Factors of choosing port to call for shipping companies based on Analytic Hierarchical Process

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Abstract: When deciding ports to call for shipping companies, many factors such as cargo demand, level of service in port facilities and terminals, convenience in scheduling may be taken into account.
However, when developing a model to simulate carrier's port choice behavior for the purpose of port policy evaluation such as by the author (Shibasaki et al, 2005), factors that cannot be transformed into transportation cost or time tend to be ignored. Therefore, in this research, the author estimates a weight of each factor in choosing port to call for better understanding their behavior, by applying Analytic Hierarchical Process (AHP) proposed by Saaty (1980), based on the results of interview survey to Japanese shipping companies including containership, international ferry and RORO ship.

Key Words: *AHP, estimates a weight of each factor in choosing port, containership, international ferry and RORO ship*

1. Introduction

In recent years, since the 90's, accelerated growth in international cargo movement has been seen due to economic globalization accompanied by economic growth in developing countries in Eastern Asia. Furthermore, an increase in international logistics for future will be expected in response to an increased demand for products in Asian countries as called world factory, due to economic growth in the emerging countries in other region than Eastern Asia such as Middle East and Africa. In this situation, the ports in Eastern Asian region are promoting improvements in port facilities such as berths with greater depth, so that they meet higher standards to enable mass transportation of large containerships with a higher logistical efficiency. Since in Japan, 99% of resources and goods are imported or exported through seaports, there are many foreign trade port in Japan. Though, some of them are selected as Japan's Hub Ports for foreign trade, and under promoting improvement, but severe competition from ports in Eastern Asian countries with higher standards is anticipated. However, the improvement of port facilities requires a great deal of money and a long construction period. Therefore, it is essential to analyze and estimate the trends of port

demand to accurately conduct effective investment and port sales.
The cargo demand of port has been analyzed based on statistical data such as trade and maritime transport statistics that reflect the port choice behavior of shipping companies and shippers, as well as operation costs including vessel's cost, fuel cost, port associated costs, waiting time due to port congestion and anchoring time. Actually, such information was mainly obtained from the results of interview surveys from Japanese shipping companies. Based on such analyses, models are developed with costs and time as explanatory variables, then, an optimizing calculation is performed under the principle of cost minimization and profit maximization. However, in these models, factors such as level of service in related facilities including logistics warehouses, situation of competition with other companies, long-term strategy of shipping companies, which cannot be converted into money, tend to be ignored. In this case, understanding quantitatively how much shipping companies and shippers relatively emphasize these factors would be very useful, not only to enhance the accuracy of the model simulation, but also to review the items to be improved and discuss priority in the long-term port planning.
Therefore, in this research, the decision-making factors for the ship allocation of the shipping companies have been investigated by estimating the weight of each factor quantitatively. The sampled shipping companies are divided into containership and international ferry/RORO ship companies and the decision-making factors are set based on the results of an interview survey with shipping companies. Based on the interview survey results, a questionnaire investigation is performed with shipping companies and each factor is evaluated by means of applying an Analytic Hierarchical Process (AHP).

2. Related Literature Review

A lot of research concerning the port choice behavior of shipping companies and shippers has been performed recently. Reviews of the models on the behavior of shipping companies are summarized in Christiansen et al. (2004 and 2007). Meanwhile, examples of the model on the behavior of shippers are shown in Malchow and Kanafani (2001), Dai (2001), and Itoh et al. (2002). Also, for example, Shibasaki et al. (2005) developed a model considering both behaviors. In these researches, it has been confirmed that cargo handling ability, number of ships to call at the port and frequency, freight charges, port charges and safety of port are the important factors. Therefore, quantification of the relative weight of each factor in the choice of ports to call is certainly an important research for effective port investment, long-term planning and policy simulation. From this viewpoint, for the attempt at quantification of such factors, Wong et al. (2008) estimates weight of transportation modes including maritime, road, and rail transportation by means of applying AHP, based on the results of the questionnaire to shippers in the Pearl River Delta, Guangdong Province, China. There is also a research of the attractiveness evaluation of ports to call, with the sightseeing factors around the ports to call and convenience of ports, based on the results of the questionnaire in particular for cruise ship companies (Shibasaki et al, 2008). However, there are few researches conducted from this viewpoint, as far as the authors know.

3. Research methodology

3.1 Selection of shipping companies

This research aims at weight evaluation of decision-making factors for ship allocation by means of applying AHP.
In AHP, first the hierarchical structure consisting of "Objective", "Evaluation" and

"Alternative" layers is set up. Then, the weight of the "Evaluation" (here, the decision-making factors for the ship allocation) and the weight of "Alternative" (here, each port to call) are determined based on the results of the questionnaire given to the experts. AHP has the merit that it does not need a lot of samples. On the other hand, which items are selected for the evaluation, influences the results greatly. Therefore, for the criteria setup, it would be desirable to review them elaborately, based on the results of the questionnaire given to decision-makers and experts.
In this research, after the shipping companies were divided into two types; containership and international ferry/RORO ship companies, and the interview survey to them was performed, the evaluation criteria were set up. Also, the questionnaire investigation asking the weight for them was conducted, for each type company with a sample of few persons in two shipping companies. The results of the questionnaire are shown in Table 1.

Table 1 Results of Questionnaire

Ship Type	Shipping Company Name	No. of Samples	Remarks
Containership Company	Company A	1	Investigation Period: Jan. 19 to Jan. 31, 2009 For Company A, as the results are summarized as the answer of company A, the No. of samples is turned to be one.
	Company B	3	
RORO Ship/Ferry Company	Company R	4	
	Company F	4	

3.2 Summary of the interview survey

Based on the results of the questionnaire to the containership companies, the most important factor for deciding the region and port to call is cargo demand. Then, the frequency of cargo shipping (times per week) or scheduling for the operation route are considered to determine the number of ships to be allocated. At the same time, the ship type is decided in consideration of depth of the quay and the sea route. Finally, considering the number of days required for one loop of a voyage, the number of ports to call is set up. For a port handling a small amount of cargo, the service using feeder ship is provided. Based on the information about the port congestion and terminal service level, calling or skipping is finally determined.
For international RORO ship/Ferry companies, the companies where this interview survey was performed, do not select two or more ports of call, unlike containership companies. They basically perform a"1 Port to 1 Port" transportation operation. Because of this, as the results of the interview survey giving them the condition that the development of a new route is assumed, they answered that the decision-making is done basically with the same process as that in the containership companies. However, for the ferry company, as it also transports passengers, factors such as sightseeing spots in the hinterland, would be also important.

3.3 Evaluation criteria

The evaluation criteria (decision-making factors of the ship allocation for shipping companies) is set up based on the results of an interview survey, which are shown in Table 2.

