물流學碩士 學位論文

The Effects of Green Port Construction for Improving the Port Competitiveness

Supervisor Hwan-Seong Kim

August, 2011

Graduate School of Korea Maritime University

Department of Logistics

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Supervisor

Prof. Hwan-Seong Kim

By

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A thesis submitted in partial fulfillment of the requirements

for the degree of

Master of Logistics

Department of Logistics

Graduate School of Korea Maritime University

August, 2011

本 論文을 **Wang Liru** 의 物流學碩士 學位論文으로 認准함.

委員長 郭圭錫 ㊞

委　員 南奇燦 ㊞

委　員 金煥成 ㊞

2011 년 8 월

한국해양대학교 대학원

Acknowledgement

I sincerely would like to appreciate my supervisor Professor Kim Hwan-Seong. With his help and constant encouragement, whether study or daily life, I successfully complete my master course in Department of Logistics. His strict academic attitude and enthusiasm deeply impressed me, and helped me to archive success in research and study.

I am grateful to Professor Nam Ki-Chan, Logistics System and Transportation Planning; Professor Kwak Kyu-Seok, Port Logistics and Social Engineering; Professor Shin Jae-Yeong, Management Science and Logistics Information System. They all helped me immeasurably in detailing comments.

I also would like to thank to all the members of Logistic Automation Lab for giving me a helpful, active and comfortable environment: Ms. Jo Min-Ji, Mr. Tran Ngoc Hoang Son, Mr. Lim Chang-Won, Mr. Tran Xuan Thuong, Mr. Park U-Seok, Ms Lee Myung-Hwa.

I also would like to give special thanks to my parents for their love supporting me all the time, and Korean and Chinese friends for their friendliness, sharing, and confidence: Ms. Jeong Eun-Sil, Mr. Kim Jong-Hak, Mr. Lim Jin-Gang, Mr. Chen Chao, Mr Miao Yu, Ms Guan Xin, Ms. Tian Mingbo, and so on.

Korea Maritime University, Busan, Korea

June 30th, 2011

Wang Liru

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Abstract

According to increase the economy development, the global warming and the environment pollution are the greatest problems in the world. Since <Kyoto protocol> has been brought out in 1990, citizens pay more attention to climate change and environment protection. By the trend of environment protection, port department makes a great effort on green port construction against the pollution.

The aim of this study is concerns with the effects of Green Port construction for improving the port competitiveness. First of all, the definition of Green Port is described and its main characteristics are shown by using four classifications.

Second, the measure factors for Green Port construction is suggested by through the previous literature reviews and an evaluation model is designed.

To evaluate the Green Port construction, the questionary survey for Green Port specialists and port officers is achieved. And the effect factors for Green Port construction are obtained by using AHP(Analytic Hierarchy Process) method. Last, the relationship between Green Port construction and port competitiveness is verified by analyzing the effect factors. Thus, the port competitiveness would be improved by construction of Green Port.

항만경쟁력 강화를 위한 그린포트 구축효과 분석

Wang Liru

물류시스템공학과

한국해양대학교 대학원

국문초록

2009 년 세계 경제 위기 이후 회복세로 바뀜에 의해 항만산업의 물동량이 증가하고 선박의 대형화 및 신속화가 점차 가속화됨에 따라 항만 시장도 경쟁이 치열할 것으로 전망되어진다.

한편 교토의정서가 공식 발효됨에 따라 각국에서는 대기오염에 대한 관심이 증가되고 있으며 CO_2 배출량에 대한 감축 목표를 설정할 정도로 대기오염을 방지하는 자구책을 강구하고 있다. 이에 따라 항만에서도 그린포트로의 전환이 불가피한 실정이다.

따라서 본 연구에서는 그린포트구축 활동을 항만의 경쟁력관점에서 고찰하여 각 특징을 분석한다. 또한, 전문가의 설문조사를 행하고, 이에 대한

AHP 분석을 통하여 그린포트 구축 활동간의 우선순위를 도출하며, 구축결과가 항만의 경쟁력에 어떠한 영향을 미칠 것인지를 고찰한다.

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Chapter 1: Introduction

1.1 Research background and objective

The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change (UNFCCC). The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions to fight global warming. These amounts will be lower an average of five per cent based on 1990 levels over the five-year period 2008-2012. The protocol was initially adopted on 11 December 1997 in Japan, but entered into force on 16 February 2005. As of July 2010, 191 countries and states have signed and ratified the protocol.

After <Kyoto Protocol> has brought out in 1997, more and more people put their attention on environment pollution. Rapid development in industry department brings out air, water, soil, noise, and wildlife pollution and destruction. As the health development of economic, alleviating environmental pollution and restoring original ecology extremely necessary.

Focus on the long-term and future development in the port, many counties government and ports authorities pay attentions on Green Port construction.

In the short term, C40 World Ports Climate Conference draws up some adaptive plans among big cities and major ports. The plans include the incentives provided to green ship user, cooperation among the C40 member ports, encouragement to develop and utilize the Alternative Maritime Power and so on.

In EU, Green Port major policies is prohibition the ship utilization on fuel which sulfur content over 2% (after Jun.2010, the limitation of sulfur content is 1%). There are also Marco Polo I and Marco Polo II plans in EU. In Marco Polo I, Modal Shift Action, Catalyst Action and Common Learning Action are included from 2003 to 2006. And after 2007 in Marco II, Motorways of the Sea Action, Traffic Avoidance Actions and Rail Synergy are added.

In US, people pay more attention to developing the new technology for reducing CO_2 emission. Such as power generator and renewable resources and Northwest Ports Clean Air Strategy.

Compared with other departments, green policy in port department is explained as green maritime and green shipping. For example, super-eco ship building and Modal Shift promotion.

The same aim to Hong Kong Ports, AMP, E-RTG, hybrid truck, bio-diesel, recycling energy, CNG, LNG and development are in utilization.

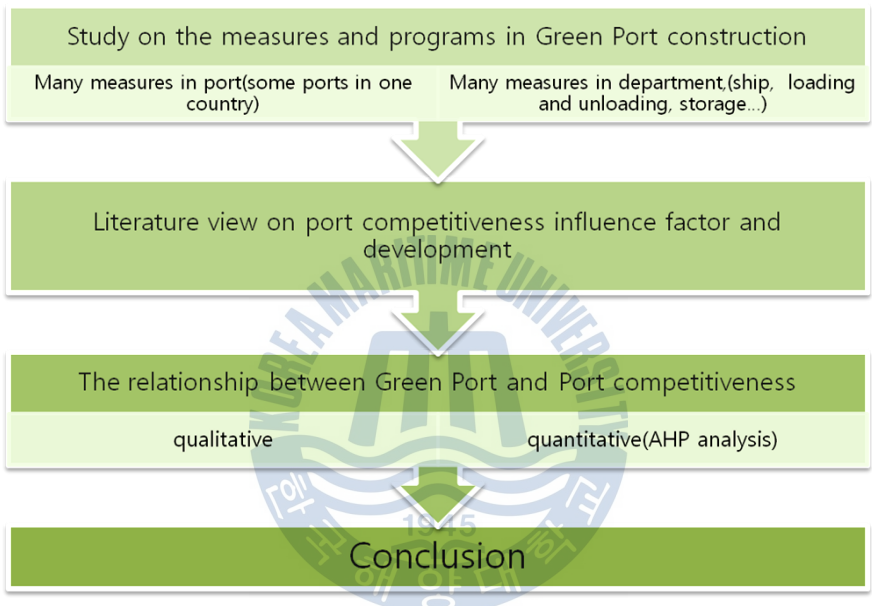
“Green Growth Policy” is the measure which brought out by the Korean government. Follow this strategy, Korean port authority also takes out the “Green Port building comprehensive plan”. Furthermore low carbon self-sufficiency port, the disaster safety port, eco-friendly port and resource recycling port are the understandings on the Korean “Green Growth Policy”.

As the port support policies being changed, port competitiveness factors are changed. Especially, the importance degree of each factor has been changed a lot. The purpose of this study is explaining the competitiveness effects changed which taking Green Port measures and programs port and give a better advice and suggestion to Green Port construction.

1.2 Scope and structure of research

The method to analysis the effects of Green Port construction for improving port competitiveness is AHP (Analytic Hierarchy Process).

