AN EASTERN ASIAN PORT CHOICE MODEL OF INTERNATIONAL CONTAINER CARGO FLOWS IN ASIAN AND PACIFIC REGION

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Abstract: This paper analyzed the competition among international ports with the case study of Eastern Asian ports, and also developed a simulation model which analyzes the Eastern Asian port choice of international container cargo flows in Asian and Pacific Region. This model consists of two parts, the port choice model of container carriers and the port choice model of shippers. The analytical result is that the condition of competitions among international ports depends mainly on international container cargo volumes of its hinterland, transportation costs and transportation times. In order to improve the condition of competitions in Japanese International ports, it is quite important to reduce transportation costs and transportation times.

1. INTRODUCTION

In recent years more large-sized container vessels have been built and container carriers in Asian countries have been more influention position in international freight market. As the freight fare competition among container carriers has been more intensified, container carrier companies have rationalized their administration. The strategic alliance has been formed among the companies.

Though asian countries have constructed main international ports in recent years, the severe competition among container carrier companies induces the simillar competition

among international ports.

This paper analyzed the competition among international ports with the case study of Eastern Asian ports, and also developed a simulation model which analyzes the Eastern Asian port choice of international container cargo flows in Asian and Pacific Region.

2. LITERATURE REVIEW

Kimura (1985), Kuroda and Yang (1995), and Fujino *et al* (1995) state that the port choice depends on both the port choice of container carriers and the port choice of shippers ,and also equilibrates both choice in the game theory. This approach is used in this paper.

This analysis is different from theirs in the following points;

First; case study of Eastern Asian ports

Second; non-cooperative game analysis in the port choice of container carriers.

3 FACTORS IN COMPETITION AMONG INTERNATIONAL PORTS

The major factors in competition among international ports are thought to be the volume of international container cargo in the port hinterland, transportation cost, and transportation time.

3.1 Volume of Cargo in the Port Hinterland

When viewed in terms of port location (e.g., presence or absence of competition with other international container ports in the vicinity, accessibility of the port, relationship with carrier routes, etc.) and level of port services (duration of stay in the port, fixed time, and port and harbor charges), there are basically two types of international port hinterland: that directly backing ports (hereinafter referred to as "Area I") and that more distant from ports (hereinafter referred to as "Area II"). If there is good access between the port and Area II, the carrier can handle in-bound and out-bound shipments of cargo for Area II through that port. **(Fig 1)**

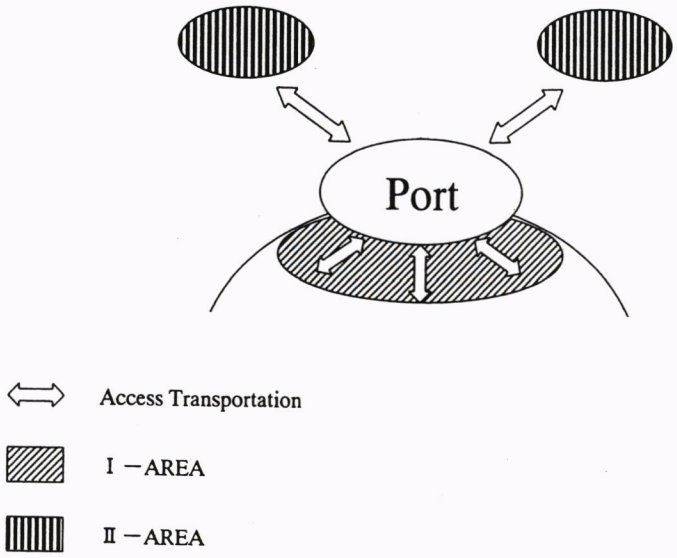


Figure 1. Volume of Cargo in the Port Hinterland

Area II is thought to change along with changes in the conditions of time and cost depending on location and the level of services. For example, with the construction of an international port in an adjoining district, space that was once Area II could conceivably become Area I of a new port. **(Fig 2)**

