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An economic analysis of concentration in port operations: the case of Haiphong Port

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AN ECONOMIC ANALYSIS OF CONCENTRATION IN PORT OPERATIONS

The case of Haiphong port

By

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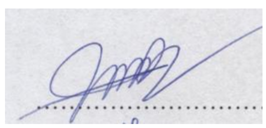
DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views and are not necessarily endorsed by the University.

(Signature): 

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ABTRACT

Title of Dissertation: **An economic analysis of Concentration in Port Operations, the case of Haiphong port**

Degree: **Master of Science**

The fragmentation of a port system is relatively widespread in many ports worldwide. The more fragmented a port system is, the more small terminals it has. Nowadays the larger container vessels and much bigger liner alliances have been requiring the large container terminals, a port under fragmentation has faced hindrances for attracting these customers. More especially, when small terminals are managed and operated by different multiple terminal operators, it results in the severe intra-competition among these operators.

How is a port system considered as the fragmented port? How correlated are the terminal operators' sizes and their business performances? This dissertation wants to summarize various methodologies to measure the concentration or fragmentation degree of a port system and find out the correlation between the business size of multiple terminal operators and their business performances through a case of the port of Haiphong. Furthermore, the fast improvement of advanced technology, the strict regulations about environmental and safety issues that are big challenges for the further development of average and small operators are also analyzed in detail.

KEYWORDS: Concentration, fragmentation, business performance, business size, the port of Haiphong.

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LIST OF ABBREVIATIONS

VPA	Vietnam Seaports Association
OECD	Organisation for Economic Co-operation and Development
KPI	Key performance indicator
HHI	The Herfindahl–Hirschman Index
N-HHI	The normalized Hirschman-Herfindahl index
RORO	Roll-on/Roll-off
UN	United Nations
SSA	Shift share analysis
GECI	Geo-Economic concentration index
CR	Concentration ratio
DWT	Deadweight tonnage
RTG	Rubber tyred gantries
GHG	Greenhouse gas
IMO	International Maritime Organization
MEPC	Marine Environment Protection Committee
EEDI	Energy efficiency design index
MARPOL	The International Convention for the Prevention of Pollution from Ships
ECAs	Emission Control Areas
ICS	Institute of Chartered Shipbrokers
SSE	Shore side electricity
EU	European Union
HPA	Hamburg Port Authority
IT	Information technology
GAS	Gate Automation System
VBS	Vehicle booking system
AI	Artificial Intelegence
TEU	Twenty-Foot Equivalent Unit
SME	Small to medium enterprise

CHAPTER 1: INTRODUCTION

1.1. Background

Vietnam is a country located in the South China Sea with a coast of 3444 kilometers in length. Vietnam's sea area is located on sea arterial routes connecting the Pacific Ocean to the Indian Ocean, Middle East and Europe to Asian. Northern Vietnam is steadily becoming a production hub for the electronics, automotive and precision machinery sectors. South Korea's Samsung electronics, for example, has established mobile phone plants in this region. Furthermore, the geographic advantages have brought a large volume of cargo from neighboring countries such as Southern China and Laos. According to the statistics of the World Bank (2018) concerning container port traffic, there was the fast increase of Vietnam's throughput volume during the period of 16 years, particular the growth ratio was around 614% between 2000 and 2016. While this growth rate in six recent years in Vietnam has constantly taken a high position, about 44% among these following selected Asian countries (see Table 1).

Table 1: The container throughput in some Asian countries

No	Country Name	2000	2010	2016	Growth ratio (2016 / 2000)	Growth ratio (2016 / 2010)
1	China	41,000,000	139,358,200	199,565,501	387%	43%
2	India	2,450,656	9,112,108	12,083,010	393%	33%
3	Indonesia	3,797,948	8,089,047	12,431,700	227%	54%
4	Korea, Rep.	9,030,174	18,516,901	26,373,000	192%	42%
5	Malaysia	4,642,428	18,203,567	24,570,000	429%	35%
6	Singapore	17,100,000	29,178,500	31,688,000	85%	9%
7	Thailand	3,178,779	6,520,905	8,239,363	159%	26%
8	Vietnam	1,189,796	5,886,249	8,495,730	614%	44%
9	Philippines	3,031,548	5,087,499	7,421,441	145%	46%

Source: World Development Indicators (World Bank, 2018)

As shown in table 2, the data collected from Vietnam seaports association indicates that the port of Haiphong is one of the most crowded and crucial port systems in Vietnam, especially in Northern Vietnam. Being the biggest port in the North, Haiphong's container throughput always takes a leader position in the region. Particularly, the volume of container throughput in 2016 was about 2.7 million TEUs, approximately 100% of the northern part's figures, and 20.26% of the whole country's capacity. However, the volume of exported cargoes passing through the Northern ports in Vietnam have been affected by the strong competition from other exporting countries such as China, Bangladesh and Indonesia. Therefore, being the international gateway in the North of Vietnam, with one-fourth of Vietnam's wharf length, the port of Haiphong has many opportunities and challenges to promote a national competitive edge in future developments.

Table 2: The container throughput of the main Vietnamese ports in 2016

Number	Ports	Container throughput (TEUs)	%
A	***Northen***	***2,664,566***	***20.27%***
1	Quang Ninh	1,594	0.01%
2	Hai Phong	2,662,972	20.26%
B	***Central***	***476,748***	***3.63%***
3	Quy Nhon	96,892	0.74%
4	Nghe Tinh	59,856	0.46%
5	Da Nang	320,000	2.43%
C	***Southern***	***9,933,335***	***75.58%***
6	Dong Nai	12,793	0.10%
5	Binh Duong	201,387	1.53%
7	Ba Ria Vung Tau	1,988,507	15.13%
8	Ho Chi Minh City	7,730,648	58.82%
	Others	68,728	0.52%
-	**Total**	**13,143,377**	**100.00%**

Source: Data collected from Vietnam Seaports Association (VPA,2018)

Currently, there are around 14 container terminals that are operated by nine different operators over 10000 meters of quay length in the port of Haiphong (see table 3). These terminals are located alongside the Cam River from the upstream to downstream area (see figure 1). In there, the handling capacities have fluctuated from 200 to 1000 TEUs/meter-year. These figures partly reflect the fragmentation of the Haiphong port system when compared to several major ports in the world which have a larger throughput as well as higher productivity but a fewer number of terminals and operators, as shown in table 4. In particular, the port of Hamburg is currently operated by five different operators over 9248 meters of quay length. With 15862 meters of quay length, all the container terminals of Singapore are operated by only one port operator named PSA. According to Nguyen Xuan Thanh and Jonathan Pincus (2011), the port fragmentation in Vietnam was caused by the poor coordination among government agencies at different hierarchies including the central government, the related ministries, and local government. The local agencies have a discretionary right towards applying the central government's policies. They tend to attract more investors in the port area to develop the maritime industry as well as the local economy. Particularly, private businesses could be approved easily to possess land to operate port activities by the local government. Port sector requires an intensive capital, while various operators have different capabilities. It resulted in the various terminal sizes, normally, not economic of scale size. As a result, the port of Haiphong is in the situation of the excess of small terminals and the lack of big terminals. This fragmented tendency is considered as limiting the operational efficiency and wasting investment of the port of Haiphong (Blancas, 2013). Despite the numerous advantages about the length of berth and geographical location, the Haiphong port cannot handle big vessels serving the direct Transpacific routes. Additionally, due to a large number of terminal operators, terminals in proximity also have caused the fierce intra-port competition between terminal operators, especially when it comes to pricing competition. Old terminals in the upstream area have been willing to decrease the port tariff to attract more customers leading to the unfair competition in this region.

Figure 1: Port of Haiphong system

Source: (OECD,2016)

Table 3: Container terminals and operators in the port of Haiphong

No	Area	Terminals	Terminal Operators
1	City center	Green Port	Vietnam Container Shipping JSC
2		Nam Hai	Gemadept
3		Chua Ve	Port of Haiphong JSC
4		Doan Xa	Doan Xa Port
5		Transvina	Transvina
6	Dinh Vu Industrial zone	PTSC Dinh Vu	Petroleum Technical Services Corporation
7		SNP128	Saigon Newport Corporation (SNP)
8		SNP 189	Saigon Newport Corporation (SNP)
9		Hai An	Haian Port Company Limited
10		Tan Vu	Port of Haiphong JSC
11		Nam Hai Dinh Vu	Gemadept/VIPCO
12		Vip Green Port	Vietnam Container Shipping JSC
13		Nam Dinh Vu	Gemadept
14	Lach Huyen (new port)	Haiphong International container terminal (HICT)	Haiphong International Container Terminal Company Limited

Source: Author compiled from company websites

Table 4: Number of terminals and operators of some global ports

Number	Port	Country	Quay length (meter)	Number of terminals	Number of operators
1	Singapore	Singapore	15862	4	1
2	Busan	Korea	8673	9	9
3	HongKong	China	7804	5	5
4	Hamburg	Germany	9248	7	5
5	Anwept	Belgium	12010	8	5

Source: (Moon,2018)

Hence, this research wants to measure the level of fragmentation in the Haiphong port system. Subsequently, six container terminal operators, which are listed companies with both public and private shareholders, both large, medium and small business sizes, are chosen to evaluate the business performances when operating the fragmented container terminals, analyze difficulties for further developments for the whole system, as well as the individual ones.

1.2. Aims and objectives

The aim of this dissertation is to evaluate the level of fragmentation of the port of Haiphong. Afterward, the collection of key performance indicators (KPIs) for assessing the correlation between the size of terminal operators and their business performances in Haiphong's port system is established. Simultaneously, the challenges caused by business size are also analyzed to prove the importance of economies of scale. As a consequence, it is expected to assess how well this current fragmentation situation for the future development of the port of Haiphong in general and the port operator businesses in particular.

1.3. Research questions

In order to accomplish these mentioned objectives, this research will try to answer the list of research questions as follows:

a. How fragmented is Haiphong 's port system currently?

b. Which key performance indicators (KPIs) should be considered to measure the relationship between the size of the selected port operator businesses and their own business performance?

c. Does the business scale impact significantly on the business performance and the growth of the firm?

d. What are the challenges for the future development of port of Haiphong with this fragmented situation?

1.4. Methodology

1.4.1. Data collection

The secondary data collection method is used in this thesis, which was based on annual reports and financial reports of the above-mentioned port businesses in Vietnam. Furthermore, the statistics from the World Bank, Vietnam ports association, published studies in Vietnam and abroad as well as books and dissertations via the library at World Maritime University and other reliable websites collected for the analysis.

1.4.2. Methodology

This dissertation is conducted by using both the quantitative and qualitative methods. Initially, some methodologies, namely the concentration ratio, the Herfindahl–Hirschman Index (HHI) and the normalized Hirschman-Herfindahl index (N-HHI) are applied to measure the level of fragmentation in the port of Haiphong. Then the quantitative data analysis is used to measure the business performance of the selected terminal operators, particularly the KPIs such as throughput, business growth ratio, unit cost and productivity are calculated from the collected secondary data. Moreover, the fluctuated trend of these indicators during the research period together with the comparisons among companies are also mapped for the deep analysis about the correlation between the scale of terminal operators and these KPIs that reflects the efficiency of businesses.

In the next stage, further discussions about the challenges of the fragmentation approach in terms of technological, environmental and safety aspects in the Haiphong's port system in general and terminal operators in particular are analyzed by using the qualitative method.

1.5. Expected results

Firstly, the HHI score, N-HHI score, and concentration ratio will evaluate the absolute degree of fragmentation in the port of Haiphong.

Secondly, the KPIs system is expected to reflect the relationship between the business size and the performance of firms.

Thirdly, the quantitative and the qualitative analyses provide an overlook about the fragmentation of Haiphong port and the difficulties for the development of the port system in Haiphong.

1.6. Thesis structure

This thesis comprises five chapters as follows:

Firstly, chapter 1 is about the introduction that provides the background of the port of Haiphong, especially container terminals and their operators, aims and objectives, research questions, and research methodologies, along with the expected results.

Followed by chapter 2, the literature review where the port system development regarding concentration and fragmentation approach, the driving factors and some methodologies in the previous studies are discussed. Moreover, the concept of a port operator and the assessed criteria are mentioned to elaborate the object of the study.

Thirdly, the next chapter is the main part of this dissertation. Data collection and deep analyses about the degree of fragmentation together with the correlation between business size and their firms' KPIs in the Haiphong port system are presented.

Subsequently, the further discussions about the challenges of the fragmented port of Haiphong in the future development are analyzed in chapter 4.

Last but not least, the final chapter reviews the research problems, the research results, limitation of the research as well as the future research intentions.

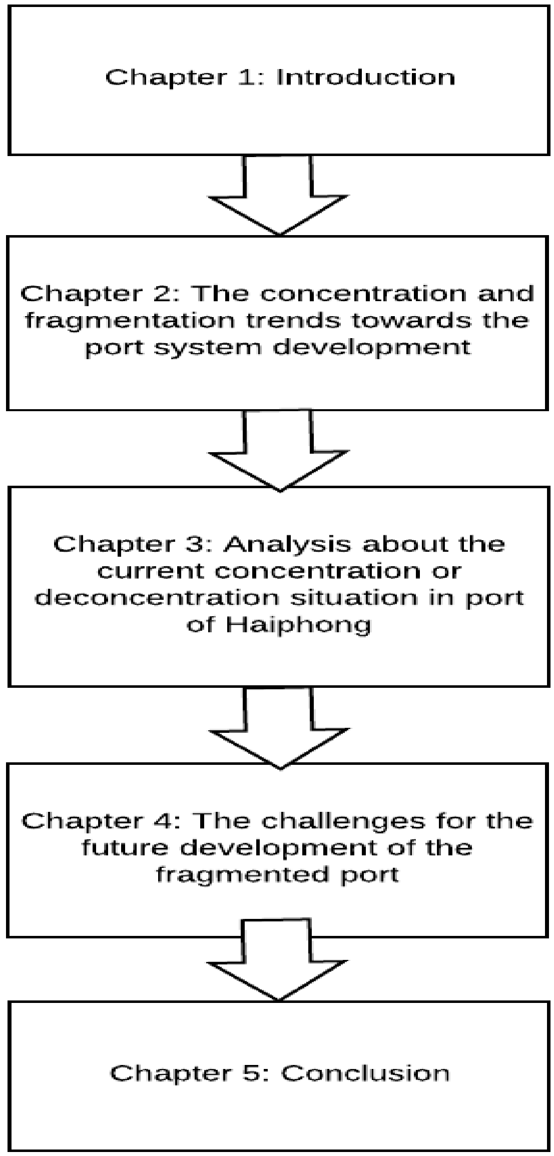

Figure 2: Dissertation structure flow chart

CHAPTER 2: CONCENTRATION VERSUS DECONCENTRATION IN PORT OPERATIONS

2.1. Port system development regarding concentration and fragmentation tendency.

The Anyport model of Bird (1971) identified three main traditional periods towards the development of port infrastructure including setting, expansion and specialization. In particular, the first phase is setting as it depends highly on geographical advantages. The development process begins from the original port which is responsible for the regional economic growth. The expansion phase follows together with the revolution of the industry where leading to the sharp growth of seaborne trade demand, ports needed to expand, upgrade equipment and provide more value-added services. Then, specialization is required to face the larger volumes of cargo, larger vessel sizes and the more specialized requirements of customers. As a result, specialized terminals were born, especially container terminals, roll-on roll-off cargo terminals, conventional general cargo terminals and liquid dry bulk terminals. Furthermore, this model was also developed by Notteboom and Rodrigue (2005). Regionalization is considered as a vital phase in the contemporary development of port systems - the spatial evolution. In particular, the geographical scope of a port should be expanded beyond the port itself, encompassing hinterland and inland distribution centers.