And research process in this study is shown in <Figure 1.>



<Figure 1.> Research process

In chapter 1, research background and objective, research method and process are included. And chapter 2 introduces the Green Port construction background, definition, the Green Port construction situation in many countries and each department introduction in Green Port construction. The chapter 3 views the literature on port competitiveness and obtains the influence factors used in this study, trend and relationship between port competitiveness. The chapter 4 based

on the survey data and calculates each indicator importance degree by AHP method and analysis the result. Finally, in chapter 5, the conclusion summary the whole study by the result analysis.

Chapter 2: Green Port Construction Situation

2.1 Green Port Construction Background

As the United Nations Secretary General has said, the greatest challenge which we are facing is environmental regulators. It is a growing crisis with economic, health and safety, food production, security, and other dimensions.

The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions to fight global warming. These amount to an average of five percent bellow 1990 level over the five-year period 2008-2012.

The protocol was initially adopted on 11 December 1997 in Japan, but all of the member countries entered into force on16 February 2005. The Kyoto Protocol

was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. The detailed rules for the implementation of the Protocol were adopted at COP 7 in Marrakesh in 2001, and are called the “Marrakesh Accords.”

Follow the <Kyoto Protocol>, several "flexible mechanisms" are allowed. Such as emissions trading, the clean development mechanism (CDM) and joint implementation. The mechanisms allow Annex Ⅰ counties to meet their GHG emission limitations by purchasing GHG emission reductions credits from elsewhere, through financial exchanges, projects that reduce emissions in non-Annex Ⅰ countries or Annex Ⅰ countries with excess allowances. The mechanisms help stimulate green investment and help Parties meet their emission targets in a cost-effective way.

Therefore, many countries take action on reducing the GHG discharge emission. For example, increase the energy utilization efficiency; develop the solar power, wind energy, tidal energy and other clean energy in their industry. The details about objective of GHG emission reduction in main countries are displayed as the following <Table 1.>.

<Table 1.> Objective of CO_2 reduce in main countries

	Bench mark of Year	Objective (%)	Absolute quantity (%)	Remark
EU	1990	20~30	-20~-30	Norway, New Zealand 40% reducing.
USA	2005	17	-3	Passed by House of Representatives
Japan	1990	25	-25	On the premise of attention with China, India
Korea	2020 (BAU)	30	——	Discharge amount is up to 564million don in estimation
China	2005	40~50	60~150 (2005)	Each GDP
India	2005	20-25	——	With the developed countries participation
Russia	1990	25	-25	Be neutral country
Norway	1990	30~40	-30~-40	——
New Zealand	1990	10~20	-10~ -20	——
Austria	2000	5~25	-3~-11	——
Canada	2003	20	-3	——
Mexico	2002	50	——	With the developed countries participation
South Africa	2020 (BAU)	34	——	With the developed countries participation
Brazil	2020 (BAU)	36~39	-20 (2005)	——

(Korean Maritime Institute, 2009.5)

2.2 The Definition of Green Port

As the global warming affecting in the world, climate has been heavily changed, natural disaster frequently occurred, natural resources depletion and supply imbalance cause crisis to reach a high level. For the purpose of getting away from financial crisis and creating the new growth motivity, the counties in the world make more efforts on developing economic.

Because of the realization of this global climate and environment crisis, Korean government had brought out the “Green Growth Policy”. And it made the “Green Growth Policy” be embodied and law-governed, announced “Low Carbon Green Growth of the Basic Law”.

In order to coordinate with this policy and law, build up the “Green Growth”, everyone make their efforts and reach “Green Growth” in Korea each department. As a important industry department, port authority also take activity to match the national strategy of “Green Growth” and draw up the plan on “Green Port” construction.

However, there isn’t a clear definition about the Green Port. Korean Land, Transport and Maritime Ministry have explained the Green Port as follows: Green house gas Reducing, Energy Effciencing Nature-friendly Port. The explanation is very easy to understand, but from a professional point of view, it not very

comprehensive and concrete. So, we have to understand the concept in the Green Port Construction measures and programs. There are about 4 kind explanation and promotion programs in the Green Port. Respectively, the port which based on green technology and green business, creating new growth motive, improving living standards, jumping in the ranks of the advanced port.

<Figure 2.> Green Port appearance and basic definition

In the "Green Growth National Strategy Policy", there are 10 pieces of policy directions and 50 researches, each department should choose the appropriate one. Follow these researches, chose by port availability, especially, "Low Carbon

Self-sufficiency Port", "The Disaster Safety Port", "Eco-friendly Port" , "Resource Recycling Port" and in this study, Green Port construction is a plan on comprehensive and mix of 4kinds of Green Port Construction.

Table 2.2.1. Four Promotions for Green Port Construction

Promotion Program (Green Port type)	Activities
Low-Carbon Self-Sufficiency Port	* Eco-friendly inland transportation system building * New renewable resources power equipment utilization * AMP, LED utilization
The Disaster Safety Port	* Disaster Prevention environment infrastructure building * Disaster prediction and corresponding system utilization
Eco-Friendly Port	* Beauty the port by green park, planting and so on * Provide eco-friendly port building programs
Resource Recycling Port	* Port waste (silt, soil...) effectively recycling system * Establish resource recycling port paragon

As table.1 shown, each type of Green Port has a separate emphasis. Eco-friendly inland transportation system, which encourages utilizing rail, canal, barge clean system, reduces the truck application amount. AMP means Alternative Maritime Power supply system, replaces with ship power generation. The Green Port construction in most of counties is the low-carbon self-sufficiency

port. And in their construction maybe add a few other type promote director, like beauty the port by green park, planting and so on.

However, in this study, the Green Port concept is a comprehensive plan among 4 types, not a specialization system.

2.3 Green Port Construction Situation in major countries

After <Kyoto protocol> having brought out, each department began to take affords on the reducing the GHG (greenhouse gas) emission. In port department, the activities are embodied in the Green Port construction. In this study, many major ports in US, EU, Japan, and Korea are chose to explain for research.

2.3.1 US

① LA/LB Port:

In order to achieve to reduce marine pollutants standby and build clean port, LA/LB Port, standby resource ministry and environment protection ministry signed a 5year plan on clean standby action cooperation.

This promotion business plan set a set of marine pollutants standby emission limitation on the ship department from the statistics year 2006-2007 to 2010-2011, handling department, heavy duty equipment truck department and so on. Such as

in Green Port Technology construction department, measures and programs are shown in following Table.

Table.2.3.1 the details of LA/LB Port Green Port Promotion Programs

	Promotion Program
Heavy Equipment Truck/ Heavy Equipment	*Replace and Update Aging Facilities *Substitute Fuels and Clean Fuel Incentives *Budgetary for the Development of Substitute Fuels
Marine Vessels, Tugs	* Ship Speed Reduction within the Port * Electrical supply of parking in the Berth * Use low-sulfur fuel (supplementary motor)
Handling Equipment	
Air Quality Monitoring	* Measure ambient air pollution levels in the vicinity of the Port * Include a number of real-time air quality measurements

On the restrict situation of heavy equipment trucks and others, vessels must to be replaced and rebuilt in order to minimum the emission of NO_x. And the trucks which don't reach the regulate standard, do not allowed to get in the port. These regulations will help their owner to replace and update trucks, and also set up a replacement plan to 16,000 aging trucks, make the replace done by 2012. As foundation repaired, the cargo owner must to pay an addition tax about 20ft 35$, 40ft 79$.

In the maritime department, the speed reduction incentive took action in Jan.2005. When ship entry into the port boundary, speed must be reduced under 20 miles, 12kont. At the beginning, the effect of this plan is very clearly, so, the limitation may be raised to 40mile. And AMP (Alternative Maritime Power) is encouraged to be built and developed, as to ship use their engine and get GHG emission.

② New York- New Jersey Port

The New York- New Jersey Port Authority brought out environment policy on CO_2 emission reduction. The main concepts as following: first, reduce PX, SO_X 3% each year, and CO_2 5%. Second, ship must utilize sulfur-low fuel as a obligation. Third, AMP is provided. Forth, modern the unloading and loading equipment must be built. Fifth, promote trucks replacement. Sixth, reform the ship engine. Seventh, invent 9 billion dollars in the following 10 years. Eighth, invent to all hybrid equipment (325). Ninth, install the hybrid truck in AMPT and NYCT.