Table 2 Evaluation Criteria Details

Evaluation Layer Level 1	Evaluation Layer Level 2	Description
Cargo Demand	Scale of shipper	Conditions for the stable cargo business factors such as the No. of shippers, their business scale, distance between the shipper to the port, etc.
	Logistics Facilities	Convenience factors such as logistics warehouse, inland depot, etc.
	Access/Egress to port	Accessibility to artery roads or highways and proximity to airports or railways
	Long-term strategy	Development ability to the general distribution business and in the case that it is selected for business development
Routing	Distance between ports	Facilitated scheduling depending on the distance between ports of call (increase/decrease of the No. of assigned ships)
	Competition with other companies	Competitor shipping companies or alliance
	Influence from other routes	Influence from other routes such as ship assignment, etc.
	Total cost	Balance between incoming and outgoing (one-way cargo transport, empty container, chassis), transshipment charge, fuel charge, etc.
Terminal	Efficiency of handling	Efficiency of handling affecting lead-time, such as the basic No. and capacity of gantry cranes and cargo handling equipment
	Terminal service	Factors associated with carry-in or carry-out time limitation including terminal operation time and gate open/close time
	Administration service	Bounding or custom clearance procedure time limitation, exceptional preferential treatment
	Storage capacity	Storage space area, No. of box stacks, arrangement and handling availability at the peak time
	Terminal charge	Terminal charge and monetary preferential treatment, etc.
	Handling charge	Cargo handling charge and monetary preferential treatment, etc.
Port Facility	Level of service of port	Conditions related to the service level of port such as scale of quay and route (drift limitation), etc.
	Convenience of port	Easy scheduled service conditions such as port congestion, route control, Calmness of water of the port, etc.
	Prioritized usage of berth	Exclusive berth or preferential treatment to use public berth
	Safety of port	Public order and social conditions around the port of call: security of the port, cargo stoppage possibility due to strike, etc.
	Port charge	Port charge and monetary preferential treatment
Attracting Passengers (Only for ferry)	Tourist resources	Property of tourist sites such as natural or historical sites, and the No. of sight-seeing spots
	Population of the area around the port	Market scale of the area around the port, such as population
	Terminal attractiveness	Accessibility of terminals, improvement of the facilities and surrounding landscape
	Cooperation system in the area	Installation of guide sign to the terminal or PR cooperation, etc.

4. Hierarchical Structure in AHP

The hierarchical structure set up based on the results of the interview survey is shown in Figure 1 and Figure 2 for containership and RORO ship/ferry companies respectively. The top layer of this hierarchical structure is the “Decision of Calling Port”, which is the purpose of the decision making. In the middle layer the evaluation criteria are shown. These are the decision factors for the ship allocation of shipping companies. The evaluation criteria described in Table 2 are set up in the two levels. The bottom layer is referred to as the “Alternative Layer”, and in this research the optional ports (each port to call) are included. The optional ports are chosen from the ports that have been used before, based on the results of interview survey. The ports dealt with in this research are shown in Figure 3. The number of optional ports is fixed to two for each questionnaire, so as not to increase the load of the respondents of the questionnaire investigation.

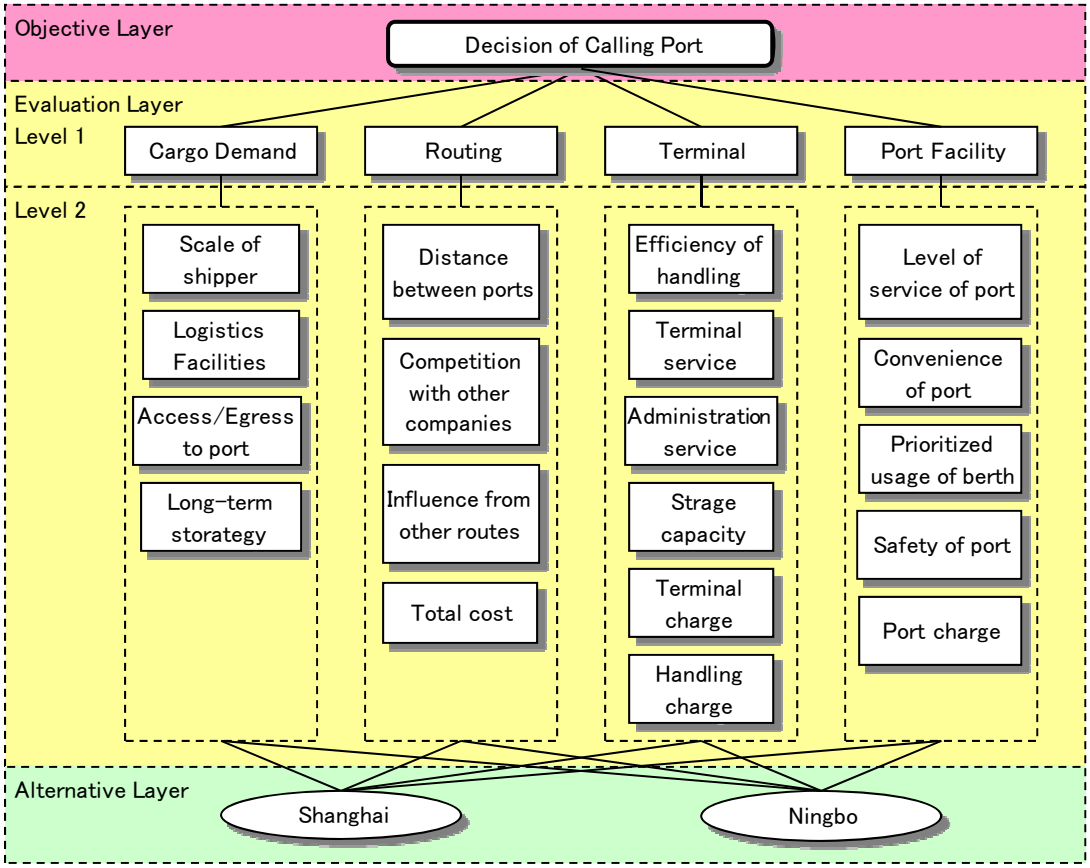


Figure 1 Hierarchical Structure in AHP in this Research
(Example of containership-choice of Alternative; Shaghai/Ninbo)