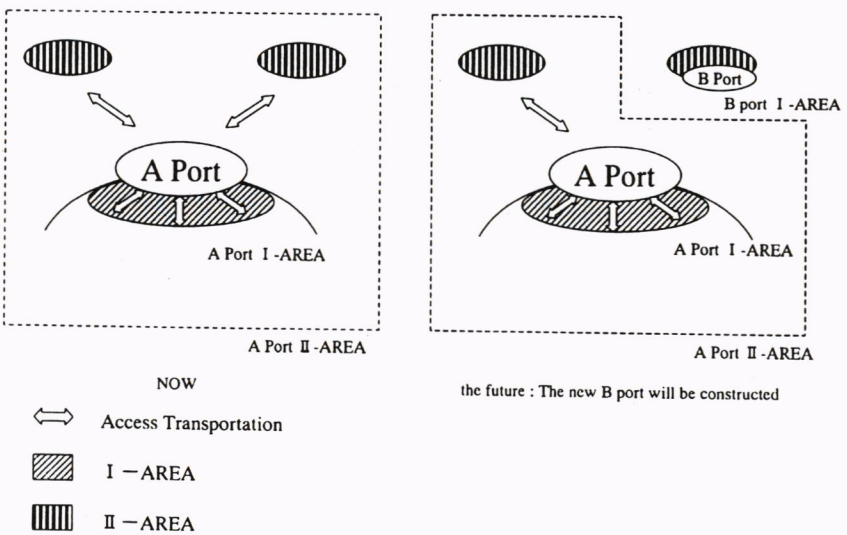


Figure 2. Condition of Competitions among Ports will be changed

3.2 Cases of the Ports of Singapore and Hong Kong

In the port of Singapore, there are numerous carriers providing feeder service links with other ports in the area, and these form a network of highly frequent feeder service (an outstanding case in point is Regional Container Line, the biggest feeder carrier in Singapore). Area II can consequently be considered to include Malaysia and Indonesia, where international ports are less developed. **(Fig 3)**.

Amid the expansion of cargo of international trade in southern China, carriers have had no choice but to use the port of Hong Kong for the same because of the lagging development of ports on the mainland. Efforts are being made to improve access from Hong Kong to all of China by road, rail, and other means.

