TẠP CHÍ ISSN: 1859-316X
KHOA HỌC CÔNG NGHỆ HÀNG HẢI
JOURNAL OF MARINE SCIENCE AND TECHNOLOGY

# FACTORS AFFECTING CONTAINER TERMINAL COMPETITIVENESS IN HAI PHONG USING ENTROPY ALGORITHM

# ÁP DỤNG PHƯƠNG PHÁP TRỌNG SỐ ENTROPY ĐỂ ĐÁNH GIÁ YẾU TỐ ẢNH HƯỞNG NĂNG LỰC CẠNH TRANH CỦA BẾN CẢNG CONTAINER Ở HẢI PHÒNG

**NGUYEN THI HUONG GIANG**

*Department of Maritime Business, Faculty of Economics, Vietnam Maritime University*

*Email: giangnth.kt@vimaru.edu.vn*

**Abstract**

*Nowadays, ports get affected by competition more than ever before, especially in the era of containerization. Thus, it is essential to gain great insights into the competitiveness of container ports as well as its determinants. This research aims to investigate what are the main factors for evaluating port competitivenes. Five key evaluating Level 1 criteria consisting of Level 1 criteria are weighted by adopting an objective weighting technique, so-called the Entropy algorithm. The results reveal that the facility is the most critical determinants of port competitiveness, followed by port throughput, port service quality, port charge, and port location. This research contributes to the literature of port competitiveness by proposing an approach combined both quantitative and qualitative evaluations.*

**Keywords**: *Criteria, port competitiveness, Hai Phong seaport, Entropy weight.*

**Tóm tắt**

*Ngày nay, các cảng biển bị ảnh hưởng bởi sự cạnh tranh hơn bao giờ hết, đặc biệt là trong thời đại container hóa. Vì vậy, cần thiết phải có được những hiểu biết sâu sắc về khả năng cạnh tranh của cảng container cũng như các yếu tố quyết định nó. Nghiên cứu này nhằm mục đích xác định các yếu tố chính ảnh hưởng tính cạnh tranh của cảng. Năm tiêu chí cấp độ 1 đánh giá chính bao gồm 19 tiêu chí cấp độ 2 được tính trọng số bằng thuật toán Entropy. Kết quả cho thấy cơ sở vật chất là yếu tố quan trọng nhất quyết định tính cạnh tranh của cảng biển, tiếp theo là sản lượng, chất lượng dịch vụ cảng, phí cảng và vị trí cảng. Nghiên cứu này đóng góp vào cơ sở lý luận về tính cạnh tranh của cảng bằng cách đề xuất một phương pháp tiếp cận kết hợp cả đánh giá định lượng và định tính.*

**Từ khóa**: *Tiêu chí, năng lực cạnh tranh cảng, cảng biển Hải Phòng, trọng số Entropy.*

## 1. Introduction

Today, it is widely believed that ports constitute an important economic activity in coastal areas, taking charge of a vast majority of trade as well as export and import. Ports are also crucial to the support of economic activities in the hinterland since they act as an interface between sea and land transport (Dwarakish and Salim, 2015). In addition, ports are not only fundamental links in supply chain networks but also a primary means of integration into the global economic system. Obviously, the port industry is a vital part of economic sectors, specifically the strong influence of container ports.

Given today's competitive environment, the competitions among container ports have become fiercer. Evaluating the competitiveness of ports has become a critical issue related to the survival and development of the port itself (Tongzon, 2009). Hence, it is essential to gain sufficient understanding of the competitiveness of container ports as well as its determinants.

