



Connectivity and Seaport Competitiveness in Ho Chi Minh City: Managerial Implications for Port Management

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Abstract

Purpose: Port competition has received increasing academic attention over the past four decades, especially regarding connectivity and competitiveness. Although numerous studies have examined the impact of port connectivity, the underlying mechanisms through which both hinterland and maritime connectivity affect port competitiveness remain insufficiently explored. This study develops and tests a model to evaluate the influence of port connectivity on port competitiveness in Ho Chi Minh City (HCMC). **Research Design, Data, and Methodology:** This study employs a mixed-methods approach, integrating both qualitative and quantitative research methodologies in a flexible and complementary manner. Data were collected through a non-probability snowball sampling technique, involving 370 respondents. A 5-point Likert scale was used, and Structural Equation Modeling (SEM) was employed to validate the proposed hypotheses. **Results:** Results reveal five key factors affecting connectivity: Locational advantage, seaport service quality, Information technology integration, Port infrastructure quality, and port authorities. Both hinterland and maritime connectivity were found to play significant roles in enhancing port competitiveness. **Conclusion:** The findings provide practical implications for port managers and policymakers, while also contributing to the academic literature by offering a clearer understanding of port connectivity's role in emerging markets like Ho Chi Minh City, particularly in the context of sustainable development.

Keywords : Hinterland Connectivity, Maritime Connectivity, Seaport Competitiveness, Seaport Connectivity, Distribution Center

JEL Classification Code: M10, M21, M19, R41

1. Introduction

Since the 1990s, there has been a global shift in manufacturing patterns, leading to significant changes in the factors that influence shippers' choice of transportation modes. Seaports have become crucial components in national economic development, playing a pivotal role in

facilitating international trade. To address the increasingly complex, dynamic, and unpredictable port environment, scholars from various disciplines have developed a range of models and decision-support tools specifically for this field. One of the key areas of research in this field is port competition, which has garnered significant academic interest over the past four decades. While studies on port

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competitiveness can be traced back to the 1960s, such as Britton's (1963) work, the rapid development of this research domain began in the late 1980s, with seminal contributions from Murphy et al. (1989), Warf and Kleyn (1989), and Williams (1988).

Due to the complex nature of port competition and the varying interpretations of port competitiveness found in the literature, there are three main research directions related to connectivity (including both hinterland and maritime connectivity) that have garnered the attention of scholars. The first stream examines connectivity from the perspective of competitive port strategy (Jensen & Bergqvist, 2013). The second stream considers connectivity as a set of factors that contribute to port competitiveness, highlighting its significance (Yeo et al., 2011; da Cruz et al., 2013; Kaliszewski et al., 2020). The third stream, which analyzes the factors influencing port competitiveness, has only recently gained attention. Studies in this category often take a customer-oriented approach, reflecting a growing trend in port competitiveness research to understand the needs of shipping companies (Yu et al., 2023). Notable contributions to this stream include works by Jeevan et al. (2019), Pietrzak et al. (2020), Tijan et al. (2022), Deshmukh and Song (2023), and Martinez Moya et al. (2024). Although the factors discussed in this stream have not been frequently cited, the related studies are relatively recent, suggesting that further investigation may be warranted (Yu et al., 2023).

Overall, the literature on the impact of port connectivity on port competitiveness is extensive, but there is a lack of exploration into the specific mechanisms through which these factors exert positive or negative influences. Current studies have not comprehensively and clearly articulated how port connectivity, both through hinterland and maritime connectivity, affects port competitiveness. While each of these dimensions has been studied individually, the interaction between them in forming an integrated connectivity system has not been thoroughly investigated. This is a critical research gap, as these factors do not operate in isolation but may interact to generate synergistic or counteracting effects on port competitiveness. This issue is particularly relevant in the emerging context of Ho Chi Minh City (HCMC) port, which was ranked 22nd and 26th among the world's top 50 container ports by cargo volume in 2020 and 2021, respectively, according to the World Shipping Council (2022). The port is also a member of the International Association of Ports and Harbors (IAPH) and the ASEAN Ports Association (APA). However, while HCMC port was once located on the periphery of the city, it is now situated at the very center due to rapid urban expansion. As a result, port connectivity, particularly land transport access, has become increasingly constrained, with chronic traffic congestion caused by the high volume of freight trucks passing through urban areas. Notably, there

exists a considerable imbalance in port utilization within HCMC. While Cat Lai Port has been operating far beyond its planned capacity, several neighboring ports—such as SPCT, SP ITC, and Hiep Phuoc—remain significantly underutilized despite possessing modern infrastructure. This situation underscores the urgent need to improve port connectivity and enhance the overall competitiveness of the city's seaport system. Addressing these challenges is not only essential for port authorities and policymakers but also presents important avenues for academic inquiry.

2. Theoretical Basis and Literature Review

2.1. Theoretical Basis

Resource-Based View (RBV) Theory

The Resource-Based View (RBV) focuses on analyzing internal resources and their influence on a firm's competitive advantage. Originating from the work of Penrose (1959), RBV emphasizes the strategic role of unique assets and capabilities, and was further developed by Wernerfelt (1984). In the context of seaports, numerous studies have identified port connectivity—both hinterland and maritime—as a critical resource that enhances competitiveness, attracts customers, increases throughput, reduces logistics costs, and improves operational efficiency. However, establishing and sustaining connectivity advantages requires substantial resources and effective coordination among stakeholders. The RBV has been applied in various seaport studies, including Singapore (Gordon et al., 2005), Algeciras (Acosta et al., 2007), Rotterdam and Barcelona (Van der Lugt et al., 2014), and Antwerp (Haezendonck & Langenus, 2019), affirming its relevance and applicability in port-related research.

2.2. Literature Review

2.2.1. Seaport Connectivity

Seaport connectivity serves as a measure that combines time efficiency and transport capacity, reflecting the strategic importance and strength of ports within the global container shipping network (Jiang et al., 2015). It also denotes the actual capability of shipping lines to move containers between international ports (Ramudhin & Ratliff, 2013). While ports seek to enhance their maritime connectivity, such connectivity is largely influenced by the strategic choices and selection criteria of shipping companies (Martinez-Moya et al., 2024). Nonetheless, port connectivity extends beyond integration into the maritime transport network; it plays a vital role in optimizing the overall supply chain by reducing logistics costs and transit times. Therefore, it is essential to examine port connectivity

from both maritime and hinterland perspectives (Indriastiwi et al., 2021; Zhang & Jing, 2019).

Maritime connectivity: Maritime connectivity refers to the level of connectivity between a seaport and shipping lines, and is a crucial factor in the decision-making process for shipping companies (Martínez Moya & Feo Valero, 2017; Low et al., 2009). As a result, port authorities prioritize maintaining the attractiveness of their port to shipping lines in order to expand their destination market connectivity. However, it is important to note that maritime connectivity also encompasses the linkage between ports themselves (Arvis et al., 2018). In other words, it provides insight into how well a port is connected to other ports (Indriastiwi et al., 2021).

Hinterland Connectivity: In the 21st century, the competitive arena between ports has expanded beyond the port area to the port hinterland. As a result, ports are now forced to compete beyond their immediate location (Parola et al., 2017). Port-hinterland connectivity has emerged as one of the most crucial factors in port competition (Ferrari et al., 2011; Parola et al., 2017; Wang et al., 2016). Hinterland connectivity is largely determined by intermodal networks that extend from the port to the hinterland (Arvis et al., 2018; Parola et al., 2017). However, in recent years, the importance of efficient hinterland logistics and connections has been recognized in ensuring the speed of goods flow (Gattuso et al., 2023). In addition to expanding intermodal networks, ports have also begun to integrate with hinterland logistics nodes (Álvarez-SanJaime et al., 2015; Zhang et al., 2018). These logistics nodes, often referred to as logistics hubs, serve as distribution and consolidation points for goods in the hinterland. However, in this emerging aspect of port-hinterland connectivity, these logistics nodes have become intermediaries or transaction points between ports and the hinterland market. Typically, logistics nodes are located near ports, industrial clusters, or densely populated hinterland areas (Deshmukh and Dong, 2023).