In the case of Australia's port system, the development process encompassed five main phases, namely, dispersed ports, penetration lines, concentration, centralization and decentralization. Rimmer (1961) acknowledged that concentration in the third phase promotes a port to attract more cargo with a smaller amount of expense. The concentration tendency has been applied widely in the containerization era, even though the deconcentration has existed for a long time.

In the research of Kenyon (1970), he mentioned that the containerization evolution and the growth of international trade would impact significantly on the stage of concentration in a port system. The bigger ports or larger operators could utilize economies of scale to handle the larger volume of container traffic at the smaller amount of cost. Although in this period, containerization did not develop fully as today, Kenyon (1970) could forecast that small players would be out of the market because of challenges of upgraded infrastructure as well as diseconomies of scale.

More significant, Hayuth (1981) introduced his five-stages model describing the development of container ports system and driving factors behind as well. Initially, the first period was the pre-conditions for a change towards containerization era. Port itself in this stage had to cope with severe difficulties to fulfill their traditional business, mainly, breakbulk cargoes or bulk cargo. Besides, requirements for the change needed those following factors: (a) serious weaknesses in that port system such as an inefficiency of cargo handling methods, high risks, damages, low productivity; (b) the interested parties that expect improvement such as governments, shipowners, shippers and port operators; (c) the adaption of parties in the industry to that changes; (d) potential benefits for all players. The second phase is the beginning of container port development. The larger ports started more easily adapting to containerization trend. More specifically, the larger throughput of bigger ports gave them incentives to find out new solutions for more efficient cargo handling. Simultaneously, these operators could utilize the more massive amount of capital for investing new operational system. On the other hand, these larger ports with higher numbers of skilled staffs could adapt to the changing more successfully. Moving to the third stage, this period was the boom of containerization and port concentration. Container traffic mainly concentrated at the first container ports in the second phase due to numerous advantages of leaders, the speed of development, the intensive capital. In the meantime, the feeder ports system was starting forming to support the bigger ports. Those bigger ports tended to penetrate the distant hinterlands. This expansion caused the different structure of market share among ports in the particular region. The fourth and fifth stages are considered as the most crucial parts in the development process of container ports. Especially, at the fourth stage, shipping lines wanted to concentrate their cargo in fewer ports due to the economic reasons such as the larger volume of traffic could reduce the transport unit cost. The concept of 'load center' was developed to imply only some big ports which can concentrate the container traffic. Ports were divided into two main groups. In there, the group of large ports competed for long distance shipments while other small players shared the remaining pie. At the end of the day, the small ports in proximity tended to be invaded significantly by the dominant container ports whose have the excellent hinterland connection. However, the challenges by smaller neighboring ports were also considered in the final phase. Load centers could struggle with several difficulties. That are the increase of congestion, lack of expanded space when container traffic increases while other smaller ports are trying to attract customer by various incentives, for example, cheaper tariffs, dedicated terminals, etc. Moreover, the far distance inside the load centers could result in the higher time cost. Therefore, carriers could change from big ports to smaller ports leading to the deconcentration or fragmentation to small players.

Taaffe, Morrill, & Gould (2002) reviewed and analyzed five periods of the development process of seaports in several underdeveloped nations combining scattered ports, concentration, feeder ports development, interconnection and high-priority of main streets. More specifically, in the beginning, numerous small ports ran the traditional port functions to support trade activities. In the next phase, the port concentration trend developed. Some main ports became main points in a particular region due to various unique advantages such as channel access, depth, and convenient hinterland connection. Then after the feeder ports system and hinterland connection were developed to connect to those main ports. Simultaneously, some small and inefficient ports may disappear out of the port system as a consequence of a concentration tendency.

2.2. Concept of concentration and fragmentation

2.2.1. Port concentration

a. Definition

By reviewing the previous studies about concentration/ fragmentation tendency in the maritime industry, especially the port industry, there are several ways to interpret this content as follows.

According to United Nations (UN, 1998), concentration in the maritime industry is a fact that some larger ports, shipping businesses, and their alliances have been increasing their market share at the cost of other remaining smaller firms. This research indicates some figures that reveal this trend. In detail, the container cargo segment had been increasingly transshipped, as a result, the volume of throughput of ports which provide transshipment services has grown considerably. Besides, the size of container vessels has tripled for three decades. The trend of merging and acquisition of shipping lines has been becoming popular to form the giant shipping firms. Especially, there are currently 67 shipping lines operating container vessels all over the world however approximately 90% of vessel capacity is controlled by the top 10 shipping lines (SAFETY4SEA, 2018).

Furthermore, Hayuth (1981) defined that concentration is a phenomenon of concentrating cargo traffic in load centers at the cost of smaller ports.

Meanwhile, concentration in container cargo segment is also understood as a polarization of total volume of container throughput in only a few big container ports.

Monios and Wilmsmeier (2010) argued that the concentration could be defined from two perspectives. Firstly, geographical concentration implies that the number of ports is concentrated in a proximity region. For example, 85% of the volume of containers was handled by ports in the south of the UK. Secondly, cargo traffic is concentrated in a few big ports.

b. Driving factors of the concentration tendency

The United Nations (1998) believed that one of the main motivations in the ports and shipping industry is to gain economies of scale. Firstly, big ports or big operators can reduce the unit cost when a huge amount of fixed cost is divided into a larger volume of container traffic. Moreover, policy instruments are also other implications of port concentration pattern. Governments generally apply policies aiming to develop the national maritime industry, more specifically, the port industry. Therefore, they have to focus on a few regions where have geographical advantages and other comparative advantages to promote the regional and national economy as well as international trade. On the other hand, the United Nations emphasized the crucial role of transshipment hubs towards the concentration trend. In fact, these transshipment centers were not international gateways for promoting import - export cargoes and good hinterland connectivity. More significant, these ports are located in favorable locations close to vital shipping routes. Then they specialize in the transshipment function that handles the massive amount of cargoes of the surroundings.

Port governance models also impact on the concentration issue. In some countries, there are different levels of port governance. According to Le and Ieda (2010), in the case of China, the general rules and policies are managed by the central government, particularly, the Chinese maritime government agency. However, some specific strategies are operated by local governments together with port authorities, such as foreign investment. More global terminal operators invested in the selected ports under the concession contracts. Thus the volume of throughput of some other seaports or terminals that were not in this kind of investment decreased significantly because of the close relationship between the global shipping lines and the global terminal operators. In contrast, with the centralized governance model, the central government plans to make the specific seaports becoming the hub ports. For instance, the Korean government planned to develop the Busan Port to be ‘The hub port in the Pacific for the 21st century’. To implement this ambitious strategy, 8.5 billion US dollars were invested to construct 30 berths for container vessels in Kadukdo - the southwest of Busan (Cullinane & Song, 2007).

The fast increase of the container throughput has required advanced technology for both shipping companies and port operators. Particularly, ports have to expand to become deep seaports, invest in modern technology such as cranes, cargo handling equipment and information technology. Consequently, the amount of expenses has skyrocketed therefore only big operators can bear and invest more in the initial phases.

Many ports could die because of the reduction of the number of port calls by shipping lines. On the one hand, the increase of ship size could limit the port selection. Only ports having enough draft, modern equipment, technology, and being close to vital shipping routes are prioritized. Notably, the amount expenses for feeders and multimodal transportation connection when arriving big ports are somewhere even less than the initial amount when using the small ports. They are some main reasons for the concentration of container traffic at fewer ports that are mostly the load centers. On the other perspective, the developed inland transportation system can be competitive advantages of some ports but threaten the other ports' existence. For example, in the port range of Le Havre-Hamburg, the majority of shipping routes has passed through the five big ports due to the efficient inland connectivity system. These above-mentioned issues create the comparative advantages for some specific ports leading to the concentration of cargoes in these ports (UN,1998).

2.2.2. Port fragmentation.

a. Definition

In contrary, fragmentation or deconcentration is a phenomenon of dispersing the cargo traffic from a few ports to a wider number of ports.

Other studies mentioned that deconcentration is considered as the process of diffusing cargoes from load centers to smaller ones.

b. Driving factors of deconcentration tendency

Deconcentration happens because of various reasons such as the shortage of space at the load centers, congestion, policies of the government and the selection of customers.

Load centers may face inefficient operations if the throughput continuously grows up because there is no space for further spatial expansion at these load centers. This issue leads to the challenge of the peripheral ports as Hayuth (1981) mentioned. The smaller players could easily attract cargo traffic thanks to the cheaper port tariffs and other incentives (Slack & Wang, 2002).

Government intervention impacts not only the concentration but also the deconcentration trend. For example, in the case of Hongkong, Slack and Wang (2002) mentioned that the challenges from the periphery towards load centers were caused by the governmental policy. Being one of the biggest ports in China, Hongkong did not match any criteria driving the deconcentration tendency as Hayuth (1981) mentioned such as the congestion, the low productivity, the shortage of space. This diffusion of cargo traffic in Hongkong was caused by the support of the state for small ports in the peripheral area to accommodate larger vessels. Another example of a government policy causing fragmentation is in Japan. The strategy of the Japanese government was balancing the volume of throughput among ports. Port authorities have received relatively similar subsidies. Therefore, the container traffic has been dispersed equally among ports in Japan (Le and Ieda, 2010).

Alternatively, the fragmentation situation could originate from the institutional fragmentation and the failure of coordination among governmental bodies at the different levels. In there, the central government does port planning for the whole, the local government and port authorities are responsible directly for the detailed planning and implementing. For instance, in Vietnam, local officials can adjust how they implement the central government policies. While the port sector is capital intensive, it requires investment in the long term, close coordination of public and private investment, as well as regulations. As a consequence, the poor coordination and the variety of investment sources created the fragmented port system in Ho Chi Minh City, Vietnam. (Nguyen & Pincus, 2011).

2.3. Previous studies about concentration/deconcentration tendency and applied methodologies

To measure the concentration degree of the container port system in the US, Hayuth (1988) applied the Gini coefficient that is a statistical tool developed by Corrado Gini in 1913 together with the Lorenz curve that visualizes the Gini coefficient. More importantly, the Lorenz curve measures the cumulative percentage of ports' market shares on the vertical axis while the horizontal axis depicts the cumulative proportion of the number of ports. In general, the Lorenz curve reflects the change of the aggregate container throughput of ports in the port system. If all ports have the same container traffic, the Gini coefficient is zero, and the Lorenz curve is a diagonal line. Otherwise, the Lorenz curve deviating from the diagonal line implies the concentration level. The region between the diagonal line and the Lorenz curve is the concentration area. The more substantial the deviation of the Lorenz curve is, the higher the concentration of port system is. The Gini coefficient is the ratio of the concentration area to the total area between the diagonal line and the horizontal axis (A/A+B) as in the following figure 3. Gini coefficient is defined as formula 1.

$$\mathbf{G = 0.5} \sum_{i=1}^{N} | X_i - Y_i | \qquad (1)$$

$$(0 < G < 1)$$

In detail: Xi is the cumulative proportion of the number of ports/terminals/ operators from the 1st firm to the ith firm

Yi is the cumulative proportion of the market shares of port/terminal/ operator from the 1st firm to the ith firm

N : the number of ports/terminals/ operators in port system

G : Gini coefficient

The result of the concentration degree that is measured by the Gini coefficient is reflected in the following table.

Table 5: The concentration degree

Result of the Gini coefficient	**The degree of concentration**
G < 0.3	Significant fragmentation
0.3 < G < 0.4	Moderate fragmentation
0.4 < G < 0.6	Moderate concentration
0.6 < G < 0.9	Significant concentration

Source: (Richard A. Benson, 1970)

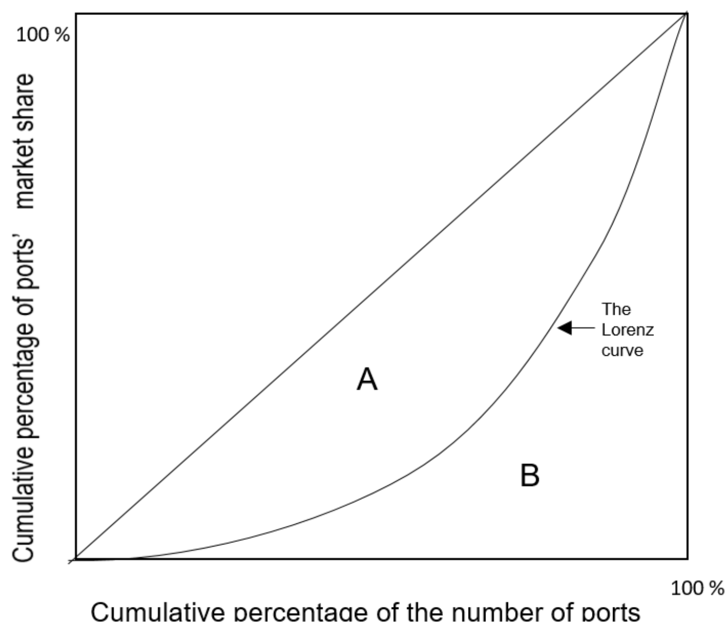

Figure 3: The Lorenz curve and Gini coefficient relationship

Source: (Richard A. Benson, 1970)

This study concluded that more than 20% of the number of ports in the US port system handled almost all the volume of container traffic during the period of 15 years, from 1970 to 1985. Notably, the Lorenz curve and Gini coefficient reflected the similar degree of concentration with small changes in this research period.