Vietnam is a coastal nation having enormous potential for marine economy development. Thus, the wealth of national maritime economy, especially the port industry gains much more concerned. Moreover, Hai Phong seaport is the largest seaport in the Northern region and the second in the country, contributing helping Hai Phong city become a logistics center of the Northern region and the whole country. In statistics from the Vietnam Seaport Association in 2023, of the total container cargo throughout Vietnam of nearly 17.5 million TEU, Hai Phong seaport area accounts for nearly 30%. The seaport is the gateway connecting developed countries in Northeast Asia such as China, Japan, Korea, Taiwan and Hong Kong. The volume of container cargo through Hai Phong enter and exit containers increases every year. Many new and modern container terminals were established to serve the sharp increase in container cargo through Hai Phong. There are 16 active container ports, serving imported and exported

goods locally and nationwide (Table 1). This creates fierce competition, strongly affecting the competitive position between edges in the system.

*Table 1. List of container terminals in Hai Phong*

| No | Terminal | Operation year | Berth Length |
|---|---|---|---|
| *1* | Nam Hai | 2009 | 144 |
| *2* | Đoan Xa | 2002 | 210 |
| *3* | Transvina | 2005 | 120 |
| *4* | Green Port | 2003 | 303,5 |
| *5* | Chua Ve | 2000 | 848 |
| *6* | Tan Cang 128 | 2013 | 422,2 |
| *7* | Tan Cang 189 | 2011 | 180 |
| *8* | Hai An | 2011 | 150 |
| *9* | Đinh Vu | 2007 | 427 |
| *10* | PTSC Dinh Vu | 2011 | 330 |
| *11* | Tan Vu | 2000 | 1.325,6 |
| *12* | Nam Hai Dinh Vu | 2013 | 455 |
| *13* | Vip Greenport | 2016 | 377,2 |
| *14* | Nam Đinh Vu | 2018 | 880 |
| *15* | TC-HICT | 2018 | 800 |
| *16* | MIPEC | 2020 | 380 |

*Source: Hai Phong Maritime Administrarion*

Nevertheless, most of the previous papers focus on the issue of improving port efficiency whereas there is a limited number of researches embarked on port competitiveness. With a view to filling the research gap, this study proposes a combined approach including quantitative and qualitative data to identify factors affecting the competitiveness using the case study of all container terminals in the area of Hai Phong. In light of the increasing importance of seaport competitiveness, this research is conducted, aiming to investigate what are the main factors for the evaluation of terminal competitiveness.

## 2. Literature

This section embarks on comprehensive literature with a view to giving an insight into the competitiveness of container ports.

### *2.1. Port competitiveness*

In maritime literature, port competitiveness has been defined in several ways. Port competition refers to the development and application of differentiated strategic alternatives so as to allure more customers over other ports (Yeo, 2010). Thus, the most competitive port will be able to develop and apply a differentiated strategy, attracting more clients and traffic than its competitors. From another point of view, the competitive position of a container port is determined by its competitive offering to the host of shippers and shipping lines for specific trade routes, geographical regions, and other ports to which container port is connected (Notteboom and Yap, 2012). Although the concept of port competitiveness has been explained by scholars in various ways, generally, it can be concluded that port competitiveness refers to the abilities that ports have which differentiate themselves from their counterparts in the process of gaining their competitive objectives, such as, manufacture's abilities of appealing to customers, possessing and controlling the market.

### *2.2. Methodology on assessing port competitiveness*

Given that there is no consensus about the ideal methodology for evaluating the competitiveness of port, the wealth of literature on the subject provides a rationale for the various possibilities. According to Manzano et al., (2009) methodologies can be grouped into two categories: quantitative methods and procedures under the Multi-Criteria Decision-Making method (MCDM).

In terms of quantitative methods, several researchers have deployed frameworks of Data Envelopment Analysis (DEA), cluster analysis, and regression technique to measure port competitiveness. Wu and Lin made use of DEA to evaluate the current status of India's ports in comparison with its counterparts in emerging markets and advanced economies.

In respect of MCDM methods, Manzano et al., (2009) emphasized that these approaches allow us to consider both quantitative and qualitative indicators. MCDM is appropriate for contexts where decision making is based on a variety of viewpoints that are not always quantifiable. Yeo (2010) applied a fuzzy methodology to investigate port competitiveness based on the expert judgements of logisticians. Kim, (2016) suggested using TOPSIS algorithm combined with Entropy weight to draw conclusions on the overall competitive potentials of three ports in Korea and seven ports in China.

