Comparison of Environmental Performance and Economical Benefit of Land and Marine Transportation System - Validation of LCIA with AHP method - *1

By Kho Shahriar IQBAL (*Student Member*) *2 and Kazuhiko HASEGAWA (*Member*) *2

The environmental impact of shipping a certain amount of cargo between Yokohama and Fukuoka by road transport and marine transport was assessed using life cycle impact assessment with some weighting factors estimated from the opinions of general consumers by analytic hierarchy process. These impacts were compared to find the environmental destruction index to show the effect of modal shifting of this amount of cargo from road to waterway. The similar impacts were also assessed by two other methods namely Eco-indicator '99 and Externalities. Then these results were compared to validate the first method (LCIA-AHP) of comparison. The economical benefit and customer service quality were also assessed and compared in this comparison process.

Keywords : *Transportation, Environment, Life Cycle Impact Assessment, Modal Shift, Kyoto Protocol*

1. Introduction

" Massive flooding, disease and drought could hit rich and poor countries around the world over coming decades, if global warming is not halted. ...... The scientists said they foresaw glaciers and polar icecaps melting, countless species of animals, birds and plant life dying out, farmland turning to desert, fish-supporting coral reefs destroyed, and small island states sunk beneath the sea. " It was written in the New York Times on February 19, 2001. Numerous natural evidences show the certainty of climate change. A lion part of the causes behind this change is human induced.

Among the human activities causing the climate change, use of transports and burning the fossil fuel for energy are vital. Environmental friendly and economically feasible transportation system planning has become a very essential subject matter in recent days. Many developed countries like Japan along with other developing countries are trying to reduce the influences towards climate change caused from various sectors as well as transportation. Besides the research for improving the technology, searching for alternative transport modes from the existing types has become another interesting field for researcher. Hasegawa *et al* [1),2)] and Fet *et al* [3)] showed methodologies to compare the existing transportation system from the environmental viewpoint and suggested for modal shifting towards the better one.

In this paper, considering the Yokohama-Fukuoka route in Japan, the ecological impact and the economic performance of land vehicles (truck) and the marine transports (cargo ship) were evaluated and compared. For evaluating environmental influence, three different approaches - life cycle impact assessment (LCIA) with analytic hierarchy process (AHP) or valuation by consumers ' choice[1),2)], Eco-indicator ' 99, and external costs, were considered. Required freight rate (RFR) to attain a prefixed rate of return on the investment was considered for the economic

*1 Read at the Spring Meeting of Kansai Society of Naval Architects, Japan, May 25,2001, Received at June 8,2001

*2 Dept. of Naval Architecture and Ocean Engineering, Osaka University

comparison. For the consideration of customer service, the time taken by the transport authority to serve the cargo owner was estimated and compared for the mentioned transportation system types. Finally, the results from different approaches were compared.

2. Methodology

To evaluate the economic and environmental performance of the transports, a model case was studied where it was assumed that in average 1500 ton of break bulk type cargo to be carried from Yokohama to Fukuoka and same amount from Fukuoka to Yokohama in a day by trucks or ships. Details of the routes and the transports considered are given in Table 1. Two alternative transportation systems are shown in Figure 1. On the top, the transportation system used for the usual inland courier service mainly based on trucks is shown. The bottom part of the figure shows the alternative transportation system using mainly cargo ships.

According to Table 1, truck requires 32.5 hours for one trip in this route. Considering 30 off-hire days, the maximum round trip per annum per truck was 124. At 90% average loading condition, one 11 ton truck (with 10.7 ton cargo capacity) is capable of carrying a total of 1194.12 ton of cargo through one way in one year. To perform the task of carrying 547500 ton of cargo each way in one year, 460 trucks were required. Similarly, with 39.35 hours trip time and 45 off-hire days, the maximum round-trip per annum per ship was 98. Considering the average loading condition as 50% of the 5000 ton ship (4500 ton cargo capacity), the total number of round-trip required was 243, that is, 3 ships were required to perform the same task.

