

An Empirical Study on the Modal Shift from the Lorry Based Transportation to the Environmental Intimate Coastal Shipping

Ki-Myung Ahn* · Min-Ho Ha†

*Professor, Division of Shipping Management, Korea Maritime University, Busan 606-791, Korea

†Graduate school of Korea Maritime University, Busan 606-791, Korea

Abstract : The lorry based transportation system in Korea has many problems such as high domestic logistic cost, environment pollution and road damage etc. Hereupon, the necessity of improvement for national logistics system has been proposed continuously. Therefore we carried out this research through AHP (Analytic Hierarchy Process) to measure relative importance between effect factors and constraint factors and examined the possibility of Modal Shift from lorry transportation to coastal transportation. As the results of this research, the relative priority on modal shift policy enforcement (0.556) is higher than that of maintenance of the present transportation system (0.444).

Key words : Coastal shipping, National logistics system, AHP method, Modal shift

1. Introduction

The lorry based transportation system in Korea has many problems such as high domestic logistic cost, environment pollution and road damage etc. These problems which based on the insufficiency of the related laws or the institutional supports by Korea government have brought serious unbalance and distortion in the national logistics system. Furthermore, an inefficient transportation system has an effect on not only obstructs national economic development but also deteriorates a nation living conditions. Therefore, the necessity of its improvement has been proposed continuously.

Currently many interests about environment issue have been rising after Kyoto Protocol (2001, 2005) which is an agreement for the reduction of greenhouse gases and its practice scheme as well as the necessity of conversion for an effective national logistics system which be able to reduce an energy consumption in high oil prices era.

Table 1 Displacement comparison between lorry and coastal shipping

	Lorry(A)	Coastal shipping(B)
CO	0.5	0.04
CO ₂	98	15
HC	0.2	0.01
NO _x	1	0.3
SO ₂	0.03	0.3

Source : OECD Maritime Transport Committee, "Transport and Sustainable Development".

In these situations, importance of the coastal shipping which is more environment-friendly and higher energy efficiencies than lorry transportation has been recognizing as alternative transportation which meets future logistics policy direction.

Table 2 Comparison of the fuel consumption between lorry and coastal shipping

(Unit : TEU)

	Coastal shipping	Lorry
Fuel consumption(ℓ)	4.9	103

Source : Recited KITA Report (2007.04.09) from Korea maritime institute.

However, transportation share rate for the lorry was increased continuously from 87.83 in 2001 to 90.35% in 2004, while that for the coastal shipping is decreased from 9.19% to 6.94% in the same period. In addition share rate on transportation market for coastal shipping is getting worse.

There are some reasons why coastal shipping has been getting worse. Firstly, the deregulation such as the licence system to the registration system led excessive competition with sharply increased tonnage by the entry of old vessels in 1999. Secondly, Even though coastal shipping contains complicated structural problems such as low connectivity, inaccessibility than others, the services improvement to shipper side has never considered sufficiently. Lastly, the

† Corresponding Author : Min-Ho Ha, pver3@hanmail.net, 051)410-4385

* kmahn@hhu.ac.kr, 051)410-4385

insufficiency of the government policy, the limit of related law and system for a coastal shipping renovation also makes stagnation in the coastal shipping industry. Moreover, the capital structure of most coastal shipping enterprise is feeble, Korean government should support strongly to raise the efficiencies and the competitiveness of coastal shipping market.

Therefore, this research was carried out to see the possibility of modal shift by coastal shipping from road transportation using AHP (Analytic Hierarchy Process) method through the relative importance measurement of the effect factors and the obstacle factors.

2. Literature Review

The former literatures of this research mostly focus on the advantages of the coastal shipping comparing with road transportation. The other words they did not mainly mention why there are still difficulty in shifting of transportation from lorry to coastal shipping. Therefore this study focuses on constraint reasons and economic and environmental effects respectively. The preceding studies regarding the coastal shipping are followed. Shin et al.(2001) estimated the environmental expenses based on individual means of each transportation according to the road transportations and the coastal shipping and by comparing it, in the governmental sphere, calculated the effects of how changes of the transportation could have an effect on improvement of environmental expenses. Also by using this results, in the governmental sphere, this research proposed political alternatives in order to eliminate irrationality of individual means of transportation and rational distributions of the investments regarding transportation facilities.

