Analysis on Low-carbon & Green Container Port-building Goal System

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Abstract

Based on the intrinsic mechanism of container port operation, this paper analyses the influence factors of the container port low-carbon greening development. Then the goal system of low-carbon & green container port development is put forward which includes discharge and control of pollutants, carbon emissions, energy consumption, scheduling management level, use of energy saving technology and management institution, etc. The build of the goal system can offer decision-making reference and theoretical basis for building low-carbon & green container ports.

Keywords: container ports;low-carbon;green;goal system

Introduction

Container ports are not only the centralized place for transport ships, vehicles and all kinds of cargo handling and carrying equipment to transshipment operation, but the discharging concentration place of carbon dioxide, all kinds of pollutants, noise and energy consumption. Under the new situation of global environmental degradation and energy crisis, building low-carbon & green container port and realizing the sustainable development have become an urgent problem.

Thomas. A. grigalunas (2004) from the cost point stated the factors which restricted port sustainable development, and put forward a number of sustainable development suggestions for container port [1]. E. Peris-Mora et al. (2005) proposed a system of port sustainable environmental management indicators to provide reference for low-carbon & green container port building [2]. By using the cost-benefit analysis method, Dong Liangcai and Liu Huayu (2010) evaluated the environmental impact of container port construction project [3]. Ling Qiang (2010) stated the importance of establishing the evaluation index system of the green port and put forword green port's conception, as well as introduced its guiding ideology, the design principles, the indicator composition and the application method, which could be referenced [4]. Wang Dandan (2011) added resource consumption and environment influence to quantitative analysis of port economic contribution, formed new input and output appraisal system of

port, and made comprehensive evaluation for the port development and coordination between benefits and environment pollution on the basis of appraisal [5]. Dong Guosong, etc. (2011) presented the goal system of low-carbon & green port [6]. Gao Dan (2011) adopted data envelopment analysis method to calculate the comprehensive efficiency of domestic ports, and put forward corresponding measures of domestic green port building concerning the scientific planning, port resource integration, green science and social responsibility [7].

In conclusion, there are few researches directly aimed at low-carbon & green container port building. Based on the intrinsic mechanism of container port operation, this paper analyses the influence factors of the container port low-carbon greening development, puts forward the goal system of low-carbon & green container port which can offer decision-making reference and theoretical basis for building low-carbon & green container ports.

The intrinsic mechanism of container port operation

Through system analysis, this paper analyses container ship discharge operation process (loading operation process is on the contrary) which is shown in fig.1.

From fig. 1, it is known that the container ship discharge operation process involves ship berthing, container unloading and horizontal transportation, container stacking and in and out of gate etc. Arrived at anchorage, container Ship berthing is assisted by tug traction; after that, directly delivered containers are unloaded by quay crane and carried away by external container truck via the gate, while the containers requiring stacking are transported by internal container truck which undertakes the horizontal carriage between the quayside and container yard, both the internal and external container trucks need to queue up for operation; Forklift truck, gantry crane and reach stacker bear the work of container stacking. In addition, the particularity of reefer, dangerous and specific containers requires particular supervision; the distribution of containers are finished by external trucks through the highway or by rail which bears the sea-rail combined transportation, external trucks queue at the gate for the checking of container information.

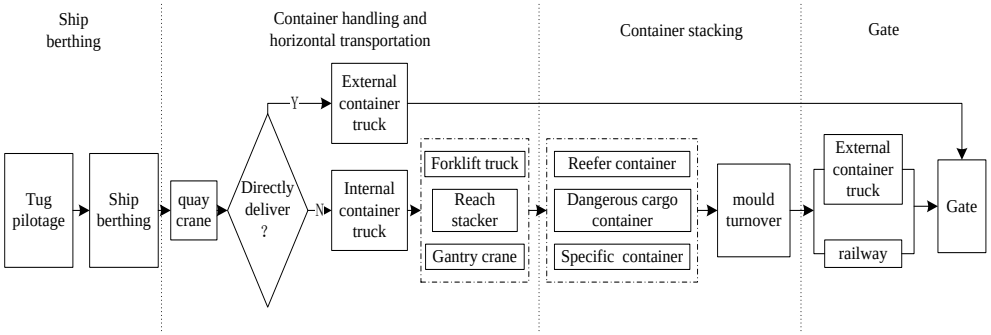


Fig.1 Discharge operation process of container ship

Influence factors of low carbon & green container port building

Based on the analysis of figure 1 the discharge operation process of container ship, this paper adopts fishbone diagram to find out the main influence factors of low-carbon & green container port building, as shown in fig. 2.