2.1 Life Cycle Impact Assessment and Environmental Destruction Index

Life cycle impact assessment (LCIA - standardized as ISO 14042)[4] is a tool to evaluate product's influence on the environment through the evaluation of each step of a product or process life. From raw material acquisition through production, use and disposal, LCIA studies the environmental aspects and potential impacts of that product on the environment [5]. Assessing the amount of compounds released during the production and operation of the transportation systems considered, the total impact of each system was estimated and compared to find the environmental destruction index. Seven types of compounds or substances (energy consumption, heat radiation, CO_2 emission, NO_X emission, SO_X emission, phosphorous emission, particulate matter emission) which have influence on 6 different impact categories (fossil fuel exhaustion, local warming, global warming, acid rain, eutrophication, air pollution) were considered for this comparison. It was difficult to get the actual amount of compounds released in the different step of the life cycle of a transport. Here these amounts were used

Table 1 Route and trip particulars.

	Truck	Cargo ship
Route name	Yokohama-Fukuoka	
Route length	1200 km	1000 km
Capacity	11 tons	5000 tons
Transport velocity	50 km/h	23 knots
Total trip time	32.5 h	39.35 h
Travel time	24 h	23.48 h
Loading & unloading time	2 h	8 h
Delay	25%	25%
Off hire days per annum	30	45
Max. round trip per annum	124	98
Fuel type used	Light oil	Heavy oil
Fuel consumption	4 km/l	150 g/PS-h
Fuel cost	70 yen/l	15 yen/l
Fuel specific gravity	0.85	0.9
Engine power	600 PS	12000 PS
Average loading condition	90%	50%
Harbor charge/trip		20000 yen
Life time	10 years	20 years
Transport between stock-point and ship (by truck)		
Distance		10 km
Travel time		12 min
Price of transport	$1x10^7$ yen	$1.50x10^9$ yen
Transport tax/year	43600 yen	250000 yen
Depreciation	$2.0x10^6$ yen	$7.5x10^7$ yen
Maintenance cost/year	100000 yen	2000000 yen
Other cost/year (Weight tax, insurance, etc.)	192000 yen	2000000 yen
Labor cost/man-hour	2500 yen	2500 yen
Number of crews/drivers	2	6

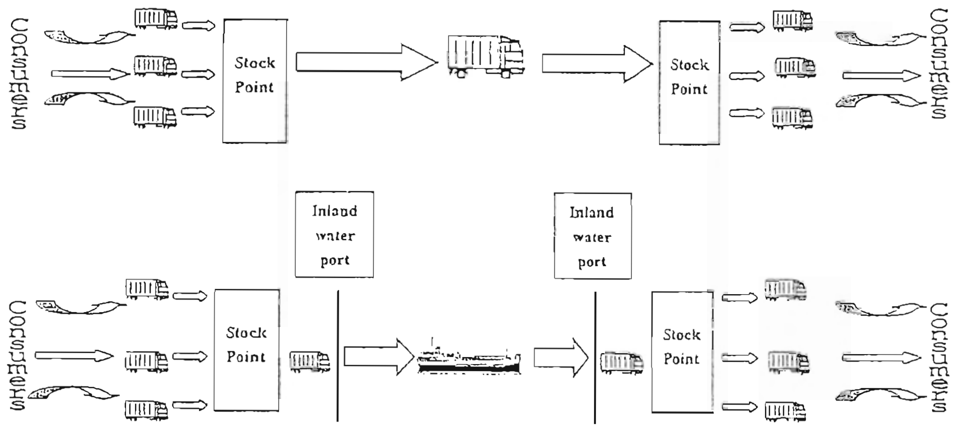

Fig. 1 (top)Transportation system of usual inland courier service, (bottom) proposed alternative transportation system for inland courier service.

as mentioned in ref. (2), those collected from various internet resources. The amounts of compound or substance are shown in Table 2

2.1.1 Valuation by Consumers' Choice

Multiplying the total amount of compounds or substances released by respective characterization factors, the impacts were estimated according to the following equation[3].

$$EP(j) = \sum Q_i \times EF(j)_i \qquad (1)$$

Where, *EP(j)* is the sum of the potential contribution from the impact category, Q_i is the emissions of compound i, $EF(j)_i$ is the characterization factor of compound i related to the impact category j.

The characterization factors for various compounds or substances related to the impact category are shown in Table 3. The characterization factors were according to reference (3). The factors for energy use for fossil fuel exhaustion, heat radiation for local warming, SO_X emission for eutrophication and particulate matter for air pollution were assumed by the authors.