Park(2003) analyzed the strategies of the coastal shipping companies, analysis of coastal shipping systems in order to prepare the schemes that can be used to revitalize the coastal shipping of containerized cargo in Gyeonggi and Incheon area. And by deriving the constraints and alternatives of coastal transportations, he explored avenue for logistics effectiveness between import-export companies and discharge ports and on the other hand, he discussed the institutional supports and revitalization schemes.

Through this research he recognized the strong points of the coastal transportation those are environmentally friendly and energy effective transportation and showed the alternative schemes.

Cho(2003) analysed the problems such as unbalance of domestic transportation system, the reason of increasing logistics cost in national logistics system, and he suggested

some strategies to revitalize the coastal shipping comparing to freight level, energy consumption comparing to road transportation.

Kim et al.(2006) introduced British Modal Shift, Freight Facilities Grants(FFG), in executed the case study for an environment-friendly transportation network construction.

Jun(2007) analyzed the disadvantages of coastal shipping concerning transportation hour and transportation expenses, which occurred by structural problems of the transportation system. He presented that Korean government should support comprehensively to solve these problems.

The preceding researches regarding the revitalization scheme of coastal shipping are showed on Table 3.

Table 3 Preceding research

Author	Research
Shin et al. (2001)	Environment expenses presumption and comparison of the road transport and coastal shipping.
Park, y.a. (2003)	Coastal shipping revitalization plan of containerized cargo in Gyeonggi and Incheon area.
Cho, k.s (2003)	Modal Shift policy vision : Coastal Shipping.
Kim, et al (2006)	The case study for an environment-friendly transportation network construction ; Freight Facilities Grants(FFG).
Jun, h.j. (2007)	Coastal transportation structure and competitive power analysis .

3. Methodology

3.1 The Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is a powerful and flexible decision making process to help people set priorities and make the best decision when both qualitative and quantitative aspects of a decision need to be considered. By reducing complex decisions to a series of one-on-one comparisons, then synthesizing the results, AHP not only helps decision makers arrive at the best decision, but also provides a clear rationale that it is the best. Designed to reflect the way people actually think, AHP was developed in the 1970's by Dr. Thomas Saaty, while he was a professor at the Wharton School of Business, and continues to be the most highly regarded and widely used decision-making theory.

The AHP engages decision makers in structuring a decision into smaller parts, proceeding from the goal to objectives to sub-objectives down to the alternative courses of action. Decision makers then make simple pairwise comparison judgments throughout the hierarchy to arrive at overall priorities for the alternatives. The decision problem may involve social, political, technical, and economic factors. The AHP helps people cope with the intuitive, the rational and

the irrational, and with risk and uncertainty in complex settings. It can be used to predict likely outcomes, plan projected and desired futures, facilitate group decision making, exercise control over changes in the decision making system, allocate resources, select alternatives, do cost/benefit comparisons, evaluate employees and allocate wage increases.

3.2 Model of hierarchy structure

1) Survey sub criteria and criteria verification

We carried out survey with carriers, shippers, and shipping/port professionals by using telephone, e-mail and visit in person to derive detailed attributes regarding the possibility of Modal Shift over 1 month from 10th of May to 15th of June in 2007.

Simultaneously, visiting foreign transportation web-site and literature review, we collected all 28 detailed attributes.

Table 4 Detailed attributes

Detailed Attributes
road damage decrease, road construction cost curtailment, lack of harbor penetration road/railroad, Cargo equipment deficiency, lack of freight custody facility, logistics cost curtailment in enterprise, traffic accident decrease, transportation reliability, transportation frequency, transportation hour, transportation expenses, transportation connectivity, information system, traffic congestion decrease, emergency transportation, energy curtailment, air pollution decrease, noise pollution decrease, nature destruction, lack of cooperation among related bodies, difficulty in Financial Procurement, small-scale of coastal shipping company, old vessel, fleet structure, high usage cost of port facility, registration standard, insufficiency of related laws and regulations, lack of coastal shipping system(28)

As shown Table 5, we decided 19 criteria based on the consultations from shipping/port professionals for avoiding duplication and the objectivity among these detailed attributes.