Studies on port connectivity consistently highlight the critical role of locational advantage, as each port possesses a unique hinterland shaped by cost, terrain, and distance—all factors inherently tied to geographic positioning. Ports situated in favorable locations benefit from reduced transport costs as distances increase, thereby enhancing hinterland connectivity (Martínez-Moya & Feo-Valero, 2020; Ramudhin & Ratliff, 2013; Zhang & Jing, 2019). Using the Analytic Hierarchy Process (AHP), Ugboma et al. (2006) demonstrated the significance of location in connecting with domestic markets. Guy and Urli (2006), in their comparison of Montreal and New York, further showed that connectivity relies not only on geography but also on market linkages via shipping routes. This underscores the importance of both strategic placement and

extended market access in areas of geographic overlap. Tongzon (2009) identified geographic location as one of four key determinants of maritime connectivity, a view supported by prior research (D'Este & Meyrick, 1992; Ha, 2003; Hayuth, 1991; Ng, 2006).

Zhang and Jing (2019) argue that the quality of seaport services is positively correlated with port connectivity, specifically through their collection and distribution capabilities. This reflects the accessibility of the port to both inland road and maritime transport. The combination of maritime and rail transport has led to a continuous increase in cargo volume through Bohai Rim port systems, resulting in a significant improvement in port connectivity. Additionally, Ugboma et al. (2006) consider port fees as one of the factors that affect a port's accessibility to domestic customers. In a comparison of factors that may impact a port's connectivity with both domestic customers and shipping lines, Lee et al. (2010) found that there is no significant difference in the influence of customer service capability on both parties. This factor is considered important by both domestic customers and shipping lines when making their choice. This finding is consistent with the conclusions of Ha (2003), Jiang et al. (2015), Tongzon and Sawant (2007), Zarei (2015).

Furthermore, the information technology integration at seaports (ITIS) plays a crucial role in facilitating effective communication between ports and their domestic customers, shipping lines, customs, and other port users. This not only increases port efficiency but also ensures the secure tracking of relevant information. Additionally, partners are increasingly interested in ports that have ITIS systems in place, particularly those that offer online payment options for port fees. Moreover, ITIS is continuously being developed to allow exporters to track their goods from the port of origin to the port of destination (Rajasekar & Rengamani, 2019). This finding is consistent with the results of a study conducted by Grosso and Monteiro (2008) on the port of Genoa, which demonstrated the positive impact of tracking and tracing capabilities and the relevance of electronic information on port connectivity. Similarly, Lee et al. (2010) found that the advanced port management factor, which includes ITIS, significantly affects both hinterland and maritime connectivity in the Korean port system. Other studies (Hayuth, 1991; Ng, 2006; Ha, 2003; Mittal & McClung, 2016) have also highlighted the importance of ITIS in enhancing both hinterland and maritime connectivity.

In the context of global value chains, policymakers and port managers are investing in infrastructure to develop competitive port systems and enhance hinterland connectivity (Wang et al., 2016). The definition of port infrastructure has expanded to include inland transport services serving the port area and neighboring countries

(Tongzon & Sawant, 2007; Zaman et al., 2015). The importance of infrastructure for hinterland connectivity has been highlighted in various studies, including those by Grosso and Monteiro (2008), De Langen (2009), Lee et al. (2010), Ramudhin and Ratliff (2013), Mittal and McClung (2016), Zhang & Jing (2019), Rajasekar and Rengamani (2019). Shipping lines often prefer ports with large-scale infrastructure, as it helps reduce maritime transport costs by avoiding port congestion, vessel waiting times, and improving economies of scale (Tongzon, 2009).

According to De Langen (2009), the port authority (PA) plays a crucial role in enhancing hinterland access. The quality of port access is heavily influenced by the performance of the PA. In a study by Van den Berg et al. (2012) on the port of Barcelona, it was found that the PA has made investments in rail systems and locomotives to improve connectivity with the hinterland. Additionally, the PA can implement policies to promote the integration of sea freight with other modes of transportation such as road, rail, or barge (Hintjens, 2019). The PA also utilizes forms of collaboration, such as long-term contracts with shipping lines that include profit-sharing provisions, to attract shipping lines (Notteboom, 2009).

2.2.2. Seaport competitiveness

There have been numerous studies on seaport competitiveness, but the concept itself has not been thoroughly discussed. Notteboom (2009) argues that seaport competitiveness is a complex issue that cannot be fully explained by easily identifiable and quantifiable factors. Port policy is defined as the competitiveness of a port in comparison to other ports and its contribution to the socio-economic development of the region it serves (Meersman et al., 2009). However, from the perspective of customers, ports that contribute the most to reducing overall costs in related transport chains are more likely to be chosen as ports of call. Therefore, the concept of port competitiveness is approached through a microeconomic analysis, viewing ports as sources of value creation for businesses involved in the service production process (De Martino, 2018). This perspective includes the ability of ports to provide services that meet quality standards in both domestic and international markets at competitive prices, resulting in adequate profits (Yeo & Song, 2006). Recently, Kaliszewski et al. (2020) also introduced the concept of port competitiveness as the ability to offer services more attractively than domestic and foreign competitors.

The competitiveness of a port is determined by its ability to efficiently transport cargo from the hinterland to its final destination. This is a crucial factor in the selection of ports (Martínez Moya & Feo Valero, 2017). The level of this ability is closely tied to the port's hinterland connectivity. The significance of hinterland connectivity has been widely

acknowledged as a key aspect of port competitiveness and development worldwide (Merk & Notteboom, 2015; Lee et al., 2017). In highly competitive port environments, hinterland connectivity can have a significant impact on a port's competitiveness. Hinterland connectivity is characterized by dedicated transport corridors for port cargo, such as designated rail lines connecting to ports or roads used by both freight trucks and local vehicles (Zhang, 2009).

In addition, Hayuth (1991) argues that shipping lines are increasingly focused on cost control and coordination throughout the entire transport chain. As a result, they are seeking to lease and operate their own container terminals. This trend puts pressure on ports to meet the specific needs of individual shipping lines and provide them with dedicated terminals in order to gain a competitive advantage. However, competition among regional ports is intensifying due to the growth of global container trade and larger vessel sizes. This has led to an increase in bargaining power for shipping lines. As a result, ports are facing challenges in adapting to the demands of serving large vessels, long vessel pull times, and dynamic supply chains (Khalid & Al-Mamery, 2019). A study by Nguyen and Woo (2022) ranked the competitiveness of the 10 largest container ports in Southeast Asia based on factors such as connectivity, cargo throughput, and port infrastructure. The study found that connectivity is a crucial factor in the success of Singapore as the most competitive container port in the region. Similarly, the competitiveness of Canary ports has been attributed to their focus on specialized value-added services and increased traffic in these services (Tovar et al., 2015).

3. Methodology

3.1. Hypotheses and Research model

3.1.1. Hypotheses Development

The location of a port is a crucial factor in its planning and construction, as well as its impact and connectivity within the maritime transport network (Mou et al., 2021). This has been highlighted in various studies, such as those by Martínez-Moya and Feo-Valero (2020), Ramudhin and Ratliff (2013), Ugboma et al. (2006), and Zhang and Jing (2019). Furthermore, the significance of geographical location in enhancing a port's hinterland connectivity has been discussed in research by D'Este and Meyrick (1992), Guy and Urli (2006), Ha (2003), Hayuth (1991), Ng (2006), Tongzon (2009), and Ugboma et al. (2006). Therefore, this study aims to further investigate this relationship, leading to the formulation of hypotheses H1 and H2:

H1: The locational advantage of a port has a positive impact on hinterland connectivity.

H2: The locational advantage of a port has a positive impact on maritime connectivity.