The environmental destruction indices were calculated multiplying the ratio of the amount of impact by truck transportation system to that of the ship transportation system with some specific weighting factors for each impact category. The weighting factor for each impact category is shown in Table 4. A questionnaire was used to survey the opinions of some of the general consumers like naval architects, students, environmentalists, transport related researchers from various countries including Japan, Bangladesh, Pakistan, Indonesia, Nepal, Canada, Australia, asking to assess the weighting factors to various impact categories according to their dominance to environment change. The persons questioned were asked to consider two environmental impacts each time and compare their dominance to the climate change to assess the weighting factor. For example, they were asked to compare the 'local warming' with 'global warming' and to judge which one is absolutely/very strongly/strongly/weakly important over another or whether both are equal in importance for the environment. One hundred and twelve persons responded to the questionnaire. Then analytic hierarchy process (AHP)[6] was used to calculate the weighting factors. The weighting factors shown in Table 4 are add up to 1.000 as these are normalized according to Saaty[6].

2.1.2 Valuation by Eco-Indicator '99

Eco-indicator '99[7], which was based on damage function method, considered three significant types of damages to find the weighting factors for the compounds emitted to the environment. Those were i) human health, ii) ecosystem quality, and iii) resources. The weighting factors, those are common to the compounds considered in this study are shown in Table 5. Beside these, Eco-indicator '99 considered more substances. Some of them are N_2O, CH_4, NH_3, NMVOC, and land use. The weighting factors for SO_X in Table 5 was taken as same as the weighting factor for SO_2 in Eco-indicator '99. Only the hierarchistic values were

Table 2 Amount of compound or substance released during production and use.

Compounds/Substances	Truck	Cargo ship
During the production phase		
Energy (MJ)	$7.25x10^5$	$1.39x10^8$
Heat (MJ)	not available	not available
CO_2 (ton)	58.79	$1.07x10^4$
NO_X (kg)	87.11	$4.85x10^4$
SO_X (kg)	$3.03x10^2$	$1.32x10^4$
Phosphorous (kg)	68	$9.65x10^3$
Particulate Matter (kg)	not available	not available
During the operation phase		
Energy (MJ/ton-km)	3.93	0.62
Heat (MJ/kg of fuel)	42.7	40.7
CO_2 (g/ton-km)	188	58.4
NO_X (g/ton-km)	1.49	0.81
SO_X (kg/ton of fuel)	4.2	48.3
Phosphorous (kg)	not available	not available
Particulate Matter (g/kw-h)	0.205	0.2

Table 3 Values of the characterization factors.

Impact category	Responsible compounds	Characterization factors
Fossil fuel exhaustion	Energy use (MJ)	1.0
Local warming	Heat radiation	1.0
Global warming	CO_2	1.0
Acid rain	NO_X	0.7
	SO_X	1.0
Eutrophication	NO_X	1.35
	SO_X	1.0
	Phosphorous	32.03
Air pollution	Particulate matter	1.0

Table 4 Weighting factors for environmental impacts.

Impact category	Weighting factor
Fossil fuel exhaustion	0.143
Local warming	0.105
Global warming	0.271
Acid rain	0.165
Eutrophication	0.096
Air pollution	0.22

taken here, though there were two other types namely individualistic and egalitarian[7].

2.1.3 Valuation by External Cost or Externalities

Fuel cycle external cost or externalities are the costs imposed on society and the environment that are not accounted for by the producers and consumers of energy, i.e. that are not included in the market price. They include damage to the natural and built environment, such as effects of air pollution on health, buildings, crops, forests and global warming; occupational disease and accidents; and reduced amenity from visual intrusion of plant or emissions of noise. Traditional economic assessment of fuel cycles got the tendency to ignore these effects.

The ExternE[8] method is an attempt in assessing the external cost of fuel consumption monetarily. This method has given importance to three compounds only. Those are CO_2 for global warming, NO_X for regional impact and particulate matter for local air pollution. The external costs of these compound types are shown in Table 5. Originally these costs were estimated[9] in ECU. Here these values were converted to yen using the conversion rate as 1ECU=1EURO = 107 yen.