③ Seattle Port

In Seattle Port, Air Environment Maritime Improvement plan has been accepted in 2005. The plan includes, first, set up Puget Sound Maritime Air Forum and make one AMP provide services for two tour ships; second, change the diesel hybrid equipment into electric utilization. Third, use bio-diesel and diesel catalyst, and reduce the emission. Forth, emphasize the standard and plan of truck, minimum the idling time.

Seattle Port, Tacoma Port and Vancouver made a assignment and promote "Northwest Ports Clean Air Strategy".

④ Auckland Port

Auckland Port, set up the aging replacement plan in 2008, and invent 20 milion dollars, gas emission should reach the level. And cargo transport system in port hinterland, port authority and Air environment management committee make cooperation and give an incentive to truck which use new clean technology.

Table.2.3.2 Short term and Long term Green Port Plans in Auckland Port.

		Shipping outside port boundary	Unloading and loading equipment	railway	truck	Port selection
Short-term (2010)	Reduction objective	* when supplementary engine start in the ship parking, utilize the fuel of sulfur content under 0.5%, reduce PM emission. * when main engine start in the ship parking, utilize the fuel of sulfur content under 0.5%, reduce PM emission.	use super sulfur-low diesel or eco-diesel, reduce PM emission	Smart Way (Seattle, Tacoma Port)	reduce PM emission,and by 1994 level	
	programs	* substitute fuel and use the clean fuel * reform the engine and port-processing equipment. * incentive * ship speed reduction incentive	*track and energy efficient modernize * Exhaust gas treatment device settings *set a level on super sulfur-low diesel or eco-diesel and research on renewable energy technology	*transform the clean engine and post-processing equipment * use super sulfur-low diesel or eco-diesel *idling time control system education	*modern truck utilization *install DPF and DOC * Web-based reservation system and the active use of the Paper gate RFIDimplementation * Using web-based reservation system	* use super sulfur-low diesel or eco-diesel *changes in the fuel * hybrid utilization in the pilot
Long term (2015)	Reduction objective	* in order to reduce 80% of NO_X emission, use content of 0.1%sulfur-low fuel.	* by the Tier4, reduce 80% of unloading and loading equipments. * purchase new equipment by the regulations	compliance EPA 2007 with new regulations	heavy truck 80% follow the2007 PM level. (100%take action by 2017)	
	programs	* AMP * post-processing equipment. * eco-friendly ship development	*reform unloading and loading equipment *hybrid or electrical power unloading and loading equipment utilization *terminal optimal design	* electrical power unloading and loading equipment utilization *development and utilization on idling time control system	* truck license program implementation *electrical and hybrid utilization * RFID technology utilization in the terminal	*AMP *reform the engine

2.3.2 EU

Rotterdam Port

As the biggest Port in EU, Rotterdam Port takes more affords in reducing the CO_2 emission. Main programs are low carbon footprint, AMP and so on. The limitation of CO_2 emission reduces down 50% of 1990, by 2025.

In July 2008, the authority of Rotterdam port gave international cooperation with other ports an extra boost by organizing the World Ports Climate Conference. During this conference, the authority of Rotterdam discussed possible ways in which ports and business could reduce air pollution and CO_2 emissions. The proposals the authority of Rotterdam was set out in a declaration, which was supported by all 55 port cities attending the conference. The conference resulted in five projects to improve air quality and reduce CO_2 emissions. The authority of Rotterdam is behind the project to further elaborate an Environmental Ship Index.

The Rotterdam Climate Initiative is a joint venture with the municipality of Rotterdam, DCMR Environmental Protection Agency Rijnmond and Deltalinqs. Common goal is to halve CO_2 emissions in the region by 2025 in comparison with 1990 levels. In connection with the Rotterdam Climate Initiative, the port works on (together with DCMR and others) creating an infrastructure for the capture,

transport and storage of CO_2. A business case presented in the summer of 2008 is now being elaborated into a business plan. The business case concludes that Rotterdam can begin in 2015 with the capture, transport and underground storage of five million tons of CO_2 per annum. This means that the basic infrastructure will then be in place for further growth in capture and storage to twenty million tons in 2025

In 2008, a start was made on the development of a sustainability index for activities relating to the P for Planet (environment). In 2009, it will further expand the index to cover the P for People and the P for Profit. In the first phase of the sustainability index, CO_2 footprint, sustainable purchasing, sustainable building and sustainable land allocation will be covered.

2.3.3 Japan

① Tacoma Port

In the Tacoma Port, there are some programs on protecting the air, water, and soil environment.

In the air protection department, “Northwest Ports Clean Air Strategy”, “Green Gateway for Trade” and “Truck Program” had brought out to against air pollution. The concepts include: using ultra-low sulfur diesel, bio-diesel and other cleaner-burning fuels in cargo-handling equipment; using low-sulfur distillate

fuels at berth; adding “green design” environmental features to ships, including diesel-electric motors that save up to 30 percent in fuel and significantly reduce emissions; setting targets to change older, less-efficient truck engines; installing anti-idling devices on rail-switching engines, as well as partnering on other innovative technological advance.

The Port of Tacoma’s four dockside rail yards move cargo quickly and efficiently from container terminals. They also reduce the number of trucks on city streets and highways. Each full train that leaves the Port represents 250 to 300 trucks not on our roads, reducing roadway congestion and diesel emissions. The lowest emission route to ship cargo from Asia to the U.S. Midwest is through the Puget Sound, according to the results of a study by Herbert Engineering released in May 2009.

And in the land protection program, there are successful clean projects, open spaces and future habitat restoration. In 2007, the Port purchased about 70 acres of open space known as Julia’s Gulch and Storey Pit, located between the Tideflats and residential Northeast Tacoma. Monitor water quality system is in utilization in the water department in Tacoma Port.

② Tokyo Port:

In the Tokyo Port, Green Port programs are almost similar with Tacoma Port, e-RTGC (Rubber Tired Gantry Crane), the barge between Tokyo and Yocohama,

which shorten international maritime container cargo transportation land distance, super eco-shipbuilding technology dissemination and promotion, green business certification operation and shippers and logistics companies support cooperation

③ Osaka Port and Hakata Port

AMP, electrical power equipment and solar power equipment are in utilization in Osaka Port. E-RTGC and solar power of refrigerated container are in utilization in the Hakata Port.

2.3.4 Korea

In Busan Port, a set of Green Port took implementation such as LNG truck, E-RTGC equipment utilization, eco-friendly transport means conversion (rail, canal, barge) and GHG emission reduction obligation Table2.3.3

<Table 2.3.3> Summary of the Main Port of Green Port Measures.

COUNTRY	PORT	MEASURES
US	LA/LB Port	Green flag, AMP, discharge gas reduction obligation, recommends use of alternative fuels and clean fuel, funding for the development of alternative fuels, facilities by new engine development instead of NOx emissions, green truck program (reduce:70%-80%), low-sulfur fuel utilization, restore and revitalize the Los Cerritos Wetlands.
	New York Port	AMP, modernized facilities utilization, high speed hybrid yard
	Auckland Port	Incentives on the new cleaning technology, containers transportation system
	Seattle Port	AMP, green ship membership , Tier 4 level , reducing PM by 1994 level , Smart Way program, Northwest Ports Clean Air Strategy
EU	Rotterdam Port	Clean engine (barge), green ship membership, carbon footprint calculation, cruise ship which under port authority change to use low-sulfur fuel, low emission engine development and utilization, Green Award, AMP, ship recycling incentives.
Japan	Tokyo Port	RTGC (Rubber Tired Gantry Crane), apply for the barge between Tokyo and Yocohama, shorten international maritime container cargo transportation land distance, super eco-shipbuilding technology dissemination and promotion, green business certification operation, shippers and logistics companies support cooperation
	Osaka Port	AMP, electrical power equipment, solar power equipment
	Hakata Port	E-RTGC, solar power utilization in refrigerated container
Korea	Busan Port	LNG truck, E-RTGC, eco-friendly transport means conversion (rail, canal, barge), GHG emission reduction obligation.

2.4 Green Port Indicators Research

As the previous section list shown, Green Port measures and programs are substantially the same.

When a ship entry in the port boundary from voyage, many ports give a incentive on shifting and utilizing sulfur-low fuel, and reducing the speed under 20 miles; when the ship berth in the port, the alternative maritime power are provided, which replace its power generation.