The concentration and deconcentration in various port areas in Europe, such as Atlantic, Hamburg - La Havre, Mediterranean range during the period 1980 - 1994 were researched by Notteboom (1997). In fact, in the 1980s, all port ranges were in the concentrated situation. Nonetheless, till to the 1990s, it moved toward the deconcentration tendency due to the change of container traffic from load centers to smaller ports in the region. Subsequently, the recent study of Notteboom (2010) about the updated concentration trend of 78 ports in the container port system in the European countries from 1985 to 2008. His research results reflected that the container ports remain more concentrated than other cargo segments. In other words, the container market gained the highest concentration level while the lowest level was observed in the conventional cargo market. To prove these critical implications, Notteboom used different methodologies in two of his researches, namely, the normalized Hirschman-Herfindahl index (N-HHI), Gini coefficient and shift-share analysis.

In the beginning, shift-share analysis (SSA) was used to evaluate the growth of the regional economy. This statistical tool was used by Notteboom (1997) to measure the port system's development. It is separated into two components, the share effect and the shift effect. The share effect is the expected growth of port throughput when the whole port range's container traffic increases. In other words, the increase of throughput of particular ports remains their market shares in the entire market (Huybrechts, 2002). However, the shift effect is the fact that a specific port can lose or win from rivals in the same market. These formulas 2 and 3 are used to define these two elements.

$$SHARE_i = \left(\frac{\sum_{i=1}^{n} TEU_{it1}}{\sum_{i=1}^{n} TEU_{it0}} - 1\right) \times TEU_{ito} \qquad (2)$$

$$SHIFT_i = TEU_{it1} - \frac{\sum_{i=1}^{n} TEU_{it1}}{\sum_{i=1}^{n} TEU_{it0}} \times TEU_{ito} \qquad (3)$$

In there:

SHAREi is the share effect of ith port/ terminal/ operator during the period t1 - t0

SHIFTi is the shift effect of ith port/ terminal/ operator during the period t1 - t0

TEUit1: the container throughput of ith port/ terminal/ operator at the t1

TEUit0: the container throughput of ith port/ terminal/ operator at the t0

n is the number of ports in the port system

Furthermore, the Herfindahl index or Herfindahl–Hirschman Index (HHI score) is commonly used to measure the concentration or fragmentation level in the different industries. Recently, it was used by Neil Davidson (2018) to measure the fragmentation level of some port systems in the world. Formula 4 defines the HHI score.

$$\text{HHI} = \sum_{i=1}^{n} s_i^2 \qquad (4)$$

$$(\frac{1}{n} \leq \text{N-HHI} \leq 1)$$

In there:

HHI is the concentration index

Si is the market share of ith port / ith terminal / ith operator in the port system

n is the number of ports/ terminals/ operators.

The system is more concentrated when the HHI score is close to 1. It means that the disparity of market share goes up. On the other hand, if the HHI reaches 1/N, the system is completely fragmented.

Subsequently, the normalized Hirschman-Herfindahl index (N-HHI) is the variation of the HHI score to measure the degree of concentration in various industries. In the case of the port industry, this index also analyzes two main factors that are the number of ports and their container traffic. More specifically, N-HHI is defined as follows (see formula 5).

$$\textbf{N-HHI} = \left(\frac{\sum_{i=1}^{n} TEU_i^{\,2}}{\left(\sum_{i=1}^{n} TEU_i\right)^2} - \frac{1}{n}\right) / \left(1 - \frac{1}{n}\right) \qquad (5)$$

$$(0 \leq \text{N-HHI} \leq 1)$$

In there:

N-HHI is the concentration index of port system

n is the number of ports/terminals/operators in the port system

TEUi is the container traffic of ith port/terminal/operator

According to Notteboom (2009), the degree of concentration that is measured by N-HHI score is classified in table 6.

Table 6: The result of N - HHI score

Result of N-HHI score	**The degree of concentration**
N-HHI < 0.1	Fragmented system
0.1 < N-HHI < 0.18	Moderate concentration
N-HHI > 0.18	High concentration

Source: (Notteboom,2009)

The higher value of N-HHI reveals the higher level of concentration of a particular port system. If the value of N-HHI reaches 1, the port system is fully concentrated. Only one port dominates in that port range, or just one port operator occupies most cargo in the particular market. On the contrary, when the value of N-HHI is close to the minimum value, the market is highly unconcentrated when the ports or port operators have similar market shares. Nevertheless, this indicator was argued that it is not accurate if the research sample is ports or terminals or operators in a broad scope, such as the whole country or ports in different countries. It should be used only in the particular market.

When comparing the concentration level among different countries, Le and Ieda (2010) indicated that the HHI method still had some weaknesses. More especially, the HHI score of a smaller port system with fewer ports seems higher than that value of a larger system that has many ports. Hence, the HHI score should only be used in the case of all firms involved in the same market competition. It could not be used in the wider market, such as various nations. As a consequence, another method was developed based on the HHI score to solve the limitation's HHI score. The Geo-Economic concentration index (GECI) was applied in comparing and evaluating the concentration degree among three Asian countries, namely, China, South Korea, and Japan by Le and Ieda (2010). GECI tries to reflect the competition level between two ports by analyzing the overlapping hinterland among them, as well as other unique characteristics of each country. The formula 6 defines the GECI.

$$\textbf{GECI} = \sum \frac{s_i^2}{\sum w_{ij} s_j} \qquad (6)$$

In detail:

s_i is the market share of ith port

s_j is the market share of jth port

w_{ij} is the level of market sharing of two ports

According to Sys (2009), the concentration degree could be analyzed by the concentration ratio (CR) that is accumulating the market share of the particular big firms in the market. The main difference between the concentration ratio and other methodologies to measure the concentration or fragmentation tendency is the research sample. The concentration ratio focuses on some big firms while other tools take into consideration almost firms in the industry. For instance, CR(1), CR(3), CR(5) represent the total market share of the one, three, five most significant players, respectively. If these largest businesses have a higher concentration ratio, they will have more market power. Sys (2009) believed that the market is significant oligopoly when CR(1), CR(3) reach 50%, 75%, respectively. The concentration ratio CR(k) is defined in this formula 7.

$$\mathbf{CR(k)} = \sum_{i=1}^{k} S_i \qquad (7)$$

In there: Si: the proportion of container throughput of ith largest ports/ terminals/ operators in the port system (i = 1,2,..k).

The studies about the concentration or fragmentation tendency in the Vietnam port system have still been limited. Nguyen & Pincus (2011) analyzed the reasons for the fragmented Ho Chi Minh city's port system in southern Vietnam by the qualitative method. Pham et al. (2016) evaluated the trend of deconcentration of container terminals in northern Vietnam during the period 2005 to 2014. Several ways were applied to measure the level of deconcentration such as the Lorenz curve and Gini coefficient, shift-share analysis.

2.4. Concept of operator

2.4.1. Definition

According to Jurgen Sorgenfrei (2013), there are several definitions regarding the operator. Firstly, a business operating only one single terminal is called a terminal operator, while port operators diversify their activities in several terminals inside one single port such as container terminal, general cargo terminal, and Ro-Ro terminal. On the other hand, if these companies can actively operate in several ports, then it is named multiple port operator. Furthermore, multiple terminal operators are used for those companies which run the same type of terminals in a single port. Likewise, global terminal operators are active in many container terminals around the world, especially, the PSA, the DP World, the APM operator. For example, the PSA is one of the largest global terminal operators which has their footprint in 16 countries with more than 40 terminals across Asia, Europe, and the Americas (Priyankar Bhunia, 2018).

Table 7: Summary of different type of operators.

Business operates in	**Similar type of terminal**	**Various types of terminal**
Single port	Multiple terminal operator	Port operator
Multiple ports	Global terminal operator	Multiple port operator

2.4.2. Criteria evaluating the competitive situation of operators

It is acknowledged that ownership is a critical criterion used to analyze operators. These operators could be state-owned companies, semi public-private firms or fully private entities. They could be the state firms' outlets, daughters of shipping companies promoting the efficiency of their supply chain, for example. (Jurgen Sorgenfrei, 2013). Those factors impact significantly on the investment plan, productivity, cost, profit of each terminal. Recently, pure state operators have decreased dramatically, instead of more and more semi-public companies as well as private operators all around the world.

The second standard is cargo segments that form different analyzing criteria, particularly operational key performance indicators, productivity, infrastructure, and equipment, etc. For example, some operators focus on specialized terminals, such as container terminals, dry bulk cargo terminals, liquid bulk cargo terminals, Ro-Ro cargo terminal, while others diversify their business with broader activities for various type of cargo.

Followed by the number of terminals, when researching about operators, it is necessary to cover information of all the terminals they are operating. Operators can run different terminals to handle the same type of cargo or variety of cargo segments. This data reflects the size of their businesses, then, analyzes how the size, as well as this variety, create advantages and disadvantages for firms against their rivals.

Furthermore, the market share of operators within a single port or even a port range has also played a vital role to assess operators. Data about the throughput of each operator over the years can reflect their growth rate, productivity, and how efficiency inputs are utilized. However, one more important perspective is how relevant those numbers are. For example, an operator could handle 1 million TEUs while the whole port operates 5 million TEUs. Therefore, the corresponding market share is 20%. It can be assumed that this operator runs the business under the competitive market. Conversely, in the case of the smaller port volume, around 1.2 million TEUs, the operator is considered as the dominant player in the market. In two different examples, the operator has specific market behaviors.

Additionally, to evaluate the competitive level and market position of operators, Jurgen Sorgenfrei (2013) recognized the necessity of detailed business activities including revenue and cost, profit and loss, annual reports, financial reports together with all the factors as mentioned earlier. This set of analyzed information is a useful tool to check, assess and rank the market position of operators.

2.5. Conclusion

In summary, the previous studies mainly focus on the concentration and fragmentation in a wide port ranges, such as European ports, Hamburg - La Havre, Mediterranean range or the overall port system of countries such as Japan, China, Korea, whereas, the studies about the concentration degree of a particular port are still limited.

To fill the gap of the previous literature review, this dissertation measures the level of concentration or fragmentation in Haiphong port system during the period 2010 - 2017 by applying the concentration ratio, the Herfindahl–Hirschman Index, the normalized Hirschman-Herfindahl index. The object is businesses that operate the same kind of terminals – container terminals within the port of Haiphong. They are also named multiple terminal operators. In addition, this study analyzes further the importance of economies of scale towards the development of business by comparing some key performance indicators (KPIs) that are criteria to evaluate port operators such as revenue, profit, and labor productivity among port operators in the next chapter.

CHAPTER 3: ANALYSIS ABOUT THE CURRENT CONCENTRATION OR FRAGMENTATION SITUATION IN THE PORT OF HAIPHONG

3.1. Overview about the multiple terminal operators in the Haiphong port system

As mentioned above, the Haiphong port system has nine businesses operating approximately 14 terminals that can handle container cargo alongside the Cam River and one new terminal in Lach Huyen area. On average, these port businesses in the Haiphong area have been operating one terminal. In particular, three larger firms are operating around 2 - 3 container terminals. All these large operators own the biggest and most modern container terminals in the downstream area. Port of Haiphong joint stock company, Gemadept and Viconship have operated Tan Vu, Nam Hai Dinh Vu, Vip Green port, respectively. Table 8 reveals some characteristics about capacity, the number of berth, the length of berth and the depth of wharf of these terminals that are essential factors attracting cargo traffic and creating their competitiveness in this port region.

In detail, the downstream terminals encompass Tan Vu, Nam Hai Dinh Vu, Nam Dinh Vu, VIP Green, PTSC Dinh Vu terminals whereas Chua Ve, Nam Hai, Green port, Transvina, Doan Xa terminals belong to the upstream group. As shown in table 8 below, the first terminal group has more advantages about draft, channel access, the length of berth as well as more modern equipment technology than the others. More specifically, the depth of wharf of terminals in the downstream area is more than 9.0 meters while this figure of the upstream terminals has fluctuated around 7.0-8.0 meters. Secondly, the downstream terminals generally have two berths while the average value of the others is one berth. On the other hand, terminals of the large operators have at least two berths and the remaining owners operate one berth. Therefore, the more berths the terminals have, the more advantages to accommodate vessels at the same time the terminals have. Additionally, time accessing all terminals alongside the upstream river is more prolonged than terminals located close to the estuary mouth. Last but not least, some bigger container terminals started operating recently. As a result, modern technology, and equipment are other competitive advantages of this terminal group.

Besides, those nine multiple terminal operators are all listed in the stock exchange. Investors can be private or state companies as well as foreign or domestic entities. Together with the geographic and size advantage as above, the investment of domestic and international shipping lines into this port sector has played a crucial factor in attracting container traffic.

Table 8 : Characteristics of multiple terminal operators

No	Operator	Terminal	DWT	Operation year	Capacity (1000 TEU)	No of berth	Length of berth (m)	Depth alongside (m)
1	PHP	Chua Ve	20000	2000	550	5	848	8.4
		Tan Vu	55000	2008	1000	5	981	9.4
		Total			1550	10	1829	
2	GMD	Nam Hai	10000	2009	200	1	310	7
		Nam Hai Dinh Vu	30000	2014	500	2	450	9.0
		Total			700	3	760	
3	VCS	Green Port	20000	2003	350	2	371	8.2
		VIP Green Port	30000	2016	500	2	400	9.8
		Total			850	4	771	
4	DVP	Dinh Vu	40000	2007	450	2	425	10.2
5	PSP	PTSC Dinh Vu	20000	2011	300	1	250	8.5
6	HAP	Hai an	10000	2011	250	1	150	7.0
7	SNP	Tan Cang 128	15000	2013	250	1	225	8.2
8	Other	Transvina	13000	2005	150	1	168	7.8
9	DXP	Doan Xa	10000	2002	200	1	210	8.2

Source: Author compiled from VPA (2018) and annual report of those operators

Note: PHP: Port of Haiphong Joint Stock Company, GMD: Gemadept Corporation, VCS: Viconship, DVP: Dinh Vu port development and investment joint stock company, PSP:

PTSC Dinh Vu, HAP: Hai An port, SNP: Saigon New Port, DXP: Doan Xa port joint stock company.