The external costs of particulate matter were calculated according to the following equation[9]. In this equation only $PM_{2.5}$ was taken in account, but the same equation was used in this paper for accounting total emission of particulate matter.

External cost of $PM_{2.5}$ = (115000 ECU/ton of $PM_{2.5}$)*(X ton of $PM_{2.5}$)*(Population Density)+9000 ECU

Where X is the total amount of particulate matter in ton. The population density (in thousands per sq. km) is the density considered in the locality where the emission occurs. Here the population density was taken as the average density in the prefectures, which the truck passes through on the way to Fukuoka from Yokohama. In case of marine transportation the average population density of the coastal prefectures was taken. The data of the area and the number of population were taken from ref. (10).

Table 5 Weighting factors according to Eco-indicator '99 and ExternE.

Compound or substance	Unit	Weighting factors by Eco-indicator '99	Weighting factors by ExternE (yen)	
			Truck	Cargo ship
Energy consumption	MJ	0.00343		
Heat radiation	MJ			
CO_2 emission	Ton	5.47	256.8	256.8
NO_X emission	Kg	2.76	428	428
SO_X emission	Kg	1.5		
Phosphorous emission	Kg			
Particulate matter	Kg	0.255	6795570	7853800

2.2 Economic Index

To find the economic superiority required freight rates (RFR) at 5% rate of return for the investment to the truck and the cargo ship were calculated and compared. RFR is the minimum freight rate required to meet the expected rate of return (i) on the principal investment or initial price (P) and the annual cost (C) within a specified length of period (N). Here annual cost includes the fuel cost, maintenance cost, crew cost, insurance etc. The RFR was calculated using the following equation[11),

$$RFR = \frac{\frac{P}{spw} + C}{L} \qquad (2)$$

Where, RFR=Required freight rate (yen/ton), P=Price of the transport or first cost (yen), C=Annual cost (yen), L=Amount of cargo carried (ton/year)

$$spw = \frac{(1+i)^N - 1}{i(1+i)^N} \qquad (3)$$

Where, spw=Series present worth factor, i=Rate of return, N=Number of year in operation

Series present worth factor, also called annuity factor, is the multiplier to convert a number of regular (annual) payments into the present sum.

2.3 Service Index

The service index is the ratio of the time required by the truck transport authority to that of the ship transport authority to serve the cargo owners. Here it was considered as the ratio of trip time shown in Table 1.

3. Results and Findings

The environmental destruction indices calculated by three valuation approaches are shown in Figure 2. Valuation by ExternE has shown the highest index of 5.81. That is, the truck transportation system in the mentioned model is 5.81 times detrimental to human life and the nature according to ExternE method. The Eco-indicator '99 has shown the lowest index of 3.62. Of course some compounds or substances like N2O, CH4, NH3, NMVOC, and land use, those are included in Eco-indicator '99, were not considered here because of unavailability of data. The index calculated by the methodology proposed by the authors got the value in between, which is 4.06. This value was based on the consumers' choice. Figure 3 shows the indices for economical and customer service performance of truck transportation system with compared to marine transportation system. In RFR consideration the truck transport is 17.97 times less attractive than marine transport for the task considered here. The only merit goes in favor of truck transports is the service time. Here this index is 0.83.

4. Uncertainties

There are a number of uncertainties involved in such study. It is very difficult to get the actual amount of emissions occur during the production and use of transports. Moreover these emissions vary according to transport type, operating condition, fuel type used, etc. The values of weighting factors also vary according to which impact category is given more importance by the decision maker.

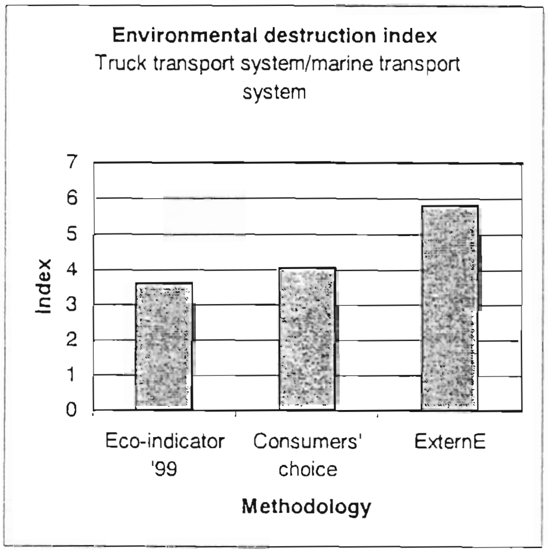

Fig. 2 Environmental destruction indices by three different valuation approaches.

