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The Impact of Seaport Connectivity on Competitiveness: Evidence from Ho Chi Minh City

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Abstract. This study develops a structural model to analyze the impact of connectivity on seaport competitiveness, using Ho Chi Minh City Port as a case study. Survey data was obtained from 370 port authority experts, managers and business professionals. PLS-SEM analysis indicates connectivity factors like services, facilities and authorities influence competitiveness directly and indirectly. However, geographical location has the strongest effect. The results provide valuable insights for port managers to prioritize investments in transport infrastructure and coordinate with shipping lines. Enhancing connectivity emerges as vital for handling larger vessels and traffic growth.

Keywords: Partial Least Squares-Structural Equation Modeling (PLS-SEM); Bootstrap; hinterland and maritime connectivity; seaport competitiveness; Ho Chi Minh City, Vietnam.

1. Introduction

Seaports are crucial conduits for import and export activities, linking sea routes to various transportation networks. Vietnam, a coastal nation with approximately half of its provinces and cities bordering the sea, boasts a coastline spanning over 3,260 km. Despite this extensive coastline and strategic geographical positioning along international maritime routes, Vietnam's seaport development has not progressed adequately. The current seaport system suffers from fragmentation, outdated infrastructure, high customs clearance costs, and an imbalance in port sizes.

The primary challenge facing seaport development in Vietnam is the need to enhance connectivity and competitiveness. This study focuses on three key objectives: (i) establishing the relationship between a seaport's connectivity and its competitiveness, (ii) developing a quantitative model to quantify this relationship, and (iii) deriving policy implications to improve the capacity of Ho Chi Minh City seaports.

2. Theoretical Basis and Literature Review

2.1. Theoretical Basis

Industrial Cluster Theory: Porter’s concept (1998) of an industrial cluster emphasizes the geographic linkage of companies and institutions within a specific field, fostering mutual support for enhanced competitiveness. Seaports, today, are viewed as multi-industry economic clusters encompassing post-port logistics areas and multi-modal transport.

Vertical Integration of Ports and Network: Containerization has led to increased cooperation between ports and shipping lines to minimize risks. Shipping lines engage in vertical integration, owning or leasing port equipment, and participating in inland transport.

Horizontal Integration of Ports: Ports integrate into networks of foreign, neighboring, and domestic ports, sharing resources and cooperating through port authority policies.

Stakeholder Theory: Stakeholder theory underscores the diverse interests of individuals or groups influencing or being affected by an organization. Balancing stakeholder interests is crucial, emphasizing the need for decisions that consider the interests of all parties involved in the port system.

Institutional Theory: Institutions, comprising formal and informal rules, shape economic environments. Institutions, including port authorities, can either facilitate or hinder strategic options for developing connectivity. Port authorities act as territorial-bound institutions, influencing local institutional logic.

Port Geography Theory: Studying ports within a network context, port geography emphasizes effective spatial planning, connectivity, and the relationship between ports and hinterlands.

Theory of Competitiveness: Porter's Diamond model highlights conditional factors, market demand, supporting industries, strategy, and structure as key interconnected factors influencing the competitive advantage of countries in specific industries. The model is applied to seaports, emphasizing the impact of fundamental strengths and weaknesses on competitiveness.

2.2. Literature Review

Seaport connectivity involves the integration of maritime, inland, and port linkages, as emphasized by recent studies. To comprehensively study seaport connectivity, one must consider the entire freight transport chain and evaluate both hinterland connections (inland ports and trade) and maritime connections.

Hinterland connectivity, crucially dependent on intermodal networks from the port to the hinterland, plays a pivotal role. The smoothness of seaport-inland connections must align with maritime networks to maintain port competitiveness. The increasing size of ships, coupled with the emergence of distribution centers and satellite port networks, can exacerbate bottlenecks related to port hinterland connectivity.

Maritime connectivity encompasses the links between ports and shipping lines, as well as inter-port connections. Of these, the link with shipping lines holds particular significance, reflecting a port's capacity to handle vessels of varying sizes. Factors such as port depth, mooring systems, and facilities influence this connection. The sea connectivity of a port, representing its link to the main sea network, necessitates efficient sea transport services for the global movement of goods between the focal port and others. Achieving optimal sea connectivity requires a strong association with shipping lines.

Several recent global studies underscore the significant influence of geographical location on seaport connectivity across various regions. A comprehensive study focusing on maritime nations asserts that logistics services play a crucial role in positively influencing maritime connectivity. Pivotal factors affecting seaport connectivity include facility quality, costs, services, and geographical location.