Port services are positively related to a port's connectivity through its collection and distribution capacity. This reflects the port's accessibility to both inland road transport and maritime transport. The impact of port services on hinterland and maritime connectivity has been demonstrated in studies by Ha (2003), Jiang et al. (2015), Lee et al. (2010), Tongzon and Sawant (2007), Ugboma et al. (2006), Zarei (2015), Zhang and Jing (2019). Since most studies suggest that port services positively influence connectivity, this research aims to further test this relationship. Therefore, hypotheses H3 and H4 are proposed:

H3: Seaport service quality has a positive impact on hinterland connectivity.

H4: Seaport service quality has a positive impact on maritime connectivity.

ITIS plays a key role in enhancing both hinterland and maritime connectivity of seaports, particularly in the context of the rapid development of digital technologies. Specifically, the adoption of modern technological solutions helps optimize port operations. The importance of ITIS for port connectivity has been emphasized by Ha (2003), Grosso and Monteiro (2008), Lee et al. (2010), Mittal and McClung (2016), Ng (2006), Rajasekar and Rengamani (2019). Therefore, hypotheses H5 and H6 are proposed:

H5: ITIS has a positive impact on hinterland connectivity.

H6: ITIS has a positive impact on maritime connectivity.

Port infrastructure quality is considered a critical determinant of both hinterland and maritime connectivity. When selecting ports, customers and shipping lines often assess the capability of port infrastructure to meet their operational needs, particularly in handling large and specialized shipments. The significance of port infrastructure in facilitating connectivity has been highlighted in numerous studies (Grosso & Monteiro, 2008; Lee et al., 2010; Mittal & McClung, 2016; Rajasekar & Rengamani, 2019; Ramudhin & Ratliff, 2013; Tongzon, 2009; Tongzon & Sawant, 2007; Zhang & Jing, 2019), emphasizing its far-reaching impact on operational efficiency and the port's ability to attract trade partners. Therefore, the following hypotheses are proposed:

H7: Port infrastructure quality has a positive impact on hinterland connectivity.

H8: Port infrastructure quality has a positive impact on maritime connectivity.

Studies on the role of port authorities in port connectivity have consistently highlighted their positive contribution to enhancing both hinterland and maritime connectivity. Port

authorities play a facilitating role in improving hinterland connectivity (De Langen, 2009; Hintjens, 2019; Van den Berg et al., 2012) as well as in strengthening maritime connectivity (Hintjens, 2019; Notteboom, 2009). Based on these studies, the following hypotheses are developed for further empirical testing:

H9: Port authorities have a positive impact on hinterland connectivity.

H10: Port authorities have a positive impact on maritime connectivity.

In a competitive environment, customer satisfaction with container terminals is influenced by various factors; however, connectivity is considered a key determinant of port competitiveness and a consequence of the port selection decisions made by customers and shipping lines (Martínez Moya & Feo Valero, 2017). The impact of both hinterland and maritime connectivity on port competitiveness has also been emphasized in the studies of Lee et al. (2017), Merk and Notteboom (2015), Nguyen and Woo (2022), Pietrzak et al. (2020), Tovar et al. (2015), and Zhang (2009). Based on these studies, the following hypotheses are proposed:

H11: Hinterland connectivity has a positive impact on seaport competitiveness.

H12: Maritime connectivity has a positive impact on seaport competitiveness.

3.1.2. Research model

Drawing on theories of hinterland connectivity, maritime connectivity, and port competitiveness, as well as insights from previous studies, the author develops a research model comprising twelve hypotheses. These hypotheses are designed to capture key aspects related to hinterland and maritime connectivity, as well as port competitiveness, in the context of globalization and the rapid advancement of technology.

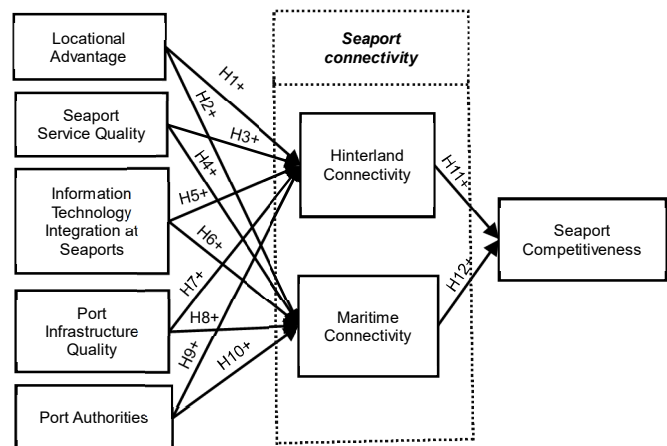


Figure 1: Propose research model

3.2. Survey Design and Measurement

This study employs a mixed-methods research approach that effectively integrates both qualitative and quantitative methods. This methodological combination enables researchers to leverage the respective strengths of each approach while mitigating their limitations. Furthermore, mixed methods are particularly well-suited to addressing the growing complexity of contemporary social phenomena (Ho & Thuong, 2023).

At the initial stage, the Grounded Theory (GT) approach was employed to analyze and synthesize relevant existing theoretical foundations, identify research gaps, formulate hypotheses, and develop the theoretical model and measurement scales. Subsequently, a series of discussions and consultations were conducted with 15 experts in the seaport sector to refine the research model, identify additional factors, and adjust the measurement scales to align with the specific research context in Vietnam.

In the quantitative phase, building upon the findings of the qualitative study, a preliminary measurement scale was developed and pilot-tested with 100 experts in the seaport sector. The aim was to assess internal consistency using Cronbach's alpha and to evaluate construct validity through Exploratory Factor Analysis (EFA). The scale was designed using a five-point Likert format, ranging from "strongly disagree" to "strongly agree," to ensure objectivity and reliability in data collection. For the main survey, 400 questionnaires were distributed, resulting in 370 valid responses from maritime transport experts in Ho Chi Minh City. A non-probability sampling approach, specifically the snowball sampling technique, was employed via face-to-face interviews. To analyze the data, the study utilized EFA, Confirmatory Factor Analysis (CFA), and Structural Equation Modeling (SEM). SEM was employed to assess both the measurement and structural models, test the proposed hypotheses, and examine causal relationships among variables. In particular, SEM allows for testing the relationships between observed and latent variables, as well as the overall fit of the theoretical model with empirical data. It integrates multiple statistical techniques, including regression analysis, factor analysis, and analysis of variance.

Finally, model estimation was conducted using the bootstrap technique. Structural equation modeling methods typically require a large sample size (Anderson & Gerbing, 1988); however, academic research often encounters constraints in sample availability. In such cases, bootstrapping emerges as a suitable alternative (Schumacker & Lomax, 2010). This resampling technique uses the original sample as a basis to generate multiple random subsamples, with a commonly recommended minimum of 1,000 resamples (Hair et al., 2019).

To measure the constructs Locational Advantage, Seaport Service Quality, Information Technology Integration at Seaports, Port Infrastructure Quality, and Port Authorities, the questionnaire was designed with four observed variables for each construct. These items were adapted and refined from the measurement scales developed by Pham (2021), Munim et al. (2022), Rajasekar and Rengamani (2019), Munim et al. (2022), and De Langen (2009), respectively. For the constructs Hinterland Connectivity, Maritime Connectivity, and Seaport Competitiveness, the questionnaire included three observed variables per construct, which were adapted from the studies of Arvis et al. (2018), Martinez-Moya et al. (2024), and Da Cruz (2012), respectively.

4. Results

4.1. Reliability Analysis of Measurement Scales Using Cronbach's Alpha

According to Ho and Thuong (2023), Cronbach's alpha coefficient evaluates the internal consistency of a measurement scale based on the variance of each observed variable and the correlation of each item with the sum of the remaining items. Therefore, conducting a Cronbach's alpha analysis is essential.

When performing the reliability analysis for each construct using SPSS version 26, all observed variables yielded Cronbach's alpha values exceeding the acceptable threshold of 0.6. Specifically, the reliability coefficients for the constructs were as follows: GEOL = 0.795, PSER = 0.844, INFT = 0.838, PFAC = 0.833, PAUT = 0.807, HCON = 0.845, MCON = 0.840, and PCOM = 0.832. Additionally, all Cronbach's Alpha if Item Deleted values were lower than the overall Cronbach's alpha for each corresponding scale, indicating that no items needed to be removed.