### *2.3. Determinants of port competitiveness*

In order to measure the competitiveness of ports, it is essential to determine the components or factors that influence competitiveness.

By conducting a systematic literature review of

TẠP CHÍ ISSN: 1859-316X
KHOA HỌC CÔNG NGHỆ HÀNG HẢI
-JOURNAL OF MARINE SCIENCE AND TECHNOLOGY-

leading peer-reviewed international journals in the period from 1983 and 2014, Parola et al., (2017) summarized that the drivers of port competitiveness are composed of port cost, hinterland proximity, hinterland connectivity, port geographical location, port infrastructures, port operational efficiency, port service quality, maritime connectivity, nautical accessibility, and port site.

Analysis of Nguyen et al. (2016) so far has been recent research on port competitiveness in the case of Vietnam. They used a group of seven quantitative factors including throughput, number of berths, berth length, berth maximum draft, container yard area, medium vessel size, and average handling productivity to investigate the competitive advantages of eleven container terminals in Northern Vietnam.

The evaluation of port competitiveness has been approached from the port stakeholder's perspective as well. The findings in the paper of Cruz et al. implied that the competitive edge of a seaport industry is perceived differently by users and service providers.

In general, it can be recognized from the series of previous studies that port competitiveness depends on various determinants which are both quantitative and qualitative in nature. Quantitative factors are those that can be potentially measured and compared in an objective manner, such as port physical facilities, port container throughput, port charges and so on. Qualitative factors include subjective influences such as port service quality, reliability, flexibility, convenience, the port's marketing efforts, the relationship between port operators and their customers, etc.

## 3. Methodology and Selection of Evaluating Criteria

The Entropy value is employed to derive the objective weight of the evaluation criteria.

### *3.1. Entropy weighting technique*

In typical MCDM approaches, it is essential to determine the weights of attributes because they reflect the relative importance in a decision-making process. There are many techniques to elicit weights, which are divided into two categories: subjective methods and objective methods.

The subjective methods determine weights solely according to the preference or judgments of decision makers. However, the subjectivity and the non-determinacy in expert's judgments cannot be avoided when using subjective weighting methods. Moreover, some subjective weighting methods seem to be not favorable to deal with the large set of criteria and sub-criteria.

The objective methods determine weights by solving mathematical models automatically without any consideration of the decision maker's preferences. These methods are based on the inherent information of attributes to identify weights of attributes, which could eliminate man-made disturbances and makes results in more accord with facts. One of the typical objective weighting measures is Entropy method, which was introduced into information theory by Shannon (1948). The Shannon Entropy is the measurement of uncertainty in information formulated in terms of probability theory. The smaller discrepancy of the alternatives in the certain attribute is, the greater the entropy value is, and the less information the attribute describes. It means that the entropy weight of this criterion is likely to be small due to its less importance in the decision-making process (Qiu, 2002).

According to Yin and Ren (2018), the Entropy value and Entropy weight of each attribute can be obtained directly from the decision matrix following the procedure below:

**Step 1: Normalize data**

The normalized value $z_{ij}$ is obtained by:

$$z_{ij} = \frac{x_{ij} - x_j^{\min}}{x_j^{\max} - x_j^{\min}} \quad (1)$$

Where $x_j^{\max}$ is the maximum performance rating among alternatives for attribute $C_j(j = 1,2,\ldots,n)$ and $x_j^{\min}$ is the minimum performance rating among alternatives for attribute $C_j(j = 1,2,\ldots,n)$; $z_{ij} \in [0,1]$.