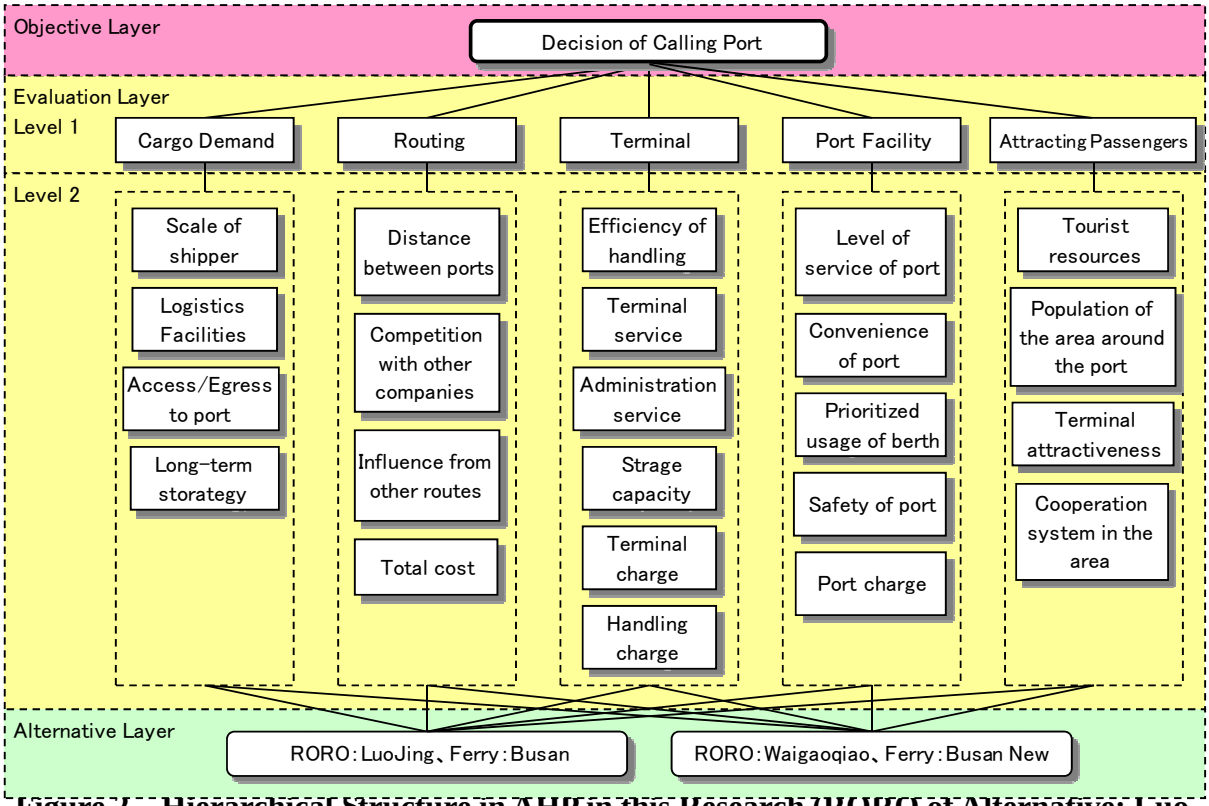


Figure 2 Hierarchical Structure in AHP in this Research (RORO of Alternative; Luo Jing Port/Waigaoqiao Port, Ferry of Alternative; Busan Port/Busan New Port)

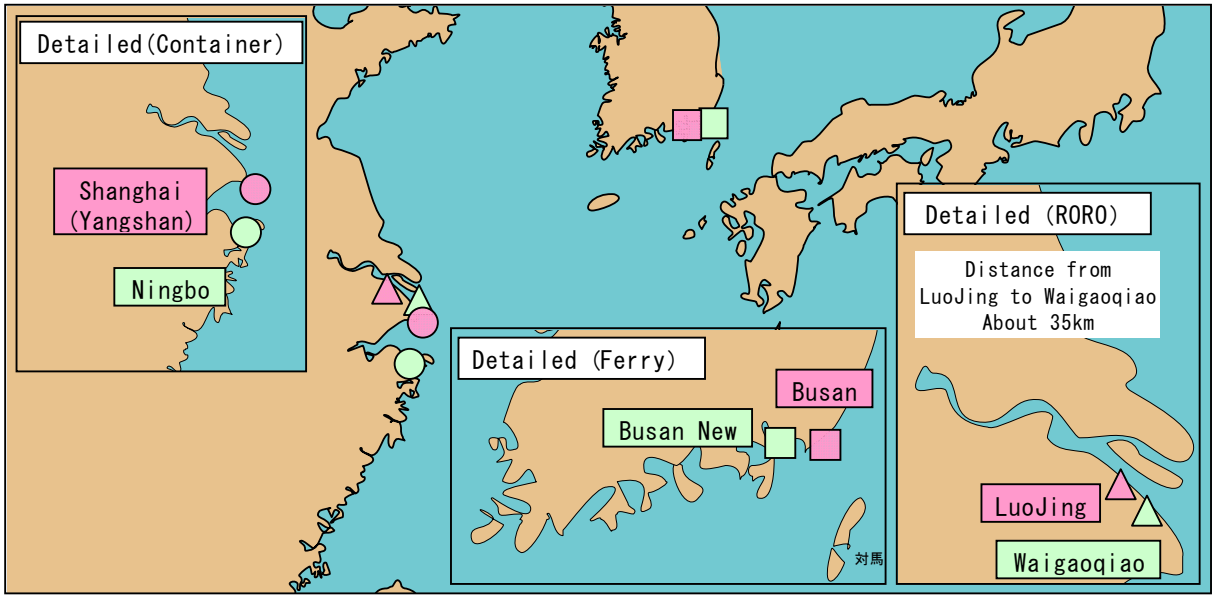


Figure 3 Alternative Ports of Call

5. Weight Estimation for the Ship Allocation Factors based on AHP

The weight estimation was performed with paired comparisons, based on the results of questionnaire. The estimation results for the containership companies are shown in Figure 4 and Table 3 and for the RORO ship/Ferry companies are shown in Figure 5 and Table 4.

5.1 Weight Estimation results for the Evaluation criteria

5.1.1 Container Ship

5.1.1.1 Weight in Level 1

In the weight estimation results for Level 1 shown in Figure 4 and Table 3, the weight is higher in “Cargo Demand” and “Routing” in this order and the weight is lower in “Terminal” and “Port Facility” compared to the above two factors for both companies. From the result, it is assumed that the shipping companies emphasize the factors related to cargo amount and number of ships to be used, because these factors directly related to income and expenditures.

On the other hand, focusing on the weight differences between the two companies, the weight difference between “Routing” and “Cargo Demand” of Company A is smaller than that of Company B. In addition, Company A emphasizes “Port Facility” more than “Terminal”, which is also a different point from that of Company B. In considering the weight differences between two companies, it can be said that because Company A highly emphasizes the efficient ship allocation, it estimates the weight of “Routing” and “Port Facility” much more than Company B. Meanwhile, it can be also said that because Company B emphasizes the efficiency of cargo handling much more than Company A, the weight of “Cargo Demand” and “Terminal” of Company B is higher than that of Company A.

5.1.1.2 Weight in Level 2

For the weight in Level 2, among the breakdown items of “Cargo Demand”, Company A emphasizes “Scale of Shipper”, while Company B emphasizes “Long-term Strategy”. Combining the above results in Level 1, it can be understood that Company B emphasizes the present cargo volume and its future increase.

For “Routing”, as Company A seems to emphasize efficient ship allocation, the weight of “Competition with other companies” and “Influence from other routes”, is higher than that of Company B.

