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Hierarchical Cluster Analysis on Competitiveness of Container Terminals in Northern Vietnam

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Abstract : *Vietnam's sea-port industry has experienced a significant development in recent years. Especially in Northern Vietnam, both the demand and supply of handling services for containerized cargoes have increased at a considerable rates. Accompany with such movement, the competition among container terminals in the area becomes fiercer. In this paper, Hierarchical Cluster Analysis is employed to classify all 11 container terminals in Northern Vietnam by collecting data concerning terminal competitiveness. After the classification, each group will be discussed in order to reveal more details about their competitive characteristics. The paper consists of five sections. Section 1 is the general introduction. Section 2 provides a general literature review about competitiveness and factors to evaluate competitiveness. Section 3 explains variables and methodology applied to do the analysis. Section 4 presents the results with linkage to the current condition. Section 5 summarizes the analysis results. It is shown that container terminals in Northern Vietnam should not only pay attention to their service qualities but also have to find out an appropriate mechanism to avoid unhealthy competition. The paper is expected to contribute a background for further researches in container terminals' competition in the region as well as hints for operators in planning and making decisions.*

Key words : *Port industry, container terminals, Northern Vietnam, competitiveness, Hierarchical Cluster Analysis,*

1. Introduction

Vietnam's sea-port industry has experienced a significant development in recent years. According to Vietnam Maritime Administration (hereafter Vinamarine), there are totally 44 sea-ports including 219 terminals, 44,000 meters of berth and the designated capacity reaches 470 ~ 500 million tons annually. The total throughput of all the system recorded in December 20, 2014 was 370 million tons, 14% higher than that of the previous year. In terms of containerized cargoes, the total throughput was 10.2 million twenty foot equivalent units (TEUs), increasing 20% compared with that of 2013 (Vinamarine, 2015). The amount of cargoes handled, however, highly concentrate on the two cities in Northern and Southern of the country, named Haiphong and Ho Chi Minh city, respectively. The Northern sea-ports are being responsible for about 30% of the country total throughput whereas the Southern one accounts for more than 60%. The domination of sea-port system in the South is undoubted due to the geographical location but in recent years, Southern ones have presented an emerging movement, especially in terms of containerized cargoes. Terminals in Haiphong city, for instance Dinh Vu, Hai An, Greenport … continuously run over capacity while the capacity of others in Ho Chi Minh city, excluding Cat Lai, is employed only 50% (BSC, 2015). The container terminals in Haiphong city are also presenting a gradual development in both throughput and income while all in the Southern develop slightly or even cope with recession.

Accompany with the increase of demand, the supply of the port industry in Northern of Vietnam, together, shows an upward trend at a considerable rates. From 2005 to 2014, both the number of berth and total berth length have doubled the figure and area of container yard in the whole region has increased more than three times from about 47,000 to 1,600,000 ㎡. The trend, therefore, is hardening the competition among container terminals and it can be seen in Figure 1.

Through the period from 2000 to 2012, the supply was always higher than the demand and the gap was even greater after 2012. After 2017, the competition in the area will be forecasted to be tougher when the two expected

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terminals including Vinashin DinhVu and LachHuyen begin their operation. Competitive analysis, therefore, becomes critical in order to contribute suggestions to terminals operators for generating suitable plans and strategies. One of the first steps is to classify all players into different groups so that further strategic analysis can be followed subsequently.

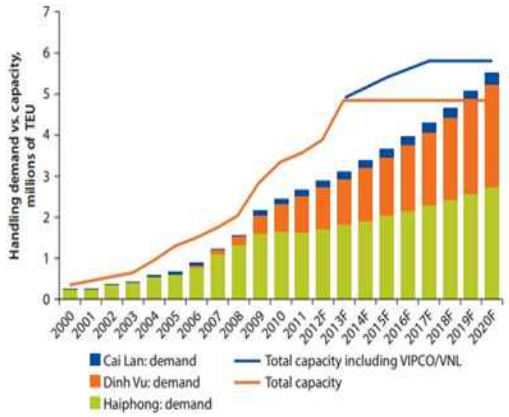

Fig. 1 Demand and Supply of Northern Container Terminals without Lach Huyen (The Worldbank, 2014)

There are, certainly, various approaches to sort container terminals in Northern Vietnam. Some of the easiest ways base on locations and ownership. In terms of location, they can be divided in to ones in Haiphong city and others in QuangNinh provinces. Terminals in Haiphong city, then, can be sorted into DinhVu terminals or Haiphong terminals. The former includes terminals locating in the connection point between Cam river and the Gulf of Tonkin with higher advantage of depth while the later is made by ones locating inside of the river. In terms of ownership, 11 container terminals are identified by national control (ones that are under 100% or mostly ownership of Vinalines) or private. The share-holding of Vinalines in 7 container terminals in the region are presented in Table 1.