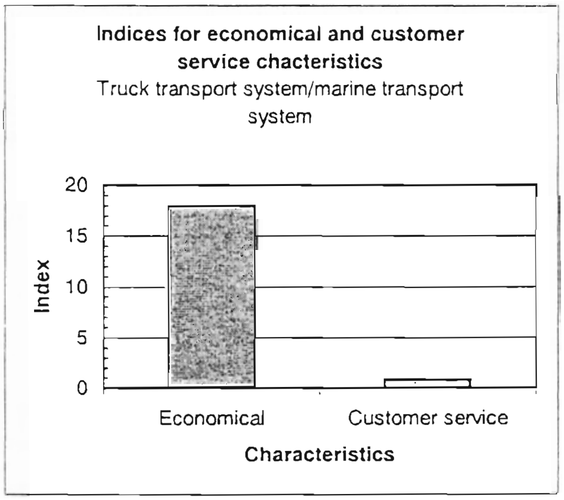

Fig. 3 Economic index and customer service index.

There are high uncertainties in forecasting the anthropogenic climate change. For example the global warming potential (GWP) estimated by IPCC[12] has uncertainty about +/- 35%. So, to implement the result of such studies, one should be aware of these uncertainties

5. Conclusions and Comments

The results found by the method of considering consumers' choice in finding the superiority of transportation system proposed by these authors showed a value laid in between the values found by Eco-indicator '99 and Externalities. This method has an advantage of considering the opinions of experts as well as general consumers.

The usual consumers ' view in choosing transport for their cargo shipment is giving priority to the freight rate and the time required for the shipment. The impact of the transport on the environment is not considered significantly by the general consumers. This is probably because of the lack of sufficient information available to the general consumers on the destruction made by the transports to the environment. If they were aware of the real scenario, it would be easy to convince them to use the transports less detrimental to the environment.

From 26 responses to a survey by the authors, it was found that 77% of the consumers were ready to choose marine transport in place of truck for their cargo shipment after providing the information that the truck is more than two times detrimental to the environment and about 18 times costlier, even though it was said 2 times faster. Only exceptions were mentioned in cases of shipping perishable goods and in urgent requirement. In a previous survey[1] by these authors, it was found that general consumers are ready to accept a certain amount of delay while shipping their goods.

The following conclusions can be made from this study that the marine transportation system -

-is more than 4 times less detrimental than the road transportation system from the view point of environmental destruction.

-provides attractive freight rate.

-is slower in customer service but within acceptable limit chosen by most of the general consumers.

Now it's the duty of the national leaders to take the decision to promote marine transportation system to reduce the cause behind the climate change. This will also help to implement the Kyoto Protocol[13], where Japan made a commitment to cut its own greenhouse gas emission by 6% below the 1990 level in the period 2008-2012.

This research may be continued in the following area -

-The environmental impacts due to cargo handling systems.
-The use of land area and the effects of noise exposure.
-The cost of traffic accidents.

6. Acknowledgements

The authors acknowledge the award of a Monbusho Scholarship to the first author. The authors also acknowledge the help of Prof. A. M. Fet of Norwegian University of Science and Technology, Norway and Prof. K. Nishiwaki of Ritsumeikan University, Japan.