Furthermore, the corrected item-total correlation for all observed variables exceeded the recommended minimum value of 0.3, ranging from 0.585 to 0.755. This suggests that the scales are reliable and suitable for subsequent exploratory factor analysis (George & Mallery, 2003).

4.2. Exploratory Factor Analysis

To examine the correlations among the measurement variables, this study employed Principal Axis Factoring with Promax rotation, which allows for a more accurate reflection of the underlying data structure in exploring the dimensionality of the scales (Anderson & Gerbing, 1988). Several conditions must be met to ensure the appropriateness of EFA. Specifically, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy must fall

between 0.5 and 1.0 ($0.5 < KMO < 1.0$) to indicate that factor analysis is suitable for the data. In addition, the significance level of Bartlett's Test of Sphericity should be less than 0.05 ($p < 0.05$), suggesting that the observed variables are sufficiently correlated to justify factor analysis (Hair et al., 2019). To determine the number of factors to be retained, the study followed the criterion that each extracted factor should have an Eigenvalue equal to or greater than 1, and the total variance explained should exceed 50% (Anderson & Gerbing, 1988). Given the sample size of 370 observations, factor loadings equal to or greater than 0.30 in the pattern matrix were considered acceptable to confirm the convergent validity of the measurement items.

The factor extraction results for the independent variables indicate that the factors were grouped into five distinct components, corresponding to the measurement constructs proposed in the theoretical model. The total variance explained reached 66.233%, with an Eigenvalue of 1.797.

Regarding the EFA for Hinterland Connectivity (HCON), three observed variables were extracted, yielding a total variance explained of 76.356% and an Eigenvalue of 2.291. Similarly, the EFA for Maritime Connectivity (MCON) extracted three observed variables, explaining 75.765% of the variance, with an Eigenvalue of 2.273. For Seaport Competitiveness (PCOM), three variables were also extracted, with a variance explained of 74.946% and an Eigenvalue of 2.248.

The Kaiser-Meyer-Olkin (KMO) measures ranged from 0.719 to 0.825, and the significance values of Bartlett's Test of Sphericity were all 0.000 ($p < 0.05$), indicating the suitability of the data for factor analysis. No cross-loading or item misplacement was observed during the extraction process. Therefore, all measurement scales meet the required criteria for construct validity.

4.3. Confirmatory Factor Analysis

In order for the measurement model to truly fit the actual data, it must meet five important indices, including: (i) the ratio of chi-squared to degrees of freedom (Cmin/df), (ii) the TLI (Tucker-Lewis Index), (iii) the CFI (Comparative Fit Index), (iv) the NFI (Normed Fit Index), and (v) the RMSEA (Root Mean Square Error of Approximation) (Gefen et al., 2011).

The CFA results shown in Figure 2 confirm that the model satisfies the following criteria: CMIN/df = 1.469, which reflects a good fit (Bentler & Bonett, 1980; Bagozzi & Yi, 1988); TLI = 0.962, demonstrating an excellent fit (Hu & Bentler, 1995); CFI = 0.967, indicating an excellent fit (Hu & Bentler, 1995); NFI = 0.904, indicating a good fit (Hu & Bentler, 1995); and RMSEA = 0.036, suggesting an excellent fit (Browne & Cudeck, 1993). These findings

indicate that the model aligns well with the market data without requiring any adjustments.

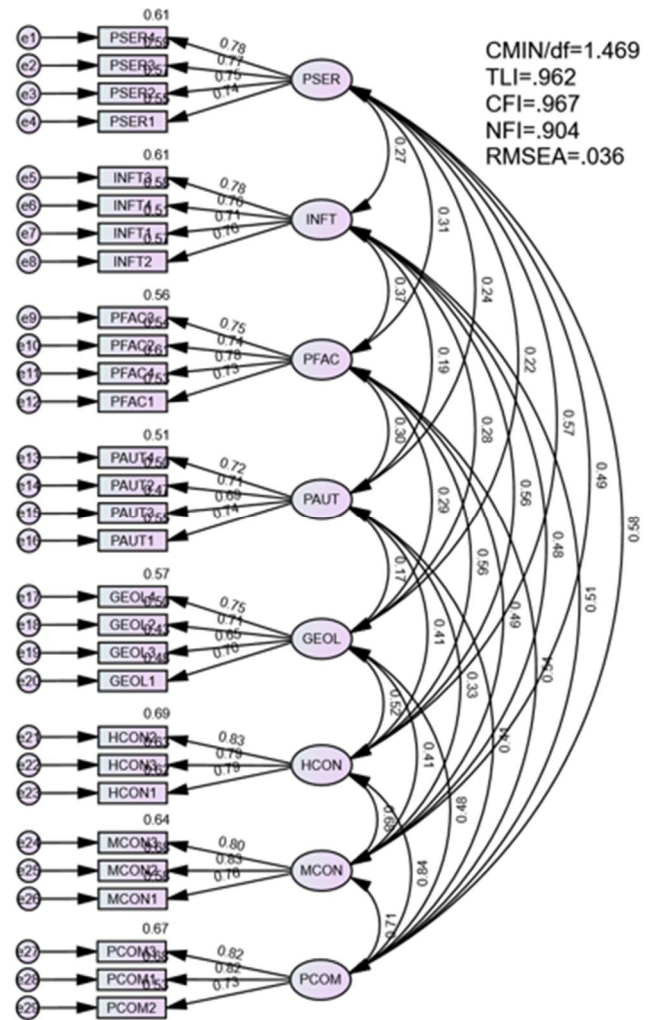


Figure 2: Confirmatory factor analysis results

In addition, composite reliability (CR), convergent validity, and discriminant validity were also examined. According to Hair et al. (2019), CR values should be 0.70 or higher to be considered acceptable within a measurement model. As shown in Table 1, all constructs used in this study demonstrate adequate reliability, as both CR and Cronbach's alpha values exceed the 0.70 threshold. Therefore, all reliability indicators fall within the acceptable range, confirming the internal consistency of the scales.

Based on Table 1, the average variance extracted (AVE) for all constructs exceeds 0.50, except for the GEOL scale, which recorded a value close to the threshold (0.494). According to Fornell and Larcker (1981), an AVE of at least 0.50 is required to establish convergent validity. However,

they also suggest that if the AVE is slightly below 0.50, the construct may still be considered valid provided that the composite reliability exceeds 0.70. Therefore, although not all constructs achieved the ideal AVE value, the results indicate that the scales demonstrate acceptable convergent validity.

Table 1: Composite Reliability (CR), Average Variance Extracted (AVE), and Cronbach's alpha

Construct	CR	AVE	Cronbach's alpha
PSER	0.846	0.579	0.844
INFT	0.840	0.568	0.838
PFAC	0.834	0.558	0.833
PAUT	0.807	0.511	0.807
GEOL	0.796	0.494	0.795
HCON	0.847	0.648	0.845
MCON	0.840	0.636	0.840
PCOM	0.834	0.626	0.832

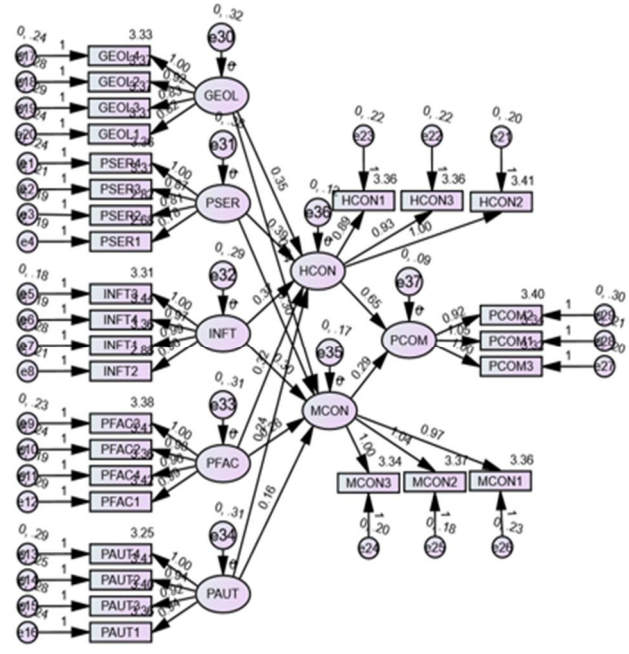
In addition, the study employed the Heterotrait-Monotrait (HTMT) ratio of correlations to assess the discriminant validity of the constructs. According to Hu and Bentler (1999), when two constructs are considered conceptually distinct, the HTMT value should be below the recommended threshold of 0.90. As presented in Table 2, all HTMT values are below 0.708, indicating that the constructs are empirically distinct from one another.