Next, in the cargo unloading and loading department, the same with above, utilization of sulfur-low fuel and electrical equipment are promoted, and eco-driving education to driver is necessary: what speed is fuel fully burning and emission minimum point.

In the cargo transport department, in other words, truck department, the replacement on aging trucks is popular in many ports, aging trucks are prohibited close to port, at the same time, an incentive or support function are provided on aging replacement. The automated equipments are recommended to utilize in the Green Port like hybrid yard tractor. And a perfect plan on truck running also could reduce the idling time and against the emission of CO_2.

The details reference the following Table 2.4.1

Table.2.4.1 Green Port measures in port each department

		Emission reduction programs
Ship department	Shipping in the port boundary	*Obligation on the utilization of sulfur-low fuel *Reform ship engine and utilize hybrid *Speed reduce in the port entrance(a off-shore fee incentive)
	Off-shore	*AMP *Shift utilization system of clean fuel
Unloading and loading department		* Obligation on the utilization of sulfur-low fuel * Replace electrical equipment * Eco-driving
Truck department		*Hybrid yard tractor utilization *Promote aging truck replacement. *Minimum the idling time
Others		*LED light in the Port *Develop renew and recycle resource energy.

The Green Port measures in this study are e-RTGC, AMP, AGV, Green Ship certification system, incentives on the new clean technology, Green Flag(speed reduction incentive),eco-friendly transport means conversion, joint distribution, the cost on account of CO_2 emission, CO_2 emission reduction polities and beautiful environment construction in inner harbors.

The details and definition on each Green Port measure and the relationship with Port Competitiveness will be expressed in next chapter.

Chapter 3: The Relationship between Port Competitiveness and Green Port Construction

3.1 Port Competitiveness Literature Review

Although past studies on port selection models have focused on port selection made by port facilities, port services, port rates and charge and location.

Murphy made a survey between 534 shipping companies and port authorities in 1989 and between 1850 shipping companies and port authorities in 1992.

Comparing with other papers, Murphy's got a survey among more widely objects. In his paper, port selection(port competitiveness) was seen to affected by facilities situation, appropriate pilotage, max ship entrance probability, the

capability of handling non-regular cargos, whether to provide information of ship nationality or not, and port services level.

In French model (1979), there are two factors affecting the port selection (port competitiveness), endogenous factor and exogenous factor. In endogenous factors, there are adequacy and physical plant condition of terminal facilities, terminal rate and charges, frequency and geographic coverage of ship and freight services, the capacity of connecting to inland rails or transport net and the services provides for the shipping or logistics. And exogenous factors included the size and economic capacity of hinterland as a source exports or market for imports, national economic situation, trade policy and support established by government, the situation at home and abroad.

The same as French's paper, in Pater's paper, in 1990, there are endogenous and exogenous factors too. In endogenous, there are the services provides for the shipping or logistics, capacity of terminal facilities, situation and condition of facilities, operation strategies established by port authority, convenience to utilize. And the political situation at home and abroad, social change, economic factor, stabilized labor and capital. However, in 2004, there is a tremendous change in Peter's new paper. There are four parts, multi-modal process, interface, transport modes, infrastructure. Multi-model Process part, includes ship entrance rapid speed and accuracy, shipper and shipping companies reactive, operation flexibility. Interface, includes labor power, information technology and so on. And there are

ship, calls frequency and amount of fleet factors in the transport modes part. In the infrastructure part includes port facility, equipments and so on.

Port facilities, rates and charges, services, inland situation and social circumstance factors affect the port selection and competitiveness a lot from the research until 1992 by Murphy. And in Lirn and Pater research 2003-2004, the new and detail factors are shown to us.

We can clearly see the contents in next table.

Table 3.1.1 Prevention literature research results

	Influence factors
French (1979)	Endogenous: port facilities, port rate and charges, calls frequency, port services, port connection with inland. Exogenous: economic size of hinterland, national economic situation, trade policy, home and abroad situation
Willingale (1982)	voyage distance, economy size, entrance to port and route, port facilities, max ship entrance probability, port operation, rates and charges, port authority, scale of port.
Slack (1985)	cost of inland transportation, port proximity, ship demurrage, multi-transport.
Peter (1990)	Endogenous: port facilities, condition of facilities, operation strategies, convenience to utilize. Exogenous: political situation, social change, economic factor, stabilized labor and capital
UNCTAD (1992)	port facilities, services, location, level of financial industry, information communication system, social circumstances, economic stability.
Murphy (1992)	facilities situation, appropriate pilotage, max ship entrance probability, the capability of handling non-regular cargos, whether to provide information of ship nationality or not, port services level
Lirn (2003-2004)	physical and technologic facilities, geopolitical location, port operation and management, shipping and terminal cost.
Peter (2004)	Multi-modal Process; ship entrance rapid speed and accuracy, shipper and shipping companies reactive, operation flexibility. Interface: labor and capital. Transport modes: ship, calls frequency and amount of fleet factors

And, there are many experts and scholars research for the influence factors to port selection and competitiveness in Korea. The specific content follows table5.

Table 3.1.2 Literature research in Korean academia

	Influence factors
Jeon Il-su (1992)	location, facilities, charges service level (EDI), terminal operation, port authority.
Lee Seok-taek & Lee Cheol-yeong (1993)	location, facilities, throughput, charges, service, operation situation.
Kim Hak-so (1993)	export: shipping amount of annual, cost of each ton of cargo, marine transport distance, inland transport cost of each km of cargo, loading time. import: marine transport distance, inland transport cost of each km of cargo, amount of liner ship,
Yeo Gi-tae (1996)	location, facilities, throughput, charge, service, operation situation
Ha Dong-u & Kim Su-yeop (1998)	location, facilities, service level, logistics charges, environment of logistics service
Yeo Gi-tae (1999)	location, facilities, throughput, charges, service.
Jeong Tae-won & Kwak Gyu-seok (2001)	throughput, quay length, yard area, GNP
Kum Jong-su (2001)	distance between port and cargo site, terminal facilities service, the capacity of multi-transport, capacity of cargo handling, administrative service, rates and charges of inland transport, congestion
Yeo Gi-tae (2002)	location, throughput, facilities, service level
Kim Jin-gu (2002)	port facilities, location, cargo amount, rates and charges, services.

Jang Yeong-tae (2005)	voyage: degree to attract cargo, cargo handling cost, amount of handling cargo, connection to inland, service reliability, location, berth availability, quay length, feeder network, depth, transshipment volumes, cargo security, profitability. offing: degree to attract cargo, berth availability, cargo handling cost, transshipment volumes,
Han Cheol-hwan (2005)	cargo handling amount, port facilities, location, rates and charges, level of service.
Heo Yun-su (2005)	port facilities, rates and charges, services, marketing, geopolitics location, economic and social circumstance.
Kim Geun-seop (2007)	port services, facilities, cargo handling amount, location, cost, productivity factor, global factor,
Oh Ga-yeong (2008)	rates and charges, services, port characteristics

Many experts and scholars make a research on port selection and competitiveness recently. But the factors selection criteria are difference. Nevertheless, the main factors are facilities, services, cost and so on.

Therefore, port competitiveness factors which chose in this study are port facilities, port services, port rates and charges, and social circumstance.

However, the main factors are not the whole factors any more, more and more detail factors and characteristic factors appearance. Port selection and competitiveness factors have changed. And the development content is introduced in next part.

3.2 Port Competitiveness Development Tree

As mentioned above, port facilities, port rates and charges, and port location are the basic factors in the port selection and competitiveness.

From the following table, we can discover that, first one, facilities, rates and charges and location are the most important factor in port selection and competitiveness; second one, the importance of social circumstance turns larger; inland connection is necessary all the time.