References

1) Hasegawa K, Hamamoto H, Iqbal K S; Comparison of Land and Marine Transportation System from the view point of Life Cycle Impact Assessment. Journal of Kansai Society of Naval Architects, Japan, No.232, pp.219-225, 1999.
2) Hasegawa K, Iqbal K S; Inland Transportation System Planning by Life Cycle Impact Assessment: a case study. Journal of Marine Science and Technology, Vol. 5, pp. 1-8, 2000.
3) Fet A M, Michelsen O, Karlsen H; Environmental Performance of Transportation - A Comparative Study.ENSUS 2000, Newcastle upon Tyne, 2000
4) ISO. Environmental Management - Life Cycle Assessment - Life Cycle Impact Assessment. ISO/DIS 14042. International Organization of Standardization,1998.
5) Ciambrone David F; Environmental Life Cycle Analysis. Lewis Publishers, New York, 1997.
6) Saaty T L; The Analytic Hierarchy Process. McGraw-Hill International Book Company, USA, 1980.
7) Goedkoop M and Spriensma R; The Eco-indicator '99. A damage oriented method for life cycle impact assessment. Pre Consultants, Amersfoort, 1999.
8) ExternE. Externalities of Energy. http://externe.jrc.es/index.html, 1997.
9) Bickel P, Schmid S, Krewitt W, and Friedrich R; External Costs of energy conversion - Improvement of the ExternE methodology and assessment of energy related transport externalities. ExternE, 1999.
10) Statistics Bureau; Statistical Yearbook of Japan. Management and Coordination Agency, Government of Japan, 2001.
11) Buxton I L; Engineering Economics and Ship Design. British Maritime Technology Limited, UK, 1987.
12) Inter Governmental Panel on Climate Change (IPCC); Trace Gas Radiative Forcing Indices. http://www.ipccnggip.iges.or.jp/index.html, 1995
13) Kyoto Protocol; United Nations Climate Change Conference, Kyoto, Japan. http://www.unfccc.de/resource / docs / convkp/kpeng.htm, 1997

Discussion

[Discussion] (University of Kobe Mercantile Marine) Eiichi Nishikawa

I have read your paper with interest, which deals with difficult subjects to be considered scientifically. I wish your future progress, and if possible, would like to discuss together. Please explain the following three points.

1) You have compared three methodologies by total evaluation of three independent elements. The key point of comparing the three methodologies is how to decide the weighting factors of unique evaluation with different elements. What is the superiority of authors' proposed method "LCIA-AHP" compared with other two methods?

2) I would like to ask on the comparing condition concerning the trip time of trucks and ships.

- To estimate the cargo demand of the ship from the size and the condition, it requires in average 0.5 or 1 day idling time, because it trips 1 or 0.5 time a day.
- It (possibly a container ship) requires cargo handling at a stock-point and requires loading/unloading time. We, furthermore, have to consider that the origins of cargos are widely distributed. How do you think about the time required for shipping the cargo from the origins to the stock point? Isn't it necessary to take into account an additional time for above-mentioned reason for the case of ships?

3) I suppose you are treating container ships as ships. What is the TEU (Twenty-feet container Equivalent Unit) of the container, when you quote the ship of 5000 tons cargo capacity? How do you estimate or choose 12,000 PS main engine for her power? I appreciate your kind consideration.

[Author's Reply]

Please accept authors' thanks for your discussion. The replies to the questions are as follows:

1) In other two methods the weighting factors are monetary and damage values, those based on the value of life and property loss incurred by the damage to environment. These values were calculated with consideration of local or regional socio-economic condition, which may widely vary from developed country to developing countries. Experts may also differ in giving priority to one impact over other. In the methodology proposed in ref. 2), the authors considered all the opinions from experts as well as general consumers in the hierarchy process. This method can even take into account the hierarchy established by Eco-indicator '99 and Externalities with some adjustment. Thus, the proposed LCIA-AHP method can include opinions from different disciplines those may vary in giving priority to one impact over other.

2) The loading/unloading time required for the ship was considered according to Table 1. But the time required to collect the cargoes from widely distributed origins was not considered. It is a complex task to compare the additional time required to pile up the whole amount of cargo for ship, which is 2250 tons at 50% loading condition in this case. It was assumed that the cargoes were readily available at the stock point. Although the collecting time should be added with the trip time of the ship, the authors will still find enough margin available for ship's trip time, considering the allowance of delay acceptable by the consumers shown in the previous result in ref. 1.

3) The TEU of the ship was taken as 500, as mentioned in ref. 1. In fact the cargo should be considered of break-bulk-type, because these are to be collected from various sources. The engine power, which was taken as 12000 PS, was collected from the particulars of a real ship mentioned in ref. 1.

[Discussion] (University of Tokyo) Kato Yoichi

Please answer the following questions:

1) Which compound got the strongest influence?

2) If there were any mistakes in the emission data considered, how would you explain the results? What changes may occur in Fig.2 and Fig.3 in that case?