Research emphasizes the paramount importance of facility factors—specifically, port facilities and transportation infrastructure around the port—in shaping seaport connectivity. The decision to choose a port is guided by factors such as hinterland connectivity, port costs and productivity, electronic information, and logistics services. Studies also highlight the impact of information technology on seaport connectivity.

Port authorities play a pivotal role in shaping the development of a country's seaport system. Actively engaging port authorities is crucial for coordination within clusters and transport chains, leading to more efficient supply chains and competitive ports. Consequently, they are incentivized to enhance coordination within port clusters and supply chains, contributing to effective hinterland access by investing in infrastructure and terminals both within and outside the port area. Moreover, port authorities can improve hinterland access by establishing infrastructure access rules and implementing a system of port communities. A study establishes a positive impact of port authorities on maritime connectivity. The role of port authorities is increasingly pivotal in shaping the development of a country's seaport system.

With empirical studies, we propose the following hypotheses:

- *Hypothesis H1: Geographic location has a positive impact on hinterland connectivity;*
- *Hypothesis H2: Seaport services have a positive impact on hinterland connectivity;*
- *Hypothesis H3: Information technology has a positive impact on hinterland connectivity;*
- *Hypothesis H4: Seaport facilities have a positive impact on hinterland connectivity;*
- *Hypothesis H5: Seaport authorities have a positive impact on hinterland connectivity;*
- *Hypothesis H6: Geographic location has a positive impact on maritime connectivity;*
- *Hypothesis H7: Seaport services have a positive impact on maritime connectivity;*
- *Hypothesis H8: Information technology has a positive impact on maritime connectivity;*
- *Hypothesis H9: Seaport facilities have a positive impact on maritime connectivity;*
- *Hypothesis H10: Seaport authorities have a positive impact on maritime connectivity.*

2.3. Hypotheses and Research model

Containerization has led to a reduction in shipping costs and time, enhancing reliability and security, thereby enabling large-scale global sourcing and manufacturing, stimulating demand for sea transport (Levinson, 2006; Notteboom, 2007). Consequently, it has significantly intensified competition among seaports (Luo and Grigalunas, 2003; Cullinane and Song, 2006; Da Cruz, 2012).

Van Klink (1998) argues that focal ports are uniquely positioned to stimulate multimodal transport on one hand and utilize multimodal systems to expand their hinterland on the other. The hierarchy of public authorities in ports is established through the privatization and commercialization of operations (Cullinane and Song, 2002; Brooks, 2004; De Langen, 2009; Baştuğ et al., 2022). Consequently, private ports possess more competitive advantages than public ports (Fleming and Baird, 1999).

Zhang (2009) examines how hinterland connectivity can influence the competitiveness of a port in an environment with numerous competing ports. Hinterland connectivity is characterized by transport corridors dedicated to seaport cargoes, such as designated railway lines connecting to ports or inland roads used by both freight trucks and local commuter cars.

Merk (2010), in a study of OECD seaport cities, believes that hinterland connectivity is one of the most critical factors affecting seaport competitiveness. Scaramelli (2010), in research on Valencia seaport, demonstrates that inland connectivity affects seaport competitiveness. On the contrary, Hayuth (1982) argues that shipping lines are increasingly attempting to control costs and coordinate their activities throughout the entire transport chain. They seek to lease and operate their container terminals as a priority. Ports that can meet the specific requirements of individual shipping lines and provide them with dedicated terminals will gain a competitive advantage.

A study of the Port of Rijeka in Croatia by Tijan et al. (2022) indicates that one of the significant factors influencing port competitiveness is inland and maritime connectivity. Research on the seaport system in Bangladesh by Saha (2022) asserts that inland port development affects the enhancement of seaport competitiveness. Nguyen and Woo (2022) examined the connectivity of the ten largest container ports in Southeast Asia and found that their connectivity is confirmed to be one of the primary factors helping Singapore become the most competitive container port in the region. Connectivity is also a crucial factor that aids Canadian ports in promoting their competitiveness (Beatriz and Alan, 2015).

Since 2000, numerous studies worldwide have shown that seaport connectivity has impacted the improvement of competitiveness (In China, Song and Yeo, 2004; Yeo et al., 2008; Gao et al., 2018; in Africa, Abbes, 2015; in Poland, Pietrzak et al., 2020; in Asia, Europe, the Middle East, and Africa, Hu, 2021; in Croatia, Tijan et al., 2022).