Table 3.2.1 Main factor in the Pretentious Research

	port facilities	rates and charges	inland connection	social circumstance	location
French (1979)	√	√	√		
Wiliingale (1982)	√	√			
Slack (1985)			√		
Pater (1990)	√			√	
UNCTAD (1992)	√			√	√
Murphy(1992)	√				
Jeon Il-su (1992)	√	√			√
Lee Seok-taek & Lee Cheol-yeong (1993)	√	√			√
Kim Hak-so (1993)		√	√		√
Yeo Gi-tae(1996)	√	√			√
Ha Dong-u & Kim Su-yeop (1998)	√				√
Yeo Gi-tae(1998)	√	√			√
Jeong Tae-won & Kwak Gyu-seok (2001)				√	
Kum Jong-su (2001)	√	√	√	√	
Kim Jin-gu(2002)	√	√			√
Yeo Gi-tae(2002)	√				√
Lirn(2003-2004)	√	√			√
Pater(2004)				√	
Jang Yeong-tae (2005)		√	√		√
Han Cheol-hwan (2005)	√	√			√
Heo Yun-su (2005)	√	√		√	√
Kim Geun-seop (2007)	√	√		√	√
Oh Ga-yeong (2008)		√			

3.3 The Relationship between Port Competitiveness and Green Port Construction

Following the research above, Port facilities, rates and charges, inland connection and social circumstance are chose in this study port selection and competitiveness department.

e-RTGC: Electric rubber tired gantry crane is a mobile gantry crane used for stacking intermodal containers within the stacking areas of a container terminal. e-RTGC are used at container terminals and container storage yards to straddling multiple lanes of rail/road and container storage, or when maximum storage density in the container stack is desired.

AMP: is shorted for Alternative Marine Power and It's a facility which provides the electric system in the land for ship which entry in the port. The facility can reduce emissions which ship get entrance in the port.

AGV: is a mobile robot that follows markers or wires in the floor, or uses vision or lasers. They are most often used in industrial applications to move materials around a manufacturing facility or a warehouse. Automatic Guided Vehicle systems work around-the-clock making continuous flow and just-in-time delivery easier to achieve. Application of the automatic guided vehicle has broade

ned during the late 20th century and they are no longer restricted to industrial environments.

The e-RTGC, AMP and AGV are the new clean facilities and equipments in the Green Port, they don't reduce the efficiency of handling cargo, and they also reduce the CO_2 emission account.

Green ship certification system: if a ship utilizes clean and CO_2 emission reduction technology on the ship building, adds equipment and management and son on, certification would be received. And the port authority gives some incentive and preferential treatment among 45 ports. Such as, a better schedule is provided for green membership ship, priority in handing cargo and discount on entrance fee.

Incentives on the new cleaning technology: There are two expressions about this measure: one is that the port authority give a incentive to ship which have a great utilization on the new cleaning technology; and the other one is that environment provide many incentives to the authority which utilize the new cleaning technology in the port, such as LED street lamp, solar power cranes.

Green flag: The Green Flag incentive program was set up to encourage ships to slow down in order to improve air quality. The Green Flag program provides approximately $2 million a year in discounts for vessel operators who slow their ships to 12 knots (22km/h) or less within 20miles (32km) of the harbor.

According to the Port, the Green Flag program reduced air pollution by 600tons in 2007 and is expected to do better in 2008.

All of Green ship certification system, incentives on the new cleaning technology and Green Flag are incentives provided for users of port, and aimed at reduce port rates and charges. So, the 3 measures belong to affect port rates and charges.

Eco-friendly transport means conversion: Eco-friendly means of transport are much accounted of green port, for example, railway, discharge less GHG emission than truck, barge, with a clean engine among the river and inshore, canal.

Joint distribution: joint distribution is a collaborative system which port provides among many logistics companies. It can make the cargo handling speed rapidly and reduce cargo storage time for CO_2 emission reducing, such as refrigerated container. In an addition, it also makes the logistics companies' transport more efficient.

Cost on amount of CO_2 emission: differenced from other port, the cost on amount of CO_2 is included in the port cost. The cost aims to reduce the CO_2 emission directly

CO_2 emission reduction policies: compared with other traditional port, Green Port gives more cost discount and incentives, but in an addition, there are many policies on CO_2 emission restriction. Such as aging trucks restrictions in inland transport department, ship entry speed reduced and fuel changed in the ship

department and so on. Whether these restriction policies constrain port development or not and the degree of these policies constrain port development will be explain by the AHP results.

Beautiful environment construction in inner harbors: some ports in the western countries are opened as a travel place for visitors, so as to change the polluted impress and raise the position in our heart.

Cost on amount of CO_2 emission, CO_2 emission reduction policies and beautiful environment construction in inner harbors can affect the social circumstance factor. Whether these measures can or not improve the social circumstance and port competitiveness, we have to see the next calculation and results.

Chapter 4: The Green Port Competitiveness Analysis

4.1 The Green Port Competitiveness Model by AHP

The AHP is one multi-criteria decision making method, which has been extensively applied to a variety of decision-making situations. The multi-criteria techniques are considered to be a promising framework for evaluation of decision-making factors since they have the potential to take into account conflicting, multidimensional, incommensurable and uncertain effects of decisions explicitly.

In order to apply the AHP method, a hierarchical decision schema was constructed by decomposing the decision problem into its decision elements.

After that, the importance or preferences of the decision elements are examined in a pair-wise comparison to the elements in the hierarchy. The parameters are estimated using pair-wise comparisons between the importance of the attribute or decision element in the function using data made by each responder. Making comparisons is a question of which of the two attributes is more import as well as how much more important.

Follow these theories, the Green Port Competitiveness Model choose factors as follow: in port competitiveness factors part, there are port facilities, port rates and charges, inland connection, social circumstance; in Green Port construction part, there are e-RTGC, AMP, AGV, green ship certification system , green flag, incentives on the new cleaning technology, ,eco-friendly transport means conversion, joint distribution, CO_2 emission reduction policies, cost on amount of CO_2 emission, beautiful environment construction in inner harbors.

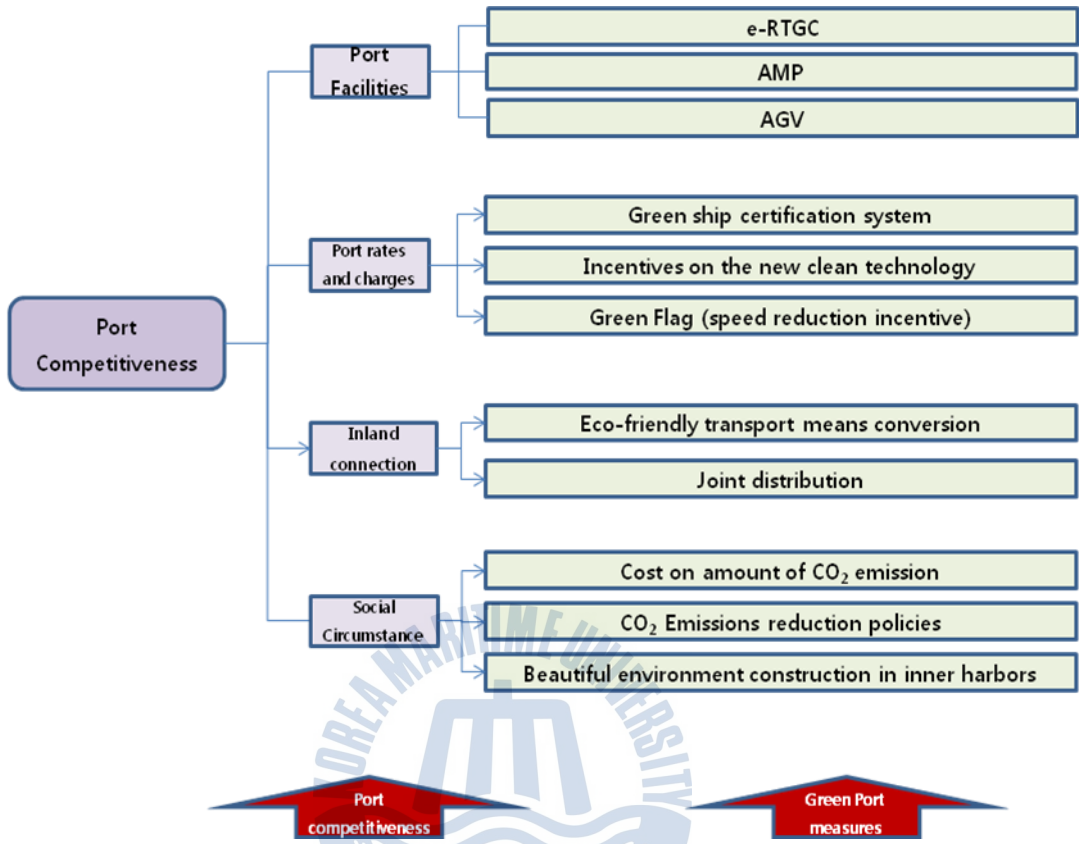


Figure 4.1 Green Port Competitiveness AHP model.