3.2. Measuring the level of fragmentation

3.2.1. Data construction

To evaluate the concentration degree in the port industry in the case of Haiphong port system, the annual volume of container traffic during seven years from 2010 to 2017 collected from almost all container terminals of nine multiple terminal operators in Haiphong. Data was compiled from the statistics of Vietnam seaports association. Simultaneously, the author also reviewed the container throughput from annual reports of these port businesses to verify the collected figures. Afterward, to use the HHI, N-HHI, concentration ratio methodologies, the market share of each operator was calculated. Those numbers are shown in table 9 below.

Table 9: The container throughput and market share of multiple terminal operators in port of Haiphong in 2010 - 2017

No	Operator	Terminal	2010		2011		2012		2013		2014		2015		2016		2017	
			Throughput (1000 TEU)	Market share (%)	Throughput (1000 TEU)	Market share (%)	Throughput (1000 TEU)	Market share (%)	Throughput (1000 TEU)	Market share (%)	Throughput (1000 TEU)	Market share (%)	Throughput (1000 TEU)	Market share (%)	Throughput (1000 TEU)	Market share (%)	Throughput (1000 TEU)	Market share (%)
1	PHP	Total	953	41.89	1,018	37.94	964	35.27	1,040	33.33	1,002	29.02	1,020	26.63	1,086	26.95	1,200	27.22
2	DVP	Dinh Vu	399	17.54	439	16.36	455	16.65	516	16.54	574	16.62	628	16.40	641	15.91	661	15.34
3	GMD	Total	210	9.23	313	11.67	232	8.49	252	8.08	537	15.55	699	18.2	748	18.57	807	18.73
4	VSC	Total	335	14.73	373	13.90	396	14.49	347	11.12	360	10.43	366	9.56	649	16.11	827	19.20
5	PSP	PTSC Dinh Vu	-	-	76	2.83	155	5.67	241	7.72	265	7.67	238	6.21	183	4.54	243	5.64
6	HAP	Hai An	-	-	110	4.10	183	6.70	277	8.88	309	8.95	330	8.62	323	8.02	310	7.20

7	SNP	Tan Cang 128	-	-	-	-	-	-	130	4.17	135	3.91	201	5.25	209	5.19	243	5.64
8	Other	Transvina	159	6.99	127	4.73	104	3.81	80	2.56	57	1.65	113	2.95	70	1.74	62	1.44
9	DXP	Doan Xa	219	9.63	227	8.46	244	8.93	237	7.60	214	6.20	235	6.14	120	2.98	55	1.28
	Total		2,275	100.00	2,683	100.00	2,733	100.00	3,120	100.00	3,453	100.00	3,830	100.00	4,029	100.00	4,308	100.00

Source: Author compiled from VPA and annual reports of businesses

3.2.2. The Herfindahl–Hirschman Index

$$\textbf{HHI} = \sum_{i=1}^{n} s_i^{\,2} \qquad \textbf{(4)}$$

Table 10: The HHI score of multiple terminal operators in Haiphong port system in 2010 - 2017

Year	2010	2011	2012	2013	2014	2015	2016	2017
HHI	0.250	0.220	0.200	0.179	0.166	0.159	0.171	0.177

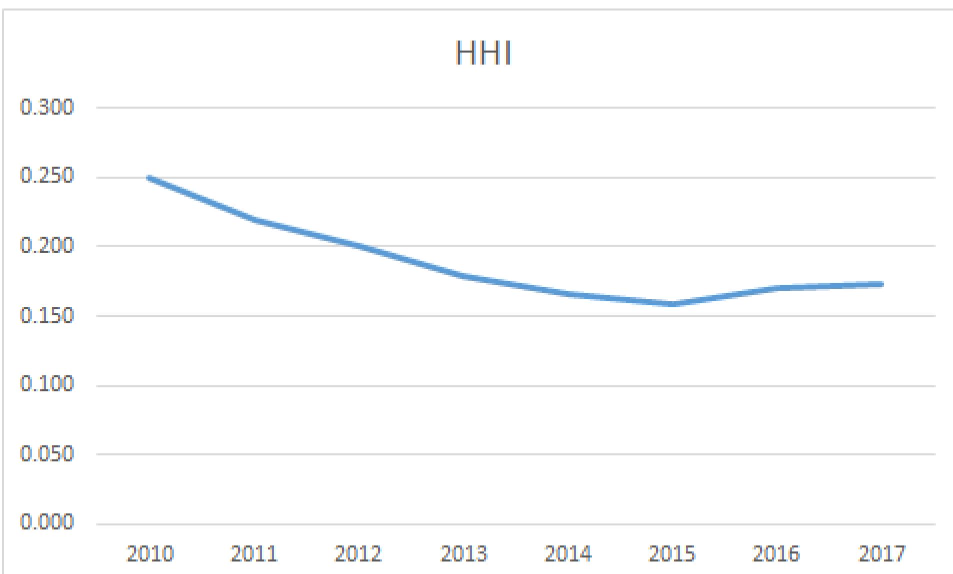

Figure 4: HHI of multiple terminal operators in Haiphong in 2010 - 2017

Table 10 and Figure 4 reveal the significant decrease of the HHI score of the Haiphong port system during 2010 - 2017. In 2010, the HHI score reached a peak at 0.25. This number reduced gradually to 0.15 in 2015. Since 2015, the HHI score has fluctuated around 0.15 with only minor changes. The continuous decrease together with the low values of the HHI score illustrated the fragmentation trend in the port of Haiphong in 2010 - 2017.

3.2.3. The normalized Hirschman-Herfindahl index

$$\textbf{N-HHI} = \left(\frac{\sum_{i=1}^{n} TEU_i{}^2}{(\sum_{i=1}^{n} TEU_i)^2} - \frac{1}{n}\right) / \left(1 - \frac{1}{n}\right) = \left(HHI - \frac{1}{n}\right) / \left(1 - \frac{1}{n}\right) \qquad (5)$$

$$(0 \leq \text{N-HHI} \leq 1)$$

Table 11: The N-HHI of multiple terminal operators in Haiphong in 2010 - 2017

Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
HHI	0.250	0.220	0.200	0.179	0.166	0.159	0.171	0.173
N	6	8	8	9	9	9	9	9
N-HHI	0.1007	0.1035	0.0828	0.0768	0.0622	0.0538	0.0671	0.0692

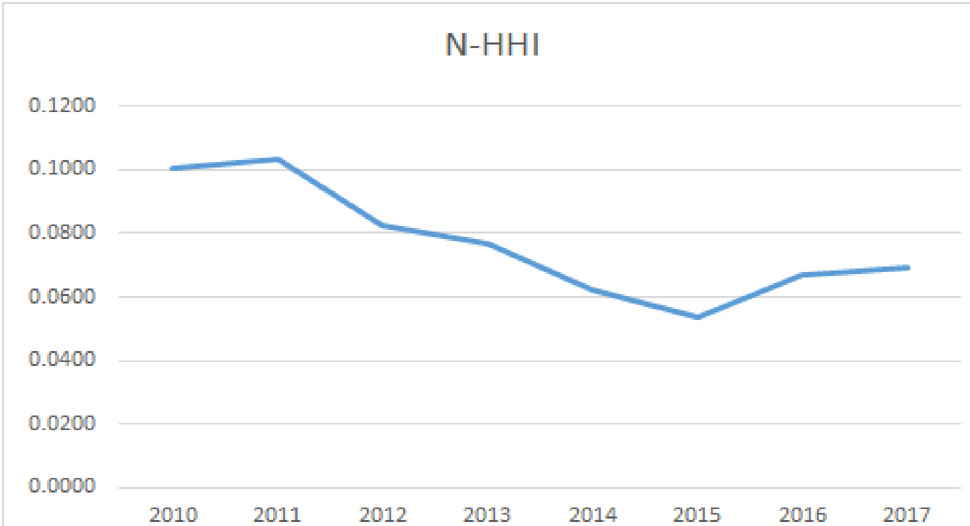

Figure 5: N-HHI of multiple terminal operators in Haiphong in 2010 – 2017

As is illustrated by table 11 and figure 5, the N-HHI score shows the similar trend of the concentration degree in the studied port area. The highest value of N-HHI was 0.1035 in 2011. This number dropped to 0.0538 in 2015. Afterward, the N-HHI score was relatively stable at 0.06 during the last two years, 2016 and 2017. According to Notteboom's research (2009), if the N-HHI fluctuates between 0.1 and 0.18, the industry is considered as a moderate concentration while the N-HHI is smaller than 0.1, the system is unconcentrated. Therefore, in the Haiphong case study, the N-HHI score from 2012 to 2017 indicated that the port system is significantly fragmented.

3.2.4. CR(k)

$$\mathbf{CR(k)} = \sum_{i=1}^{k} S_i \qquad (7)$$

Table 12: The concentration ratio of the largest operators and three largest operators in the port of Haiphong.

Year	2010	2011	2012	2013	2014	2015	2016	2017
The 1st largest operator	PHP	PHP	PHP	PHP	PHP	PHP	PHP	PHP
The 2nd largest operator	DVP	DVP	DVP	DVP	DVP	DVP	DVP	VSC
The 3rd largest operator	VSC	VSC	VSC	VSC	GMD	GMD	GMD	GMD
CR(1)	41.89%	37.94%	35.27%	33.33%	29.02%	26.63%	26.95%	27.22%
CR(3)	74.15%	68.21%	66.41%	60.99%	61.19%	61.28%	61.63%	64.29%

Note: PHP: Port of Haiphong joint stock company, GMD: Gemadept, VCS: Viconship, DVP: Dinh Vu port development and investment joint stock company.

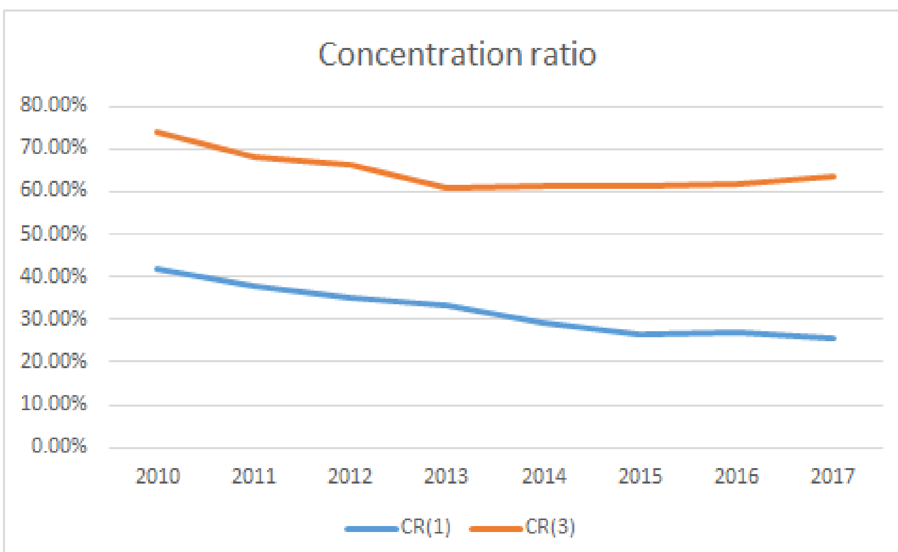

Figure 6: The fluctuation of the concentration ratios of the largest operators and three largest operators in the port of Haiphong.

Table 12 and figure 6 indicate the change of concentration ratios of the largest operator and the three largest operators in the Haiphong port in 2010 - 2017. The port of Haiphong joint stock company has remained in the leading position with the highest container market share for many years. However, the domination of this operator declined sharply in this studied period. Particularly, the port of Haiphong joint stock company occupied approximately 42% of the market share in 2010; then this number decreased gradually to around 25% by the end of 2017. On the other hand, the market share of the top three largest operators also declined considerably. These figures show the deconcentration trend as same as the two above methodologies.

3.2.5. Discussion about the fragmented port system in Haiphong.

Initially, the Haiphong port system experienced a concentration model. In particular, the HHI score, and N-HHI score in 2010 reflected the moderate concentration level. Then after the figures reveal the fragmentation trend of the Haiphong port system. As can be seen from table 8, the number of port operators increased from 6 to 9, while the number of terminals also grew by five terminals in 7 years. These terminals have been developed toward the downstream area. In the beginning, almost all of the container terminals located close to the urban area along the Cam River with geographical disadvantages. Therefore, the necessity of terminals to be closer to the estuary mouth was acknowledged. The emergence of larger terminals with modern facilities and equipment as well as location benefits in the downstream area changed the ranking of port operators as shown in table 12. For instance, Nam Hai Dinh Vu that started operation in 2014 marked Gemadept in the third position in the area. In 2016, the VIP Green Port that has the capacity of 500000 TEU in the first phase emerged. It resulted in Viconship becoming the second largest operator instead of Dinh Vu port development and investment joint stock company.

This increase in the number of container terminals, as well as port operators, resulted in the fragmentation system. Furthermore, this situation in Haiphong port was also caused by the poor coordination among governmental agencies, especially the central government and the local government. The central government and other related ministries planned for the whole country and regions. However, the local government has a discretionary right in implementing these plans and policies. To develop the economy in general and port industry in Haiphong, the local government encouraged investment in the port sector. However, port investment requires the huge of capital. As a consequence, the large volume of operators and variety of terminal sizes emerged.

According to Neil (2018), the volume of annual throughput that is in the range of 2.5 to 5 million TEUs is considered as a medium-sized port. He proved that the highly fragmented level in small or medium-sized ports causes the operational complexity in handling the large volume of cargo. In the case of Haiphong, the annual container traffic fluctuated from 2.2 million TEUs to 4.3 million TEUs over 7 years. Hence, it can be considered as the medium-sized port.

In conclusion, in this part, the first research question is answered through indicators and analysis in reality. The port of Haiphong is a medium-sized port and highly fragmented during the studied period 2010 - 2017. Then the next part of this dissertation will find the answers how the business performances of these multiple terminal operators have been and how the size of the business has impacted on business performances. Six multiple terminal operators including three larger operators, one medium and two smaller operators are studied to explain the two next research questions.