Based on empirical studies, we propose the following hypotheses:

- *Hypothesis H11: Hinterland connectivity has a positive impact on improving seaport competitiveness;*
- *Hypothesis H12: Maritime connectivity has a positive impact on improving seaport competitiveness.*

It is required to have a theoretical assessment and empirical study for further research to expand this theory and provide more empirical evidence and policy implications related to improving seaport competitiveness. Previous studies highlighted the factors that impact seaport connectivity with qualitative analysis or measurement of relationships using quantitative models such as statistical testing, or separate regression models, but did not provide a complete basis for a comprehensive analytical framework on seaport competitiveness. Therefore, the purpose of this study is to extend the findings from previous ones and integrate analysis of their correlation into a structural model. The research teams selected a case to study seaport competitiveness in Ho Chi Minh City Port as shown in Figure 1.

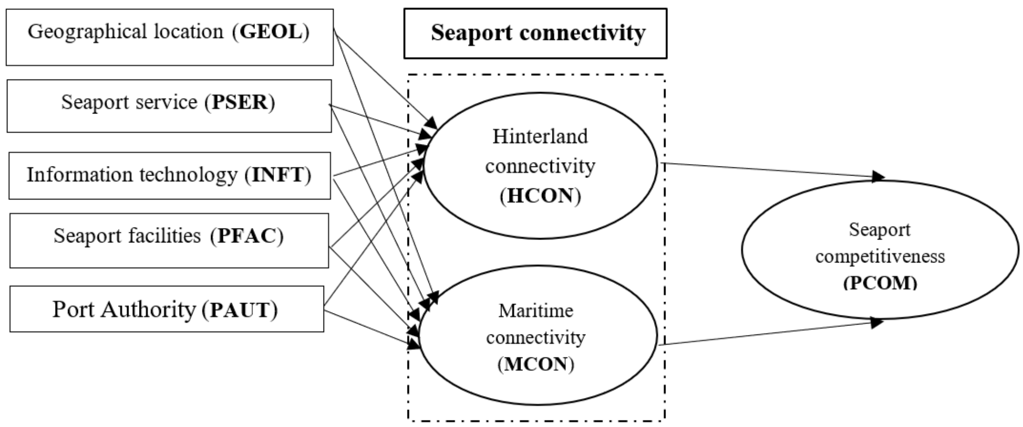

Fig.1: Theoretical research model

3. Research Methodology

Measurement: All scales are modified from previous studies to fit the research context in Vietnam. We designed a three-step process for the survey. First, we carried out a survey using the expertise method of discussing with 10 seaport management experts with at least five years of experience working at agencies related to the port industry, who are leaders of departments and agencies in Ho Chinh Minh to refer to measuring scales and observation variables that are suitable for the Port Logistics industry. Second, a pilot survey with 10 managers of import and export companies and 10 managers of shipping lines in Ho Chi Minh City to verify if there were any errors in the questionnaire. The sample was selected based on the respondents' willingness to participate in this study. Third, a complete survey was conducted for seaport management experts (20 people), managers of domestic shipping lines (250 people), and managers of foreign shipping lines whose ships docked at Ho Chi Minh City port (130 people). They all had experience in handling cargoes in Ho Chi Minh City seaport. A total of 400 respondents filled out the questionnaire.

A five-point Likert scale starting from "strongly disagree" to "strongly agree" was used to measure all observation variables. To measure "Hinterland connectivity" and "Maritime connectivity" scales, 6 observation variables were included in the questionnaire. These measurements were mainly based on research on the performance of the ports in Barcelona, Marseilles Egypt, and Morocco by Arvis *et al.* (2018). For "Geography", 4 observation variables were included in the questionnaire. It was mainly based on research on the performance of the ports in Vietnam by Ha Minh Hieu (2020). For "Seaport facilities", 4 observation variables are included in the questionnaire. It is mainly based on research on the ability to attract customers at Chittagong Port, Bangladesh by Munim *et al*. (2022). For "Information Technology", 4 observation variables were included in the questionnaire. It was mainly based on research on the port system in Chennai, India by Rajasekar and Rengamani (2019). For "Port Authority", 4 observation variables were included in the questionnaire. It was mainly based on research on port networks by De Langen and Sharapova (2013) and it was adjusted to suit the Vietnamese situation and had several new observation variables built by the authors from the expertise discussion results such as "Port authority can actively participate in investment projects for highway and barge terminals outside their port area"; "Port authority builds a port community information system to allow an effective communication between companies, contributing to the coordination of the transport chain." For "Seaport service", 4 observation variables were included. It was mainly based on research on the Chittagong port network in Bangladesh by Munim *et al.* (2022) and it was adjusted to suit the Vietnamese conditions and had several new observation variables built by the authors from the results of expert discussions such as "Handling of cargos and containers was secure and reliable"; "Procedures and documentation of the port are effective and quick". For "competitive advantage", 4 observations were included in the questionnaire. It was mainly based on research on port connectivity and competition in Southeast Asia by Nguyen & Woo (2022) and had several new observation variables built by the authors from the results of expert discussions such as “Annual share growth of the port against the adjacent region/country”; “Dynamic changes of cooperation policies based on economic fluctuations around the world and increasing revenue”. Details of the scales are in the Appendix (Table A).