Table 1 Vinalines' share-holding of Container Terminals in Northern Vietnam

Terminals	Operators	Share-holding(%)
Chua Ve	Hai Phong port	100
TC Dinh Vu		
Dinh Vu	Dinh Vu JSC	60
Doan Xa	Doan Xa port	51
CICT	SSA	51
Quang Ninh	Vinalines	100

Source : The Worldbank, 2014

Other approach is cluster analysis. By employing Hierarchical Cluster Analysis, the paper is going to classify 11 container terminals in Northern Vietnam after collecting data concerning terminal competitiveness.

This paper consists of five sections. Section 2 provides a general literature review about competitiveness and factors to evaluate competitiveness. Section 3 explains variables and methodology applied to do the analysis. Section 4 presents the results with linkage to the current condition. Section 5 summarizes the analysis results.

2. Literature Review

Port competitiveness (or competition) has been examined and researched by number of scholars. According to different approaches, port competitiveness can be explained and evaluated in different ways. Wayne K.Talley (2009) stated that port's competitiveness may be evaluated in terms of the growth, market share and diversification of its traffic volume. Talley also classified port competition into intra-competition and inter-competition. Inter-competition is competition between different ports, whereas intra- competition is competition among marine terminals in the same port. According to Verhoeff (1981), port competition falls into 4 levels, including: competition between port undertakings, competition between ports, competition between port clusters and competition between ranges.

From the user's perspective, factors determining port competitiveness are port location, costs at port, port facility, shipping services, terminal operators, port information systems, hinterland connections, customs and government regulation (Chi-lok A. Yuen, 2012). From the perspective of port selection criteria, Aronietis et al. (2010) defines decision variables in choosing a port as cost, location, port operations quality and reputation, speed, infrastructure and facilities availability, efficiency, frequency of sailing, port information system, hinterland connection and congestion. Willingale (1981) focused on infrastructure, port cost, hinterland connection and navigational distance between ports. Collision (1984) identified port capacity, reliability of port schedule and vessel's average waiting time. Cabral A.M. Rios (2014) used nine factors including throughput, berth length, number of berth, delay time for mooring, port tariff, berth depth, medium consignment rate, medium board, delay time for load/unload cargo.

Number of scholars also added port efficiency as a factor determining port competitiveness including: Tongzon (2001), Rios and Macada (2006), Cullinane and Wang (2010).

In Vietnam, the topic of port competitiveness has been researched by a few of scholars but those focused only on the current condition of Vietnam's sea-ports and improvement of sea-port's infrastructure, regulations rather than systematically examining impact of factors concerned. Many of those also lack of analytical tool to effectively explore the competitiveness in Vietnam sea-port industry.

3. Methodology

Hierarchical cluster analysis is an analytical method commonly employed to classify number of entities based on the difference of their characteristics. Hierarchical clustering provides a useful summary of the data, as the hierarchy may correspond to a meaningful taxonomy. There are two approaches to hierarchical clustering: agglomerative clustering approach which intends to group small clusters into bigger ones (Jung and Kim, 2001) and divisive clustering approach which splits big clusters into smaller ones. The agglomerative clustering (bottom-up) approach is the most popular hierarchical clustering. The idea is to use the data to build a binary tree that successfully merges similar groups of points (Subrata Das, 2014). In order to compose groups, with the given measure between points, there are some ways to identify intergroup similarity. The first is Single-linkage or the similarity of the closest pair:

$$d_{SL}(A,B) = \min_{i\in A, j\in B} d_{i,j}$$

The second is Complete-linkage or the similarity of the furthest pair:

$$d_{CL}(A,B) = \max_{i\in A, j\in B} d_{i,j}$$

And the third is Group-average or the average similarity between groups:

$$d_{GA} = \frac{1}{N_A N_B} \sum_{i\in A} \sum_{j\in B} d_{i,j}$$

Hierarchical cluster analysis is applied popularly in wide range of fields, for instance: business and marketing, computer science, social science …. Cabral (2014) recommended this technique is likely to be suited to any ports database and can be applied to any ports around the world. Cabral applied three clustering methods: K-means, PAM and Hierarchical and concluded that the last one is the best algorithm. The Hierarchical analysis can be solved by varieties of software including MATLAB, STATA, SASS, SPSS. In this paper, SPSS is chosen.