3.3. The size of operators and the business performances assessment

3.3.1. The growth of business

<u>a. The growth of throughput</u>

Table 13: The throughput growth of multiple terminal operators in the Haiphong port system

No	Business	Terminal	Throughput (1000 TEU)					%			
			2013	2014	2015	2016	2017	2014/ 2013	2015/ 2013	2016/ 2013	2017/ 2013
1	PHP	Chua Ve	487	490	328	202	190	1%	-33%	-59%	-61%
		Tan Vu	553	512	692	884	1010	-7%	25%	60%	83%
		Total	**1040**	**1002**	**1020**	**1086**	**1200**	**-4%**	**-2%**	**4%**	**15%**
2	GMD	Nam Hai	252	260	235	222	168	3%	-7%	-12%	-33%
		Nam Hai Dinh Vu		277	464	526	639	-	68%	90%	131%
		Total	**252**	**537**	**699**	**748**	**807**	**113%**	**177%**	**197%**	**220%**
3	VCS	Green Port	347	360	343	320	318	4%	-1%	-8%	-8%
		VIP Green	-	-	23	329	509	-	-	1330%	2113%
		Total	**347**	**360**	**366**	**649**	**827**	**4%**	**5%**	**87%**	**138%**
4	DVP	Dinh Vu	516	574	628	641	661	11%	22%	24%	28%
5	PSP	PTSC Dinh Vu	241	265	238	183	243	10%	-1%	-24%	1%
6	HAH	Hai an	277	309	330	323	310	12%	19%	17%	12%

Source: Author compiled from the annual reports of these selected multiple terminal operators

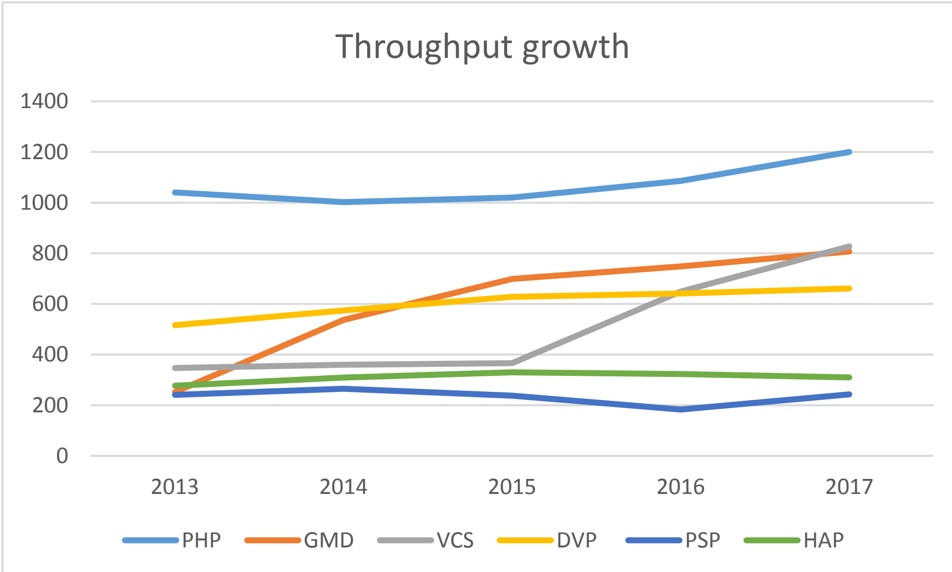

Figure 7: The throughput growth

As shown in table 13 and figure 7, the throughput of the top larger businesses increased faster than the throughput of the smaller ones during five years, 2013-2017. Notably, the total throughput of Gemadept Corporation in the Haiphong port system had the most rapid growth by 220%. It was caused by the starting operation of Nam Hai Dinh Vu terminal located in the Dinh Vu industrial zone in 2014 that has strategic advantages of geographical location together with modern equipment to accommodate the current largest vessels coming to Haiphong port. In contrast, the container traffic of Nam Hai terminal decreased gradually at the same time due to the severe competition among terminals in the port system, the difficulty of the international shipping industry in this period, along with the movement trends toward the downstream terminals of shipping lines. Followed by the other big operator, the Viconship has ridden the container traffic boom because of the extraordinary growth of the container throughput of the new terminal VIP Green that has a prime location at the downstream area. Simultaneously, the investment of Evergreen line, as well as relationships with other big shipping lines such as Maersk Line, COSCO, OOCL, are considerable benefits to help VIP Green increase the traffic volume. On the other hand, the remaining terminal of Viconship – Green port has been going through tough times as the Nam Hai terminal and other upstream terminals. However, the booming of throughput of VIP Green has compensated for the loss of Green port. Additionally, in the large operator group, the port of Haiphong joint stock company is the most significant player in this port operation sector, the container traffic occupied approximately 30% of the total throughput of the Haiphong port as illustrated in table 12. However, the graph and table13 depict the moderate increase in the whole business's container traffic. This is caused by the sharp decrease of throughput in Chua Ve terminal because of the disadvantage of the downstream location and the emergence of several new terminals near the mouth of the estuary. Whereas the cargo volume in the Tan Vu terminal still increased considerably, particularly, by 83% in 2017.

Subsequently, the Dinh Vu port development and investment joint stock company has steady growth in the container traffic during the studied period. More specifically, the volume of throughput of the Dinh Vu terminal increased by 22 %, 24%, 28 % in 2015, 2016, 2017 compared to 2013, respectively. Specifically, the Dinh Vu terminal is the outstanding container terminal in the Dinh Vu industrial zone and in the downstream area as well. With the geographical advantage and the length of berth, the Dinh Vu terminal was considered as the focal point serving importers and exporters in the industrial zone before the emergence of new container terminals.

The throughput volume of two smaller terminal operators that operate only one terminal did not increase as much as the above multiple terminal operators. In particular, the container throughput of the Hai An terminal was relatively stable due to the available cargo resources from affiliated companies that are domestic shipping lines. The PTSC Dinh Vu terminal's traffic decreased moderately by 24% in 2016. It was caused by the severe competition in the region, the big terminals such as Tan Vu, Nam Hai Dinh Vu have focused on the import-export cargoes, some small terminals have only concentrated on the domestic cargoes, some old terminals in the upstream area such as Nam Hai, Doan Xa have even decreased their port tariffs to attract more cargoes. Simultaneously, the limitation of capacity resulted in the low growth of throughput of this operators group.

<u>b. The growth rate of revenue</u>

Table 14: The revenue growth of the selected operators

Unit : USD

Business	Terminal	2013	2014	2015	2016	2017	%			
							2014/ 2013	2015/ 2013	2016/ 2013	2017/ 2013
PHP	Chua Ve	16,818,182	17,150,000	10,824,000	7,272,000	7,030,000	2%	-36%	-57%	-58%
	Tan Vu	20,151,320	20,727,273	30,171,200	46,863,636	47,369,000	3%	50%	133%	135%
	Total	**36,969,502**	**37,877,273**	**40,995,200**	**54,135,636**	**54,399,000**	**2%**	**11%**	**46%**	**47%**
GMD	Nam Hai	10,085,040	10,712,000	9,357,700	8,458,200	6,720,000	6%	-7%	-16%	-33%
	Nam Hai Dinh Vu		12,465,000	20,972,800	26,194,800	32,013,900		68%	110%	157%
	Total	**10,085,040**	**23,177,000**	**30,330,500**	**34,653,000**	**38,733,900**	**130%**	**201%**	**244%**	**284%**
VCS	Green Port	14,574,000	16,200,000	15,435,000	14,090,909	13,727,273	11%	6%	-3%	-6%
	VIP Green Port	-	-	920,000	15,231,364	24,513,409			1556 %	2565 %
	Total	**14,574,000**	**16,200,000**	**16,355,000**	**29,322,273**	**38,240,682**	**11%**	**12%**	**101%**	**162%**
DVP	Dinh Vu	22,754,545	24,618,182	31,854,636	31,935,455	31,382,727	8%	40%	40%	38%
PSP	PTSC Dinh Vu	8,522,727	9,805,000	9,044,000	7,045,500	8,678,182	15%	6%	-17%	2%
HAP	Hai an	7,789,240	8,343,000	8,910,000	8,075,000	7,750,000	7%	14%	4%	-1%

Source: Author compiled and calculated from the annual reports of these selected multiple terminal operators.

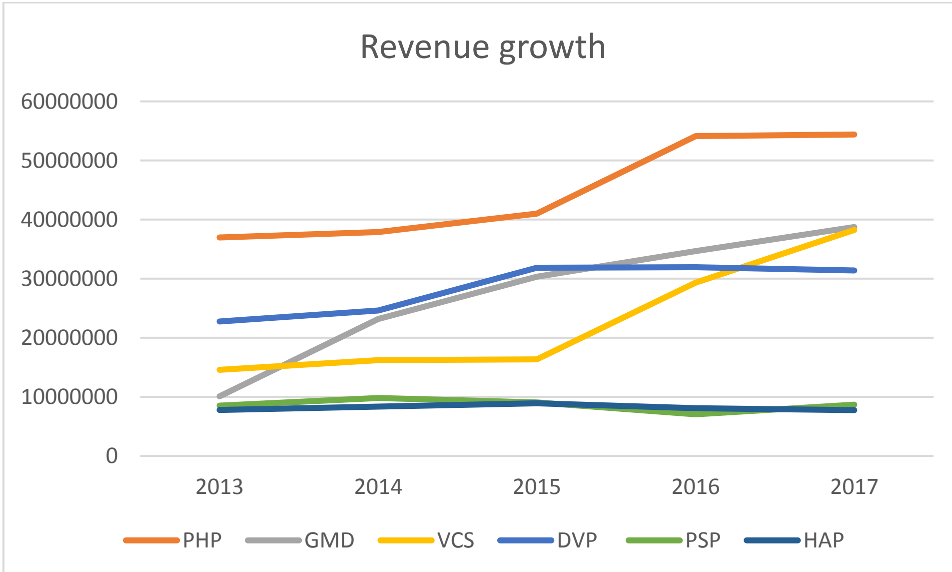

Figure 8 : The revenue growth of the selected operators

Table 14 and figure 8 also reflect the higher increase rate in the revenue of three larger multiple terminal operators. More specifically, the revenue in the container port sector of Gemadept Corporation in the Haiphong area in 2017 grew four times than the 2013 figure. The Viconship's port operation revenue in 2017 tripled the amount in 2013, whereas the largest business – the port of Haiphong joint stock company's revenue increased 1.5 times during the same period. In there, the Tan Vu terminal had the highest income in the whole port system.

Followed by the medium terminal operator, the Dinh Vu port development and investment joint stock company's revenue in the container sector were relatively stable in 2015 – 2017. Subsequent to that, there were slight changes in the revenue of smaller terminal operators (see Figure 8).

The fluctuations of these selected operators' revenue were caused by the different growth levels of the container traffic of the selected businesses as analyzed above. The increase in the volume of throughput rises the revenue value and vice versa. On the other hand, some big terminals such as Tan Vu, Nam Hai Dinh Vu, VIP Green have focused on the international customers that are big shipping lines such as Maersk Line, COSCO, Evergreen, Hapag-Lloyd, etc. As a consequence, the higher port tariff structure is another factor that impacts the revenue.

c. The growth of profit.

Table 15: The profit growth of the selected operators

Unit: USD

Operator	Terminal	2013	2014	2015	2016	2017	%			
							2014/ 2013	2015/ 2013	2016/ 2013	2017/ 2013
PHP	Chua Ve	6,636,364	7,363,636	3,896,640	2,424,000	2,850,000	11%	-41%	-63%	-57%
	Tan Vu	8,682,100	7,055,360	14,075,280	21,702,200	26,260,000	-19%	62%	150%	202%
	Total	**15,318,464**	**14,418,996**	**17,971,920**	**24,126,200**	**29,110,000**	**-6%**	**17%**	**57%**	**90%**
GMD	Nam Hai	4,538,520	4,713,636	4,509,650	4,395,600	3,528,000	4%	-1%	-3%	-22%
	Nam Hai Dinh Vu		4,709,000	9,744,000	13,150,000	17,253,000	-	107%	179%	266%
	Total	**4,538,520**	**9,422,636**	**14,253,650**	**17,545,600**	**20,781,000**	**108%**	**214%**	**287%**	**358%**
VCS	Green Port	6,288,681	6,850,800	7,065,800	6,400,000	6,773,400	9%	12%	2%	8%
	VIP Green Port	-	-	-415,455	1,301,818	4,368,273	-	-	413%	1151%
	Total	**6,288,681**	**6,850,800**	**6,650,345**	**7,701,818**	**11,141,673**	**9%**	**6%**	**22%**	**77%**
DVP	Dinh Vu	8,954,545	10,363,636	14,115,955	14,405,000	14,381,818	16%	58%	61%	61%
PSP	PTSC Dinh Vu	2,489,530	3,259,500	2,951,200	1,866,600	3,280,500	31%	19%	-25%	32%
HAP	Hai an	2,465,300	2,533,800	2,805,000	2,713,200	2,573,000	3%	14%	10%	4%

Source: Author compiled and calculated from the annual reports of these selected multiple terminal operators.

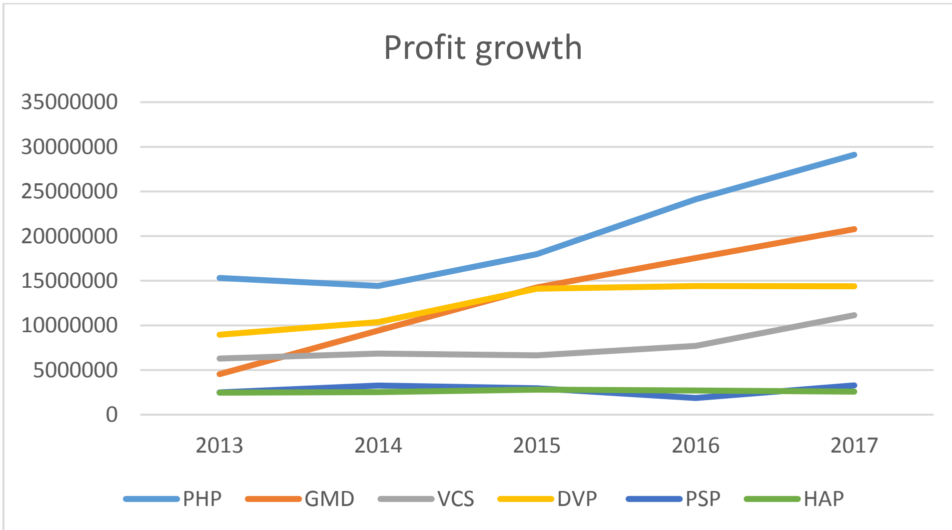

Figure 9: The profit growth of the selected operators

Table 15 and figure 9 reveal the similar changes in profit as the fluctuations of throughput and revenue. In general, almost all of the operators got specific profits. The port of Haiphong joint stock company took the lead with the highest volume of profit. Followed by Gemadept, the profit increased by 358% due to the fast rise of throughput in Nam Hai Dinh Vu terminal and the efficient cost structure. After that, the Dinh Vu port development and investment joint stock company's profit was higher than the third large operator because of the high cost of the VIP Green terminal in the initial operational stage. However, the graph also depicts that the profit of the bigger operators has tended to increase faster at the end of the studied period. Lastly, the two small operators had a steady profit based on stable container traffic.