Data collection and processing: We launched a survey in Ho Chinh Minh City with 400 questionnaires. This survey lasted from February to May 2023. After data processing, 370 reliable observations were used for data analysis. Because the theoretical model has a set of interwoven relationships, the linear structural modeling (Partial Least Square - Structural Equation Model, PLS-SEM) was used to test the above hypotheses (Anderson & Gerbing, 1988; Kline, 2011). Structural Equation Modeling was performed in 4 steps: (i) Reliability test of scale; (ii) Exploratory Factor Analysis (EFA); (iii) Confirmatory Factor Analysis (CFA) and (iv) Structural Equation Modeling (SEM). Data analysis was performed on SPSS and AMOS software version 21.0.

4. Research Results

4.1. Information about survey objects

Table 1. Characteristics of survey objects (n = 370).

	Frequency	**%**		**Frequency**	**%**
Gender			Income		
Male	295	80	<30	65	18
Female	75	20	30-40	132	36
Total	370	100	41-50	124	34
Ages			>50	49	13
<30	73	20	Total	370	100
31-45	203	55	Occupation		
46-55	60	16	Managers of domestic transport enterprises	200	54
>55	34	9	Managers of foreign transport enterprises	120	32
Total	370	100	Port authority officials	30	8
Education level			Seaport expert	20	6
Posgraduate	44	12	Total	370	100
Highschool	92	25	Marital status		
College & university	206	56	Single	135	37
Other	28	8	Married	235	64
Total	370	100	Total	370	100

(Source: Author's compilation, 2023)

Table 1 shows the details of the questionnaire. Among 370 survey observations, males account for 80%.. The ages were distributed across three groups: under 30, 31-45, 46–55, and over 55 with 20%, 55%, 16%, and 9%, respectively. Also, education levels in four groups: High school, College & university, Posgraduate, and Other, are 25%, 56%, 12%, and 8%, respectively. Occupation with four groups: Managers of domestic transport enterprises students, Managers of foreign transport enterprises businessman, Port authority officials, and Seaport experts are 58%, 23%, 14%, and 6%, respectively. The majority of survey objects is married (64%). The income of 30-50 million VND per month accounts for mainly (70%).

4.2. Scale reliability analysis

Table 2. Scale reliability test and rejected observed variables

No.	Scale	Observed variable are excluded	Alpha coefficients	Conclusion
1	GEOL	None	0.795	Good
2	PSER	None	0.844	Very good
3	INFT	None	0.838	Very good
4	PFAC	None	0.833	Very good
5	PAUT	None	0.807	Very good
6	HCON	None	0.845	Very good
7	MCON	None	0.840	Very good
8	PCOM	None	0.832	Very good

The results in Table 2 showed that: The observed variables all satisfy the conditions in the reliability analysis of the scale through an alpha coefficient > 0.6, and a variable-total correlation > 0.3 (Nunnally and Burnstein, 1994).

4.3. Exploratory Factor analysis

Table 3 shows that the factors of DCON are extracted into five factors corresponding to the measured variables of the theoretical model. The total variance extracted is 66.233% at an Eigenvalue of 1.797; EFA of HCON is extracted into four observed variables with an extracted variance of 76.356% at an Eigenvalue of 2.291%. The EFA of MCON is extracted into four observed variables with an extracted variance of 75.765% at an Eigenvalue of 2.273; EFA of PCOM extracted three observed variables with extracted variance of 74.946% at Eigenvalue of 2.248; and the promax rotation method used.