Follow the Green Port Competitiveness AHP as shown, we set a questionnaire survey to many experts, scholars working in logistics system area. And we got 15 ones, and 14 ones results are believable and integrated.

4.2 Green Port Competitiveness Analysis

The key to construction of the factors which affects the port competitiveness is to determine the conceptual model. The selection of the factors directly affects the evaluation of the result. In order to ensure the accuracy, objectivity and practicality of evaluation results, the following basic principles must be followed when selecting factors: systematic principles, the principle of universal comparability, practical principle and goal-oriented principle. In view of the foregoing, the competitiveness which affected by Green Port construction model is made. The analysis follows established principles of port competitiveness evaluation taking into account the characteristics and functions of the port as well as port facilities, port services, port rates and charges, ship entrance, inland connection, social circumstances and so on.

(1) Port facilities:

e-RTGC U_{11}, AMP U_{12}, AGV U_{13}.

(2) Port rates and charges:

Green ship certification system U_{21}, Incentives on the new clean technology U_{22}, Green Flag (speed reduction incentive) U_{23} .

(3) Inland connection:

Eco-friendly means of transport U_{31}, Joint distribution U_{32}.

(4) Social circumstances:

Cost on amount of CO_2 emission U_{41}, CO_2 emission reduction policies U_{42}, Beautiful environment construction in inner harbors U_{43}.

Table. 4.2.1 Details of Level I and Level II values.

Level I indicators	Symbol	Level II indicators	Symbol
Port facilities	A_1	e-RTGC	U_{11}
		AMP	U_{12}
		AGV	U_{13}
Port rates and charges	A_2	Green ship certification system	U_{21}
		Incentives on the new clean technology	U_{22}
		Green Flag (speed reduction incentive)	U_{23}
Inland connection	A_3	Eco-friendly means of transport	U_{31}
		Joint distribution	U_{32}
Social circumstances	A_4	Cost on amount of CO_2 emission	U_{41}
		CO_2 emissions reduction policies	U_{42}
		Beautiful environment construction in inner harbors	U_{43}

I. Determination of level I indicator weights

As the ports competitiveness evaluation indicators at this level are complex, and the elements are not easily quantified. AHP is adopted to determine the indicator weights, with the basic steps as follows:

(1) Establish a comparative judgment matrix. The comparative judgment matrix is obtained through comparing contributed proportion of multiple indicators to the overall target by the judgment scale, wherein, the fuzzy judgment number introduced is 1, 3, 5, 7 and 9, and the reciprocal of such number indicates the important degree of one element relatively to another. The results are shown in next table.

Table .4.2.2 Comparison matrix of level I indicators

	$\mathbf{A_1}$	$\mathbf{A_2}$	$\mathbf{A_3}$	$\mathbf{A_4}$
$\mathbf{A_1}$	1	1/5	1/3	3
$\mathbf{A_2}$	5	1	3	7
$\mathbf{A_3}$	3	1/3	1	5
$\mathbf{A_4}$	1/3	1/7	1/5	1

(2) Calculate the characteristic vector of the comparative judgment matrix, which refers to the weighted vector of the indicator. The writer adopts

the geometric method to calculate the characteristic vector. The calculated result is as follows:

$\omega=(0.12, 0.560, 0.26, 0.06)^T$, $\lambda_{max}=4.18$. It can be obtained from the table, R.I=0.9. Wherein, ω is the characteristic vector corresponding to the maximum characteristic value λ_{max} of the comparative judgment matrix, namely the weighted vector of the indicator; R.I is the average consistency indicator, as shown in following table.

Table.4.2.3. Average random consistency indicator R.I

Matrix Order	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
R.I	0	0	0.58	0.9	1.12	1.24	1.32	1.41
Matrix Order	9	10	11	12	13	14	15	
R.I	1.45	1.49	1.52	1.54	1.56	1.58	1.59	

(3) Conduct consistency check on the comparative judgment matrix. Adopt the random consistency proportion C.R to judge the consistency of the comparative judgment matrix. According to $C.I= (\lambda_{max} -n)/(n-1)$ and C.R=C.I/R.I, it can be obtained through calculation: C.R=0.07<0.1. Thus, this comparative judgment matrix has a satisfactory consistency, and the indicator weight coefficient calculated through this matrix is acceptable.

II. Determination of level II indicator weights

The data at this level are the details of level Ⅰ indicator. The judgment matrix obtained through comparing multiple sub-indicators under Level Ⅰ indicators is adopted to determine the weights of sub-indicators under each indicator one by one. The specific steps are as follows:

(1) The experts score the weights within the given range. To determine the weights of several small indicators under the same big indicator, it is supposed that the score of small indicator k under the indicator j made by the expert i is X_{ijk}, wherein , i=1,2,...,n, n is the total number of experts; j=1,2,...,m, m is the total number of Level Ⅱ indicator; κ =1,2,..,O_j, O_j is the number of small indicators under the big indicator j. ijκ IJK LRC l I j k

(2) The credit rating of the expert i is l; l =1, 2, 3. l =1 indicates this expert is quite familiar with the evaluated contents; l =2 indicator this expert is

with the evaluated contents; l =3 indicates this expert is not quite familiar with the evaluated contents. y_{i1} is the=0.8, y_i2 =0.5 and y_{i3}=1.

(3) The comprehensive evaluation score of small indicator l under the indicator j is as follows:

$$X_{jl} = \overline{X_{jl}} / \sum_{j=1}^{m} \overline{X_{jl}}$$

$$l = 1,2,\ldots,O_j, j = 1,2,\ldots m$$

(4) The formula for normalization processing of indicator weights is as follows, and the absolute weight of the indicator set is marked as $q=(q_1,q_2,\ldots,q_{11})$,

$$\overline{X} = \sum_{i=1}^{n} X_{ijl}\, y_{ik} / \sum_{i=1}^{n} y_{ik},$$

$$l = 1,2,\ldots,O_j = 1,2,\ldots,m$$

(5) Because of the same justification and principle, we don't give the detail about the calculation. The same with the level Ⅰ calculation, we manipulation data one by one, and get 14 results. And obtain the average

results by weighted average method. The results detail as Table for the final weights of Level-Ⅱ evaluation indicators.

Above the calculation process and method are just one of data from the questionable surveys. In this study, the final results are got from the weighted average by the results of each questionable survey.

The final results are shown as Table.4.2.4

Table.4.2.4. Indicator weights table of indicator system.

Level I indicators	Weight	Level Ⅱ indicators	Relative weight	Absolute weight	Importance percentage
Port Facilities A_1	0.2735	e-RTGC U_{11}	0.5506	0.1506	15.06%
		AMP U_{12}	0.1648	0.0451	4.51%
		AGV U_{13}	0.2826	0.0773	7.73%
Port Rates and Charges A_2	0.2902	Green ship certification system U_{21}	0.4724	0.1371	13.71%
		Incentives on the new clean technology U_{22}	0.2871	0.0833	8.33%
		Green Flag (speed reduction incentive)U_{23}	0.2405	0.0698	6.98%
Inland connection A_3	0.2865	Eco-friendly means of transport U_{31}	0.5942	0.1702	17.02%
		Joint distribution U_{32}	0.4058	0.1163	11.63%
Social environmentA_4	0.0863	Cost on amount of CO_2 emission U_{41}	0.3698	0.0319	3.19%
		CO_2 emissions reduction policies U_{42}	0.2273	0.0196	1.96%
		Beautiful environment construction in inner harbors U_{43}	0.4029	0.0348	3.48%

III. Case study

In the questionable survey, we also got the mark of Green Port measures evaluation value of many main ports, such as, Singapore Port, Shanghai Port, Hongkong Port, Busan Port, LA/LB Port, Rotterdam Port and Yocohama Port. The highest mark is 5, and lowest one is 1.