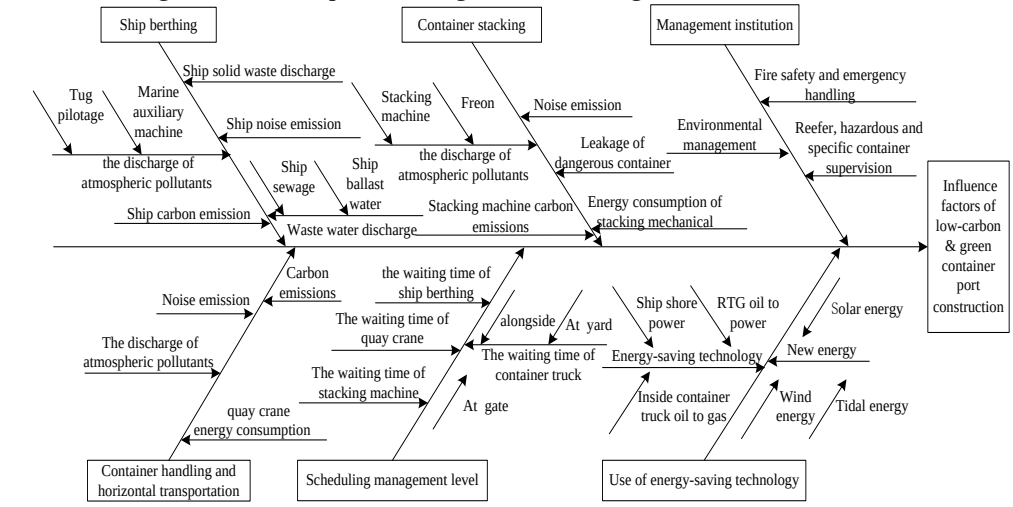


Fig.2 Influence factors of low carbon & green container port building

Fig. 2 illustrates the main influence factors of low-carbon & green container port-building including ship berthing, container handling and horizontal transportation, container stacking, scheduling management level, use of energy-saving technology and management institution, etc.

(1) Ship berthing. During the process of ship berthing the discharge of atmospheric pollutants, CO2, solid waste, waste water and noise effect low-carbon & green container port-building. The atmospheric pollutants and CO2 emissions are from the ship machine operation during the berthing process, the auxiliary operation when ship parks on the berth and the operation of tugs, while waste water contains ship sewage and ballast water, the solid waste refers to crew living garbage.

(2) Container handling and horizontal transportation. The operation of quay crane and internal container truck causes the discharge of atmospheric pollutants, CO2, noise emissions and energy consumption which impact the low-carbon green container port building.

(3) Container stacking. The operation of container stacking machine discharging atmospheric pollutants, CO2, noise, and the potential risk of dangerous cargo container leakage and energy consumption influence the low-carbon green container port building. The atmospheric pollutants mainly

come from stacking machine operation and Freon emissions.

(4) Scheduling management level. The waiting time for ship berthing, quay crane handling, container truck and stacking machine operation influence the low-carbon green container port building. Among them, container truck waiting at the shipside, yard and gate causes the waste of time.

(5) The use of energy-saving technology. The usage of port new energy and energy-saving technology influence the green container port building. Energy-saving technology contains container ship shore power technology, RTG oil to power and container truck oil to gas technology, while new energy refers to wind, solar and tidal energy.

(6) Management institution. The imperfection of environmental management institution, fire safety and emergency handling system, reefer, hazardous and specific container supervision system can affect the low-carbon green container port building.

The goal system of low carbon & green container port

Based on the analysis of fig.2 the influence factors of low-carbon & green container port building, this paper constructs the low-carbon & green container port goal system. This system includes the ecological environment, pollution emissions and control, carbon emissions, energy consumption and scheduling management level, the use of energy-saving technology and management institution, etc. as shown in fig.3.

4.1 Pollution emissions and control. Container port pollution, involving wastewater discharge, waste air pollutants, solid waste and noise are the main influence factors of its low-carbon port-building. Therefore this paper chooses wastewater discharge, disposal rate of wastewater, air pollutant emissions, noise emissions of quay crane, container truck and stacking machine and solid waste emissions to evaluate container port pollution emissions and control.