Table 3. Pattern matrix

	Component							
	1	2	3	4	5	6	7	8
PSER4	0.846							
PSER3	0.826							
PSER2	0.822							
PSER1	0.806							
INFT3		0.851						
INFT4		0.834						
INFT1		0.794						
INFT2		0.785						
PFAC3			0.843					
PFAC2			0.829					
PFAC4			0.821					
PFAC1			0.765					
PAUT4				0.812				
PAUT2				0.811				
PAUT3				0.778				
PAUT1				0.777				

GEOL4					0.820			
GEOL2					0.783			
GEOL3					0.772			
GEOL1					0.756			
HCON2						0.898		
HCON3						0.862		
HCON1						0.861		
MCON3							0.880	
MCON2							0.872	
MCON1							0.859	
PCOM3								0.877
PCOM1								0.877
PCOM2								0.843
Kaiser-Meyer-Olkin Measure					0.825	0.719	0.726	0.719
Bartlett's test					0.000	0.000	0.000	0.000
Eigenvalues					1.797	2.291	2.273	2.248
% of Extracted variance					66.233	76.356	75.765	74.946

Note: 0.5 < KMO < 1; Bartlett's test has a significance level less than 0.05; Factor Loading of observed variables (Factor Loading) > 0.5; extracted variance > 50%, and Eigenvalue > 1 (Hair *et al*., 2006).

4.4. Confirmatory Factor Analysis

The measurement models that are consistent with the actual data must be consistent with five measures: (i) Cmin/df; (ii) TLI; (iii) CFI; (iv) NFI; and (v) RMSEA (Gefen *et al.,* 2011).