Also, among the breakdown items of “Terminal”, both companies emphasize “Handling charge”. Among the breakdown items of “Port Facility”, the weight of “Prioritized usage of berth” is the highest for both companies. Among them, the fact that in Company A, the weight of “Safety of port” which directly influences the operation schedule is relatively higher than the other factors is underpinned the inference that it emphasizes the efficient ship allocation much more.

Here, for assessing the consistency of the analysis results, the C.I. value is proposed by Saaty (1980). Generally, based on the accumulated research results, it is said that when it exceeds the range from 0.1 to 0.15, it should be analyzed again from the first phase of hierarchical structure building and questionnaire investigation while the C.I. value is “0”, it is perfectly consistent. In this research, the C.I. value obtained from the results of both companies, is 0.1 or less, which is highly consistent, although it may be caused partly because the number of questions was small.

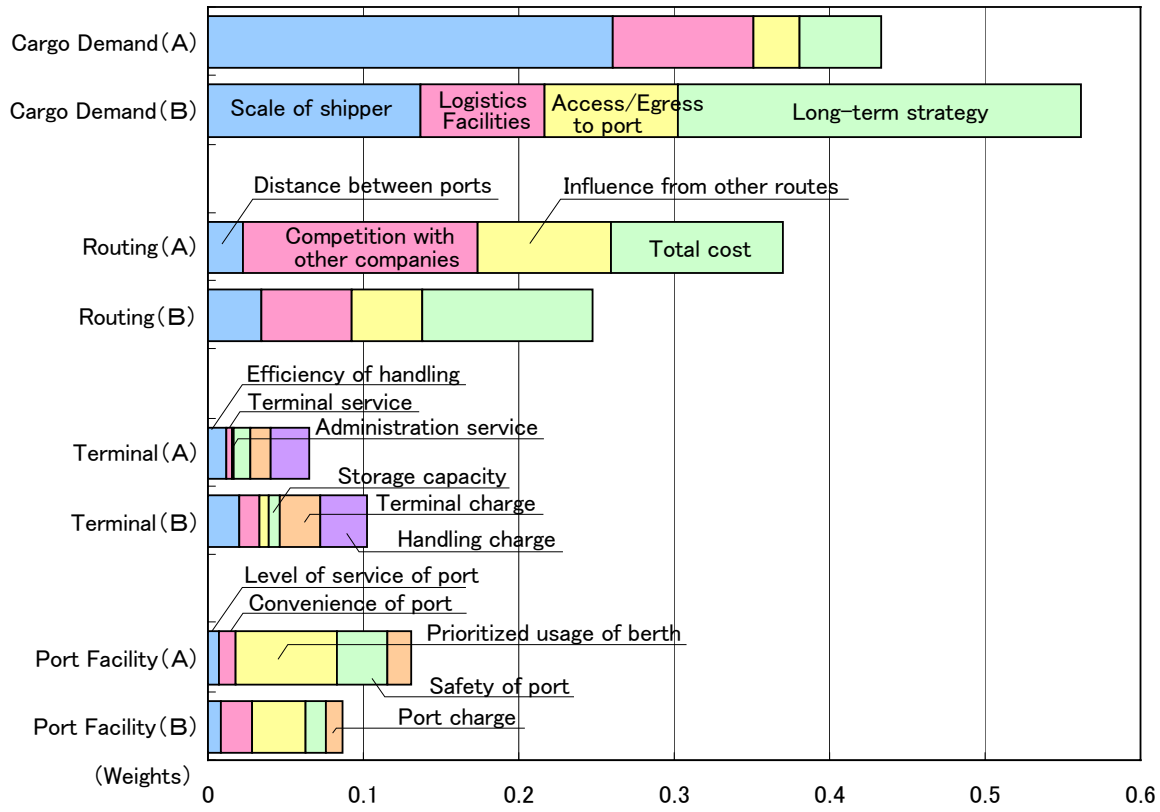


Figure 4 Weight Estimation Results for the Evaluation Criteria (Containership)

Table 3 Weight Estimation Results (Order) for the Evaluation Criteria (Containership)

Evaluation Criteria Level 1	Evaluation Criteria Level 2	Company A	(Order)	Company B	(Order)
Cargo Demand	Scale of shipper	0.261	(1)	0.137	(2)
	Logistics Facilities	0.090	(4)	0.079	(5)
	Access/Egress to port	0.030	(9)	0.086	(4)
	Long-term strategy	0.052	(7)	0.259	(1)
Routing	Distance between ports	0.022	(11)	0.034	(9)
	Competition with other companies	0.152	(2)	0.059	(6)
	Influence from other routes	0.086	(5)	0.045	(7)
	Total cost	0.110	(3)	0.110	(3)
Terminal	Efficiency of handling	0.012	(14)	0.020	(13)
	Terminal service	0.003	(18)	0.014	(14)
	Administration service	0.002	(19)	0.006	(19)
	Storage capacity	0.010	(16)	0.007	(18)
	Terminal charge	0.013	(13)	0.026	(11)
	Handling charge	0.025	(10)	0.030	(10)
Port Facility	Level of service of port	0.008	(17)	0.009	(17)
	Convenience of port	0.011	(15)	0.020	(12)
	Prioritized usage of berth	0.065	(6)	0.035	(8)
	Safety of port	0.033	(8)	0.012	(15)
	Port charge	0.015	(12)	0.012	(16)

5.1.2 International RORO Ship/Ferry

5.1.2.1 Weight in Level 1

The weight estimation results of Level 1 for international RORO ship and ferry are shown in Figure 5 and Table 4. Although there is the factor of “Attracting Passengers” only for the ferry company, the weight calculation results are adjusted to be able to compare with the results for remaining 4 factors. In a RORO ship company, the weight is higher in the factors “Cargo Demand”, “Terminal”/“Port Facility”, and “Routing”, respectively. In a ferry company, the higher factors are “Cargo Demand”, “Attracting Passengers”, “Routing”, “Port Facility” and “Terminal” respectively.

Because the RORO ship company sampled in this research compete with containership companies on its route as mentioned later in 5.2, the cargo transportation speed seems to be important to ensure its advantage against containership transport, compared to the other ship companies. Therefore, the importance of the factors “Terminal” and “Port Facility” which are related to the availability of scheduled service (arrival in time), is higher than that of the factors “Routing”.

For the ferry company, the weight of “Attracting Passengers” is high, while most of their revenue comes from cargo transport. Also, in the interview survey, the ferry departure and arrival times are set with paying attention to the convenience of passengers. Properly, like RORO ship company, the weight of the factors related to the availability of scheduled service should be higher, from the viewpoint of paying attention to the convenience of the passengers. However, because the ferry company transports passengers, preferential treatment (one of which is the prioritized usage of berth) is given by regional government to prevent passengers’ waiting time. Therefore, since the ferry company might consider the factors of “Port Facilities” and “Terminal” as having been already achieved, such factors would be dismissed.