**Step 2: Calculate the proportion of attribute's value**

$$p_{ij} = \frac{z_{ij}}{\sum_{i=1}^{m} z_{ij}} \quad (3)$$

However, when $p_{ij} = 0$, $\ln(p_{ij})$ has no meaning. It is modified as $p_{ij} = \frac{1 + z_{ij}}{\sum_{i=1}^{m}(1 + z_{ij})}$

**Step 3: Calculate the Entropy of each attribute**

$$e_j = -k\sum_{i=1}^{m} p_{ij} \ln p_{ij} \quad (4)$$

Where: $k = \frac{1}{\ln m}$ is a constant which guarantees $0 \le e_j \le 1$; m: the total number of alternatives.

**Step 4: Calculate the Entropy weight of each attribute**

$$w_j = \frac{1-e_j}{\sum_{j=1}^{n}(1-e_j)} \quad (5)$$

### *3.2. Selection of evaluating criteria*

The numerous previous studies in section 2.3 reveal a considerable range of factors that have an influence on the port competitiveness. In order to: Narrow down the number of factors; re-confirm the validity and suitability of the proposed factors from the perspective of experts in the industry; and reach the consensus between the theoretical basis and practical situation, a survey instrument was administered to the group of eight professionals, who have closely engaged in working with container terminals including people working at shipping lines, shippers, and forwarders. On the basis of the discussion and getting consensus, five Level 1 criteria were extracted from the survey. Simultaneously, the selection of 19 Level 2 criteria was further determined based on the sharing of the experts combined with references of literature. It is noticeable that all of the defined criteria are similar to the most mentioned factors in previous studies as well. The list of criteria is demonstrated in Table 2.

*Table 2. List of selected evaluating criteria*

| Level 1 criteria | Level 2 criteria |
|---|---|
| Terminal throughput | Container throughput |
| | Increase rate |
| Terminal facilities | Berth depth |
| | Berth length |
| | Number of cranes |
| | Container yard area |
| Terminal charges | Terminal handling charge |
| | Storage charge |
| Terminal location | Distance terminal - Pilot boarding position (PS) |
| | Distance terminal - Cat Bi Airport (AP) |
| | Distance terminal - Dinh Vu Industrial Zone (IZ1) |
| | Distance terminal - Chi Linh Industrial Zone (IZ2) |
| | Distance terminal - Yen Phong Industrial Zone (IZ3) |
| | Distance terminal - Phu Nghia Industrial Zone (IZ4) |
| Terminal service quality | Speed of services |
| | Reliability of services |
| | Safety of services |
| | Information services |
| | Value-added services |

## 4. Results

Conventionally, the performance of a container terminal is examined by the container throughput. In some cases, however, this indicator may be not meaningful enough. Obviously, it can be referred from Table 3 that the variation in container throughput between two consecutive years is more important than the total number of containers handled by terminal in a certain year because it not only reflects the growth rate of terminals but also proofs the terminals's attractiveness as well as the success of terminals in efforts to gain more market shares.

*Table 3. Weights of terminal throughput criteria*

| Factors | Weight |
|---|---|
| Throughput | 0.470 |
| Increase rate | 0.530 |

*Table 4. Weights of terminal facility criteria*

| Factors | Weight |
|---|---|
| Berth depth | 0.257 |
| Berth length | 0.216 |
| Cranes | 0.286 |
| CY area | 0.241 |

The weights of terminal facility criteria which consider infrastructure and superstructure systerms from Table 4 clearly show that the number cranes (0.286) is considered the most influential factor for terminal competitiveness, followed by berth depth (0.257), the area of CY (0.241), and berth length (0.216). This result implies an interesting fact that competitive capability depends more on the superstructure conditions than the infrastructure foundations. In addition, it also emphasizes the correlation between competitiveness and the extent of

TẠP CHÍ ISSN: 1859-316X
KHOA HỌC CÔNG NGHỆ HÀNG HẢI
JOURNAL OF MARINE SCIENCE AND TECHNOLOGY

specialization in the operation of terminals. The more professionally the terminal is equipped, the more competitive advantages it gains. In addition, berth depth is the second important determinant of competitiveness as it strongly determines the ability of terminals to catch up with the developing trends of the shipping industry. Nowadays, container ships tend to become larger so as to utilize the benefit of scale efficiency, consequently, the terminal making a distinction of deeper berths is likely to get the core of competitive advantages. Besides, the area of CY is considered as the basis for competition as it is crucial to the storage capacity of terminals.