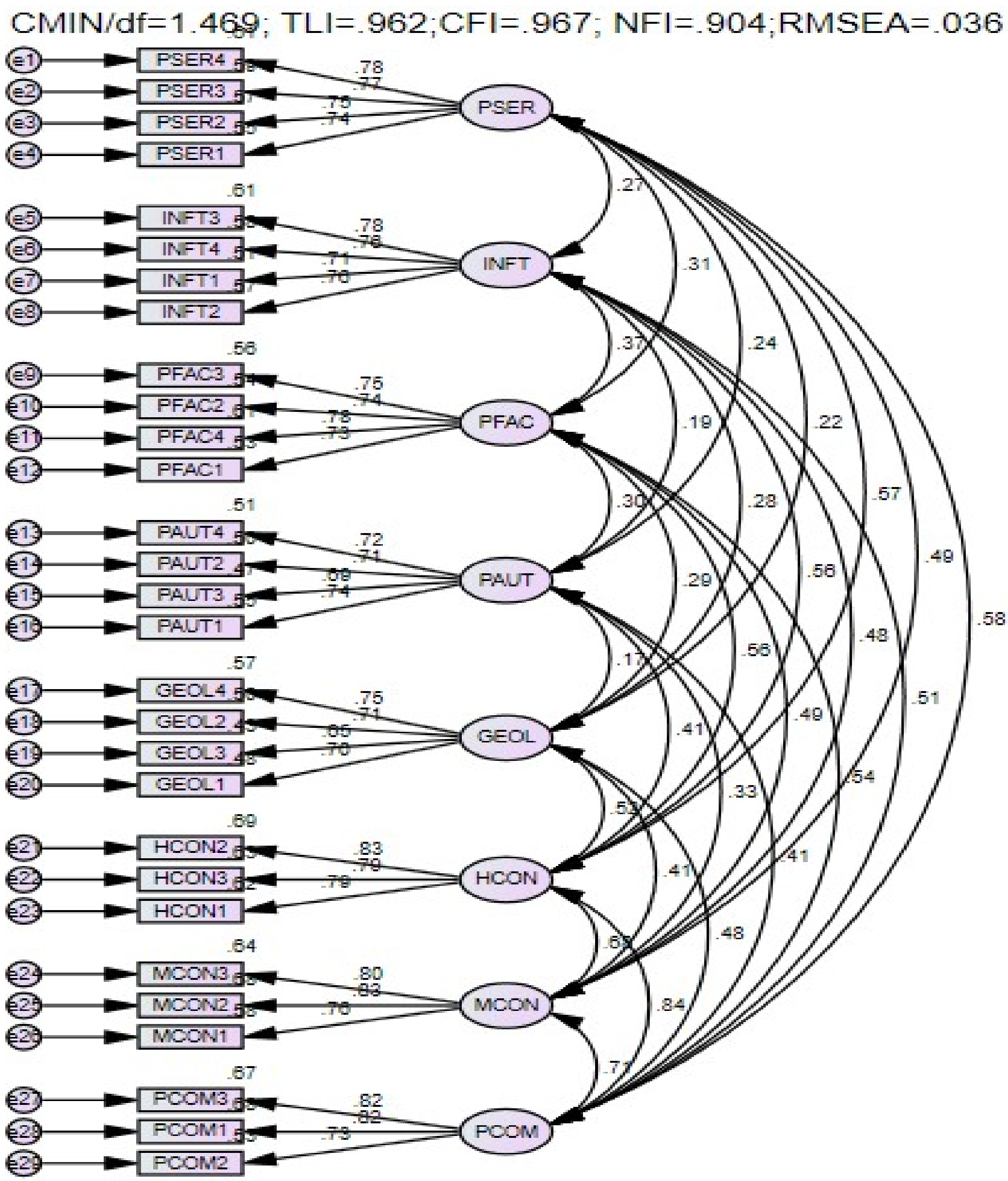

Fig.2: Confirmatory factor analysis results

Table 4. The fit indices of the CFA

No.	Measures	Indicator Standard values	Model value	Results
1	Cmin/df	χ2/ d.f. < 3 good fit; < 5 accepted; the smaller the better (Bentler and Bonett, 1980; Bagozii and Jy, 1988)	1.469	Good
2	TLI (Tucker-Lewis Index)	TLI: the closer it is to 1, the more appropriate; TLI > 0.90 is consistent; TLI ≥ 0.95 is in good agreement (Hu and Bentler, 1995)	0.962	Good

3	CFI (Comparative Fit Index)	CFI > 0.90; 0 < CFI < 1, the closer to 1, the more suitable (Hu and Bentler, 1995).	0.967	Good
4	NFI (Normal Fit Index)	NFI, the closer it is to 1, the more suitable; NFI close to 0.90 is accepted; NFI > 0.95 is, a good fit. (Chin and Todd, 1995; Hu & Bentler, 1995)	0.904	Good
5	RMSEA (Root Mean Square Error Approximation)	RMSEA < 0.05, the model fits well; RMSEA < 0.08, accepted; the smaller the better (Browne and Cudeck, 1993)	0.036	Good

Table 4 shows that the measurement model is consistent with the actual data.