4.4. Structural Equation Modeling

The results of the structural model assessment, as illustrated in Figure 3, indicate that the model demonstrates acceptable goodness-of-fit indices: CMIN/df = 1.835; TLI = 0.931; CFI = 0.938; NFI = 0.875; and RMSEA = 0.048. These values fall within acceptable thresholds, suggesting that the model fits the empirical data reasonably well. In addition, Table 3 shows that all hypotheses were supported at a confidence level exceeding 95%.

Table 2: Discriminant Validity Assessment Using the Heterotrait-Monotrait (HTMT) Ratio

	PSER	INFT	PFAC	PAUT	GEOL	HCON	MCON	PCOM
PSER								
INFT	0.230							
PFAC	0.264	0.309						
PAUT	0.195	0.155	0.249					
GEOL	0.174	0.231	0.237	0.133				
HCON	0.481	0.475	0.471	0.342	0.427			
MCON	0.408	0.401	0.410	0.276	0.342	0.571		
PCOM	0.483	0.424	0.454	0.339	0.398	0.708	0.586	



CMIN/df=1.835; TLI=.931; CFI=.938; NFI=.875; RMSEA=.048

Figure 3: Results of SEM

According to the results presented in Table 3, with regard to hinterland connectivity, the influencing factors are ranked in descending order of impact as follows: seaport service quality is the most influential, followed by information technology, locational advantage, port infrastructure quality, and finally, PA.

In contrast, maritime connectivity is influenced by the same set of factors, but in a slightly different order: seaport service quality remains the most significant, followed by information technology, port infrastructure, locational advantage, and lastly, PA.

Notably, when considering the overall impact on seaport competitiveness, hinterland connectivity emerges as the most influential factor, while maritime connectivity ranks second in terms of its contribution.

Table 3: Hypothesis Testing Results

Hypothesis	Path		Estimate	S.E.	C.R.	P	Decision	
H3	HCON	<---	PSER	0.386	0.049	7.945	***	Accepted
H1	HCON	<---	GEOL	0.352	0.053	6.587	***	Accepted
H5	HCON	<---	INFT	0.371	0.054	6.862	***	Accepted
H7	HCON	<---	PFAC	0.321	0.052	6.148	***	Accepted
H9	HCON	<---	PAUT	0.240	0.052	4.627	***	Accepted
H2	MCON	<---	GEOL	0.239	0.054	4.390	***	Accepted
H4	MCON	<---	PSER	0.300	0.050	6.012	***	Accepted
H6	MCON	<---	INFT	0.298	0.056	5.288	***	Accepted
H8	MCON	<---	PFAC	0.263	0.055	4.811	***	Accepted
H10	MCON	<---	PAUT	0.160	0.054	2.947	0.003	Accepted
H11	PCOM	<---	HCON	0.647	0.069	9.388	***	Accepted
H12	PCOM	<---	MCON	0.293	0.062	4.703	***	Accepted

4.5. Using Bootstrap to analyze the reliability of SEM results

To assess the robustness of the model, the Bootstrap method was employed with a resampling size of N = 1,000. The estimation results from the 1,000 bootstrap samples were averaged and analyzed for bias, as presented in Table 4. According to Ho and Thuong (2023), a critical ratio (C.R) with an absolute value less than or equal to 2 ($|C.R| \leq 2$) at a 95% confidence level or higher is considered acceptable.

Therefore, with a large resampling size (1,000 observations), the research model demonstrates statistical significance and produces highly reliable analytical results, which are generalizable to the broader population.

Table 4: Bootstrap Results with N = 1,000 Resamples

Parameter	SE	SE-SE	Mean	Bias	SE-Bias	C.R
HCON <- PSER	0,049	0,001	0,387	0,001	0,002	0,5
HCON <- GEOL	0,060	0,001	0,351	-0,001	0,002	-0,5
HCON <- INFT	0,059	0,001	0,369	-0,001	0,002	-0,5
HCON <- PFAC	0,060	0,001	0,325	0,004	0,002	2,0
HCON <- PAUT	0,060	0,001	0,242	0,002	0,002	1,0
MCON <- GEOL	0,066	0,001	0,237	-0,001	0,002	-0,5
MCON <- PSER	0,053	0,001	0,301	0,001	0,002	0,5
MCON <- INFT	0,069	0,002	0,301	0,003	0,002	1,5
MCON <- PFAC	0,064	0,001	0,261	-0,002	0,002	-1,0
MCON <- PAUT	0,060	0,001	0,163	0,003	0,002	1,5
PCOM <- HCON	0,066	0,001	0,647	0,000	0,002	0
PCOM <- MCON	0,064	0,001	0,296	0,003	0,002	1,5

*C.R (Critical Ratios) = (Bias) / (SE-Bias)

5. Discussion and Policy Implications

To enhance the overall competitiveness of the HCMC seaport system, a dual-focus strategy targeting both hinterland connectivity and maritime connectivity is

essential. The quantitative analysis highlights that hinterland connectivity exerts the strongest influence on seaport competitiveness. Accordingly, port authorities and managers should prioritize investments in this area.

A comprehensive strategy to strengthen hinterland connectivity should focus on three key aspects. First, improving cargo handling capacity and the flow of goods between the port and inland regions is essential, along with implementing customer acquisition measures to increase cargo throughput. Second, upgrading and optimizing domestic transportation infrastructure—including roads, railways, and inland waterways—will reduce congestion, enhance transport efficiency, and ensure smooth logistics operations. Third, developing strategic partnerships with capable domestic logistics providers and inland distribution centers will improve service quality, optimize supply chains, and reduce transportation costs. These efforts combined will not only improve operational reliability but also significantly enhance the port’s overall competitive position.

In parallel, policy initiatives to develop maritime connectivity are equally important. To achieve this, attention should be directed toward three strategic priorities. First, ensuring the sustainable growth of maritime shipping services calling at HCMC ports will help accommodate growing cargo volumes and support regional economic development. Second, improving the port’s capacity to handle larger and heavier vessels will position it as a preferred destination for major shipping lines, thereby boosting economic efficiency and competitiveness. Finally, expanding the port’s global connectivity network—while maintaining competitive shipping costs—will facilitate international trade and provide favorable conditions for importers and exporters.

In addition, developing port service quality is one of the key tasks in strengthening both domestic and international connectivity. For HCMC’s ports, four main areas require managerial focus. First, container handling capacity should

be improved through the strategic deployment of equipment to ensure reliability and operational efficiency. Second, pricing policies must align with legal frameworks while remaining attractive to customers. Third, capabilities for handling specialized cargo should be strengthened through targeted training programs, collaborative efforts, and specialized processes. Finally, simplifying customs and administrative procedures through inter-agency coordination will significantly enhance operational efficiency.

Investments in information technology (IT) are also essential for modern port development. Managers should consider four core strategies. First, implementing electronic procedures can accelerate port operations and improve the customer experience. Second, enhancing communication and data-sharing systems will ensure real-time updates and synchronization among stakeholders. Third, the development of dedicated IT systems for planning, operation, and management will reduce errors, increase flexibility, and improve performance. Finally, integrating online payment systems with banks will streamline financial transactions and promote transparency.