The terminals' revenue mostly comes from handling charge and storage charge. From Table 5, it is hardly surprising that handling charge (0.635) has a considerable contribution to the attractiveness of terminal. Since this cost is proved to make up of a major proportion of transportation cost. It has been much more concerned by customers when choosing terminal. This finding is in line with Tongzon and Heng (2005).

*Table 5. Weights of terminal charge criteria*

| Factors | Weight |
|---|---|
| Handling charge | 0.635 |
| Storage charge | 0.365 |

Obviously, the outcome from Table 6 indicates that among 6 sub-criteria, terminal's proximity to IZ 1 (Dinh Vu Industrial Zone) (0.189) is considered the most critical because all of the terminals in this research are situated in the area of Dinh Vu Trade Zone. In addition, IZ 1 is one of the biggest industrial zones in Hai Phong city. Therefore, the terminal's adaptability to this closest hinterland has a strong influence on the competitive abilities of a terminal. In term of proximity to the pilot boarding position, its importance is considerable (0.176) as it affects the terminal's accessibility to main shipping routes.

*Table 6. Weights of terminal location criteria*

| Factors | Weight |
|---|---|
| PS | 0.176 |
| AP | 0.167 |
| IZ 1 | 0.189 |
| IZ 2 | 0.158 |
| IZ 3 | 0.156 |
| IZ 4 | 0.154 |

The result generated from Table 7 reveals that reliability (0.224) is considered the most important factor determining the quality of terminal services because any kind of unreliability such as delays during operation process due to strikes, equipment breakdown, weather, etc. can cause a series of additional cost for the shipping lines or shippers and ruin the competitiveness of terminals. The second important factor is the speed of service (0.2). In the trend of just-in-time delivery, the demand for quick services is becoming more urgent. In order to meet this requirement, improving container handling productivity and reducing vessel turnaround time are the key to achieve competitive advantages for port authority and terminal operators. The third important factor is safety (0.198) since it is one of the fundamental requirements of service provision. Ranking at the fourth place is the diversity and quality of value-added services offered by terminals (0.190). Given the prevalence of door-to-door supply chain, it will be old-fashioned if terminals only focus on their two main roles including handling and storage. Nowadays, terminal operators should take auxiliary services into consideration to attract more customers. In this study, level of IT (0.187) is regarded as the least important to the terminal competitiveness. Although the modernization IT in terminals is becoming a trend and has strongly developed in the world, nevertheless, the applications of new advanced technology, as well as supportive software of management and operation in Vietnamese ports are not really striking enough to create competitive value among ports.

*Table 7. Weights of main criteria*

| Factors | Weight |
|---|---|
| Throughput (T) | 0.217 |
| Facility (F) | 0.242 |
| Charge (C) | 0.180 |
| Location (L) | 0.151 |
| Services (S) | 0.211 |

It can be interpreted from Table 8 that the facility (0.242) is the most critical determinants of port competitiveness, followed by port throughput (0.217). Facilities are always the main core of port's assets to provide services. That the reason why it is vital to the port efficiency and competitiveness. In addition, throughput is a key performance indicator of ports, which demonstrates how big of the market shares that port is holding. And it also has a close relationship with the conditions of the terminal's facility and equipment. The more dedicated terminal's equipment is, the bigger container traffic terminal is able to handle. Terminal service quality is ranked at the third

place (0.211) followed by the port charge (0.180). Although the price of goods or services is always a significant factor that consumers will consider when selecting products with similar characteristics. However, some users are actually willing to accept higher port costs in return for superior and more prestige services.