In general, the throughput, revenue, and profit of the larger operators and the growth rates are significantly higher than the smaller ones in the port of Haiphong.

3.3.2. Productivity measures – Labor productivity

Labor productivity is one of the essential criteria to measure the performance of the labor resource in particular and the whole business in general. Some KPIs that are generally used to measure labor productivity are throughput per labor, revenue per labor, and profit per labor. These KPIs are calculated as the formula 8, 9, and 10. Then, the following tables will illustrate these KPIs together with the fluctuation trends shown in the figures.

$$\text{The throughput per labor} = \frac{\textit{The volume of throughput}}{\textit{The number of workers}} \quad \text{(TEU/labor)} \qquad (8)$$

$$\text{The revenue per labor} = \frac{\textit{The amount of revenue}}{\textit{The number of workers}} \quad \text{(USD/labor)} \qquad (9)$$

$$\text{The profit per labor} = \frac{\textit{The amount of profit}}{\textit{The number of workers}} \quad \text{(USD/labor)} \qquad (10)$$

Table 16: The number of workers of the selected multiple terminal operators

Unit: worker

No	Business	Terminal	Labor 2013	Labor 2014	Labor 2015	Labor 2016	Labor 2017
		Chua Ve	246	250	252	242	230
		Tan Vu	384	393	368	375	382
1	PHP	Total	**630**	**643**	**620**	**617**	**612**
		Nam Hai	157	150	150	147	145
		Nam Hai Dinh Vu		253	250	238	220
2	GMD	Total	**157**	**403**	**400**	**385**	**365**
		Green Port	243	244	240	237	230
		VIP Green Port			70	105	137
3	VCS	Total	**243**	**244**	**240**	**342**	**367**
4	DVP	Dinh Vu	340	340	339	338	342
5	PSP	PTSC Dinh Vu	222	238	241	240	235
6	HAP	Hai an	230	235	235	237	220

Source: Author compiled from the annual reports of the selected multiple terminal operators.

It can be seen in table 16 that the total number of people working at some upstream terminals tended to reduce gradually, for instance, the Chua Ve, Green port, Nam Hai terminal due to the decrease of cargo traffic in 2013 - 2017. More specifically, some big terminals such as the Nam Hai Dinh Vu terminal own a relatively similar labor volume as the smaller terminals such as PTSC Dinh Vu and Hai An though the capacity of the large terminals approximately doubled the small ones. Even the number of workers of the VIP Green terminal was half of PTSC Dinh Vu's figure.

Table 17: Revenue per labor

Business	**Terminal**	**2013**	**2014**	**2015**	**2016**	**2017**
		Revenue / labor (USD/labor)				
PHP	Chua Ve	68,367	68,600	42,952	30,050	30,565
	Tan Vu	52,477	52,741	81,987	124,970	124,003
	Total	**58,682**	**58,907**	**66,121**	**87,740**	**88,887**
GMD	Nam Hai	64,236	71,413	62,385	57,539	46,345
	Nam Hai Dinh Vu	-	49,269	83,891	110,062	145,518
	Total	**64,236**	**57,511**	**75,826**	**90,008**	**106,120**
VCS	Green Port	59,975	66,393	64,313	59,455	59,684
	VIP Green Port	-	-	13,143	145,061	178,930
	Total	**59,975**	**66,393**	**52,758**	**85,738**	**104,198**
DVP	Dinh Vu	66,925	72,406	93,966	94,484	91,762
PSP	PTSC Dinh Vu	38,391	41,197	37,527	29,356	36,928
HAP	Hai an	33,866	35,502	37,915	34,072	35,227

Source: Author calculated from the collected data.

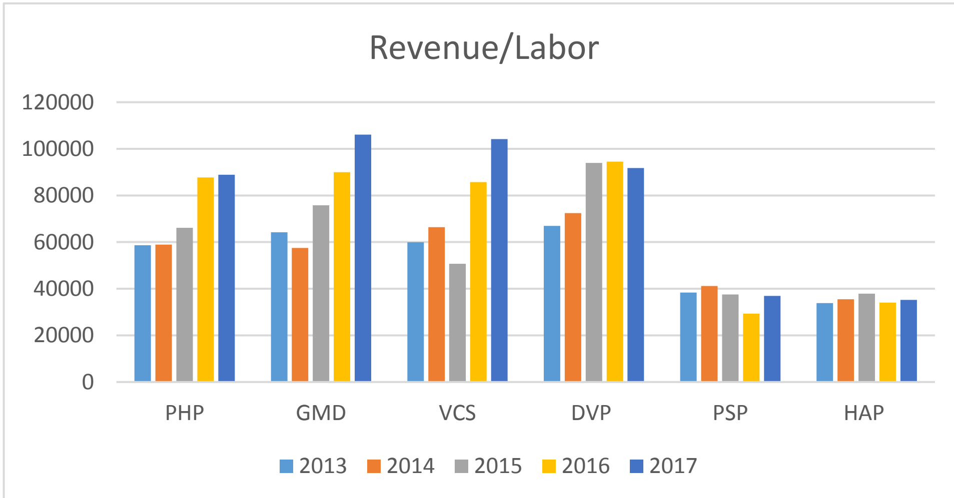

Figure 10: Revenue per labor

Table 18: Profit per labor

Business	**Terminal**	**2013**	**2014**	**2015**	**2016**	**2017**
		Profit / labor (USD/labor)				
PHP	Chua Ve	26,977	29,455	15,463	10,017	12,391
	Tan Vu	22,610	17,953	38,248	57,873	68,743
	Total	**24,315**	**22,425**	**28,987**	**39,102**	**47,565**
GMD	Nam Hai	28,908	31,424	30,064	29,902	24,331
	Nam Hai Dinh Vu	-	18,613	38,976	55,252	78,423
	Total	**28,908**	**23,381**	**35,634**	**45,573**	**56,934**
VCS	Green Port	25,879	28,077	29,441	27,004	29,450
	VIP Green Port	-	-	-3,777	12,398	31,885
	Total	**25,879**	**28,077**	**19,001**	**22,520**	**30,359**
DVP	Dinh Vu	26,337	30,481	41,640	42,618	42,052
PSP	PTSC Dinh Vu	11,214	13,695	12,246	7,778	13,960
HAP	Hai an	10,719	10,782	11,936	11,448	11,695

Source: Author calculated from the collected data.

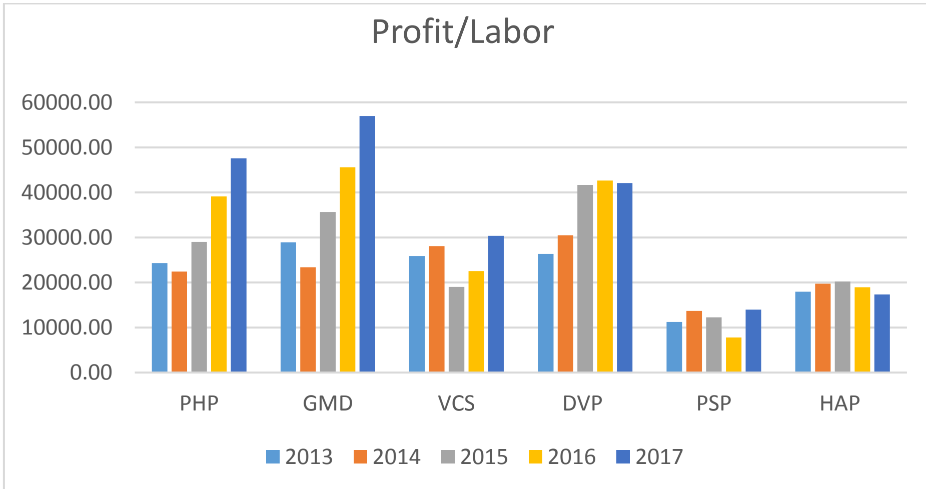

Figure 11: Profit per labor

Table 19: Throughput per labor

Business	**Terminal**	**2013**	**2014**	**2015**	**2016**	**2017**
		Throughput / labor (USD/labor)				
PHP	Chua Ve	1979.67	1960.00	1301.59	834.71	826.09
	Tan Vu	1440.10	1302.80	1880.43	2357.33	2643.98
	Total	**1650.79**	**1558.32**	**1645.16**	**1760.13**	**1960.78**
GMD	Nam Hai	1605.10	1733.33	1566.67	1510.20	1158.62
	Nam Hai Dinh Vu	-	1094.86	1856.00	2210.08	2904.55
	Total	**1605.10**	**1332.51**	**1747.50**	**1942.86**	**2210.96**
VCS	Green Port	1427.98	1475.41	1429.17	1350.21	1382.61
	VIP Green Port	-	-	209.09	3133.33	3715.33
	Total	**1427.98**	**1475.41**	**1045.71**	**1897.66**	**2253.41**
DVP	Dinh Vu	1517.65	1688.24	1852.51	1896.45	1932.75
PSP	PTSC Dinh Vu	1085.59	1113.45	987.55	762.50	1034.04
HAP	Hai an	1204.35	1314.89	1404.26	1362.87	1409.09

Source: Author calculated from the collected data.

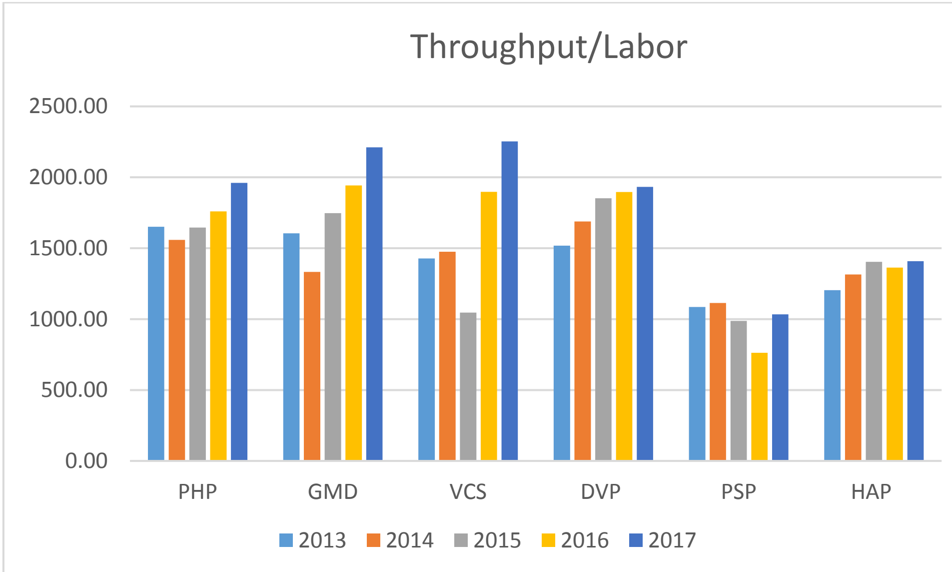

Figure 12: Throughput per labor

The general trend of these three KPIs revealed that the larger operators achieved the higher labor productivity. In detail, in 2017, the throughput per labor of GMD, VCS, PHP and DVP fluctuated more or less 2000 TEUs/labor-year whereas the PSP and HAP's this KPI were 1034 TEUs/labor-year, 1409 TEUs/ labor-year, respectively. Additionally, the revenue per labor of VCS, GMD approximately tripled this value of PSP and HAP in 2017, more especially as one labor unit could create the amount of revenue of 106120 USD/year in GMD and 35227 USD/year in HAP. In the meantime, the profit per labor also illustrates the same result. The GMD's statistic shows more than three times the HAP and four times the PSP's profit per labor unit in 2017. This value of PHP was considerably high around 47565 USD/ labor – year. Albeit the dramatic increase in throughput, VSC's profits were smaller than the two above competitors because of the high investment cost at the initial stage.

On the other hand, these labor productivity indicators of the larger businesses tended to increase significantly whereas HAP's labor productivity slightly changed. It can be seen in figure 12 that HAP's labor productivity has reduced slightly since 2015 due to the decrease of the container throughput as well as the intensive competition among operators. However, the remaining small operators PSP increased slowly their productivity thanks to the movement trend of customers towards the upstream terminals.

According to the annual report of these port operators, currently, in the port of Haiphong, the big operators have invested more in labor resources. Especially, GMD, PHP and VCS have programs to assign managers and labors to join in the education program abroad every year. For example, managers of PHP were assigned to study the advanced course for port and logistics professionals in Busan, Korea in 2018. Simultaneously, labors regularly have been updated with professional knowledge and skills, etc. These policies aim to improve the quality of human resources. It results in fewer accidents and higher labor productivity as well. The training cost/ salary fund of the smaller firms was underestimated compared to the small to medium enterprises (SMEs). This ratio of PTSC Dinh Vu was 0.17%, 0.22%, 0.11% in 2015, 2016, 2017, respectively, whereas other SMEs spent at least 1.6% of salary fund for labor training programs (PTSC Dinh Vu, 2017).

