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Development of Carbon Emission Estimation System in Port

Hyung Rim Choi[1], Sung Il Byeon[2], Chang Hyun Park[3]

[1,2,3]Dept. of Management Information Systems, Dong-A University, Korea
{[1]hrchoi, [2]skpr12}@dau.ac.kr
[3]archehyun@naver.com

Abstract. The management of greenhouse gas is insufficiently conducted in ports due to the lack of a systematic and reliable estimation system for the reduction of greenhouse gas. To help solve this problem, this study examined the method of estimating carbon dioxide emission in ports and developed a system to estimate the emission. This system is expected to be used as a basic data system for climate change response and greenhouse gas reduction policies in ports. Also, it is expected to be used for more reasonable carbon dioxide management through a dimensional analysis of the emission sources.

Keywords: Port, Carbon dioxide, Emission, System

1 Introduction

As the introduction of new port logistics technology has become necessary because of the ever-increasing cargo volume, the appearance of super-large vessels, and the increase of request for greenhouse gas reduction, countries all over the world are competitively making investments in the development of low-carbon and high-efficiency terminals to predominate the markets. For the efforts in green port construction to achieve more concrete results through increased productivity and introduction of eco-friendly technologies, it is very important to accurately identify the current state of the greenhouse gas emission and to establish its reduction goals accordingly[1][2].

This study examined the method of estimating the carbon dioxide emission in ports. As such, it designed and suggested a system to estimate the emission. Specifically, to support the decision-making for low-carbon terminal construction, this study designed a system to estimate carbon dioxide emission that occurs according to the port equipment operational plan and in connection with the port operational simulation.

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2 The Current State of Carbon Emission Estimation System

In preceding researches on greenhouse gas estimation method in domestic ports, Kim H.S. et al (2008) classified the carbon dioxide in ports into diesel, heavy oil, LPG, steam, and electricity. They derived the calculation formula as classified into vessels, unloading equipment, and trucks[3]. Han, S.H. et al (2011) prepared a list of the emission sources and studied the emission estimation method based on unloading equipment to identify the current state of air pollutants in Incheon port facilities[4].

There was also a research suggesting a monitoring system that can manage carbon emission on real-time basis using IP-RFID technology to measure carbon emission from logistical equipment (container truck, unloading equipment, etc)[5]. It was an immediate and accurate emission monitoring method through direct measurement, which is unlike the existing indirect method of carbon emission management and measurement. Currently, however, most countries measure carbon emission using the indirect method as it is difficult to directly measure greenhouse gas emitted from port equipment and vehicles.

3 Carbon Emission Estimation Method

This study only estimated the CO2 emission, which has the highest quantity and attracts the highest public interest. This study also referred to the CO2 emission estimation formula suggested by Kim, H.S. and Cho, M.J. (2008)[3].

Depending on the CO2 emission sources, estimation targets can be classified into port equipment and vehicles. The work area can be classified into quay work, yard work, and transportation work. For quay work, a container crane is used and for yard work, T/C and Y/T are used. For transportation work, Y/T is generally used. In this study, CO2 emission is estimated according to fuel and electricity consumption, not taking in consideration the characteristics of the equipment. This study excluded vessels from the target of CO2 estimation as they are considered as fixed emission sources during operational simulation[1].

To increase productivity and construct a port automation system, the terminals establish various operational plans. However, it is costly and takes much time to manufacture the unloading equipment, as well as to directly attempt the operation at ports and analyze its result. As it is also very difficult to accurately measure carbon emission by directly reflecting the fuel combustion process, the simulation methods are used for efficient measurement.

4 Carbon Emission Estimation System

With regard to the results of port operation simulation experiment, information such as the kinds of port equipment, the number of equipment, moving distance, and the kinds of fuel is generated and the generated information on equipment operation is directly related with the carbon emission estimation. For that reason, this study

utilized the information of operation simulation modeling results to estimate carbon emission. For efficient port operation, this study designed a system that can estimate carbon emission by storing the information on each equipment operation that was generated through port operation simulation, as well as provide visualized carbon emission information, which should be considered as the environmental factor in deciding the port operation method.

As shown in Fig.1 below, the entire structure of the carbon emission estimation is composed of three modules and two DBs.

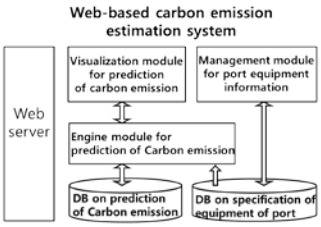

Fig. 1. Example of configuration for web-based carbon emission estimation system

The port equipment information module is a module used to manage the specification information of equipment operated in ports. To accurately estimate carbon emission, information from equipment operated in ports is inevitable. This module provides inquiry, correction, deletion, and entry functions for this information on equipment specifications. Moreover, it provides a user screen.

The carbon emission prediction engine module estimates carbon emission based on the result stored in the carbon emission prediction result DB. When the operation result of each equipment generated through the port-operation simulation experiment is stored in the carbon emission prediction result DB, this module generates carbon emission for each equipment, location, and time zone using the estimation formula, which is then delivered to the visualization module.

The visualization module expresses the carbon emission delivered through the engine module on a chart or table and after visualizing it, displays it for managers and Web users.

4.2 Operating Scenario

In the new terminal development plan or existing terminals, operational information on each equipment is stored through an operational simulation that is based on the operational plan information. Before the operational simulation starts its operation, the specification information of the equipment operated in a new or existing port is entered. The manager or user directly enters the specification information of the port equipment in the port equipment specification information entry screen. When such information of each equipment is used as the operating pattern, fuel and electricity consumption is stored in the prediction information DB as the result of an operation simulation experiment, the engine module estimates the carbon emission using the estimation formula and carbon emission coefficient. Also, the said module

subsequently delivers it to the visualization module. The visualization module statistically expresses the carbon emission generated from each kind of equipment, time zone, and location in the form of various graphs and charts through the Web.

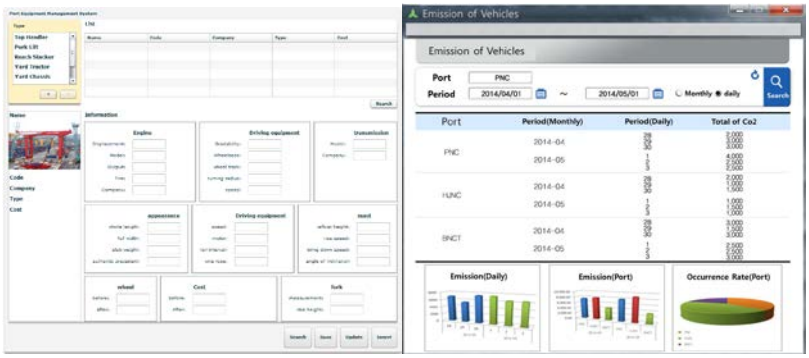

Fig. 2. Example of management system and user interface

5 Conclusion

This system can provide carbon emission information estimated by carbon emission coefficients after receiving each equipment operational information routed from the port operational simulation. This system can help in deciding an operational plan that can minimize carbon emission when establishing a plan for low-carbon port construction and new terminal development, as well as for existing terminals that are currently in operation. It can also be used for estimation and monitoring of carbon emission from the port equipment or port vehicles following their operational plan.

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