5.1.2.2 Weight in Level 2

Regarding the weight in Level 2, in the breakdown items of “Cargo Demand”, the weight of the factors “Logistics Facilities” and “Access/Egress to Port” are higher in the ferry company than in the RORO ship company. This might be because the storage yards around the terminal currently used by the ferry company are separated, and because they take accessibility for the passengers into account.

Also, because the ferry company in the question gets preferential treatment from the public sector, as mentioned before, the factors such as “Terminal”, “Administration Service”, “Convenience of port” and “Prioritized usage of berth”, are regarded as less important and lower in the weight.

The C.I. value is 0.1 or less which shows high consistency like in the results of containership companies.

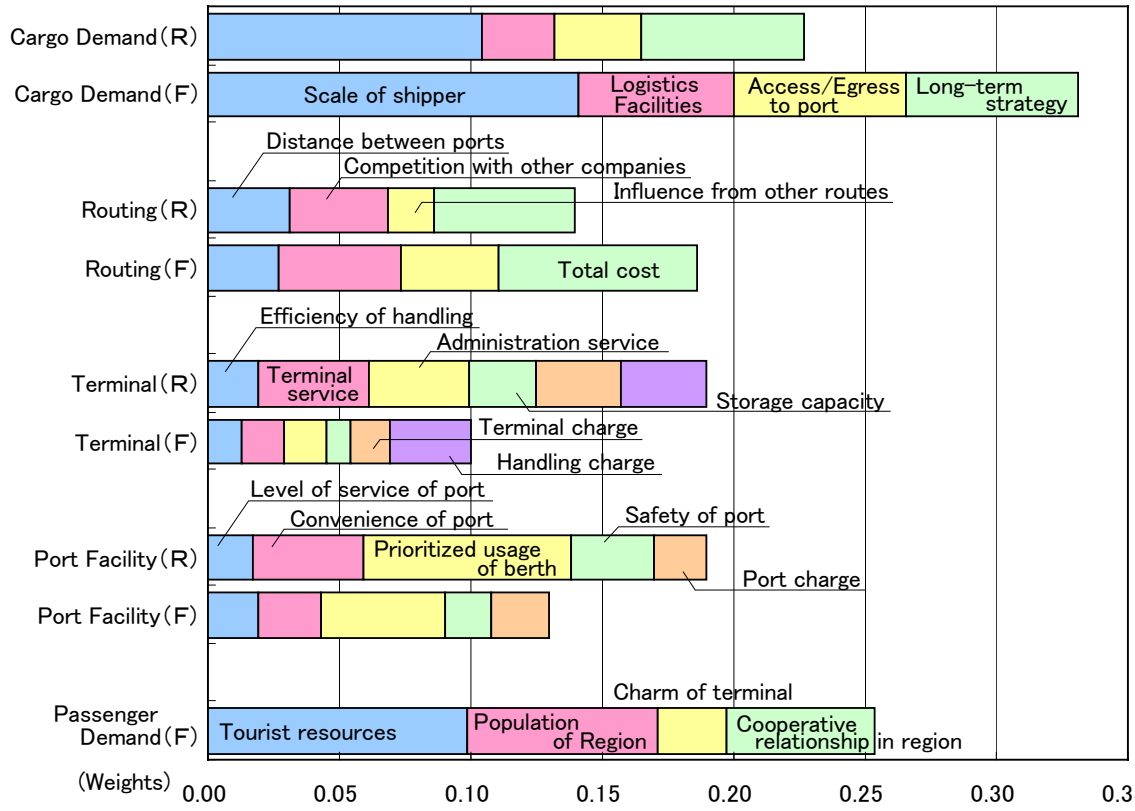


Figure 5 Weight Estimation Results for the Evaluation Criteria (RORO Ship/Ferry)

Table 4 Weight Estimation Results (Order) for the Evaluation Criteria (RORO Ship/Ferry)

Evaluation Criteria Level 1	Evaluation Criteria Level 2	RORO Ship	(Order)	Ferry	(Order)
Cargo Demand	Scale of shipper	0.458	(1)	0.425	(1)
	Logistics Facilities	0.122	(16)	0.180	(13)
	Access/Egress to port	0.145	(13)	0.197	(11)
	Long-term strategy	0.275	(4)	0.198	(10)
Routing	Distance between ports	0.222	(7)	0.145	(18)
	Competition with other companies	0.264	(5)	0.248	(7)
	Influence from other routes	0.131	(15)	0.203	(9)
	Total cost	0.383	(3)	0.404	(2)
Terminal	Efficiency of handling	0.101	(18)	0.128	(21)
	Terminal service	0.221	(8)	0.162	(16)
	Administration service	0.203	(9)	0.163	(15)
	Storage capacity	0.132	(14)	0.089	(23)
	Terminal charge	0.172	(11)	0.148	(17)
	Handling charge	0.172	(10)	0.309	(5)
Port Facility	Level of service of port	0.090	(19)	0.144	(19)
	Convenience of port	0.223	(6)	0.189	(12)
	Prioritized usage of berth	0.414	(2)	0.362	(4)
	Safety of port	0.168	(12)	0.134	(20)
	Port charge	0.104	(17)	0.171	(14)
Attracting passengers	Tourist resources			0.387	(3)
	Population of the area around the port			0.286	(6)
	Terminal attractiveness			0.102	(22)
	Cooperation system in the area			0.224	(8)

5.2 Weight Estimation results for the Alternatives

5.2.1 Containership: Shanghai Port/Ningbo Port

The weight estimation results for Alternatives are shown in Figure 6 and the general evaluation results for Alternatives are shown in Figure 7. Here, the general evaluation results combined the weight estimation results for the evaluation criteria and for the alternatives.

Company A that emphasizes efficient ship allocation, assesses that there is not difference in the weight of factors except for “Cargo Demand” and “Access/Egress to Port”, both in Shanghai and Ningbo ports. These results reflect the fact that the distance each to Shanghai Port and Ningbo Port is short, so the number of days required for a voyage is no different for both ports and that the port facilities have been improved to some extent.

On the other hand, the weight evaluation results of Company B for “Logistics Facilities”, “Long-term strategy”, “Efficiency of handling” and “Convenience of Port” are different from those of Company A.

In this research, the Yanshan terminal has been designated as an alternative to Shanghai Port. Because the Yanshan terminal is connected to Shanghai city with the Donghai Bridge with the length of 32.5km, the factor of “Access/Egress to port” is dismissed by both companies.

However, the Yanshan terminal is currently in the developmental phase and extension work is being performed, the function improvement of the port facilities and the increase of the cargo amount handled are expected in the future. As Company B emphasizes the cargo to be handled and future business possibility more, it would be supposed that they evaluated the factors on the assumption of the completion of the Yanshan terminal improvement work.

In the general evaluation results, based on the weight estimation results for the evaluation criteria as mentioned before and above mentioned weight estimation results for Alternative, it has been decided that Shanghai port stands at an advantage.

