy and resources, waste handling, and habitat quality and greenery) and the competitiveness of green port (including cost efficiency, green operation, sustainable equipment, and resources management). They finally concluded that improving the environmental performance of ports is an important determinant of port competitiveness.

Considering the exacerbation of global warming, Zhu et al. (2022) explored how to control marine greenhouse gas emissions (GHG) in Hong Kong. The authors analyzed the current policy and regulatory measures for the control of marine GHG emissions in Hong Kong, such as the use of energy-efficient transport and cleaner vehicles. Three main challenges in controlling GHG emissions from the shipping activities in Hong Kong were summarized as follows: the lack of support by the top-level action plan, the unclear control and target systems of carbon emissions, and the inadequate means and measures for green and low-carbon development. They found that merely following the IMO measures to control marine GHG emissions is

insufficient and strengthening collaborative actions with mainland China, especially the Greater Bay Area, is necessary.

Souza et al. (2022) evaluated the competitiveness of container terminals in the Brazilian market by clustering algorithms. Based on the existing literature and the characteristic of Brazilian ports, thirteen criteria were selected, i.e., two criteria related to the carrier's choice, ten criteria related to container terminals, and one related to the GDP hinterland associated with the terminals. Seventeen container terminals located in different regions of Brazil were divided into three groups. They identified that the most competitive group of terminals consisting of Santos Brasil, BTP and Paranaguá has the highest average values in eleven out of the thirteen criteria, mainly caused by the annual capacity, the number of plugs, and GDP hinterland. They observed that the limited operational draft in Brazilian container port terminals affects the reception of large ships. The investment for the Brazilian port sector to serve large capacity ships is an urgent problem.

Konstantinos et al. (2022) investigated how to construct a multi-criteria decision support framework for assessing the port sustainability planning by combining with the 2-tuple TOPSIS model, heterogeneous variables, and a fully integrated Monte Carlo Simulation. A case study of the port of Piraeus was conducted using four evaluation criteria: contribution to CO_2 emissions reduction, economic viability, investors' risk, and implementation time. The low-carbon interventions in the port of Piraeus and their vulnerability to uncertainties were examined by sensitivity analysis and robustness analysis, which can provide suggestions for relevant policymakers and decision-makers operating in the shipping and port sectors.

The maritime transportation research capability was analyzed by Lin et al. (2022). Based on the Web of Science and Scopus database, this study used 13 searching keywords (i.e., port, shipping, maritime, marine, terminal, ship, liner, vessel, seaport, water transportation, ocean freight, container, and waterway transport) and 11 excluded keywords (i.e., highway, intersection, helmet, pedestrian, fish, guardrail, aviation, airport, airline, fishery, and intermodal) to screen out 2,972 papers on maritime transportation research published in 66 journals from 2011 to 2020. The top 50 authors, affiliations, and nationalities among these papers were ranked and displayed according to the number of papers, the weighted score, and the impact score. The dynamic changes in rankings were reported in five-year intervals. The analysis results also showed that the number of papers and authors in the research area of maritime transportation has been increasing in the recent ten years.