Table 5 Goal, Objectives, sub-Objectives and alternatives

No.	Criteria Attribute Factors	No.	Criteria Attribute Factors
1	Modal Shift	11	Road damage decrease/road construction cost curtailment
2	Effect factor	12	Air pollution decrease
3	Constraint factor	13	Noise pollution decrease
4	Improving domestic logistics system	14	Difficulty in Financial Procurement
5	Environment effect	15	Lack of cooperation among related bodies
6	Traffic congestion decrease	16	Small-scale of coastal shipping company
7	Emergency transportation	17	Lack of coastal shipping system
8	Energy curtailment	18	Modal Shift enforcement
9	Logistics cost curtailment for enterprise	19	Maintenance of the present transportation system
10	Traffic accident decrease		

2) Modelling

The model of hierarchy structure is one of the most important process to solve multi-attribute decision making situation in Analytic Hierarchy Process.

We constructed hierarchy model to predict the possibility of Modal Shift from lorry transportation to coastal transportation.

As shown in Fig. 1, the goal of this model is Modal Shift, objectives are Effect Factor as the result of modal shift and Constraint Factor which obstructs to modal shift.

As the sub-objectives of effect factors are consist of Improving Domestic Logistics System and Environment Effect, and that of constraint factors are Difficulty in Financial Procurement, Lack of Cooperation among related bodies, Small-Scale of Coastal Shipping Company, Lack of Coastal Shipping System.

The sub-criteria factors of the improving domestic logistics system are Emergency Transportation, Energy Curtailment, Logistics Cost Curtailment for Enterprise, Traffic Accident Decrease, Road Damage Decrease/Road Construction Cost Curtailment and these of the environmental effect factors are Air Pollution Decrease, Noise Pollution Decrease. Fig. 1 shows the Model of hierarchy structure.

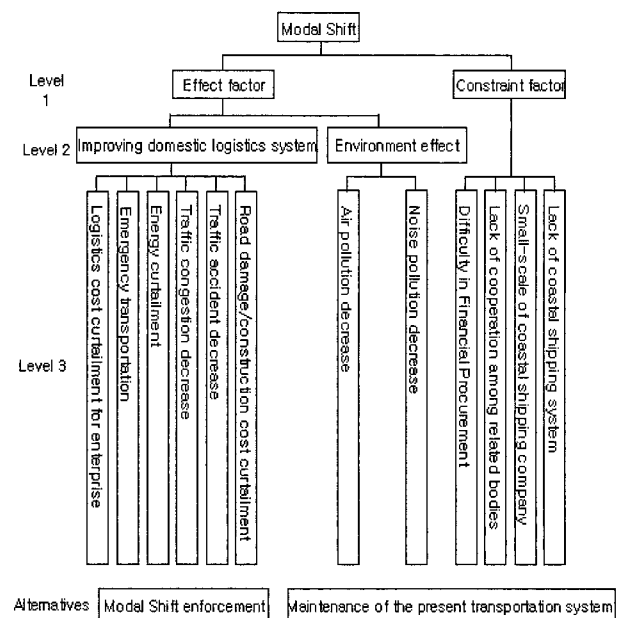


Fig. 1 Model of hierarchy structure

3) Selecting questionee

The Analytic Hierarchy Process (AHP) is a flexible decision making process to help people set priorities and make the best decision.

Selecting questionee is the most important phases in

order to lead best response in AHP. Therefore questionee not only has enough experience and expertise in the shipping/port area but also keep an objectivity to assess modal shift realization possibility.

We divided into two groups of questionee and conducted a survey.

First, the academic group ; the professors and the researchers who have got enough knowledge and experience in shipping/port industry.

Second, practical affairs group ; the staffs in charge of logistics department who have more than 10 years experience with master's/doctor's degree in the carriers and shippers.

The duration of survey was from 15 of June in 2007 to 20th of July in 2007.

We got the 40% of questionnaires in person and the 60% of questionnaires by using e-mail and fax. Although the results of the response were 24 among 35 questionnaires, we used 19 questionnaires except for 5 questionnaires which exceed 0.1 inconsistency.