Geographic location is a strategic factor in port investment decisions. HCMC's port system should be planned in proximity to major transportation routes to optimize logistics operations and minimize inland transport costs. Strengthening partnerships with international transshipment hubs can also enhance the port's position in global supply chains. In addition, locating ports near inland container depots (ICDs) and industrial zones will help create an integrated logistics ecosystem, optimize operations, and improve distribution efficiency while lowering supply chain costs.

Port infrastructure development is a prerequisite for boosting competitiveness. Storage facilities must meet safety, security, and capacity standards. Draft depth and channel conditions should accommodate larger vessels. Investments in modern wharves, piers, and loading/unloading equipment are necessary to reduce turnaround time. Moreover, internal road systems and inter-regional transport connections must be effectively planned to reduce congestion and improve operational efficiency.

Finally, enhancing the role of port authorities (PAs) in connectivity development and competitiveness is essential. Beyond traditional tools such as infrastructure investment, concession policies, and tariff management, PAs should establish transparent standards for infrastructure access and resource optimization. They should also implement a Port Community System (PCS) to improve supply chain coordination. Furthermore, PAs need to actively engage in the development of rail and inland waterway connectivity beyond the port.

6. Conclusions

This study conducted a systematic review of the existing literature on seaport competitiveness and identified several theoretical gaps related to the role of connectivity in enhancing port performance. In particular, it emphasized the need to simultaneously consider both hinterland connectivity and maritime connectivity, and to analyze their respective impacts on seaport competitiveness. Based on these insights, the study developed and validated a comprehensive set of measurement scales for three core constructs: hinterland connectivity, maritime connectivity, and seaport competitiveness—ensuring both theoretical rigor and practical relevance.

Building on the validated constructs and measurement scales, a novel, stakeholder-inclusive evaluation framework is proposed to capture the multidimensional nature of port competitiveness. This approach not only informs strategic decision-making for port managers and policymakers but also contributes to theoretical advancement by integrating both physical and relational dimensions of connectivity into the discourse on seaport competitiveness. The study thereby establishes a foundation for future research to further examine and empirically validate these dimensions across diverse port contexts, particularly in emerging markets.

References

- Acosta, M., Coronado, D., & Mar Cerban, M. (2007). Port competitiveness in container traffic from an internal point of view: the experience of the Port of Algeciras Bay. *Maritime Policy & Management*, 34(5), 501-520. DOI:10.1080/03088830701585381.
- Álvarez-SanJaime, Ó., Cantos-Sanchez, P., Moner-Colonques, R., & Sempere-Monerris, J. J. (2015). The impact on port competition of the integration of port and inland transport services. *Transportation Research Part B: Methodological*, 80, 291-302. Doi: 10.1016/j.trb.2015.07.011
- Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological bulletin*, 103(3), 411. Doi: 10.1037/0033-2909.103.3.411.
- Arvis, J. F., Vesin, V., Carruthers, R., & Ducruet, C. (2018). *Maritime networks, port efficiency, and Hinterland connectivity in the Mediterranean*. Washington D.C.: World Bank Group, Chapter 3. Hinterland Connectivity (pp.47 – 67). DOI: 10.1596/978-1-4648-1274-3.
- Bagozzi, R. P., & Yi, Y. (1988). On the evaluation of structural equation models. *Journal of the academy of marketing science*, 16, 74-94. Doi: 10.1007/BF02723327.
- Bentler, P. M., & Bonett, D. G. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin*, 88(3), 588–606. Doi: 10.1037/0033-2909.88.3.588.
- Britton, J.N. (1963). Interstate transport competition and the port

- of Melbourne. *Australian Geographical Studies*, 1(2), 84–95. DOI: 10.1111/j.1467-8470.1963.tb00010.x
- Browne, M. W., & Cudeck, R. (1993). *Alternative ways of assessing model fit*. In Testig Structural Equation Models, K. A. Bollen and J. S. Long (eds), Newbury Park, CA: Sage Publication.
- Da Cruz, M. R. P. (2012). Competitiveness and strategic positioning of seaports: The case of Iberian seaports. (Doctoral dissertation, Universidade da Beira Interior (Portugal). Retrieved Jan 15, 2023, from <https://ubibliorum.ubi.pt/entities/publication/210047a0-dc5b-4a14-9239-fbe23681c2a5>
- Da Cruz, M. R. P., Ferreira, J. J., & Azevedo, S. G. (2013). Key factors of seaport competitiveness based on the stakeholder perspective: An Analytic Hierarchy Process (AHP) model. *Maritime Economics & Logistics*, 15, 416-443. DOI: 10.1057/mel.2013.14.
- De Langen, P. W. (2009). Assuring hinterland access: the role of port authorities. *Port competition and hinterland connections*. International Transport Forum, 109-128. Doi: 10.1787/9789282102251-5-en
- De Martino, M. (2018). Port Competitiveness and Value Creation: The Network Approach. Empirical Evidence from the Italian Port System. Doctoral dissertation, University of Antwerp. Retrieved Jun 30, 2023, from <https://medialibrary.uantwerpen.be/files/7325/0504fa9c-e7e2-400e-a416-7744d2bd4ca1.pdf>
- Deshmukh, A., & Song, D. W. (2023). A New wine in new wineskins: unfolding dimension of port-hinterland connectivity and market shares. *Maritime Policy & Management*, 52(1), 55-77. Doi: 10.1080/03088839.2023.2271474.
- D'este, G. M., & Meyrick, S. (1992). Carrier selection in a RO/RO ferry trade Part 1. Decision factors and attitudes. *Maritime Policy & Management*, 19(2), 115-126. DOI: 10.1080/03088839200000019.
- Ferrari, C., Parola, F., & Gattorna, E. (2011). Measuring the Quality of Port Hinterland Accessibility: The Ligurian Case. *Transport Policy*, 18(2), 382-391. Doi: 10.1016/j.tranpol.2010.11.002
- Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of marketing research*, 18(1), 39-50. Doi: 10.1177/002224378101800104
- Gattuso, D., Cassone, G. C., & Pellicanò, D. S. (2023). A Methodology to Identify the Hinterland for Freight Ports by Transportation Cost Functions. *The Open Transportation Journal*, 17(1). Doi: 10.2174/18744478-v17-e230109-2022-26
- Gefen, D., Rigdon, E., & Straub, D. (2011). *Editor's comments: An update and extension to SEM guidelines for administrative and social science research*. MIS quarterly, 35(2), III-XI. Doi: 10.2307/23044042
- George, D., & Mallery, P. (2003). *SPSS for Windows Step by Step: A Simple Guide and Reference*. 11.0 Update (4th ed.). Boston: Allyn & Bacon
- Gordon, J. R., Lee, P. M., & Lucas Jr, H. C. (2005). A resource-based view of competitive advantage at the Port of Singapore. *The Journal of Strategic Information Systems*, 14(1), 69-86. Doi: 10.1016/j.jsis.2004.10.001
- Grosso, M., & Monteiro, F. (2008). Relevant strategic criteria when choosing a container port-the case of the port of Genoa. *In Proceedings of the European Transport Conference 2008*. Association for European Transport and contributors, 1-21.
- Guy, E., & Urli, B. (2006). Port selection and multicriteria analysis: An application to the Montreal-New York alternative. *Maritime Economics & Logistics*, 8, 169-186. Doi: 10.1057/palgrave.mel.9100152
- Ha, M. S. (2003). A comparison of service quality at major container ports: implications for Korean ports. *Journal of transport geography*, 11(2), 131-137. Doi: 10.1016/S0966-6923(02)00069-8
- Haezendonck, E., & Langenus, M. (2019). Integrated ports clusters and competitive advantage in an extended resource pool for the Antwerp Seaport. *Maritime Policy & Management*, 46(1), 74-91. Doi: 10.1080/03088839.2018.1471535.
- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8 ed). United Kingdom: Cengage Learning, EMEA.
- Hayuth, Y. (1991). Load centering competition and modal integration. *Coastal Management*, 19(3), 297-311. Doi: 10.1080/08920759109362145.
- Hintjens, J. (2019). Cooperation between sea ports concerning hinterland transport. (Doctoral dissertation, Universiteit Antwerpen). Retrieved Jun 30, 2023, from <https://repository.uantwerpen.be/desktop/irua>.
- Ho, D. P., & Thuong, V. K. (2023). *Application of PLS-SEM model in research for accounting & banking fields and writing scientific articles in Vietnam*. Eliva Press Global Ltd.
- Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural equation modeling: a multidisciplinary journal*, 6(1), 1-55. Doi: 10.1080/10705519909540118
- Hu, L. T., & Bentler, P. M., (1995). *Evaluating model fit* in R. H. Hoyle (Ed.). Structural equation modeling: Concepts, issues, and applications. 76-99. Thousand Oaks, CA: Sage.
- Indriastiwi, F., Hadiwardoyo, S. P. & Nahry (2021). Port Connectivity Model in The Perspective of Multimodal Transport: A Conceptual Framework. IOP Conference Series: *Materials Science and Engineering*, 1052(1), 012008. Doi: 10.1088/1757-899X/1052/1/012008
- Jeevan, J., Chen, S. L., & Cahoon, S. (2019). The impact of dry port operations on container seaports competitiveness. *Maritime Policy & Management*, 46(1), 4-23. Doi: 10.1080/03088839.2018.1505054
- Jensen, A. and Bergqvist, R. (2013). Seaport strategies for pre-emptive defence of market share under changing hinterland transport system performance. *International Journal of Shipping and Transport Logistics*, 5(4/5), 432-448. Doi: 10.1504/IJSTL.2013.055274
- Jiang, J., Lee, L. H., Chew, E. P., & Gan, C. C. (2015). Port connectivity study: An analysis framework from a global container liner shipping network perspective. *Transportation research part E: Logistics and transportation review*, 73, 47-64. Doi: 10.1016/j.tre.2014.10.012
- Kaliszewski, A., Kozłowski, A., Dąbrowski, J., & Klimek, H. (2020). Key factors of container port competitiveness: A global shipping lines perspective. *Marine Policy*, 117, 103896. Doi: 10.1016/j.marpol.2020.103896.
- Khalid, A., & Al-Mamery, M. (2019). Competitiveness of Arabian