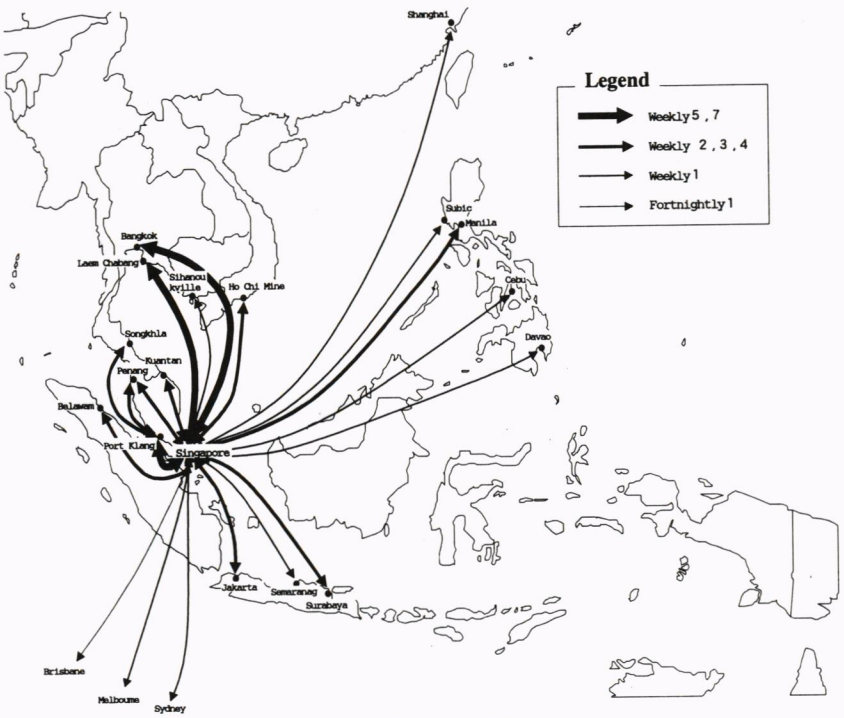


Figure 3. Case Study of Singapore

3.3 Case Study of the Mediterranean Sea

There are three major international ports on the Mediterranean Sea: the Algeciras port, the Malta port, and the Gioia Tauaro port. At each of these ports, there is little cargo originating from or destined for Area I. However, each is also characterized by a lack of other international ports in the vicinity, a location on carrier routes, and a well-developed network of feeder service with other Mediterranean ports. In addition, their services related to transshipment of inbound and outbound Area II cargo have excellent features such as short requisite stays and low port charges. For this reason, Area II may be regarded as comprised of Spain, Portugal, and Morocco in the case of Algeciras and of Italy and Greece in those of Malta and Gioia Tauaro. Carriers presumably determine ports of call based on decisions about the volume of in-bound and outbound cargo in Area II. **(Fig 4)**