Port waste water mainly includes ship ballast water and sewage. Ship ballast water can cause foreign biological invasion, destroying the local ecological balance; sewage makes water eutrophication and produces all kinds of pathogens.

Waste water disposal rate refers to the processed wastewater quantity accounted for the proportion of total sewage discharge.

Atmospheric pollutants include NOx, SOx, air particulate matter and Freon discharged by the operation of auxiliaries, quay crane, container truck, and stacking machine. The chemical transformation of NOx and SOx is the main reason for rain. As condensation nucleus, air particulate matter increase cloud cover and precipitation as well as the occurrence frequency and the duration of fog. The extensive use of refrigerant Freon by reefer container consumes large quantity of ozone, creating the greenhouse effect and resulting in the increased incidence of skin cancer.

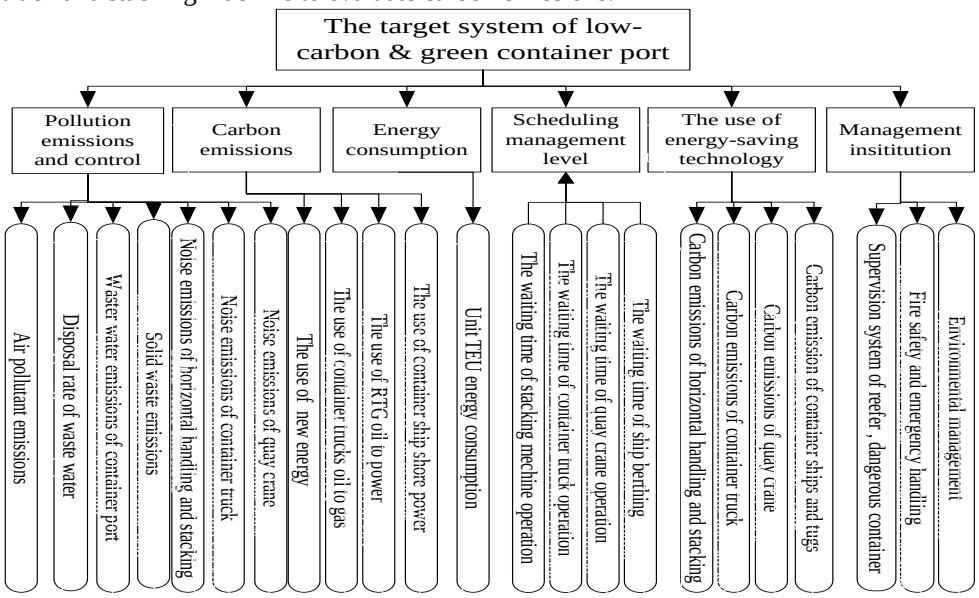
Fig. 3 the goal system of low carbon & green container port

Container port noise mainly comes from vessel arriving, quay crane handling, container truck and stacking machine operating. Noise has an environmental

impact on the vicinity of port, which is harmful to people's health and quality of life. Noise value is applied to the relevant provisions of the noise emission standards within the boundary of industrial enterprise factory GB12348-2008, the noise emissions standards of port and the rivers area GB1139-89 and the design specification of industrial enterprise noise control GB J87-85.

Solid waste is mainly from vessel garbage. Improper handling of solid waste leach ate causes groundwater pollution, and eventually it can threat human health through the food chain.

4.2 Carbon emissions. Though not pollution gas, the concentration of carbon dioxide over than the atmospheric standard will cause the greenhouse effect, raising temperature and being a threat to human security, so reducing carbon emissions has become the consensus of all over the world. Container port carbon emissions are mainly from the operation of auxiliaries, quay crane, container truck, and stacking machine. Therefore this paper chooses carbon emissions of the container and auxiliary ships, carbon emissions of quay crane, container truck and stacking machine to evaluate carbon emissions.



4.3 Energy consumption. As the material basis of human activities, energy consumption is one of the important indicators of evaluating container port low-carbon & green degree. Energy is consumed via handling and auxiliary production. Auxiliary production energy consumption includes maintenance of harbor ship, office buildings and wharf facilities, port sewage treatment, water supply and other kinds of power consumption.

Unit TEU energy consumption means the annual energy consumption of container port container divided by port throughput, being an important indicator of port energy consumption level, it can not merely be used for vertical comparison within a for port, but also can be used for horizontal comparison

between different port.