3.3.3. The unit cost

The unit cost of each multiple terminal operator includes two main components: the operating unit cost and the unit time cost. In other words, the operating unit cost is the direct cost that is the amount of money paid by operators to handle one TEU. The unit time cost is considered as the indirect cost that a customer suffers more for one TEU in the case of the longer turnaround time due to congestion, low productivity, etc. These two components of the studied businesses are illustrated in the following table 20 and 23.

$$\text{The operating unit cost} = \frac{The\ yearly\ operating\ cost}{The\ volume\ of\ throughput}\ \text{(USD/TEU)} \qquad (11)$$

Table 20: The operating unit cost

Business	Terminal	2013	2014	2015	2016	2017
		Operating unit cost (USD/TEU)				
	Chua Ve	20.9	20.0	21.1	24.0	22.0
PHP	Tan Vu	20.7	26.7	23.3	28.5	20.9
	Total	**20.8**	**23.4**	**22.6**	**27.6**	**21.1**
	Nam Hai	22.0	23.1	20.6	18.3	19.0
GMD	Nam Hai Dinh Vu	-	28.0	24.2	24.8	23.1
	Total	**22.0**	**25.6**	**23.0**	**22.9**	**22.2**
	Green Port	23.9	26.0	24.4	24.0	21.9
VCS	VIP Green Port	-	-	58.1	42.3	39.6
	Total	**23.9**	**26.0**	**26.5**	**33.3**	**32.8**
DVP	Dinh Vu	26.7	24.8	28.2	27.3	25.7
PSP	PTSC Dinh Vu	25.0	24.7	25.6	28.3	22.2
HAP	Hai an	19.2	18.8	18.5	16.6	16.7

Source: Author calculated from the collected data.

The operating unit cost is measured by the total annual operating cost divided by the total yearly throughput. As illustrated in table 20, the operating unit cost of some larger operators was more or less the smaller ones' operating unit cost. In particular, VSC has the highest amount of this cost, around 33 USD/TEU due to the fact that the new terminal VIP Green was started recently and invested as one of the most modern container terminals in Haiphong in particular and in the Northern Vietnam in general. While the operating unit cost of PHP and GMD fluctuated around 22 USD/TEU. This figure of PHP in 2016 peaked at 27.6 USD/TEU when the Tan Vu terminal's operating unit cost increased to 28.5 USD/TEU due to the increase of the investment cost for new equipment and hiring the container management software.

For the DVP operator, the operating cost has been relatively high because of a large amount of general and administrative expense. In detail, DVP has the large volume of labor leading to a large amount of labor expense. Furthermore, being the strong competitor in the region, DVP has continuously invested in facility and equipment to attract more cargoes, especially, the international shipping lines. In 2016, DVP invested in one more quayside container gantry of 45 tons and continued the project by investing 4 rubber-tired gantries (RTG).

Last but not least, the final group with the smaller players, the operating unit cost of HAP was lowest among these studied operators. This value decreased gradually in 2013 - 2017, from 19.2 USD/TEU to 16.7 USD/TEU. It could be explained by the steady throughput and a downward tendency of depreciation cost of Hai An terminal. On the other hand, the operating unit expense of PTSC Dinh Vu was much more 6 - 8 USD/TEU than HAP's expense. This value was even higher than the large operators' numbers; it fluctuated around 25 USD/TEU. Because the PTSC Dinh Vu terminal has been under pressure of investment cost, most of the capital costs came from the new investment in the entire infrastructure of the land area. Besides the cost of capital, the high revenue structure from domestic customers also made a low profit.

Moving to the second part, the turnaround time encompasses waiting time, maneuvering time, productive time and idle time. In detail, the maneuvering time is from arrival at the entrance buoy to the anchor. The waiting time is the time that vessels wait for berth between anchor in and anchor out. The productive time is pure cargo handling time. Lastly, the idle time is preparing time for cargo handling after berthing and procedure before leaving (Moon, 2018).

According to the statistics of the research operators, it is assumed that the vessel size is 1000 TEU, the volume of cargo loading and unloading is around 500 TEU. Then the average turnaround time of each terminal is collected in table 21.

Table 21: The average turnaround time

Unit: hours

Business	Terminal	Average Maneuvering time	Average waiting time	Average idle time	Average productive time	Average turnaround time
PHP	Chua Ve	3.3	0.0	2.0	20.0	25.3
	Tan Vu	2.7	0.8	1.4	11.1	16.0
	Total					
GMD	Nam Hai	3.7	0.9	2.1	16.7	23.3
	Nam Hai Dinh Vu	2.5	3.5	1.8	11.9	19.7
	Total					
VCS	Green Port	3.5	0.5	2.0	16.1	22.1
	VIP Green Port	2.0	0.3	1.5	10.4	14.2
	Total					
DVP	Dinh Vu	2.3	8.5	1.8	13.9	26.5
PSP	PTSC Dinh Vu	2.3	1.0	2.4	25.0	30.7
HAP	Hai an	2.8	15.6	2.2	22.7	43.4

Source: Author compiled from the multiple terminal operators

Table 22 collects the value of one container 20 feet of two popular kinds of cargoes that regularly export and import through the port of Haiphong. It is assumed that the interest rate is 10%/year. Then the opportunity cost per year is calculated as follows:

The opportunity cost per unit = The value of a container 20 feet x Interest rate (USD/TEU-year) (12)

Table 22: Assumption the opportunity cost of 1 container 20 feet (1 TEU)

Type of cargo	Container Value	Cargo Value	Total Value	Opportunity cost in 1 year
Furniture	2000 USD	30000 USD	32000USD	3200 (USD/TEU-year)
Cotton towel	2000 USD	20000 USD	22000 USD	2200 (USD/TEU-year)

Source: Author compiled and calculated.

Then, the second component of the unit cost is defined in the following formula 13.

The unit time cost = The opportunity cost per hour x The turnaround time (USD/TEU) (13)

Table 23: The total unit cost in 2017

Unit cost: USD/TEU

Business	Terminal	Operating cost	Time cost		Unit cost	
			Cotton Towel	Furniture	Cotton Towel	Furniture
PHP	Chua Ve	22	6.4	9.4	28.4	31.4
	Tan Vu	20.9	4.1	5.9	25	26.8
	Total	**21.1**	**5.3**	**7.6**	**26.3**	**28.7**
GMD	Nam Hai	19	5.9	8.6	24.9	27.6
	Nam Hai Dinh Vu	23.1	5	7.3	28.1	30.4
	Total	**22.2**	**5.5**	**8.0**	**27.7**	**30.2**
VCS	Green Port	21.9	5.6	8.2	27.5	30.1
	VIP Green Port	39.6	3.6	5.3	43.2	44.9
	Total	**32.8**	**4.6**	**6.7**	**37.4**	**39.5**
DVP	Dinh Vu	25.7	6.8	9.8	32.5	35.5
PSP	PTSC Dinh Vu	22.2	7.8	11.4	30	33.6
HAP	Hai an	16.7	11	16.1	27.7	32.8

Source: Author calculated from the collected data.

It can be seen clearly in table 23 that in 2017, the unit cost of two larger operators, namely PHP, GMD were smaller than the medium and small businesses. Meanwhile, the VSC's figure was still high due to the large volume of initial investment. Especially, in the case of cotton towel container, the time cost of smaller terminals doubled or even tripled the new big terminals. For example, Hai An terminal's time cost nearly showed three times, 2.7 times and 2.5 times the time expense of VIP Green, Tan Vu, and Nam Hai Dinh Vu terminals respectively. Consequently, the higher value of time cost increased the total unit cost of medium and small operators. In the future, when the throughput of the big terminals will increase, simultaneously the investment cost in the beginning stage of new terminals will decrease slowly, the unit cost of those big terminals in particular and the big operators in general will decline gradually. Then the big players will achieve a higher profit thanks to economies of scale.

3.4. Conclusion

In summary, the analysis answers the three first research questions. More specifically, the port of Haiphong is relatively fragmented during the research period 2010 - 2017. Most KPIs reveal that the big multiple terminal operators have better business performances including higher labor productivity, the faster growth rate of business and the relatively smaller unit cost. Although the smaller companies are much more expensive than the larger businesses, these operators still have survived and achieved profit in the face of severe competition. However, they may face many other challenges in the future development with a limited size. These challenges and difficulties will be discussed in chapter 4.

CHAPTER 4: THE CHALLENGES FOR THE FUTURE DEVELOPMENT OF THE FRAGMENTED PORT OPERATIONS

4.1. Environmental aspect.

4.1.1. Environmental issues in port

Shipping emissions are the most concerning issues in ports in general. Emissions in port areas and the vicinity of ports have resulted in many environmental and health problems. In other words, when berthing, vessels use auxiliary engines to generate electrical power for lighting, communication, cargo handling of an onboard crane, and other activities on board (Winkel et al., 2016). The use of auxiliary engines increases greenhouse gas (GHG) emissions. On the other hand, port equipment and machines using diesel oil emit a massive amount of NO2, SO2, CO2. In detail, NO2 and CO2 emissions can lead to some dangerous diseases such as bronchitis while SO2 emission is strongly correlated with respiratory problems and premature births. Moreover, dust from bulk cargo and the operation of equipment are also significantly harmful to the health of labors and residents in the adjacent areas of ports. The emission in port not only affects human health but also contributes considerably to the climate change due to the adverse effects on air, water, soil quality as well as the marine ecosystem, etc. Therefore, it is critically urgent to propose and implement the global strategies and solutions to reduce the emission in ports in particular and in the shipping industry in general (Tonsich, 2017).

4.1.2. IMO's ambitions

At a meeting on 13 April 2018, the Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO) adopted strategies for reducing greenhouse gas (GHG) emissions from shipping. More specifically, the annual volume of GHG emission will reduce at least by 50% in 2050 in comparison with 2008, whereas the CO2 emission from shipping activities is forced to decline by at least 40% till to 2030, further pursuing towards by 70% in 2050 compared to 2008's the CO2 emission volume. More importantly, IMO adopted amendments to MARPOL Annex VI, regulation 21 about

Energy efficiency design index (EEDI) for RO-RO vessels and RO-RO passenger vessels. This regulation improves the higher energy efficiency design requirements for different types of ship with the proportion update for particular phases. In fact, the standards for new vessels, together with measuring the energy efficiency of existing vessel fleet, have been compulsory since 2013. Until now, there are more than 2700 new vessels certified to comply with the energy efficiency standards of IMO.

Simultaneously, on 13 April 2018, the IMO MEPC also confirmed one of the most immediate challenges of the shipping industry again. The amendments to MARPOL convention, Annex VI were adopted in 2008 regarding the 2020 global sulphur cap. In particular, the permitted sulphur content of fuel used by all vessels trading outside the sulphur Emission Control Areas (ECAs) will not exceed 0.5% instead of the current level of 3.5%. While in the ECAs, the North America and North West European areas required the 0.1% or less sulphur content of fuel (ICS, 2018).

These environmental challenges require the immediate strategies of not only shipping firms but also port operators. Currently, some big port operators all over the world have implemented the environmental solutions to adapt to the sustainable development of the port, shipping industry, and human society as well.

4.1.3. Environmental solutions

a. <u>Shore side electricity</u>

Shore side electricity (SSE) is a new solution to reduce the adverse environmental effects of vessels at berths, such as GHG emissions, noise pollution, and air pollution. In fact, instead of using the auxiliary engines as ordinary, ships are plugged directly into the electricity network of ports. It was proven that in the UK, using SSE generating electrical power on board declined the emission of $CO2$ by 25%, $SO2$ by 46%, CO by 76% and NOx by 92%. According to Winkel et al. (2016), the application of SSE system for almost EU member states would decrease the $CO2$ emissions. His research shows that the reduction of carbon emissions in EU can reach 80000 tons of $CO2$. Subsequent to that, the expected health benefits were estimated to be approximately € 2.94 billion in 2020 when the EU ports use this SSE. However, in some countries the electricity is generated by fossil fuel, in other words, the electricity content has a high percentage of carbon. The use of SSE may increase the emissions in comparison with using the auxiliary engines of ships. Nevertheless, it is proven that using SSE still has significant advantages that move air pollution from port areas to more remote regions generating electricity.

Though the vast benefits of using SSE, the investment expenses for this electrical system on board is relatively expensive, for instance, around € 500000 for a two mega volts amp connection. On the shore side, the cost of investment fluctuates more than millions for ports. It can be invested by port operators having the intensive capital or supported from local governments.

b. <u>Cargo handling equipment</u>

Container terminals use a variety of cargo handling equipment. The degree of emissions depends on the types of equipment. Currently, there are several new developments helping to reduce the air emissions from container handling equipment such as electrification, hybrid technology, regenerating energy.

About 80% of straddle carries used worldwide are the diesel-electric machine. In some countries with less strict environmental regulations, container terminals are even using the full diesel equipment. At this time of writing, the diesel-electric equipment could have the competitive advantage because of low fuel prices in comparison with the expense of the hybrid technology. However, the newest hybrid straddle carrier can reduce 40 % of the volume of energy consumption and approximately 50 tons CO_2 emissions annually per vehicle. Therefore, there is no doubt that the hybrid system will fast become the choice of container terminals (Söderberg, 2017).

Converting the hybrid technology to electric equipment is quite straightforward because of the rapid improvement of Lithium-ion technology. The fully electric equipment declines the noise and allows zero emissions. On the other hand, with the advancement of fast charge technology, the fully electric straddle carriers and shuttle carriers can charge during idle times that do not affect terminal productivity (Söderberg, 2017).

Nonetheless, the initial investment of this advanced equipment is much higher than the traditional equipment. For example, a diesel yard tractor costs approximately 125000 USD, while an electric one costs around 300000 USD. Despite the high capital cost, the electric yard tractor's maintenance cost is lower and has a longer lifespan as well. As reported by Sisson (2017), the maintenance cost of an electric yard tractor is between 50% to 67% of the diesel equipment's expense. In addition, it is estimated that the total expense for replacing into near zero emission equipment and machinery is around 23 billion USD in container terminals in Oakland, Los Angeles and Long Beach (Mongelluzzo, 2016). In summary, small terminal operators do not concern about environmental issues due to the financial constraints. In other words, investing the fully advanced cargo handling equipment system complying with the environmental regulations requires a massive capital that the small operators cannot afford to implement. Therefore, currently, terminals within the port Haiphong system have not used clean technology for port equipment such as electric, hybrid, bio-energy ship to shore cranes, RTGs, forklifts, etc. (Roh et al., 2016)

4.2. Technological aspect

4.2.1. The development of information technology (IT)

Port operations require significant resources such as tugboats for towing vessels arriving harbor, berthing space for vessels, available cranes for cargo handling, yard space for storing and manpower keeping port working 24/7, etc. Furthermore, the variety of port operation activities, including berth assignment, shipside operation, yard operation, gate operation are highly interrelated. Ports need to coordinate these activities efficiently without any congestion and high turnaround time by using the IT system.