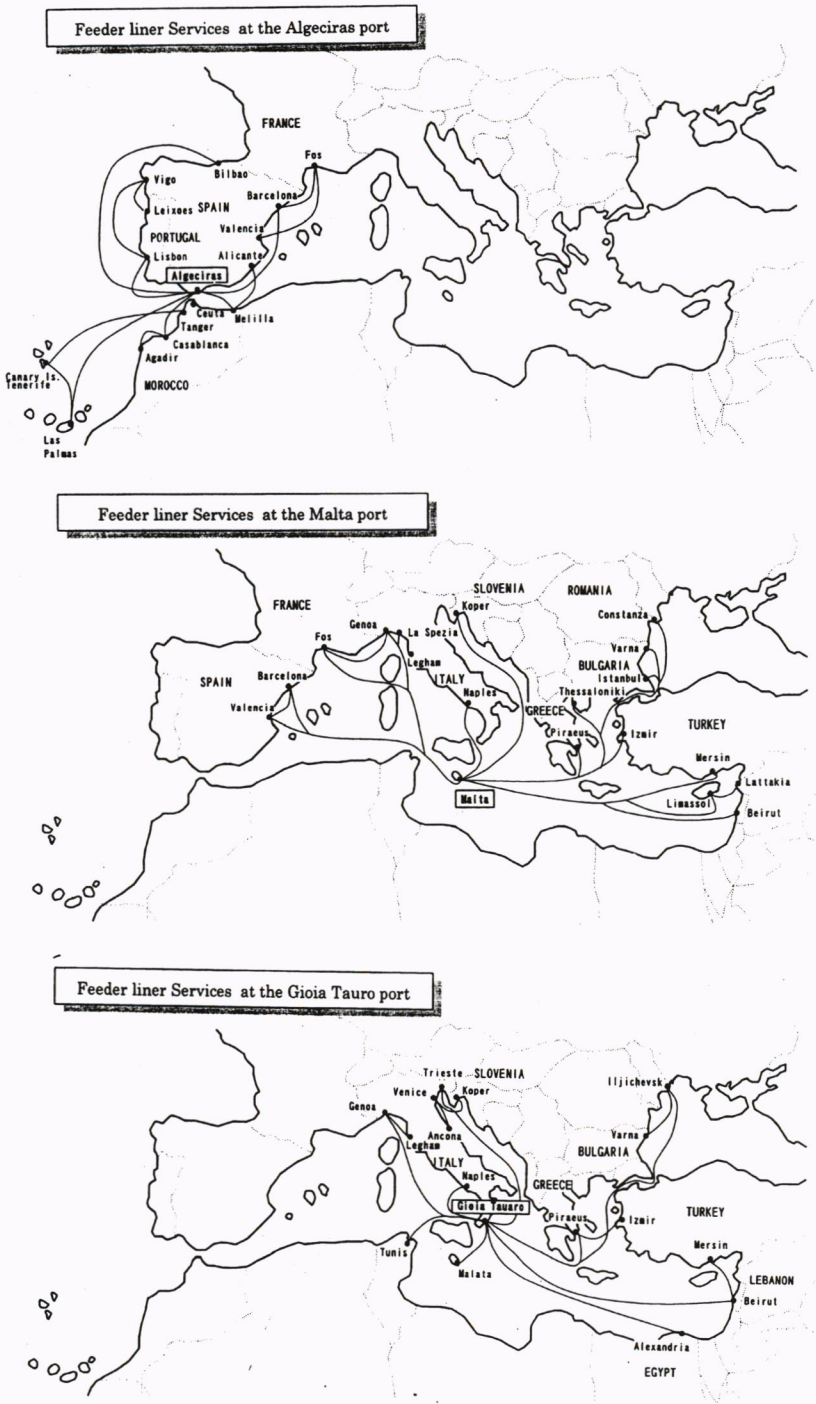


Figure 4. Case Study of the Mediterranean Sea

4. APPROACH

4.1 Model Structure

This model consists of two parts, the port choice model of container carriers and the port choice model of shippers. The port choice equilibrates both choice in the game theory (**Fig 5**).

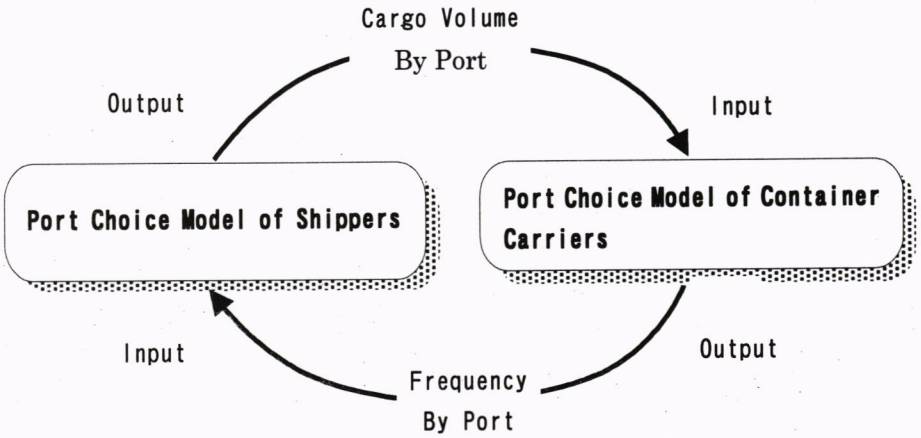


Figure 5. Model Structure

4.2 Port Choice Model of Shippers

Cargo shippers presumably select ports with reference to the level of door-to-door transportation charges and time, the port transit time, and the level of route service (frequency of calling). Shipper decisions on choice of ports are hardly based on the cost level alone; instead, there is thought to be a considerable time preference, i.e., emphasis on the frequency of calling by ships on international trade routes. To reflect this time preference, it was decided to construct a choice model for sacrifice level. This model may be expressed by the following formulas.

$$\text{Total Socrifice} : S = C + f(\omega) \times T \qquad (1)$$

Here,

C : Domestic (inland) transportation fare, port charges, fare for shipment to transshipment ports*, transshipment cost*, and Freight fare

ω : Time value (set separately for import and export)

T : Domestic (inland) transportation time, transit time, transportation time to the transshipment port*, average waiting time at the transshipment port*, and transportation time of the ship in question
(Asterisks indicate factors considered in the case of transshipment only.)