5.2.2 RORO Ship: Luo Jing Port/Waigaoqiao Port

The weight estimation results for Alternative are shown in Figure 8 and the general evaluation results are shown in Figure 9. For the factor “Distance between ports”, Waigaoqiao port is evaluated higher. For the factors “Terminal charge”, “Handling charge” and “Port charge”, there is no difference in the evaluation for Luo Jing port and Waigaoquao port. For the other factors, Luo Jing port is highly evaluated.

RORO ship company originally used Waigaoquiao port. In spite of the fact that the cargo freight for RORO ships is higher than those for containerships, they had acquired customers because the ships arrived in port on schedule and lead time is shorter, when compared to containerships. However, in Waigaoquiao port, due to severe congestion of the port, they frequently arrived at the port late. Because of this, RORO ship company changed the port to Luo Jing port with less congestion in April 2008 in order to operate on the scheduled time, regardless of the distance on the sea becoming longer. The weight estimation results for Alternative and general evaluation results reflect such situations and it has been estimated that Luo Jing port stands at an advantage.

5.2.3 Ferry: Busan Port/Busan New Port

The weight estimation results for Alternative are shown in Figure 10 and the general evaluation results for Alternative are shown in Figure 11. Busan New Port was constructed to eliminate chronic congestion in Busan Port. The results of ferry company shows that Busan New Port stands at an advantage especially in terms of “Long-term strategy” and “Storage capacity”. Therefore, the weight estimation results would reflect the large potential capacity in Busan New Port for cargo handling.

However, Busan New Port is mainly designed to be suitable for container cargo, and usage by passenger ships is not taken into account in principle. This port is also not suitable for

passenger use from the viewpoint that it is far from the city and there is no access means to the city for passengers. Due to the above reasons, the weight of Busan Port is estimated higher in the factors of “Access/Egress to port”, “Convenience of port” and “Attracting passengers”.

In the general evaluation results, based on the weight estimation results for evaluation criteria as mentioned before and from the viewpoint related to above mentioned factor “Attracting passenger”, it has been decided that Busan Port stands at advantage.

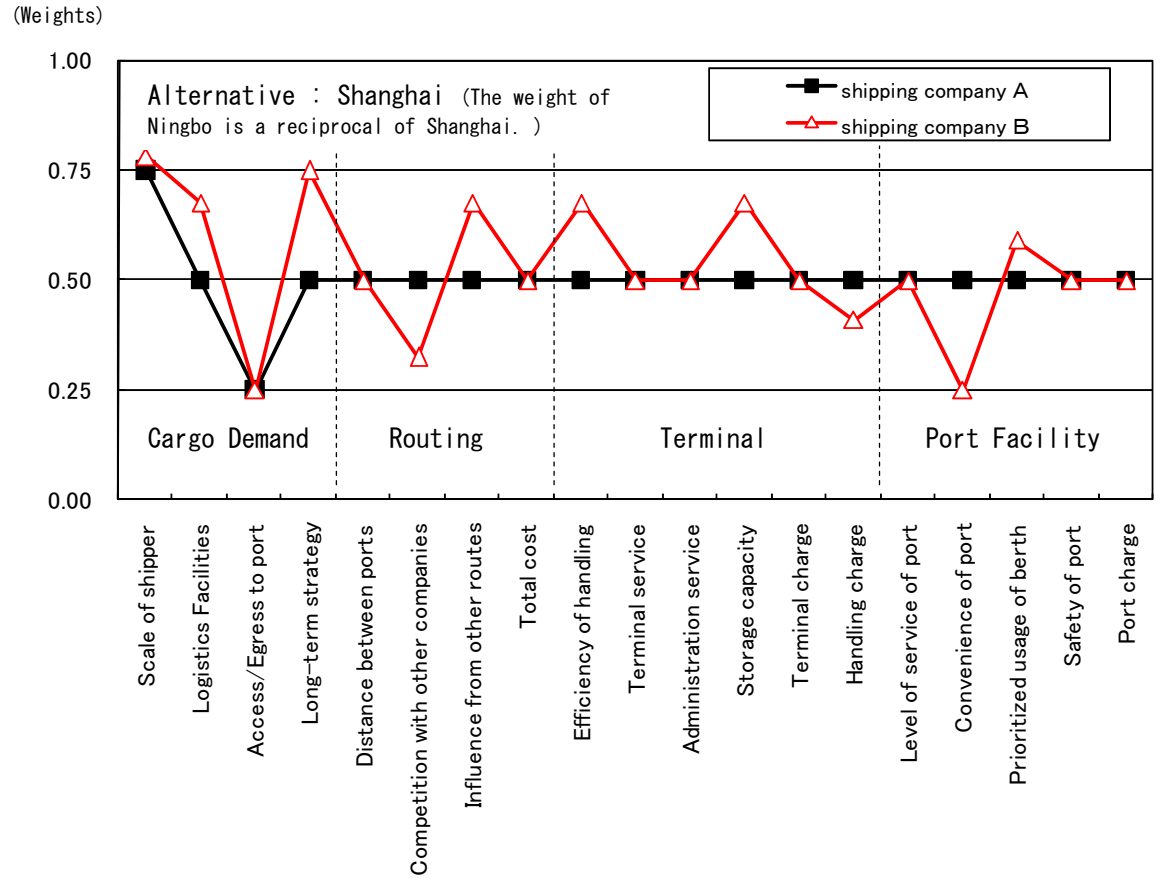
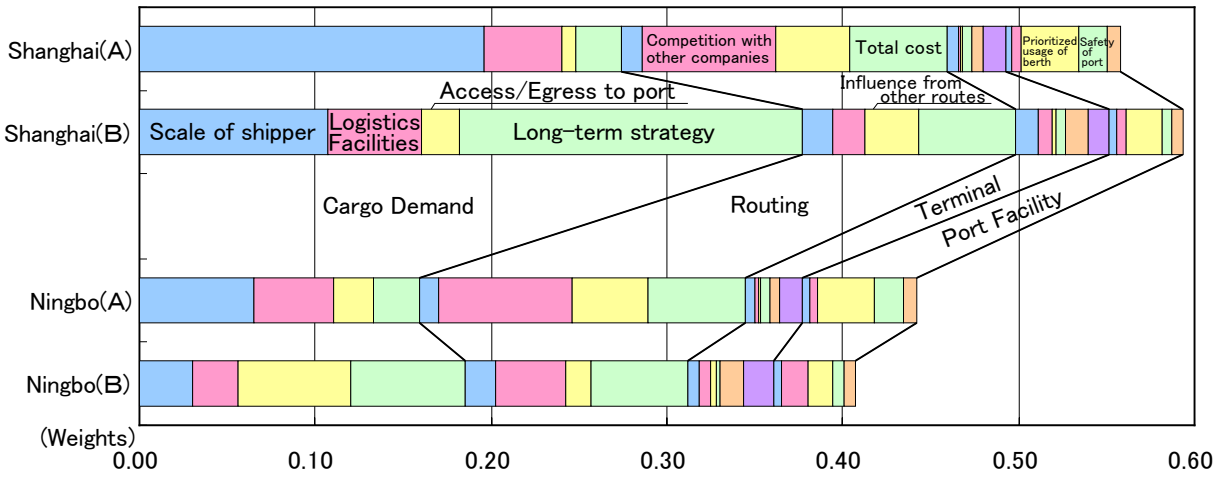