For example, in the case of Hamburg Port Authority (HPA), previously, the IT system included four separated networks. Firstly, vessels arriving at the port were communicated with and tracked by a single radar system. Secondly, train traffic was managed by another network. Next, the telephone communication was another disparate system. The last was the port's IT platform. The integration of four separated networks resulted in more fluent and close communication throughout HPA and with their customers as well. In particular, the integration of the radar system alerts port operators when vessels arrive. Furthermore, this system also connects to the network of 300 sensors installed on roads and bridges in the hinterland. These sensors provide port operators information about congested situations. Additionally, other types of port equipment such as cranes, pallets also are installed sensors. Therefore, HPA can easily manage and plan to use their resources more efficiency (Kranz, 2017).

Here is another example of the improvement of efficiency by applying IT innovation in the port of Singapore. About 6000 trucks are entering and leaving the port gate every day, while the waiting area is only for five trucks at each gate. This led to the emergence of a solution called the Gate Automation System (GAS). This innovation can shorten the processing time of trucks at gates as follows. When a container truck arrives at a gate, it takes only 25 seconds to register its arrival, record its weight, and assign its allocation automatically.

In the era of the industry 4.0, the IT innovations are deploying and applying widely to the maritime industry. Around 100 – 120 million data points are generated every day by big data from the massive variety of sources such as ports, shipping routes, etc. This helps to analyze and identify the efficient options, to exemplify, quicker shipping routes, preferred terminals. For port operators, big data can help to achieve efficiency through providing the holistic real-time information to measure the performance, analyze and find the root causes of incidents (Hepworth, 2018). In other words, the data sharing solution collects, integrates and analyzes the enormous sources of relevant information before vessels arrive by sea or cargoes arrive by land. For example, the port of Valencia undertook the data sharing solution called black boxes that they had installed boxes on almost all their ship to shore cranes, straddle carriers, trucks, forklifts inside their terminal. These boxes functions are collecting data in real time on location, operational status, energy consumption to utilize them efficiently at any time. Simultaneously, towards the increasing integration of port into the supply chain, blockchain technology will enable a port to share data throughout the supply chain by a transparent and secured process. Furthermore, according to Bouari (2018), Artificial Intelligence (AI) can strongly help port operators to work smarter. For example, beside to keep tracking container, the smart vehicle booking system (VBS) can support terminal operators assist truck drivers to pick out containers quickly when they arrive at the terminal at the booking time. Then congestion and wasted time are cut down dramatically.

The maritime industry has been facing the integration of the supply chain, the increase of scale, efficiencies and the enormous advantages of technology innovations. Ports all over the world have no choice to invest more in advanced technology for future developments. Currently, many ports are investing in the blockchain, AI technology for a wide range of applications. With the tremendous amount of investment expenses, port operators' capital has to be significantly intensive. If a port is too fragmented, each operator strives to survive and gain profit temporarily. They cannot afford to invest intensively in the future trends.

4.2.2 Towards the automation trend.

Beside to implement the environmental regulations for the future sustainable development, the electrification of port equipment is also the first step for approaching an automated solution. Warzecha (2018) mentioned that there are four steps to retrofit the manual terminal to full automation. The first step is electrifying port equipment. The second, electric RTGs have to be positioned in container blocks. Most importantly, the next step is integrating a reliable, transparent and safe transmission of data that all yard equipment items are connected with the IT system. Finally, electrification, positioning, and communication are all combined into fully automated terminals.

The automation is considered as the irrevocable trend for further development. Warzecha (2018) believed that automation is the best solution to improve the operational efficiency. Likewise, automation is agreed to bring a variety of advantages regarding efficiency, safety, and reliability (Rodrigue, 2018). For example, the Port of Baltimore in the US can increase the crane productivity to 75 container moves per hour.

However, it is suggested that if the total volume of throughput of a terminal is higher than 500000 TEUs per year, it is suitable to retrofit to the automated terminal. For smaller terminals, it is less ideal for an automation retrofit due to the high capital cost as well as the complex and skillful requirements (Neil Davidson, 2018). The capital expenses for investing a container terminal that has 400 meters of berth length is estimated at approximately 150 million USD. This amount of cost for an automated terminal is higher 50% than the traditional ones, around 220 million USD. Hence, the small terminal operators are outside of this trend.

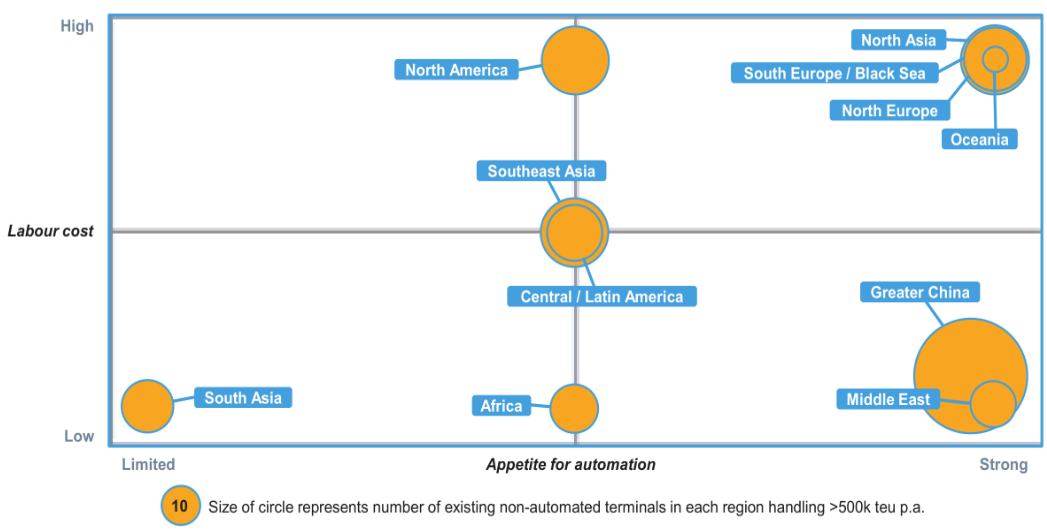

Figure 13: The potential automated terminals by the region

Source: (Neil Davidson, 2018)

Figure 13 reveals the potential development towards automated terminals all over the world. In there, the vertical axis reflects the labor expense while the horizontal axis depicts the expectation for automation. Southeast Asia is also the potential market for this tendency. More particularly, the port authority of Thailand is investing in the automated terminal in Laem Chabang port. The ten automated RTGs in ten container blocks are expected to be operated in 2018. The electrification, positioning, and data communication system will be made afterward (Warzecha, 2018).

Being the neighbor port, even with the advantages about geographical location and the significant growth of container traffic, the fragmented port system in Haiphong cannot develop more to achieve the automation level due to the restrictions on high capital expense as well as the terminals' throughput volume.

4.3. Safety aspect

According to Jones (2018), the safety level of the terminal is highly correlated to its automated level. Many incidents at terminals have root causes due to human elements. Such incidents may be classified into vessel issues and terminal issues. Specifically, for terminal issues, there are incidents during the berthing process as well as handling cargoes at the quay or yard side. First of all, in many terminals, bollards are unchecked for a long period of time. They also do not follow any international standards about the number, quality, and capacity. Hence, it could be the important point that needs to be considered when a ship is berthing. The second risk is the mooring and unmooring process. The labor skills have played the most important role during mooring and unmooring, especially in the bad weather. Thirdly, the cargo handling process is also dangerous when the non-advanced equipment requires manual workers to twist locks, show signals for equipment and machines.

New technologies have emerged to solve these unsafety problems. Typically, the vacuum and magnetic mooring systems may enhance safety when berthing. This system does not need mooring lines as according to tradition and removes port workers, as well as crews, from potentially dangerous activities. More significantly, as analyzed above, the automated terminal increases the performance efficiency of the terminal through an advanced technology system. At the same time, it decreases the presence of the human in the courtyard based on different levels of automation. Notably, a fully automated terminal seems like a ghost terminal without any person. Therefore, the risks of incidents have been reduced entirely. Nonetheless, these systems are tremendously expensive and require the intensive capitals. (Jones, 2018).

CHAPTER 5: CONCLUSION

This dissertation reviews the concentration and fragmentation tendencies of port systems, the driving factors behind these phenomena. Concentration in container port segment is acknowledged as a phenomenon of concentrating the container throughput in a few large container terminals that have increased their market shares at the cost of the remaining smaller firms. This situation is promoted by a variety of factors. The economies of scale is believed as one of the most crucial motivations, in particular, the larger container terminal can reduce the unit cost, utilize more substantial capital resource to invest in the advanced technology and equipment to handle a larger container traffic efficiently. Besides, the concentrated port system can be an implication of government that aims to develop a hub port leading to enhancing the national competitive advantages. In addition, the tendencies about the increase in ship size and the reduction of the number of port calls by shipping lines have also required larger terminals. On the other hand, fragmentation is considered as the process of dispersing the cargo traffic to a broader number of ports. It is caused by the congestion, the shortage of space at larger terminals, and the customer selection due to the cheaper port tariffs or the relationships between shipping lines and port operators. Simultaneously, the government intervention affects the formation of the fragmented port system. In detail, the poor coordination among governmental agencies at different levels leads to a heterogeneous port planning and investment.

Next, the methodologies applied to measure the concentration or unconcentration level in the previous studies in variety of port systems such as European ports, Hamburg – Le Havre range, Japanese, Korean and Chinese ports are mentioned, such as, the Gini coefficient, the normalized Hirschman-Herfindahl index (N-HHI), the Herfindahl–Hirschman Index (HHI). The HHI score and N-HHI score are used in the case of a port system in a particular region or a country, while the Geo-Economic concentration index (GECI) is applied to a wider port range among different countries. Besides, the concentration ratio CR(k) is used to evaluate the market power of the largest port operators in the market. Last but not least, the shift-share analysis considers both sides of the fluctuation of cargo traffic. The shift effect reflects how a port loses or wins from its rivals, whereas the share effect reveals the growth of a port throughput when the throughput of a port range increases.

Then, in a case of the port of Haiphong, the concentration level was measured by some methodologies, namely the HHI score, the N-HHI score, and concentration ratio. All these indicators reflected that the Haiphong port system is relatively fragmented during the research period 2010-2017. There is a large number of terminals and multiple terminal operators however there is no load center in this region. These multiple terminal operators have to compete severely to attract customers.

Meanwhile, the KPIs of different multiple terminal operators prove that the size of business affects significantly on the business performances. In more detail, the larger businesses can achieve the higher productivity, the faster business growth rate and the lower unit cost during the research period in 2013 – 2017. The smaller terminal operators have still survived despite the more expensive unit cost. However, it is clear that the fragmented service pattern and the small average size of the operators are hindrances to the further growth and development of the Haiphong port as a major gateway and foreign trade platform for Northern Vietnam. This situation is particularly serious in view of technical and environmental challenges that the port sector will face in the future.

Therefore, this dissertation emphasizes the challenges for the further developments of a global port system in general and a fragmented port system in particular. Firstly, in the technical aspect, the efficiency and safety of port operation are top concerns of port operators and ports' customer including shipping lines, shippers, freight forwarders, etc. Nowadays, the IT innovations and the advanced technology have played decisive roles to improve the port performance. Secondly, the strict regulations regarding environmental issues of the IMO require permanent environmental solutions. Electrifying port equipment and machines is considered as a great solution to have zero emission and reduce noise pollution at a port. Moreover, some big ports in the world have been using the shore side electricity for vessels at berth. However, the investments in these solutions require a massive capital at the initial stages that only big players can afford to follow the trends.

Besides the above results, this dissertation still has limitations about the data range and research methodologies. In the future, the author wants to research more about the intra-port competition by evaluating the HHI, N-HHI score and shift-share analysis. Furthermore, recommendations will be suggested for the future developments of the Haiphong port system being adapted to the worldwide improvement trends.

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APPENDICES

Appendix 1: The annual operating cost of the selected multiple terminal operators

Unit: USD

Business	Terminal	2013	2014	2015	2016	2017
PHP	Chua Ve	10,181,818	9,786,364	6,927,360	4,848,000	4,180,000
	Tan Vu	11,469,220	13,671,913	16,095,920	25,161,436	21,109,000
	Total	**21,651,038**	**23,458,276**	**23,023,280**	**30,009,436**	**25,289,000**
GMD	Nam Hai	5,546,520	5,998,364	4,848,050	4,062,600	3,192,000
	Nam Hai Dinh Vu		7,756,000	11,228,800	13,044,800	14,760,900
	Total	**5,546,520**	**13,754,364**	**16,076,850**	**17,107,400**	**17,952,900**
VCS	Green Port	8,285,319	9,349,200	8,369,200	7,690,909	6,953,873
	VIP Green Port	-	-	1,335,455	13,929,545	20,145,136
	Total	**8,285,319**	**9,349,200**	**9,704,655**	**21,620,455**	**27,099,009**
DVP	Dinh Vu	13,800,000	14,254,545	17,738,682	17,530,455	17,000,909
PSP	PTSC Dinh Vu	6,033,197	6,545,500	6,092,800	5,178,900	5,397,682
HAP	Hai an	5,323,940	5,809,200	6,105,000	5,361,800	5,177,000

Source: Author compiled from the annual reports of the selected businesses

Appendix 2: The unit time cost calculation

Business	Terminal	Average turnaround time (Hour)	Opportunity cost (USD/TEU-hour)		Unit time cost (USD/TEU)	
			Cotton Towel	Furniture	Cotton Towel	Furniture
PHP	Chua Ve	25.3	0.25	0.37	6.4	9.4
	Tan Vu	16.0	0.25	0.37	4.1	5.9
	Total	20.6	0.25	0.37	5.3	7.6
GMD	Nam Hai	23.3	0.25	0.37	5.9	8.6
	Nam Hai Dinh Vu	19.7	0.25	0.37	5.0	7.3
	Total	21.5	0.25	0.37	5.5	8.0
VCS	Green Port	22.1	0.25	0.37	5.6	8.2
	VIP Green Port	14.2	0.25	0.37	3.6	5.3
	Total	18.2	0.25	0.37	4.6	6.7
DVP	Dinh Vu	26.5	0.25	0.37	6.8	9.8
PSP	PTSC Dinh Vu	30.7	0.25	0.37	7.8	11.4
HAP	Hai an	43.4	0.25	0.37	11.0	16.1

Source: Author calculated from the collected data.