According to the Talley's theory, competition among container terminals fall into intra-competition because 9 out of totally 11 terminals locate along the Cam river in Haiphong city and the two others in Quang Ninh province are also addressed in the area of Northern sea-ports due to the classification of Vietnamese government. The terminals, therefore, have the same hinterland cities and port tariff system which is regulated by the government. The handling fee, however, is different from terminals and it is being out of control. In fact, due to the surplus of supply to demand, the bargaining power is currently in the hand of ship operators, especially foreign ones. Container terminals in Northern Vietnam are competing each other by reducing handling fee which brings large profit to foreign carriers and harms local port industry. The handling fee, as a result, is removed from selection criteria for port competitiveness and will be discussed in next section.

The nominated selection criteria for port competitiveness in the area of Northern Vietnam are presented in Table 2.

Table 2 Factors for measuring competitiveness and summary statistics of the sample

Factors	Min	Max	Mean	StD
Throughput (,000 TEUs/y)	80	551	289.18	168.04
Number of berth	1	5	2.36	1.56
Berth length (m)	144	980	438.81	304
Berth Maximum Draft (m)	7.8	13	9.23	1.89
Container Yard square (ha)	5	30	14.9	7.63
Medium Vessel size* (TEU)	300	2000	881.81	577.61
Average Handling Productivity**(TEU/h/crane)	40	60	45.45	8.2

Note : * The medium size of vessels calling each terminal, which reflects not only the capacity but also the level of services.

** The average handling productivity is the speed of unloading/discharging that terminals operate. It reflects the ability of terminals in reduce dwelling time.

The data is collected by the authors from the website of Vietnam Seaport Association (VPA) and updated annual reports of each terminal. In order to achieve a more precise result, all the data presented are the average figures of the 3 recent years.

4. Results and Discussion

The detailed database to perform the analysis is presented in Table 3, and the analysis result is revealed by the Dendrogram in Figure 2.

Table 3 Statistics database of container terminals in Northern Vietnam

Terminals	CV	TC DV	GP	T V N	DX	NH	HA	PT SC	DV	CI CT	QN
Throughput (,000 teus/y)	451	551	367	80	230	322	256	222	515	88	99
No of Berth	5	5	2	1	1	1	1	1	3	3	3
Berth Length (m)	895	980	320	169	220	144	150	250	425	594	680
Draft (m)	8.5	9	7.8	7.8	8.4	8.4	8.5	8.5	8.7	13	13
CY (ha)	20	30	10	5	8	7	15	13	24	18	14
Med vessel size	400	1200	400	300	400	600	800	800	1000	2000	1800
Avg handling productivity	40	60	50	40	40	50	40	40	60	40	40

Note: CV: Chua Ve, TCDV: TC Dinh Vu, GP: Green Port, TVN: Transvina, DX: Doan Xa, NH: Nam Hai, HA: Hai An, DV: Dinh Vu, QN: Quang Ninh

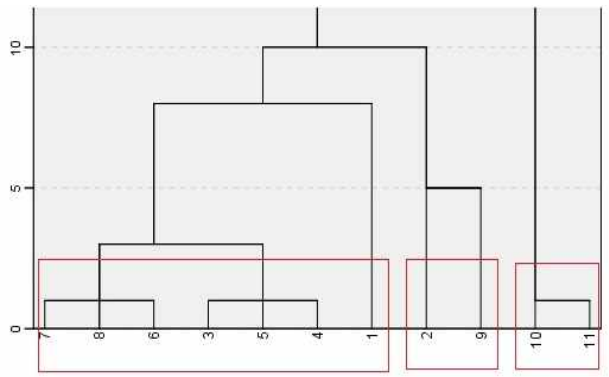

Fig. 2 Dendrogram and Groups composed

The 11 container terminals in Northern Vietnam are classified into 3 groups and each groups will be considered as the following:

a) Group 1 consists of 7 terminals including: Chua Ve, Green Port, Transvina, Doan Xa, Nam Hai, Hai An, PTSC. This group is featured by one that has only 1 berth, small container yard, maximum depth around 8 meters and medium handling productivity compared with other ones in the region. Chua Ve terminal has 5 berths but the area of container yard, depth, medium vessel size and handling productivity is limited. This group accounts for 60% of the region's annual total throughput.

b) Group 2 includes 2 terminals named: TC DinhVu and Dinh Vu. Both the two terminals are located in Dinh Vu area in the Cam river mouth with advantage of berth draft. They are all the first class terminals in the region. The medium size of vessel calling is 1,000~1,200 TEUs and the annual throughput is over 500,000 TEUs which is about 1/3 of the total throughput of the region.

c) Group 3 is composed by the 2 other terminals from Quang Ninh province: CICT and QuangNinh. Both the two terminals have advantage of infrastructure designed to accommodate 4,000 TEUs vessel. However, the current throughput is clearly inadequate. The outline of 3 groups is summarized in Table 4.