4.5. Structural Equation Modeling

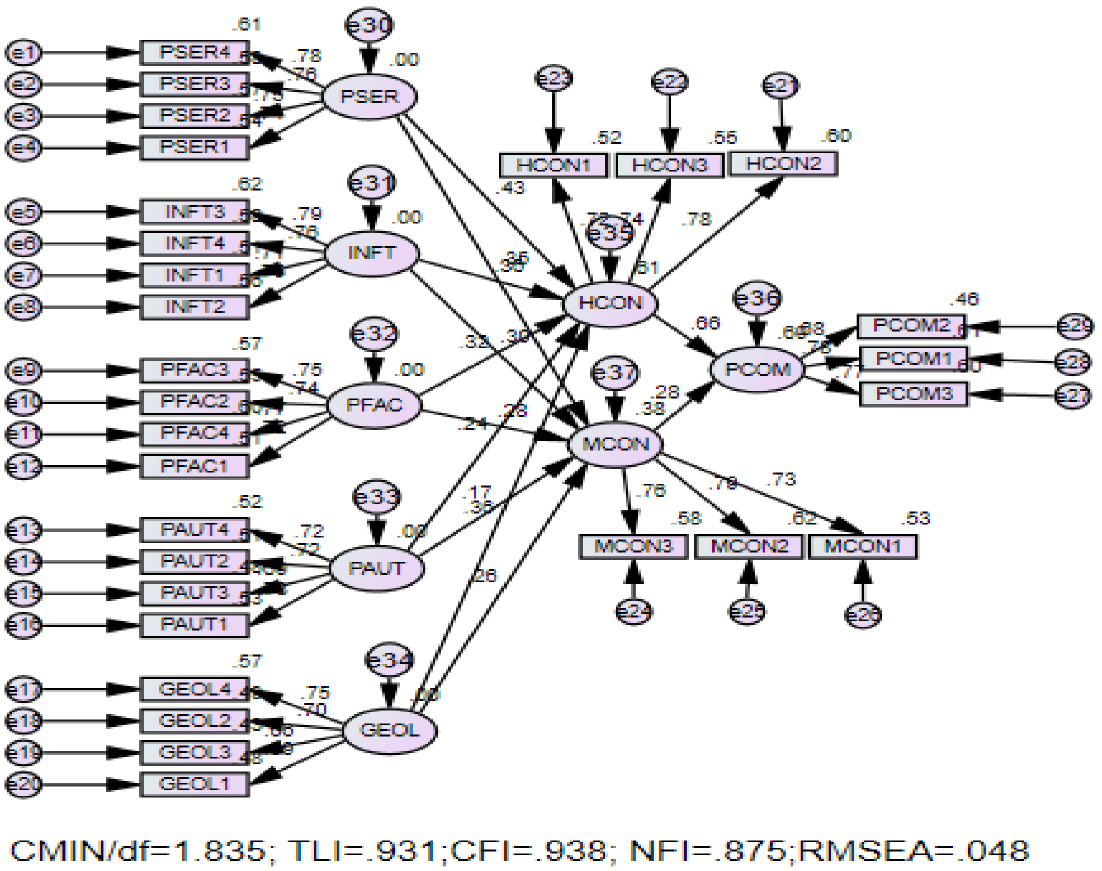

Fig.3: Results of structural equation modeling

The results presented in Figure 3 showed the model has a value of Cmin/df = 1.835; TLI = 0.931; CFI = 0.938; NFI = 0.875; and RMSEA = 0.048. Thus, the integrated model fits the actual data.

Table 5. The model fitting the actual data in this study

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

Note: *** (P_value = 0.000 / Sig. = 0.000).

In Table 5, all hypotheses are accepted with a 95% confidence level or higher (P_value ≤ 0.05).

Table 6. Magnitude of the impact

Impacts			**Regression coefficient**	**%**	**Position**
Impact on DECON					
HCON = f(PSER, INFT, PFAC, PAUT, GEOL)					
HCON	<---	PSER	0.386	23	1
HCON	<---	INFT	0.371	22	2
HCON	<---	PFAC	0.321	19	4
HCON	<---	PAUT	0.240	14	5
HCON	<---	GEOL	0.352	21	3
Total			1.670	100	
Impact on MARC					
MARC = f(PSER, INFT, PFAC, PAUT, GEOL)					
MARC	<---	PSER	0.300	23.8	1
MARC	<---	INFT	0.298	23.7	2
MARC	<---	PFAC	0.263	20.9	3
MARC	<---	PAUT	0.160	12.7	5
MARC	<---	GEOL	0.239	19.0	4
Total			1.260	100	
Impact on PCOM					
PCOM = f(DCON, MARC)					
PCOM	<---	HCON	0.647	69	1
PCOM	<---	MARC	0.293	31	2
Total			0.94	100	

Table 6 shows factors affecting HCON in order of influence from high to low PSER, INFT, GEOL, PFAC, and PAUT. Factors affecting MARC in order of influence: PSER, INFT, PFAC, GEOL, and PAUT. Factors affecting PCOM in order of influence: HCON, and MARC

4.6. Using BOOTSTRAP to analyze the reliability of PLS-SEM results

Methods of analysis of structural functions often require large samples (Anderson and Gerbing, 1988), whereas academic research is often limited in sample size. In such cases, Bootstrap is a suitable alternative (Schumacker and Lomax, 2010). Bootstrap is an alternative, repeatable sampling method in which the original sample acts as a population. The Bootstrap method generates random samples from the original sample, which has numerous observations, often choosing 1,000 observations. The estimated results from N samples are averaged, and this value tends to be close to the estimate of the population. The smaller the difference between the average value of Bootstrap regression coefficients and the model estimate with the original sample, the more reliably the model estimates can be concluded.

Table 7. Bootstrap implementation results

Parameter			SE	SE-SE	Mean	Bias	SE-Bias	CR
HCON	<---	PSER	0.049	0.001	0.387	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
HCON	<---	GEOL	0.060	0.001	0.351	-0.001	0.002	-0.5
MARC	<---	PSER	0.053	0.001	0.301	0.001	0.002	0.5
MARC	<---	INFT	0.069	0.002	0.301	0.003	0.002	1.5
MARC	<---	PFAC	0.064	0.001	0.261	-0.002	0.002	-1.0
MARC	<---	PAUT	0.060	0.001	0.163	0.003	0.002	1.5
MARC	<---	GEOL	0.066	0.001	0.237	-0.001	0.002	-0.5
PCOM	<---	DCON	0.066	0.001	0.647	0.000	0.002	0
PCOM	<---	MARC	0.064	0.001	0.296	0.003	0.002	1.5

*CR (Critical Ratios) = (Bias) / (SE-Bias)

The absolute value of CR is less than or equal to 2, so it can be said that the bias is very small, the difference is not statistically significant at the 95% confidence level (Hair et al., 2006). The regression coefficient results before Bootstrap are reliable with a confidence level greater or equal to 95%. Table 7 shows regression coefficient results before Bootstrap was reliable.