For the time value, the following log-normal distribution was employed

$$f(\omega) = \frac{1}{\sqrt{2\pi}\ \sigma\omega} \exp\left\{ \frac{-(\log\omega - \mu)^2}{2\sigma^2} \right\} \tag{2}$$

4.3 Port Choice Model of Container Carriers

To ensure the profitability of their routes, container carriers attempt to select ports of call that guarantee a volume of cargo justifying a call. Carriers presumably compete for international container cargo for each of their ships in order to obtain a sufficient volume with a limited number of calls. Carriers are under limitations as regards the round number of days on routes, and are also under pressure from shippers to shorten their lead time. They consequently want to reduce the number of ports of call, but also want to strengthen their power to collect cargo, which can be done by calling at more ports. The number of ports of call on a single route is determined with consideration of the trade-off between these two factors.
Development of the model for choice of ports by carriers incorporated the non-cooperative game theory . The individual container ships of the carriers were regarded as the game players. It was assumed that all players knew the cargo volume at each port (Pi), the total cargo volume at all ports (Σ Pi), and the number of players. In addition, the volume of cargo obtained was regarded as the player payoff (gain).

5. DATA CHARACTERISTICS

5.1 Data Sources

In the analyses, four main data sources were used; International Transportation Handbook (1996) [d], World Container Trade Volume(1996) [e], Port Import Export Reporting Service(1996) [f], Transportation Triff (hearing by container carriers and shippers).

5.2 Regional Zone

20 regional zones have been selected ; the whole Japan, the whole Korea, the whole Taiwan, 16 regional zones in China, the whole Philippines, the whole Southeast Asia (contain Singapore, Malaysia, Indonesia, Thailand, Vietnam) **(Table 1)**.

Table 1. Regional Zone

NO	Conutry	REGIONAL ZONE
1	Japan	whole Japan
2	Korea	whole Korea
3	Taiwan	whole Taiwan
4	China	Dalian
5	China	Xingang
6	China	Yantai
7	China	Qingdao
8	China	Lianyungang
9	China	Nantong
10	China	Zhangjiagang
11	China	Nanjing
12	China	Shanhai
13	China	Ningbo
14	China	Wenzhou
15	China	Fuzhou
16	China	Xiamen
17	China	Shantou
18	China	Hong kong
19	Philippines	whole Philippines
20	Singapore,Malaysia,Indonesia,Thailand,Vietnam	whole Southeast Asia

5.3 Port of Loading

13 major ports have been selected ; the Tokyo habor port, the Osaka habor port, the north Kyuushuu port, the whole Korean port, the whole Taiwan port, the Dalian port, the Xingang port, the Qingdao port, the Shanghai port, the Ningbo port, the Hong kong port, the whole Philippines port, the whole Southeast Asian port **(Table 2)**.

Table 2. Port of Loading

NO	Conutry	PORT of LOADING
1	Japan	Tokyo habor port
2	Japan	Osaka habor port
3	Japan	north Kyuushuu port
4	Korea	Whole Korean port
5	Taiwan	Whole Taiwan port
6	China	Dalian port
7	China	Xingang port
8	China	Qingdao port
9	China	Shanhai port
10	China	Ningbo port
11	China	Hong kong port
12	Philippines	Whole Philippines port
13	Singapore,Malaysia,Indonesia,Thailand,Vietnam	Whole Southeast Asian port

5.4 International OD (Direction)

Direction is North America.