3) In economic part, is the loading and transfer cost considered?

4) What do you think about considering 'the use of land area'?

5) Why only the hierarchistic values were considered? What changes will take place in figures 2 and 3 if Egalitarian and Individualistic values are considered?

[Author's Reply]

Thank you very much for your questions. The replies to your questions are as follows:

1) In this study, among the impact categories air pollution got the highest share in the environmental index value. Particulate matter was the responsible substance for this. The global warming had the second highest share for which CO_2 was responsible.

2) The sensitivity of environmental index to the amount of emissions was shown in ref. 2. Fig. 2 will change with the change of amount of emissions according to the results shown in this reference paper. Since Fig. 3 is only concerned with economical and customer service aspects, there will be no change in this figure even if the amount of any emission changes.

3) Yes the loading and transfer cost according to Table 1 was taken in account while calculating the RFR. The number of labour required for loading and unloading was considered as 10 for ship and 2 for truck.

4) The use of land area could be one of the effective factors, which is now under consideration in ongoing research of the authors.

5) Using Egalitarian damage model the environmental index will be 3.64 and in case of Individualistic damage model this value will be 1.27. In the second case the particulate matter and energy consumption were not relevant, because these substances won't have any effect in the long run. Since in the Hierarchistic model, a balance has been made between Egalitarian and Individualistic models, the authors considered the hierarchistic values only.

[Discussion] (Ritsumeikan University) Kazuie Nishiwaki

Thank you for sending me a copy of your paper. I feel honored to see the acknowledgement to me in the paper. As I am not familiar with your area of research, I am sorry, I cannot give any comment on your paper from the technical point of view. But the result itself is interesting. From a general point of view, your work will be useful for the government to explore a transportation strategy. As the vehicle emissions regulation will even more stringent in the near future, it will be more useful for them if your next work takes into consideration the future diesel emission regulation which is already prepared. Hoping your presentation will be successful.

[Author's Reply]

Thank you very much for your discussion. In this paper the authors considered the available data from the existing transportation system for the comparison in order to establish and evaluate the proposed methodology. However as you pointed out, it will be helpful to estimate the future standing of the transportation system considering the new vehicle emission regulation. After establishment of the proposed methodology, it will be, of course, one of the tools for such qualitative evaluation of any change in the transportation system including tax or regulations. Thank you again for your valuable comments and encouragement.

[Discussion] (University of Abertay Dundee, Scotland) Peter Romilly

Your paper is very interesting, and similar in approach to my work in assessing the effects of bus for car substitution. I know that it is very difficult to estimate all the monetary costs and benefits of road versus sea transport, but one suggestion I have to complete your paper is to provide a monetary figure for the overall cost saving to society, if your 1500 tons of freight is carried by ships rather than trucks. Such an estimate would be very tentative, but it would give other researchers a basis for comparison. It might also be very useful for policymakers wanting to make a case for transferring freight from road to sea. I am forwarding your paper to Dr. Luc Int Paris in Belgium, who is also interested in this type of work.

[Author's Reply]

The authors would like to express cordial thanks to you. You are right. It will be quite important to compare, though it would be tentative, with overall cost saving to society by monetary figure. However, at this moment, the authors are afraid with this monetary value because this can only be a comparison with local or regional impact. Please refer to the reply 1) of Prof. Eiichi Nishikawa ' s discussion. Yet the authors are inspired and encouraged by your valuable suggestion for their next approach.

[Discussion] (Osaka Prefecture University) Yoshiho Ikeda

In your conclusion, it is written that the marine transportation system is slower but acceptable. Please explain the reason of saying ' acceptable'.

[Author's Reply]

Thank you very much for your discussion. It is a general tendency of consumers to choose faster transport within reasonable expenses while shipping their goods. The faster speed and the ease of door to door service attract people towards the road transport for shipping. But a previous survey conducted by the authors of this paper showed[1] that the consumers are ready to accept a certain amount of delay in shipping their goods. For example, more than 60% people agreed to allow 8 hours additional time to the estimated required time of 24 hours for the shipment. Taking this result in account, the authors concluded that though the marine transport is taking 6.85 additional hours in this model case, this delay will be acceptable by the general consumers.