Table.4.2.5 Evaluation value of many main ports

	Singapore Port	Shanghai Port	Hongkong Port	Busan Port	LA/LB Port	Rotterdam Port	Yocohama Port
Port facilities	3.8000	3.6000	3.4000	3.8182	3.8000	4.2000	3.2000
Port rates and charges	3.2000	3.6000	3.1000	3.5455	3.2000	3.9000	3.3000
Inland connection	3.9000	3.4545	3.5000	2.9091	3.5000	4.5000	3.6000
Social circumstance	4.2000	3.2727	4.1000	3.2000	3.8000	4.2727	3.6000

With the Green Port and Port competitiveness indicator weights results, these ports got the final evaluation value.

Table.4.2.6 Final evaluation value on main ports Green Port measures and competitiveness

Rotterdam Port	Singapore Port	LA/LB Port	Shanghai Port	Hongkong Port	Busan Port	Yocohama Port
3.94	**3.45**	**3.30**	**3.30**	**3.19**	**3.18**	**3.17**

4.3 Results Analysis

From the results table, we can obtain the many results as following:

① The main Green Port measures which are more important to improve port competitiveness are Eco-friendly means of transport, e-RTGC and Green ship certification system; the indicator weights are 0.1702, 0.1506, and 0.1371 among the 11 indicators.

② In the Green Port construction, Cost on amount of CO_2 emission and CO_2 emissions reduction policies are the restrictions indicators, but the weight of two indicators are not big, 0.0319 and 0.0196. So, effect on Green Port construction to port competitiveness does have the weaken capacity but not clearly, strengthen more clearly. Thus, Green Port construction really could improve the port competitiveness.

③ In the case study, traditional ports Rotterdam and Singapore Port give us better examples on Green Port construction, especially, Rotterdam Port.

④ Hongkong, Busan and Yocohama Port all got a lower evaluation value. But, in detail, Hongkong and Yocohama Port got a lower on the port facilities and rates and charges; Busan Port got a higher on the port facilities and rates and charges, but a lower on the inland connection and social circumstance.

⑤ Shanghai Port doesn't have Particular strength factors, but the comprehensive strength is not bad, the same as LA/LB Port.

Chapter 5: Conclusion

In this thesis, the effects of Green Port construction for improving the port competitiveness have been studied. Under the definition of Green Port, the characteristics of Green Port and its effects has been shown by analysing the AHP method which based on the questionary survey for Green Port specialists and port officers.

Follow the results of analysis on Green Port competitiveness AHP model, Eco-friendly means of transport, e-RTGC and Green ship certification system is better for Green Port Construction, welcome for shipping companies and citizens who live around the port. And in the analysis of Port competitiveness factors, port rates and charges always affects port competitiveness a lot. As a trend, inland connection factor abstracts more attention of shipping companies.

On the trend of port department, each port should take a activity to adjust strategy for improving its competitiveness. Such as, in the main ports evaluation, Busan port get a high value on port rates and charges and port facilities, but as a lower value on inland connection factor, the final value is not as well as we look forward. In the evaluation of Singapore Port, through it gets a lower value on rates and charges, higher value on inland connection and social circumstance causes the final value are better. So, the Green Port Construction may be a trend in port department.

In the results of this thesis, Eco-friendly means of transport, e-RTGC and Green ship certification system are better solutions for Green Port Construction. And especially it can be verified that the port rates and charges always affects port competitiveness. Futhermore, the investment for Green Port construction and its effects have to be verified in the future.

References

1. Hoyle, B. S. and Smith, J., 1992, Transport and Development. In: *Modern transport geography*, edited by B. S. Hoyle, R. D. Knowles (London: Belhaven Press).pp.11-31

2. Beresford, A. K. C., De Souza, A. J. R. G. and Pettit, S. J., 2005, Stategic development of liner shipping companies and terminal operators. *Ocean yearbook 19*(Chicago, 1L: The University of Chicago Press), pp. 732-750.

3. Heaver, T. D., 2002, Supply chain and logistics management: implications for liner shipping. In: The handbook of maritime economics and business, edited by C. Grammenos (London:LLP), pp. 375-396.

4. Park. T. E (2011) "A Study on selection criteria of Green Port and evaluation of major Korean port", A master's thesis of graduate school of Incheon university.

5. Jeong,B,H (2009)"Green port management policy directions in the green growth era- The case of Gwangyang port in Republic of Korea", *Journal of Korea Port Economic Association* ,Vol.25(3) p.361-384

6. Lee. J. S., Han N. H(2009) "A study on Green Port Revitalization According to Air Pollution and Climate Change Regulations".

7. Lee. Y. K., Nan. J. W(2010)"Green Logistics Policy Analysis and Implications of Japan".

8. Lee. B. S (2010)"Tendency and Countermeasures on Green Logistics in Port Logistics Company" A master's thesis of graduate school of Korean Maritime university.

9. Lee. J. S (2009) "A Study on Green Port Revitalization According to Air Pollution and Climate Change Regulations".

10. Zhang. F. Y., Li. Z., Lu. X. J., Yao. X. L(2008)"Competitiveness of Inland Ports Based on F-AHP".

11. "Port of Long Beach, (2009) Green Port Policy, www.polb.com"

12. "The port of Los Angeles, www.portoflosangeles.org"

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ID			

「그린포트에 의한 항만경쟁력평가 모형구축」을 위한 조사

안녕하십니까?

한국해양대학교 물류시스템학과 석사과정 Wang liru 입니다.

본 연구는 AHP 기법을 활용하여 『그린포트에 의한 항만 경쟁력 평가』의 경쟁력 요소를 종합적으로 평가하여 평가 항목 간 상대적 중요도를 도출하여 그린포트가 항만 경쟁력에 영향을 얼마나 미치고 있는 지 알아보기 위한 연구입니다. 여기에 일환으로 항만 경쟁력을 결정하는 요소에 대한 중요도를 도출하기 위한 설문 조사를 실행하고 있습니다.

첫 번째 설문은 평가 요소 간 가중치를 선정하기 위한 설문과 각 요소에 포함되어 있는 지표들 간의 가중치를 선정하기 위한 설문으로 구성되어 있습니다.

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2011 년 5 월

지도 교수 : 김 환 성

(메일: kimhs@hhu.ac.kr, 전화: 051) 410 - 4334)

석사 과정 : Wang liru

(메일: wangliru@hhu.ac.kr, 전화: 051) 410 - 4914)

■ 응답자 정보

소속기간명		**소속기관 유형**	
작성자	**소속부서(직위)** :	**성명** :	
연락처	**전화번호** :	**e-mail :**	

※ 소속기관 유형 : 민간기업, 공기업, 출연(연), 대학, 정부, 협회 및 공단 기타 중 택 1

■ 사전 참조 내용

☞ 분석방법

- 계층적 분석법(AHP: Analytic Hierarchy Process)은 평가에서 고려되는 평가항목들을 계층화한 다음, 평가항목간 상대적 중요도를 측정하여 우선 시행해야 할 사업의 우선순위를 종합적으로 판단하는 의사결정 기법 중 하나임

☞ 설문 작성 예시

- 평가항목에 대한 판단을 쉽게 하기 위해서 쌍대비교방식을 사용하고 있으며 항만 경쟁력 요소 평가에서 항만 시설이 항만 서비스 보다 약간 중요 하다고 판단되면 다음 보기와 같이 표시함

· 항만시설 : e-RTGC, AMP, AGV.
· 항만비용 : 그린선박 인증제도, 친환경기술 인센티브, 속도감소 할인제도.
· 배후연계 : 친환경운송수단의 전환, 공동수배송.
· 사회여건 : 항만내 친수공간 조성계획 , CO_2 배출량 비용, CO_2 배출량 감축 정책

추진분야	절대중요		매우중요		중요		약간중요		동일		약간중요		중요		매우중요		절대중요	추진분야
항만시설	⑨	⑧	⑦	⑥	⑤	④	√③	②	①	②	③	④	⑤	⑥	⑦	⑧	⑨	**항만비용**