*Table 8. Weights of main criteria*

| Factors | Weight |
|---|---|
| Throughput (T) | 0.217 |
| Facility (F) | 0.242 |
| Charge (C) | 0.180 |
| Location (L) | 0.151 |
| Services (S) | 0.211 |

## 5. Conclusion

Nowadays, given that the competitions among terminals have become fiercer, especially in the era of containerization, it is essential to gain deep insights into the competitiveness of container terminals as well as its determinants.

Based on comprehensive literature combined with a consultant of experts in the industry, there are five key factors influencing the capability of competing of container terminals, namely, terminal throughput, terminal facilities, terminal charge, terminal location, and terminal service quality. According to the Entropy weighting algorithm, facilities are considered as the most critical determinant shaping the competitive ability of terminal. Furthermore, factors affecting container terminal competitiveness are identified which provide port authorities, policymakers, and terminal operators with the perception of their own characteristic in comparison with other competitors, which can act as hints for planning and making decisions. This study investigates the evaluation of competitiveness by both quantitative and qualitative approaches and hopefully contributes an effective platform for managerial and strategic implications.

However, the following items highlight the study' limitations: (1) depending on the users' evaluation which may be subjective and may ignore the actual conditions of the terminals (2) lacking of evaluating and ranking container terminals competitiveness in Hai Phong to have insights into strengths and weaknesses of each terminal. Therefore, some important additional studies are as follows: (1) developing a model that both considers the opinion of users of seaport services (2) ranking competitiveness of container terminals in Hai Phong.

## REFERRENCES

[1] Dwarakish, G.S. and Salim, A.M. (2015), *Review on the Role of Ports in the Development of a Nation*, Aquatic Procedia, Vol.4, pp.295-301.

[2] Kim, A.R. (2016), *A Study on Competitiveness Analysis of Ports in Korea and China by Entropy Weight TOPSIS*, The Asian Journal of Shipping and Logistics, Vol.32 (4), pp.187-194.

[3] Manzano, J.C. et al. (2009), *Low-cost port competitiveness index: Implementation in the Spanish port system*, Marine Policy, Vol.33, pp.591-598.

[4] Nguyen, M.D., Kim, S.J. and Jeong, J.S. (2016), *Hierarchical Cluster Analysis on Competitiveness of Container Terminals in Northern Vietnam*, J. Navig. Port Res., Vol.40, No.2, pp.67-72.

[5] Notteboom, T. and Yap, W.Y. (2012), *Port Competition and Competitiveness*, The Blackwell Companion to Maritime Economics, Chapter 27, pp.549-570.

[6] Parola, F., Risitano, M., Ferretti, M. and Panetti, E. (2017), *The drivers of port competitiveness: a critical review*, Transport Reviews, Vol. 37, No.1, 116-138.

[7] Qiu, W.H. (2002), *Management decision and applied entropy*, Beijing: China Machine Press, pp.193-196.

[8] Shannon, C.E. (1948), *A mathematical theory of communications*, Bell Systems Technical Journal, Vol.27(3), pp.379-423.

[9] Tongzon, J.L. (2009), *Port choice and freight forwarders*, Transportation Research Part E: Logistics and Transportation Review, Vol.45 (1), pp.186-195.

[10] Wu, Y.C.J. and Lin, C.W. (2008), *National port competitiveness: implications for India*, Management Decision, Vol.46 (10), pp.1482-1507.

[11] Yeo, H.J. (2010), *Competitiveness of Asian Container Terminals*, The Asian Journal of Shipping and Logistics, Vol.26, No. 2, pp.225-246

[12] Yin, Y. and Ren, Q. (2018), *Studying the representative volume of concrete using the entropy weight-grey correlation model*, Magazine of Concrete Research, Vol.70 (15), pp.757-769.

Received: 14 May 2024
Revised: 26 May 2024
Accepted: 07 June 2024