4. Result and Analysis by AHP

4.1 Analysis in Modal Shift criteria

The objectives of this model consist of the effect and the constraint factor.

The results of analysis, the priorities of modal shift criteria are an effect(0.634), a constraint(0.366) in order. As the priority of the effect factor is higher than constraint's, the experts assert that we need to focus on the effectiveness of the result after modal shift enforcement.

Table 6 Priority ranking of Modal Shift criteria

Sub-Criteria for Modal Shift	Priority	Inconsistency
Effect factor	0.634	0
Constraint factor	0.366	

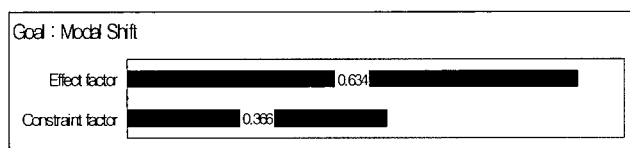


Fig. 2 Priority ranking of Modal Shift criteria

4.2 Analysis in Effect factors criteria

The sub-criteria of the effect factors is composed of improving domestic logistics system and environment effect. As the results show priority on improving domestic logistics system(0.671) and environment effect(0.329), the experts

expect to improve the economic effective side which related to an imbalance and an inefficiency of logistics system compared to a environmental matter.

Table 7 Priority ranking of respect to effect factor criteria

Sub-Criteria for effect factor	Priority	Inconsistency
Improving domestic logistics system	0.671	0
Environment effect	0.329	

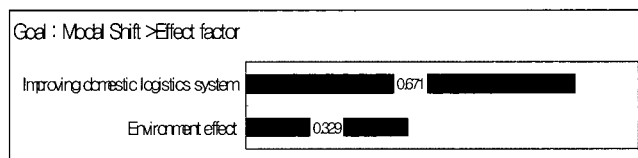


Fig. 3 Relative priorities with respect to effect factor criteria

1) Analysis in Improving Domestic Logistics System Criteria

The detailed factors of the improving domestic logistics system criteria are made up of traffic congestion decrease, emergency transportation, energy curtailment, logistics cost curtailment for enterprise, traffic accident decrease, road damage decrease/road construction cost curtailment.

The results of analysis, the priorities of the improving domestic logistics system criteria are logistics cost curtailment for enterprise(0.237), traffic congestion decrease(0.201), energy curtailment(0.170), emergency transportation(0.158), road damage decrease/road construction cost curtailment(0.123), traffic accident decrease(0.111) in order.

Logistics cost curtailment for enterprise ranks first place of priority. It shows that the higher logistics cost in company is connected directly with the higher production cost, herein company can lose its competitiveness.

Second place of priority ranking is traffic congestion decrease. Currently, the shortage of the exclusive use road lets trucks trip on the urban road and motorway and causes traffic congestion. So the experts seem to assure that modal shift is one of most effective ways to release traffic congestion.

Table 8 Relative priorities with respect to domestic logistics system improvement factors

Effect factor	Priority	Domestic logistics system improvement factors	Inconsistency	Priority
domestic logistics system improvement	0.671	Traffic congestion decrease	0.002	0.201
		Emergency transportation		0.158
		Energy curtailment		0.170
		Logistics cost curtailment for enterprise		0.237
		Traffic accident decrease		0.111
		Road damage decrease/Road construction cost curtailment		0.123

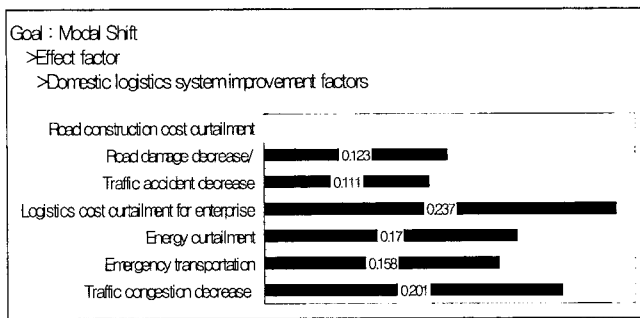


Fig. 4 Relative priorities with respect to domestic logistics system improvement factors

2) Analysis in Environmental Effect Criteria

The sub-criteria of the environmental effect consists of air pollution decrease and noise pollution decrease.