5. Discussion and Policy Implications

Our study has identified 5 factors that affect "Seaport connectivity" including PSER (Seaport service), INFT (Information technology), GEOL (Geographical location), PFAC (Seaport facilities), and PAUT (Port Authority). This result is consistent with previous research on the seaports in the Bay of Bengal by the Indian Ocean and Croatia by Tijan *et al.* (2022), Northeast China by Wan *et al.* (2022), Vietnam by Ha Minh Hieu (2020), Chittagong Port in Bangladesh by Munim *et al.* (2022) and Poland by Pietrzak *et al.* (2020).

We add new observation variables to the research on seaport competitiveness, specifically "Port authorities are proactively involved in investment projects of highway terminals and barge terminals outside their port area"; "Port authorities build a port community information system to allow effective communication between companies, contributing to the coordination of the transport chain"; "The port we are using has very good relationships with famous ports in the world"; "Annual share growth of the port against the adjacent region/country"; "Dynamic changes of cooperation policies based on economic fluctuations around the world and increasing revenue."

To improve the competitiveness of Ho Chi Minh City Port, it is necessary to pay attention to 6 factors: Geographical location, Seaport connectivity, Information technology, Seaport facilities, Port service quality, and Port Authority where the geographical location has the strongest and most significant impact on competitive advantage. This is beyond the capacity of the port authority but requires the engagement of the Government in developing the road network from the seaport to the import-export industrial zones, linked ports, and central transshipment centers. This is also a key factor for the development and improvement of competitiveness of Ho Chi Minh City seaport.

6. Conclusions and Research Limitations

In conclusion, this study offers empirical evidence that seaport connectivity significantly impacts competitiveness, with locational advantages playing a pivotal role. However, the potential benefits are constrained by limitations in linking transport networks, berths and inland waterways. The research emphasizes that authorities need to actively address bottlenecks while balancing stakeholder interests. Upgrading connectivity emerges as an imperative for ports to achieve scale economics, improve efficiency and retain market share.

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Appendix

Table A. Measurement scale and observed variables

No.	Scales and observed variables	Code
I	Geographical location	GEOL
1	The port is located near industrial parks and export processing zones	GEOL1
2	The port is located near central transshipment ports	GEOL2
3	The port is located near main transportation routes	GEOL3
4	The port is located close to other linked ports, including depots	GEOL4
II	Seaport service	PSER
5	Procedures and documents at the port are simple and quick	PSER1
6	The port is capable of handling large and special shipments	PSER2
7	Service prices at the port are reasonable	PSER3
8	The loading and unloading of goods and containers at the port is guaranteed and reliable	PSER4
III	Information technology	INFT
9	IT at the port is well connected to ensure communication between the Port and customers and public agencies (Customs, port authorities, border guards, quarantine...), as well as other port users.	INFT1
10	The port has an integrated online payment system	INFT2
11	The port has a developed IT system to manage and operate the port, using software to plan and arrange the use of wharves, yards, equipment, human resources and manage all container loading and unloading work.	INFT3
12	The availability of electronic procedures allows for faster operations.	INFT4
IV	Seaport facilities	PFAC
13	Adequacy and safety of storage facilities (storage spaces, warehouses, liquid cargo tanks...) and container loading yards.	PFAC1
14	Appropriate draft and port depth	PFAC2
15	Docking station, wharf with complete and modern loading and unloading facilities	PFAC3
16	Internal and inter-regional transport infrastructure is well planned and neatly arranged	PFAC4
V	Port Authority	PAUT
17	PAUT establishes infrastructure access rules that can improve the efficient use of infrastructure.	PAUT1

18	PAUT establishes infrastructure access rules that can improve the efficient use of infrastructure.	PAUT2
19	PAUT builds a port community information system to help exchange data between companies effectively, contributing to the coordination of the transportation chain.	PAUT3
20	PAUT is decided on the concession of port infrastructure exploitation	PAUT4
VI	Hinterland connectivity	HCON
21	The domestic transportation system (road, railway, waterway) is clear and uncongested.	HCON1
22	The number of goods entering/exiting the inland through the port is increasing.	HCON2
23	The capacity of domestic logistics service providers is high	HCON3
VII	Maritime connectivity	MCON
24	Ships of large size and tonnage enter and exit the port	MCON1
25	The number of shipping services (Including the number of transshipment and direct maritime shipments) has increased rapidly over the years	MCON2
26	Many destination ports are connected and shipping costs are reasonable	MCON3
VIII	Seaport competitiveness	PCOM
27	The volume of goods through the port increases every year	PCOM1
28	The port's market share is high	PCOM2
29	The port's revenue increases rapidly every year	PCOM3

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