Figure 6 Weight Estimation Results for the Alternatives (Containership)



Remarks

Evaluation Criteria Level 1	Evaluation Criteria Level 2					
Cargo Demand	Scale of shipper	Logistics Facilities	Access/Egress to port	Long-term strategy		
Routing	Distance between ports	Competition with other companies	Influence from other routes	Total cost		
Terminal	Efficiency of handling	Terminal service	Administration service	Storage capacity	Terminal charge	Handling charge
Port Facility	Level of service of port	Convenience of port	Prioritized usage of berth	Safety of port	Port charge	

Figure 7 General Evaluation Results for the Alternatives (Containership)

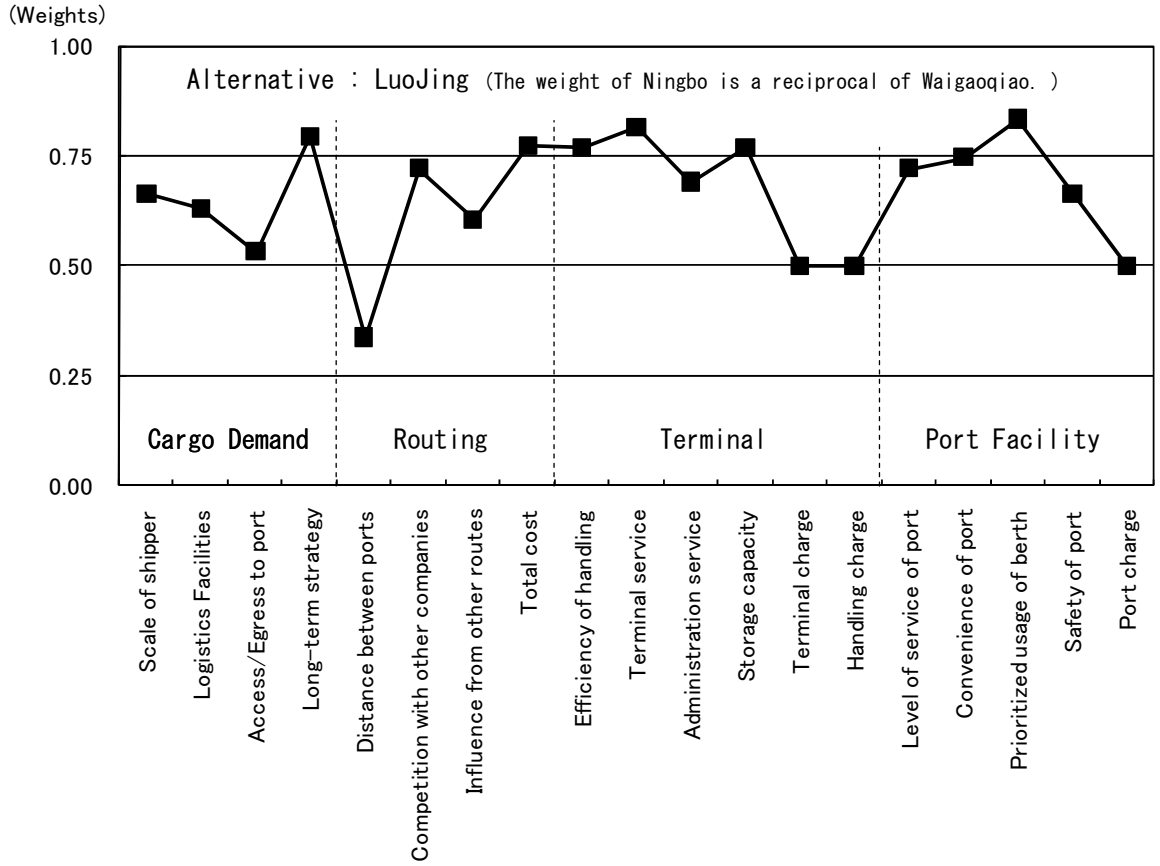
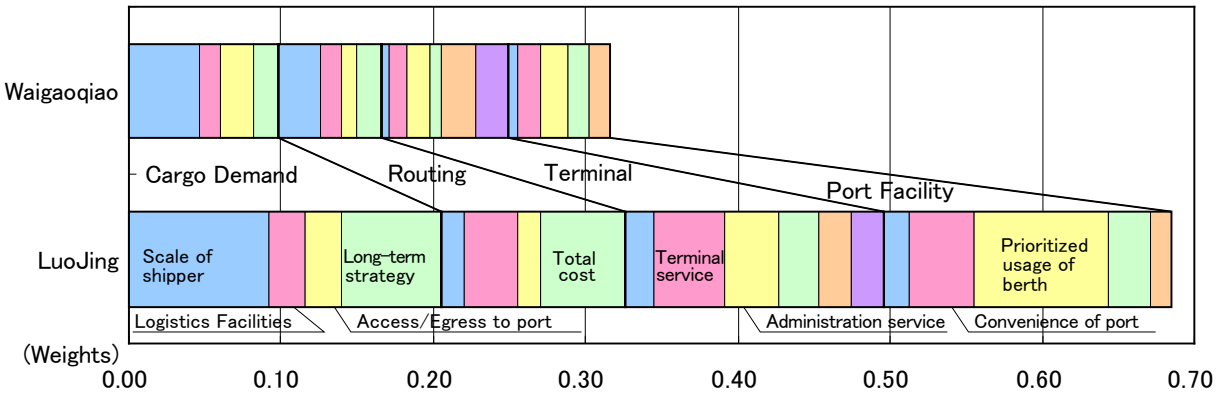


Figure 8 Weight Estimation Results for the Alternatives (RORO Ship)



Remarks

Evaluation Criteria Level 1	Evaluation Criteria Level 2					
Cargo Demand	Scale of shipper	Logistics Facilities	Access/Egress to port	Long-term strategy		
Routing	Distance between ports	Competition with other companies	Influence from other routes	Total cost		
Terminal	Efficiency of handling	Terminal service	Administration service	Storage capacity	Terminal charge	Handling charge
Port Facility	Level of service of port	Convenience of port	Prioritized usage of berth	Safety of port	Port charge	

Figure 9 General Evaluation Results for the Alternatives (RORO Ship)