As the results of the analysis, the relative priority on air pollution decrease(0.701) is higher than that of noise pollution decrease(0.299).

This result seems to be affected by high possibility of greenhouse gas reduction target country after come into effect on Kyoto Protocol(2005).

Table 9 Relative priorities with respect to environmental effect factor

Effect factor	Priority	Environmental effect factors	Inconsistency	Priority
Environmental effect	0.329	Air pollution decrease	0	0.701
		Noise pollution decrease		0.299

Modal Shift
>Effect factor
>Environmental effect



Fig. 5 Relative priorities with respect to environmental effect factor

4.3 Analysis in Constraint factors criteria

The constraint factors are made up of difficulty in financial procurement, lack of cooperation among related bodies, small-scale of coastal shipping company and lack of coastal shipping system.

The results show that the priority ranking order is lack of coastal shipping system(0.285), difficulty in financial procurement(0.244), small-scale of coastal shipping company (0.243), lack of cooperation among related bodies(0.228).

Currently, coastal shipping presents low transportation

share rate due to complicated structural problems, insufficient of exclusive use berth and lag behind of cargo handling equipment which makes long transport time and economic loss. These insufficiencies of the coastal transportation system have an effect on substantial obstacle to modal shift.

Difficulty in financial procurement ranks Second high priority. Although several financial aids such as vessel mortgage, fleet structure improvement funds from government, credit guarantee system etc exist but it is not easy for coastal shipping companies to use these supports.

Small-scale of coastal shipping company ranks third place. The reason why coastal shipping company became small-scale financially is explained by the deregulation such as the licence system to the registration system led excessive competition with sharply increased tonnage by the entry of old vessels in 1999.

Forth place of priority ranking is lack of cooperation among related bodies. Related bodies for modal shift are Ministry of Land, Transport and Marine Affairs, National Research Institution and Korea Shipping Association and so on. Even though these bodies have tried to cooperate for competitiveness of national transportation system but they have still carried out related work separately. These separate work from each body could contain possibility of the inappropriate apportionment of the resources in traffic infra construction and system construction as well as inefficient execution of national budget.

Table 10 Relative priorities with respect to constraint factor

Criteria for Modal Shift	Priority	Constraint factors	Inconsistency	Priority
Constraint factors	0.366	Difficulty in Financial Procurement	0.0002	0.244
		Lack of cooperation among related bodies		0.228
		Small-scale of coastal shipping company		0.243
		Lack of coastal shipping system		0.285

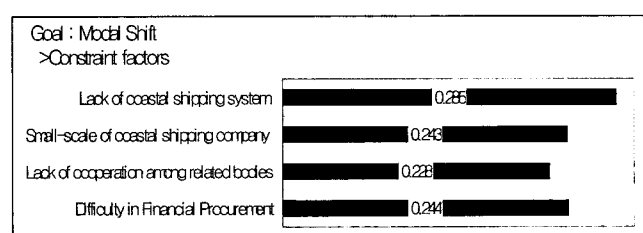


Fig. 6 Relative priorities with respect to constraint factor

4.4 Analysis in overall priority

Table 11 shows the overview priorities. The sub-criteria of the alternatives is consist of modal shift policy enforcement and maintenance of the present transportation system .

As the results of this research, the relative priority on modal shift policy enforcement (0.556) is higher than that of maintenance of the present transportation system(0.444).

The priority of the effect factor(0.634) is higher than constraint's(0.366) in level 1.

Sub-criteria of the effect factors in level 2, the relative priority on improving domestic logistics system(0.671) is much higher than environment effect(0.329) and in sub-criteria of the constraint factors, the priority ranking is lack of coastal shipping system(0.285), difficulty in financial procurement(0.244), small-scale of coastal shipping company (0.243), lack of cooperation among related bodies(0.228) in order.