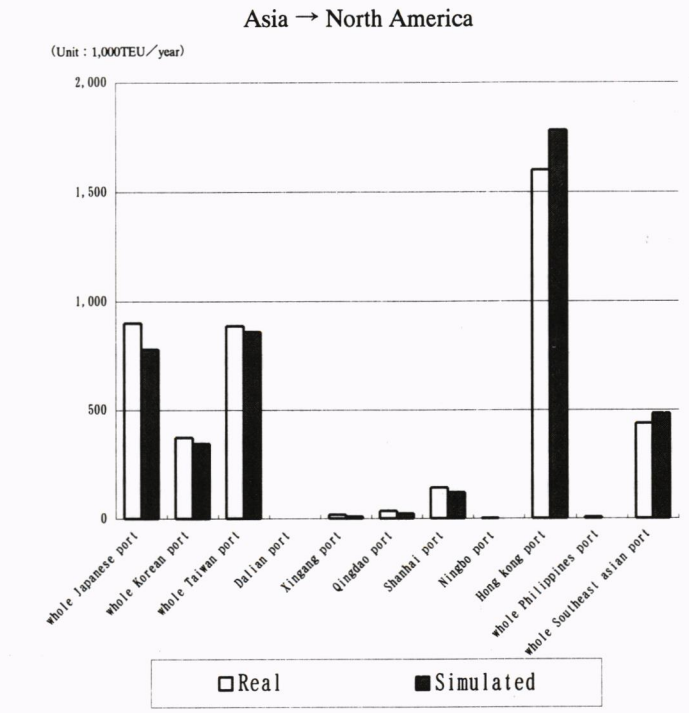
6. CONCLUSION

The fitness of the model is as shown in **Fig 6.**

As described above, the competitiveness of international container ports is largely determined by the factors of the pool of cargo in the hinterland, transportation time, and transportation cost.

According to data obtained through interviews with carriers, comparison of port-related costs per TEU at major international ports in Japan and other Asian countries reveals that the cost figures for Japanese ports are significantly higher than those at each of the other Asian ports, i.e., Kaohsiung, Pusan, Singapore, and Hong Kong. Furthermore, at the ports of Hong Kong and Singapore, measures are being taken to simplify procedures and provide for electronic data interchange (EDI) in order to reduce the requisite in-port stay to the minimum. (In Japan, the in-port stay in the case of import takes from four to five days at the least, much longer that the corresponding stay of one or two days at ports in other countries.)

If international ports in Japan are to acquire an edge in competition with major ports in other Asian countries, they must lower their transportation costs and shorten their transportation time. At present, studies are under way with a view to initiating port EDI systems in Japan. The country has been lagging relative to developed countries of the West in respect of information setups in ports, and hopes are pinned on the development of a unified system of port-centered information. It may be added that the public and private sectors are mounting joint efforts for recovery of competitiveness at major international container ports such as Yokohama and Kobe.



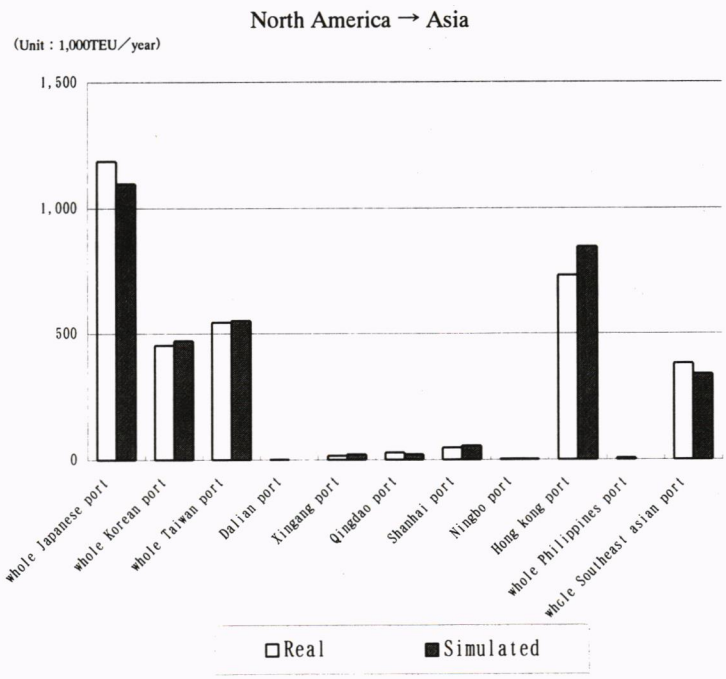


Figure 6. Fitness of the Model

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