4.4 Scheduling management level. The scheduling management in container port refers to arrange and assign the ship berth the running of the port machinery reasonably, including ship berthing scheduling system, crane handling scheduling system, container truck dispatch system, stacking machine scheduling system and gate intelligent monitoring system. The scheduling management system has a great effect on the reduction of the waiting time and the improvement of machine utilization; in addition, it will strengthen the cooperation of production operation link. The waiting time of machine operation can reflect the level of the port scheduling management, long queues often limit the efficiency of container port, cause wasting of recourses and generate serious air pollution, and affecting the construction of low-carbon & green container port. Therefore, this paper selects the waiting time of ship berthing, quay crane operation, container truck and stacking machine operation to evaluate the scheduling management level.

Container truck waiting time involves waiting for quay crane to handle containers, waiting at the container yard for stacking operation and at the gate for checking container information.

4.5 The use of energy-saving technology. Energy-saving technology helps advance reducing energy consumption and the damage rate of cargo, and promoting handling efficiency, so it is the inevitable trend for the development of low-carbon & green container port. Then this paper evaluates the use of energy-saving technologies through the use of container ship shore power technology, RTG oil to electricity, container truck oil to gas, and new energy.

The change from fuel driven to electricity or natural gas of container ship shore power, RTG and container truck can effectively reduce the emissions of carbon dioxide, NOx, SOx, and respirable particulate.

The importance of new energy in ensuring the energy security, the adjusting energy structure, and protecting e ecological environment is increasingly strengthening; the new energy sources of container port include solar, wind and tidal energy.

4.6 Management institution. Sound management institution is an important guarantee for the low-carbon & green container port building，which mainly consists of environmental management institution, fire safety and emergency handling system and the reefer, hazardous and specific container supervision system.

The environmental management institution regulates that there must be a clear requirement for every element in the item of management standards, on the basic of the initial environmental review.

Fire safety and emergency handling system is made up of the emergency legal system, the strict implementation system, the responsibility system, and the reasonable system of policies and planning.

Due to the special nature of the reefer, dangerous and specific containers, a kind of real-time monitoring system should be created to protect the security of the cargo and the surrounding environment based on RFID technology, GPRS / GPS technology and sensor acquisition technology.

Conclusion

Container ports play an important strategic position in the international logistics and maritime trade, but the rapid development of port also brings the negative impact on the environment. Low-carbon & green development has become a significant means for container ports' competition of market share. Therefore constructing low-carbon & green container port goal system has important significance.

Based on the domestic and foreign researches of low-carbon & green port, starting from the intrinsic mechanism of container port operation, this paper analyses the influence factors of the container port low-carbon greening development. Then the goal system of low-carbon & green container port is put forward. The achievements are (1) from the perspective of low-carbon & green port, this paper pinpoints the container port production operation process; (2) using the fishbone diagram analysis method, this paper determines the influencing factors of container port low-carbon greening building; (3) according to the affecting factors, this paper puts forward the goal system of low-carbon & green container port. The build of the goal system can offer decision-making reference and theoretical basis for building low-carbon & green container port as well as other types of ports.

Acknowledgement

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References

[1] Thomas A. Grigalunas, MeifengLuo, Young-TaeChang. 2001. Comprehensive Framework for Sustainable Container Port Development for the United States East Coast [A]. Maritime Development Alternative Study Port of Oakland [C]. 7TH Annual Marine Transportation System Research and Technology Coordination Conference. Washington, DC.

[2] E. Peris-Mora, J.M. Diez Orejas, A. Subirats etc. Development of a system of indicators for sustainable port management: submitted to Journal of Marine Pollution Bulletin(2005).

[3] Dong Liangcai, LIU Huayu. Economic evaluation of environmental impact for container port construction projects: submitted to Journal of Port & Waterway Engineering(2010).

[4] Ling Qiang. The Prelim inary Study of Evaluation Index System for the Shanghai Green Port : submitted to Journal of Science & Technology of Ports(2010).

[5] Wang Dandan. Preliminary study on Green Appraisal system of Port: submitted to Journal of Logistic Sci-Tech(2011).

[6] Dong Guosong, Fan Houming, WenWenhua. The Analysis of Goal System Constitution for our Low-carbon Green Port: submitted to Journal of Wuhan University of Technology(2011).
[7] Gao Dan. Green port construction based on DEA : submitted to Journal of Environmental Pollution and Control(2011).