Table 11 Comprehensive priorities

Level 1	Level 2	Level 3	Policy enforcement	Maintenance present system	Priority
Effect factor	Improving domestic logistics system	Traffic congestion decrease	0.053	0.020	0.073
		Emergency transportation	0.042	0.035	0.077
		Energy curtailment	0.045	0.030	0.075
		Logistics cost curtailment for enterprise	0.063	0.017	0.080
		Traffic accident decrease	0.030	0.023	0.053
		Road damage decrease/Road construction cost curtailment	0.033	0.023	0.056
		Subtotal	0.266	0.148	0.414
	Environmental effect	Air pollution decrease	0.091	0.043	0.134
		Noise pollution decrease	0.039	0.024	0.063
		Subtotal	0.130	0.067	0.197
Subtotal		0.396	0.215	0.611	
Constraint factors	Difficulty in Financial Procurement		0.038	0.056	0.094
	Lack of cooperation among related bodies		0.040	0.052	0.092
	Small-scale of coastal shipping company		0.041	0.056	0.097
	Lack of coastal shipping system		0.041	0.065	0.106
	Subtotal		0.160	0.229	0.389
Sum total			0.556	0.444	1.000

In level 3, the priorities of the improving domestic logistics system criteria are logistics cost curtailment for enterprise(0.237), traffic congestion decrease(0.201). energy

curtailment(0.170), emergency transportation(0.158), road damage decrease/road construction cost curtailment(0.123). traffic accident decrease(0.111) in order. In environmental effect criteria, the relative priority on air pollution decrease(0.701) is higher than that of noise pollution decrease(0.299).

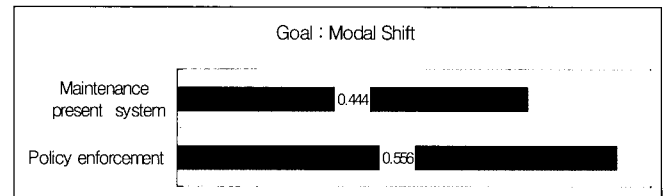


Fig. 7 Relative priorities with respect to alternatives

5. Conclusion

This research was carried out to see the possibility of modal shift by coastal shipping from road transportation using AHP (Analytic Hierarchy Process) method through the relative importance measurement of the effect factors and the obstacle factors.

We executed literature review and consultations from shipping/port professionals to derive detailed attributes and carried out survey to measure hierarchical priorities.

As the results of the analysis, the relative priority on modal shift policy enforcement (0.556) is higher than that of maintenance of the present transportation system(0.444). However high priority of the constraint factors is an obstacle to modal shift. If some problems such as complicated structural problems, insufficient of exclusive use berth and lag behind of cargo handling equipment etc are solved steady, coastal shipping will be revitalization and will be important role in national logistics system.

Some experts say if we can not reduce the differences between government and shippers, resolving the current problems will be difficult. Namely, if there are any aids to shippers' side, shippers don't have any motivations for modal shift in current supporting policy.

We need to develop integrated strategies which can reduce the priority of constraint factors.

Firstly, it need new financial plan for coastal shipping companies to strength their competitiveness by mending or replacement of their vessels. After the deregulation such as the licence system to the registration system led excessive competition with sharply increased tonnage by the entry of old vessels in 1999. These old vessels can not attract consumers any more. Secondly, infrastructure on shipping industry must be built steadily. Required not only modern

and automated cargo handling equipment but also terminal for coastal shipping and its links are urgent. For example, the Alameda Corridor which link LA ICD to LA port and Long beach deals approximately 25% of whole throughput cargoes efficiently. Lastly, the transport service focused on shippers should be developed with reforming freight framework, tax reduction, incentives. And through strengthen role of working group, let them research to revitalize coastal shipping constantly. For instance, UK government supports grant to take freight off congested roads and moving it by rail or water can have environmental and wider social benefits. And every program regarding activating coastal shipping is developed by Freight Study Group.

These integrated strategies mentioned above will improve reliability, transport hour, shipping expenses, accessibility, service frequency, linkage in coastal shipping industry.

We implemented this research using AHP with qualitative factors and showed opinions of shipping/port experts regarding modal shift. In order to overcome some limitations to this paper, however, not only the analysis of economy with both qualitative and quantitative factors should be carried out but integrated strategies should be indicated. The more detailed strategies and its propulsion plan is left for further research.

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