- gulf ports from shipping lines' perspectives: Case of Sohar port in Oman. *Journal of Industrial Engineering and Management (JIEM)*, 12(3), 458-471. Doi: 10.3926/jiem.2982
- Lee, H. Y., Kong, S., & Seo, Y. J. (2017). Evaluating determinants of effective port-hinterland connectivity in Shanghai ports. *Journal of International Trade & Commerce*, 13(6), 39-54. Doi: 10.16980/jitc.13.6.201712.39
- Lee, S. Y., Chang, Y. T., & Lee, P. T. W. (2010). Container port selection factors: heterogeneity among major market players. *Journal of International Logistics and Trade*, 8(2), 73-90. Doi: 10.24006/jilt.2010.8.2.73
- Low, J. M., Lam, S. W., & Tang, L. C. (2009). Assessment of hub status among Asian ports from a network perspective. *Transportation Research Part A: Policy and Practice*, 43(6), 593-606. Doi: 10.1016/j.tra.2009.04.004
- Martínez Moya, J., & Feo Valero, M. (2017). Port choice in container market: a literature review. *Transport Reviews*, 37(3), 300-321. DOI: 10.1080/01441647.2016.1231233
- Martínez-Moya, J., & Feo-Valero, M. (2020). Measuring foreland container port connectivity disaggregated by destination markets: An index for Short Sea Shipping services in Spanish ports. *Journal of Transport Geography*, 89, 102873. Doi: 10.1016/j.jtrangeo.2020.102873
- Martinez-Moya, J., Mestre-Alcover, A., & Sala-Garrido, R. (2024). Connectivity and competitiveness of the major Mediterranean container ports using 'Benefit-of-the-Doubt' and 'Common Sets of Weights' methods in Data Envelopment Analysis. *Maritime Economics & Logistics*, 26(2), 261-282. Doi: 10.1057/s41278-023-00258-w
- Meersman, H., Van de Voorde, E. & Vanellander, T. (2009). *Future challenges for the port and shipping sector*. United Kingdom: Informa Law from Routledge.
- Merk, O., & Notteboom, T. (2015). Port hinterland connectivity. OECD/International Transport Forum. Doi: 10.1787/2223439X
- Mittal, N., & McClung, D. (2016). Shippers' changing priorities in port selection decision—a survey analysis using analytic hierarchy process (AHP). *Journal of the Transportation Research Forum*, 55(3), 65-81. Doi: 10.22004/ag.econ.262668
- Mou, N., Wang, C., Chen, J., Yang, T., Zhang, L., & Liao, M. (2021). Spatial pattern of location advantages of ports along the Maritime Silk Road. *Journal of Geographical Sciences*, 31, 149-176. Doi: 10.1007/s11442-021-1837-9
- Munim, Z. H., Hasan, K. R., Schramm, H. J., & Tusher, H. M. (2022). A port attractiveness assessment framework: Chittagong Port's attractiveness from the users' perspective. *Case Studies on Transport Policy*, 10(1), 463-471. Doi: 10.1016/j.cstp.2022.01.007
- Murphy, P. R., Dalenburg, D. R., & Daley, J. M. (1989). Assessing international port operations. *International Journal of Physical Distribution & Materials Management*, 19(9), 3-10. Doi: 10.1108/EUM0000000000334.
- Ng, K. Y. (2006). Assessing the attractiveness of ports in the North European container transshipment market: an agenda for future research in port competition. *Maritime Economics & Logistics*, 8, 234-250. Doi:10.1057/palgrave.mel.9100158
- Nguyen, P. N., & Woo, S. H. (2022). Port connectivity and competition among container ports in Southeast Asia based on Social Network Analysis and TOPSIS. *Maritime Policy & Management*, 49(6), 779-796. Doi: 10.1080/03088839.2021.1908637
- Notteboom, T. (2009). The relationship between seaports and the intermodal hinterland in light of global supply chains: European challenges. *Port competition and hinterland connections*. Round table 143, 25-75. DOI: 10.1787/9789282102251-en
- Parola, F., Risitano, M., Ferretti, M., & Panetti, E. (2017). The Drivers of Port Competitiveness: A Critical Review. *Transport Reviews*, 37(1), 116-138. Doi: 10.1080/01441647.2016.1231232
- Penrose, E.T. (1959). *The theory of the growth of the firm*. Oxford: Oxford University Press.
- Pham, V.T. (2021). A Study on Supply Chain Management and Characteristics of Container Port Operation Efficiency in Vietnam by Emerging Measure Tools. *Special Issue on Computing Technology and Information Management*, 18, 182-205. Doi: 10.14704/WEB/V18SI04/WEB18122.
- Pietrzak, O., Pietrzak, K., Wagner, N., & Montwiłł, A. (2020). Improving seaport competitiveness by creating a connection to the national rail network. *Transport Problems*, 15(4), 149-161. Doi: 10.21307/tp-2020-056
- Rajasekar, D., & Rengamani, J. (2019). A Study on the Port Hinterland Connectivity of Chennai Port Sector. *International Journal of Innovative Technology and Exploring Engineering*, 8(4), 712-717
- Ramudhin, A. & Ratliff, D. (2013). *Assessment of Port Performance and Port Connectivity Study in Belize, Central America and the Dominican Republic*. Inter-American Development Bank. Doi: 10.18235/0000115
- Schumacker, R. E., & Lomax, R. G. (2010). *A Beginners Guide to Structural Equation Modeling*. New York: Routledge.
- Tijan, E., Jović, M., Žgaljić, D., & Aksentijević, S. (2022). Factors affecting container seaport competitiveness: Case study on Port of Rijeka. *Journal of marine science and engineering*, 10(10), 1346. Doi: 10.3390/jmse10101346
- Tongzon, J. L. (2009). Port choice and freight forwarders. *Transportation Research Part E: Logistics and Transportation Review*, 45(1), 186-195. Doi: 10.1016/j.tre.2008.02.004
- Tongzon, J. L., & Sawant, L. (2007). Port choice in a competitive environment: from the shipping lines' perspective. *Applied Economics*, 39(4), 477-492. Doi: 10.1080/00036840500438871
- Tovar, B., Hernández, R., & Rodríguez-Déniz, H. (2015). Container port competitiveness and connectivity: The Canary Islands main ports case. *Transport Policy*, 38, 40-51. Doi: 10.1016/j.tranpol.2014.11.001
- Ugboma, C., Ugboma, O., & Ogwude, I. C. (2006). An analytic hierarchy process (AHP) approach to port selection decisions—empirical evidence from Nigerian ports. *Maritime Economics & Logistics*, 8, 251-266. Doi: 10.1057/palgrave.mel.9100160
- Van den Berg, R., De Langen, P. W., & Costa, C. R. (2012). The role of port authorities in new intermodal service development; the case of Barcelona Port Authority. *Research in Transportation Business & Management*, 5, 78-84. Doi: 10.1016/j.rtbm.2012.11.003
- Van der Lugt, L. M., Rodrigues, S. B., & Van den Berg, R. (2014). Co-evolution of the strategic reorientation of port actors: insights from the Port of Rotterdam and the Port of Barcelona. *Journal of Transport Geography*, 41, 197-209. Doi: 10.1016/j.jtrangeo.2014.09.008
- Wang, G. W., Zeng, Q., Li, K., & Yang, J. (2016). Port connectivity