Table 4 Summary of groups of container terminals in Northern Vietnam

Group	Terminals	Location	Annual throughput (,000 TEUs)	Percentage of throughput (%)
1	Chua Ve	Hai Phong	1.928	60.6
	Green Port	Hai Phong		
	Transvina	Hai Phong		
	Doan Xa	Hai Phong		
	Nam Hai	Hai Phong		
	Hai An	Dinh Vu		
	PTSC	Dinh Vu		
2	TC Dinh Vu	Dinh Vu	1.066	33.5
	Dinh Vu	Dinh Vu		
3	CICT	Cai Lan	187	5.8
	Quang Ninh	Cai Lan		

Table 5 Mean values of competitive factors

Factors	Group		
	1	2	3
Annual throughput (,000 TEUs)	275.42	533	93.5
Number of berth	1.71	4	3
Berth length (m)	306.85	702.5	637
Draft (m)	8.27	8.85	13
Container Yard (ha)	11.14	27	16
Medium vessel size (TEU)	528.57	1100	1900
Average handling productivity (TEU/h/crane)	42.85	60	40

Both the terminals in group 2 are the leading ones which dominate the market by advantage of location and infrastructure and productivity. They are expected to continue their successful competition in the near future. The group 1 consists of the others container terminals in Hai Phong city. Six out of seven of those locate deep inside

the Cam river. It is difficult for ones in this group to compete effectively with the group 2. Almost the factors of competitiveness of the terminals are more or less the same. The competition among the groups, therefore, is fierce especially on the handling fee. There is currently an unhealthy competition among container terminals in Northern Vietnam. Terminal operators regularly survey the market to find out the fees quoted by others and then set up the same fees or commonly, a little bit lower to attract clients. In some cases, the handling fees even drop below the operating costs. Such condition causes various consequences. Firstly, terminals operators lost revenues, so they lack of money for re-investments as well as harbor and equipments upgrading. Secondly, the handling fees decreased but the Vietnamese goods owners do not benefit due to CIF purchasing and FOB selling. Biggest beneficiaries are, then, foreign carriers. As a result, in order to avoid losing profit to foreign carriers, those terminals should consider mutual agreement controlling the fluctuation of handling fee. The advantage is 6 out of 11 container terminals in the region are under the control of Vinalines – a national corporation and all of the terminals are member of Vietnam Port Association. The mutual awareness and partnership are, therefore, easier to reach but the challenge is to find out the balance point and the mechanism of co-operation.

The terminals in group 3 have a good potential but they are facing with difficulty in competing with competitors in Hai Phong city. The facilities in those terminals are newly installed and therefore, handling cost is much higher than that of the others. The annual reports of those terminals indicate that the handling fee per TEU in CTCT is 10 USD higher than average level of the region. In case of handling fee competition, CICT and Quang Ninh terminals fall in great disadvantage. In order to survive especially when Lach Huyen and Vinashin Dinh Vu begin their operation, the two terminals should plan particular strategies both in collecting fee and customer services. CICT and Quang Ninh terminal are both under the control of Vinalines, especially the later is owned 100% by the national corporation. New motivation of privatization in this terminal becomes important.

5. Conclusion

The environment of port industry in Northern Vietnam is currently featured by a tough competition particularly among container terminals. This competition is even forecasted to be more difficult in near future when project of Lach Huyen deep water sea-port will be completed. In this paper, 11 container terminals in the region are classified into 3 different groups by applying hierarchical cluster analysis based on a database composing of 7 factors for measuring competitiveness. The groups characterized by a set of data including annual throughput, number of berth, berth length, maximum depth, container yard area, medium vessel size and average handling productivity to some extent reveal the current position of terminals in the market. However, such position will not continue permanently. The two terminals in the group 3 are accounting for a very limited market share but both of them have advantage of infrastructure and able to compete equally with others in Haiphong city in long term. The handling fee is not mentioned in the analysis due to the wild variation recent years. The handling fee is out of effective control and used by competitors in the area to compete each other. This situation does good for foreign carriers and harm for the development of port industry in Northern area of the country. Without the handling fee, the analysis result, however, still indicates the short-term position of each group to be occurred a price-war. The requirement of a mutual agreement among all container terminals in the region, therefore, becomes critical to each player and all the industry. The advantage is 6 out of 11 terminals (4 in Haiphong city and 2 in Quang Ninh province) are under the control of Vinalines and all are member of Vietnam Port Association.

The hierarchical cluster analysis, however, is unable to indicate the operational efficiency nor the profit level of each terminal. This analysis is only one of a first step to analyze the condition of container terminals in the region and provide background for further researches. The current competitiveness of such industry in Northern Vietnam requires deeper researches about pricing and handling fee. Different methodologies, especially game theory is highly recommended.

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