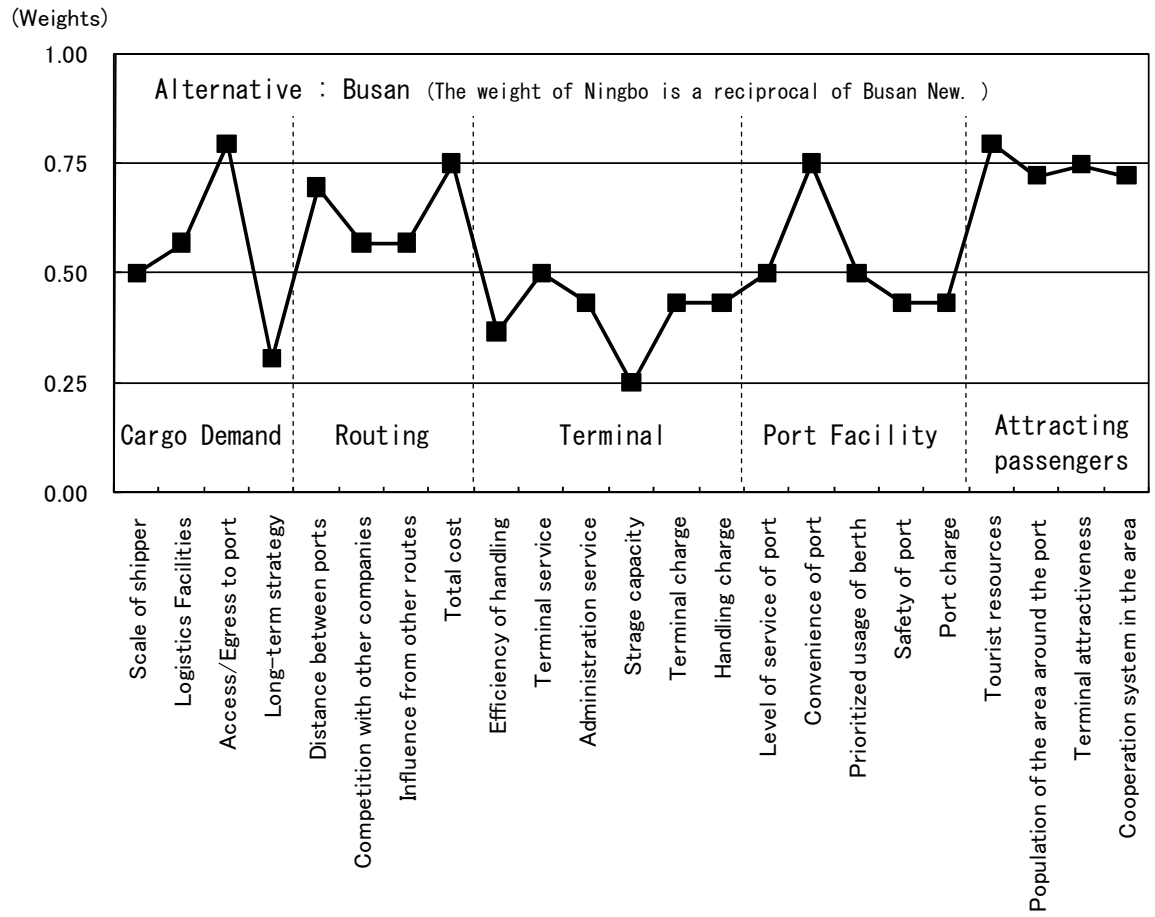
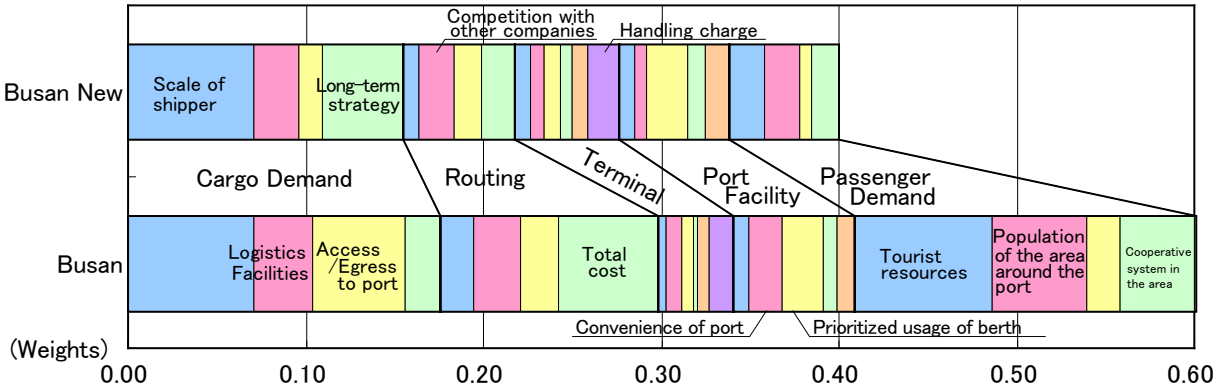


Figure 10 Weight Estimation Results for the Alternatives (Ferry)



Remarks

Evaluation Criteria Level 1	Evaluation Criteria Level 2					
Cargo Demand	Scale of shipper	Logistics Facilities	Access/Egress to port	Long-term strategy		
Routing	Distance between ports	Competition with other companies	Influence from other routes	Total cost		
Terminal	Efficiency of handling	Terminal service	Administration service	Storage capacity	Terminal charge	Handling charge
Port Facility	Level of service of port	Convenience of port	Prioritized usage of berth	Safety of port	Port charge	
Attracting Passengers	Tourist resources	Population of the area around the port	Terminal attractiveness	Cooperative system in the area		

Figure 11 General Evaluation Results for the Alternatives (Ferry)

6. Conclusion

In the estimation results, all containership companies and international RORO ship/Ferry companies selected “Cargo Demand” as the most important factor in the ship allocation. This is a natural conclusion because their choices are based on economic activities in principle. On the other hand, it is found that the factors “Port Facility” and “Terminal” have weight to some extent in the decision making of such companies.

Also, the relative relationship (quantitative weights) with the policy for hardware and software to be considered is estimated.

Moreover, while the containership companies emphasize the factors “Cargo Demand” and “Routing” that are connected directly to income and expenditures, for the RORO ship company, the weight of “Terminal” and “Port Facility” related to the availability of scheduled service, is relatively higher. It is because RORO ship company collect cargo by means of securing the scheduled operation compared to containership companies. In addition, in the ferry company, the weight of the factor “Attracting Passengers” is high nevertheless most of their revenue comes from cargo. Such differences in decision-making factors for ship allocation, depending on the ship type, can be shown in this research.

The results of this research are useful as an indicator of what is required in the current port facilities and services, and what should be improved with higher priority when planning the long-term strategy of ports. Also, it will be very useful to understand port choice behaviors of shipping companies and develop a simulation model .

In the future, there are needed to increase samples of shipping companies and improve the methodology to evaluate the weights. In addition, the method of converting the weights quantified in this research into monetary terms will be also reviewed to obtain the effects of the investment in the port facilities.

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