in a logistic network: The case of Bohai Bay, China. *Transportation Research Part E: Logistics and Transportation Review*, 95, 341-354. Doi: 10.1016/j.tre.2016.04.009

Warf, B., & Kleyn, L. (1989). Competitive status of US ports in the mid-1980s. *Maritime Policy and Management*, 16(2), 157-172. Doi: 10.1080/03088838900000040

Wernerfelt, B. (1984). A Resource-Based View of the Firm. *Strategic Management Journal*, 5, 171-180. Doi: 10.1002/smj.4250050207.

Williams, J. F. (1988). Urban and regional planning in Taiwan: the quest for balanced regional development. *Tijdschrift voor economische en sociale geografie*, 79(3), 175-187. Doi: 10.1111/j.1467-9663.1988.tb00595.x.

World shipping council (2022). The top 50 container ports. Retrieved Jun 30, 2023, from: <https://www.worldshipping.org/top-50-ports>

Yeo, G. T., Roe, M., & Dinwoodie, J. (2011). Measuring the competitiveness of container ports: logisticians' perspectives. *European Journal of Marketing*, 45(3), 455-470. Doi: 10.1108/03090561111107276

Yeo, K. & Song, D. (2006). An application of the hierarchical fuzzy process to container port competition: policy and strategic implications. *Transportation*, 33(4), 409-422. Doi: 10.1007/s11116-005-6000-4

Yu, H., Gong, Y., & Liu, J. (2023). A systematic literature review on port competitiveness. *International Journal of Logistics Research and Applications*, 1-25. Doi: 10.1080/13675567.2023.2187355.

Zaman, M. B., Vanany, I., & Awaluddin, K. D. (2015). Connectivity analysis of port in Eastern Indonesia. *Procedia Earth and Planetary Science*, 14, 118-127. Doi: 10.1016/j.proeps.2015.07.092

Zarei, S. (2015). The key factors in shipping company's port selection for providing their supplies. *International Journal of Economics and Management Engineering*, 9(4), 1317-1321. Doi: doi.org/10.5281/zenodo.1105795

Zhang, A. (2009). The impact of hinterland access: conditions of rivalry between ports. In *Port competition and hinterland connections*, OECD/International Transport Forum, 129-160. Doi: 10.1787/235411150338

Zhang, Q., Wang, W., Peng, Y., Zhang, J., & Guo, Z. (2018). A Game-Theoretical Model of Port Competition on Intermodal Network and Pricing Strategy. *Transportation Research Part E: Logistics and Transportation Review*, 114, 19-39. Doi: 10.1016/j.tre.2018.01.008

Zhang, X. & Jing, L.V. (2019). Port connectivity and spatial-temporal difference of its influencing factors: The case of China Bohai Rim ports. *Human Geography*, 34(6), 110-119. Doi: 10.13959/j.issn.1003-2398.2019.06.013

Appendixes

Appendix 1: Measurement Scale and Observed Variables

No.	Code	Scales and observed variables
I	GEOL	Locational Advantage
1	GEOL1	The port is positioned adjacent to industrial zones and export processing areas.
2	GEOL2	The port is situated in close proximity to major transshipment hubs.
3	GEOL3	The port lies near principal transportation corridors.
4	GEOL4	The port is located in the vicinity of interconnected logistics nodes, including depots.
II	PSER	Seaport Service Quality
5	PSER1	Administrative procedures and documentation at the port are streamlined and processed efficiently.
6	PSER2	The port possesses the capability to manage oversized and specialized cargo consignments.
7	PSER3	Tariff structures for port services are assessed as cost-effective.
8	PSER4	Cargo and container handling operations at the port are conducted with high reliability and assurance.
III	INFT	Information Technology Integration at Seaports
9	INFT1	The port's IT infrastructure is effectively integrated to facilitate seamless communication among port users, customers, and regulatory agencies (e.g., customs, port authority, border security, and quarantine services).
10	INFT2	An online transaction platform is available at the port, enabling digital payment processing.
11	INFT3	The port employs an advanced IT system for operational management, including the deployment of software to optimize yard planning, berth allocation, equipment usage, workforce scheduling, and container handling.
12	INFT4	Electronic data exchange systems are in place to support swift and authorized cargo clearance procedures.
IV	PFAC	Port Infrastructure Quality
13	PFAC1	Storage yards and warehousing facilities at the port are secure and sufficiently equipped.
14	PFAC2	The draft and depth of the port waters are suitable for operational demands.
15	PFAC3	Berthing areas, docks, and loading/unloading systems are adequately equipped with modern and efficient handling technologies.
16	PFAC4	Domestic and inter-regional transport infrastructure is comprehensively planned and systematically organized.
V	PAUT	Port Authorities

No.	Code	Scales and observed variables
17	PAUT1	Port authorities entities proactively engage in investment initiatives related to inland waterway and railway terminals located beyond the port's immediate jurisdiction.
18	PAUT2	Port authorities formulate regulatory frameworks that govern infrastructure access, aiming to enhance operational efficiency.
19	PAUT3	A port community information platform is developed by the authorities to facilitate seamless data exchange among stakeholders, thereby improving coordination within the logistics chain.
20	PAUT4	Port authorities retain the authority to grant concessions for infrastructure operation and exploitation.
VI	HCON	Hinterland Connectivity
21	HCON1	The inland transport network—comprising roads, railways, and waterways—is efficiently structured, with minimal congestion and unobstructed flow.
22	HCON2	The volume of cargo transported to and from inland regions via the port is substantial.
23	HCON3	Domestic logistics service providers demonstrate strong operational capacity and reliability.
VII	MCON	Maritime Connectivity
24	MCON1	Vessels with considerable size and high carrying capacity are able to access and depart from the port.
25	MCON2	The frequency of maritime services—including both direct sailings and transshipment operations—has shown consistent growth over the years.
26	MCON3	A wide range of destination ports is accessible, with shipping costs maintained at a competitive and reasonable level.
VIII	PCOM	Seaport Competitiveness
27	PCOM1	The total cargo throughput at the port demonstrates a consistent annual increase.
28	PCOM2	The port holds a significant share within its respective market segment.
29	PCOM3	Port-generated revenue exhibits a strong upward trajectory year over year.