☞ 그린포트에 의한 항만경쟁력 평가모델

☞ 경쟁력 요소 및 세부 내용

경쟁력 요소		경쟁력 요소의 세부 설명
항만 시설	**e-RTGC**	야드내에서 일정한 통로를 이동하면서 컨테이너를 처리하는 RTGC 의 에너지원을 전기로 전환한 크레인으로 CO_2 배출을 저감시킴
	AMP	정박시 선박자체동력 사용에 의해 발생되는 배기가스 배출을 억제하기 위하여 육상에서 선박에 전기를 공급하는 시설을 AMP(Alternative Maritime Power)라고 함
	AGV	항만 내의 이송수단을 기존의 야드트럭에서 AGV 로 교체하여 이송 에너지원을 디젤에서 전기로 교체하며 CO_2 배출량을 감축시킴
항만 비용	**그린선박 인증제도**	선박건조 · 선원고용 · 선박부품 · 선박관리 등에 있어 CO_2 배출량을 줄이는 활동을 할 경우 해당선박에 대하여 그린선박 인증서를 부여하는 제도임. 인증서를 부여받은 선박에 대하여 몇몇 항만들은(45 개 항만) 입항료 감면, 예도선 · 선용품 기업 이용료 감면등의 인센티브를 시행하고 있음
	친환경기술 인센티브	친환경기술을 적용하는 선박에 대하여 접안료 및 입항료 면제 등의 인센티브를 제공하는 것
	속도감소 할인제도	항만의 항계 내에서 선박의 운항속도를 줄임으로써 CO_2 배출량을 절감 시킬수 있으므로 이에 대한 선박의 속도 저감에 대한 인센티브를 제공하는 제도
배후 연계	**친환경 운송수단 전환**	내륙운송에서 주로 트럭을 사용하고 있지만 철도, 연안운송등 친환경 수송수단으로 전환하여 트럭에 의한 배기가스 배출을 억제함(모달쉬프트)

	공동수배송	각 개별 화주가 수송하는 방식에서 화주 또는 트럭운송업자가 공동으로 통합 적재 수송하는 방식으로 전환하여 수송비 절감, 차량의 적재효율의 향상, 공차율의 감소, CO_2 배출량 감소 등을 도모하는 시스템
사회 여건	**항만내 친수공간 조성계획**	항만의 수변공간을 활용한 수변공원, 야외무대, 파고라 및 벤치 등의 휴게시설과 거주민을 위한 커뮤니티공간의 조성을 행하고 관광객을 유치하는 등 각 항만의 지역적인 특색을 고려한 친수공간 조성계획
	CO_2 배출량 비용	각 국가별 및 산업별 CO_2 배출량에 대한 환산 비용(예, 배출권 거래제)
	CO_2 배출량 감축 정책	기후변화협약 및 교토의정서에 대한 각 국가들은 CO_2 배출량 감축 정책 및 항만에서의 구체적인 추진 정책

■ 그린포트에 의한 항만경쟁력 평가모델에 관한 설문 내용

1. 현재 그린포트에 의한 항만경쟁력을 평가에서 항만시설, 항만서비스, 항만비용, 입출항 요소, 배후연계, 사회여건에 대한 상대적인 중요도를 평가해 주시기 바랍니다. 보기를 참조하여 아래 분항에 “√” 표기하여 주시기 바랍니다. (반드시 한 칸에만 “√” 표시하여 주시기 바랍니다.)

평가속성	절대중요		매우중요		중요		약간중요		동일		약간중요		중요		매우중요		절대중요	평가속성
항만시설	⑨	⑧	⑦	⑥	⑤	④	③	②	①	②	③	④	⑤	⑥	⑦	⑧	⑨	**항만비용**
항만시설	⑨	⑧	⑦	⑥	⑤	④	③	②	①	②	③	④	⑤	⑥	⑦	⑧	⑨	**배후연계**
항만시설	⑨	⑧	⑦	⑥	⑤	④	③	②	①	②	③	④	⑤	⑥	⑦	⑧	⑨	**사회여건**
항만비용	⑨	⑧	⑦	⑥	⑤	④	③	②	①	②	③	④	⑤	⑥	⑦	⑧	⑨	**배후연계**
항만비용	⑨	⑧	⑦	⑥	⑤	④	③	②	①	②	③	④	⑤	⑥	⑦	⑧	⑨	**사회여건**

배후연계	⑨	⑧	⑦	⑥	⑤	④	③	②	①	②	③	④	⑤	⑥	⑦	⑧	⑨	**사회여건**

2. '항만시설'에 관한 세부요소인 e-RTGC, AMP, AGV 중 어느 항목이 상대적으로 더 중요한지 평가해 주시기 바랍니다. 보기를 참조하여 아래 분항에 "√" 표기하여 주시기 바랍니다. (반드시 한 칸에만 "√" 표시하여 주시기 바랍니다.)

평가속성	절대중요		매우중요		중요		약간중요		동일		약간중요		중요		매우중요		절대중요	평가속성
e-RTGC	⑨	⑧	⑦	⑥	⑤	④	③	②	①	②	③	④	⑤	⑥	⑦	⑧	⑨	**AMP**
e-RTGC	⑨	⑧	⑦	⑥	⑤	④	③	②	①	②	③	④	⑤	⑥	⑦	⑧	⑨	**AGV**
AMP	⑨	⑧	⑦	⑥	⑤	④	③	②	①	②	③	④	⑤	⑥	⑦	⑧	⑨	**AGV**

3. '항만비용'에 관한 세부요소인 그린선박 인증제도, 친환경기술 인센티브, 속도감소할인제도 중 어느 항목이 상대적으로 더 중요한지 평가해 주시기 바랍니다보기를 참조하여 아래 분항에 "√" 표기하여 주시기 바랍니다. (반드시 한 칸에만 "√" 표시하여 주시기 바랍니다.)

평가속성	절대중요		매우중요		중요		약간중요		동일		약간중요		중요		매우중요		절대중요	평가속성
그린선박 인증제도	⑨	⑧	⑦	⑥	⑤	④	③	②	①	②	③	④	⑤	⑥	⑦	⑧	⑨	**친환경기술 인센티브**
그린선박 인증제도																		**속도감소 할인제도**
친환경기술 인센티브																		**속도감소 할인제도**

4. '배후연계'에 관한 세부요소인 친환경 운송수단 전환, 공동수배송 중 어느 항목이 상대적으로 더 중요한지 평가해 주시기 바랍니다보기를 참조하여 아래 분항에 “√ ” 표기하여 주시기 바랍니다. (반드시 한 칸에만 “√” 표시하여 주시기 바랍니다.)

평가속성	절대중요		매우중요		중요		약간중요		동일		약간중요		중요		매우중요		절대중요	평가속성
친환경 운송수단 전환	⑨	⑧	⑦	⑥	⑤	④	③	②	①	②	③	④	⑤	⑥	⑦	⑧	⑨	**공동수배송**

5. '사회여건'에 관한 세부요소인 항만내 친수공간 조성계획, CO_2 배출량 비용, CO_2 배출량 감축 정책 중 어느 항목이 상대적으로 더 중요한지 평가해 주시기 바랍니다보기를 참조하여 아래 분항에 “√ ” 표기하여 주시기 바랍니다. (반드시 한 칸에만 “√” 표시하여 주시기 바랍니다.)

평가속성	절대중요		매우중요		중요		약간중요		동일		약간중요		중요		매우중요		절대중요	평가속성
항만내 친수공간 조성계획	⑨	⑧	⑦	⑥	⑤	④	③	②	①	②	③	④	⑤	⑥	⑦	⑧	⑨	**CO_2 배출량 비용**
항만내 친수공간 조성계획																		**CO_2 배출량 감축 정책**
CO_2 배출량 비용																		**CO_2 배출량 감축 정책**

6. 현시점에서의 그린포트 구축 상황을 고려하여 그린포트에 의한 항만의 경쟁력 요소에 따라 각 항만 간의 경쟁력을 평가해 주시기 바랍니다. (해당 항만에 대하여 느껴지시는 정도에 따라서 해당하는 점수(5-1 사이)를 ( )안에 매겨 주시면 됩니다.)

예시	매우 좋다 ⑤ ..... 좋다 ④ ..... 보통 이다 ③ ..... 안좋다 ② ..... 매우 안좋다 ①						
		싱가포르	상하이	홍콩	부산	LA/LB	로테르담	요코하마
	항만 시설	(4)	(4)	(3)	(4)	(3)	(5)	(5)

평가속성	싱가포르	상하이	홍콩	부산	LA/LB	로테르담	요코하마
항만시설	( )	( )	( )	( )	( )	( )	( )
항만비용	( )	( )	( )	( )	( )	( )	( )
배후연계	( )	( )	( )	( )	( )	( )	( )
사회여건	( )	( )	( )	( )	( )	( )	( )

감사드립니다.