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Original Article

IMPACTS OF LINER SHIPPING CONNECTIVITY AND GLOBAL COMPETITIVENESS ON LOGISTICS PERFORMANCE: THE MEDIATING ROLE OF THE QUALITY OF PORT AND INFRASTRUCTURE

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Highlights:

- LP is crucial both for national and international economy;
- carried-out research showed the impact of LSC and global competitiveness on LP in Asia;
- Asian policy-makers need a guide to focus on how to improve LP;
- the study will serve as the theory of strategies highlighting the dimension of the factors to be concentrated in this regard.

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Abstract. Logistics Performance (LP) is one of the fundamental catalysts that serve as a podium for the integration of the world economy. This study is conducted to observe the combined effects of Liner Shipping Connectivity (LSC) and Global Competitiveness Index (GCI) on LP in mediating the Quality of Port and Infrastructure (PORT). We selected 28 Asian economies and 1 special administrative region (Hong Kong) counting the year of 2007–2018. Partial Least Square – Structural Equation Model (PLS–SEM) with an extension of the Importance–Performance Map Analysis (IPMA) was applied. Empirical evidence derived from the path diagram has revealed that LSC and global competitiveness in mediating the PORT have significant effects of accelerating LP, leading to higher competitiveness in terms of strategic development and yielding better connectivity. Due to limited resources, Asian decision-makers need a guidance to focus on how to improve LP. This work also helps to highlight the dimensions of LSC and global competitiveness factors to be concentrated on and the policies to be implemented in this regard.

Keywords: logistics performance, liner shipping connectivity, global competitiveness, least square, structural equation model, importance–performance map analysis.

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Notations

AVE – average variance extracted;
BBS – broadband subscriptions;
BN – Bayesian network;
CFA – confirmatory factor analysis;
CFI – comparative fit index;
CPS – competitive price shipments;
CT – consignments tracking;
CQLS – competence and quality logistics service;
DEA – data envelopment analysis;
ECCP – efficiency of customs clearance process;
FA – factor analysis;
FLC – Fornell–Lacker criterion;
FS – frequency of shipments;
GCI – global competitiveness index;
GFI – goodness of fit index;
HTMT – heterotrait–monotrait;
ICT – information and communications technologies;
IPMA – importance–performance map analysis;
KMO – Kaiser–Meyer–Olkin;
LP – logistics performance;
LSBC – liner shipping bilateral connectivity;
LSC – liner shipping connectivity;
MFI – McDonald fit index;
MOBS – mobile cellular subscriptions;
NFI – normed fit index;
NIU – number of Internet user;
NNFI – non-NFI;
PLS – partial least square;

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PLS–SEM – partial least square – structural equation model;
PORT – quality of port and infrastructure;
QTTINFRT – quality of trade- and transport-related infrastructure;
RFI – relative fit index;
RMSEA – root mean square error of approximation;
SEM – structural equation model;
SOLP – sustainable operational logistics performance;
SRMR – standardized root mean squared residue;
TLI – Tucker–Lewis index;
TS – telephone subscriptions;
UNCTAD – United Nations conference on trade and development;
VIF – variance inflation factor;
WB – World Bank;
WEF – world economic forum.

Introduction

This study is relevant to delineate the effects of LSC and global competitiveness on LP in mediating of port and infrastructure quality. Modern logistics being strongly influenced by globalization and internationalization (Beysenbaev, Dus 2020), efficient logistics services are considered as the comparative advantages and vital catalysts of the global logistics hub (Erkan 2014; Önsel Ekic *et al.* 2016; Chen, Hasan 2020). It is very crucial both to national and international economic development (Karaman *et al.* 2020; Önsel Ekici *et al.* 2019; Sy *et al.* 2020; Wong, Tang 2018). The opportunity of bilateral trade depends on access to the high quality of logistics network (Önsel Ekic *et al.* 2016). LP in Asia still varies, particularly in the quality of trade and transport-related infrastructure. The performance score of Asia over the last few years measured by the WB was satisfactory but the score in the South Asian region was the second-lowest, 2.51 (out of 7) in 2018, compared with others, while 3.24 for Central Asia (Ahmed, Khan 2020). Since Asian transport-logistics network is essential for regional connectivity, an innovative and smart logistics approach must adopt to improve the combined LP (Su *et al.* 2011). Compared to the average score (2.40) of low-income countries, South Asia did slightly well in 2018, though it was considerably lower than the average scores of lower middle (2.60) and upper middle income countries (2.70) (Ahmed, Khan 2020). However, all previous publications focused on the LP of each country or on an economic group. Few of them have tried to combine maritime connectivity with global competitiveness. This created a gap in the development of regional LP for decision-makers. This gap and its importance lead us to conduct this empirical study to show a roadmap to improve the performance of logistics in Asia.

The qualities of logistics services as well as the port and infrastructure influence the transportation of goods between countries (Sy *et al.* 2020). The time that the world passes through is for mutual benefit and the facilitation of global trade between countries, creating opportunities to win, which is equally important for combined economies (Acar *et al.* 2015). The PORT as well as flexible regulations between countries has created opportunities but challenges for advanced and intelligent logistics networks. The performance of logistics in every economy now revolves around the public and private sector services such as policies, intervention and the implementation of good governance. However, characteristics such as the development of transport infrastructure, political dimension, intra-connectivity, public-private partnerships, global competitiveness, port and infrastructure quality serve as a podium for the intelligent evolution paths of the LP (Pettit, Beresford 2009). Here again, the efficient logistics capacities of individual companies constitute a competitive advantage over their competitors in the market (Sy *et al.* 2020).

Now the question for global logistics hub is how to increase LP, especially for the Asian economy, the ones that triggered the core of the stimulation of regional logistics development (Arvis *et al.* 2018; Bookbinder, Tan 2003) and a major transhipment market in the world (Yap, Zahraei 2018). The WB's LP index published since 2007 has raised concerns about the importance of LP among the countries. The index is performed worldwide on the basis of the survey of operators in the field. The index evaluates the performance of 6 basic indicators: ECCP, QTTINFRT, CPS, CQLS, FS, and CT. These elements of LP could be improved by combining them with indicators of global competitiveness, port quality, and LSC. Because the competitiveness of a nation is defined as the sets of institutions, market development, education and training, infrastructure, labour market efficiency, and business sophistication (Önsel Ekici *et al.* 2016), while LSC depicts how well countries are connected to global shipping networks in terms of number of ships, container-carrying capacity, vessel size, services and the number of containers deploying port companies. In addition, LP is a complex sequence (Önsel Ekici *et al.* 2016) and coordinated activities of port facilities as well as shipping connectivity as a whole. Again, it is generally accepted that the quality of port performance today plays a big role not only in cargo handling, but also maintains the aspects of LP (Jouili 2019). It has the potentiality to shape and sharpen the social and environmental performance of transportation systems as well (Gonzalez-Aregall *et al.* 2018; Hua *et al.* 2020). As shipping connectivity reduces trade costs (Hoffmann *et al.* 2020), the structure of LSC, port infrastructure endowments, and LSBC will accelerate freight rate among the countries (Wilmsmeier, Hoffmann 2008). LSBC is an extension of the country-level LSC index and is based on an appropriate bilateral transformation of transhipments, common connections and direct connections between 2 countries. LSC indicates the level of integration into the global shipping network. Therefore, integrated shipping connectivity, the quality of port facilities and global competitiveness works together as catalysts of improving LP.

The PORT contribute greatly to the development of LP. Port activities are the provision of logistics services for national and international businesses. Port logistics facilities take great advantages over the countries those who don't have these facilities at all. These lead us to select 29 economies those have the port facilities in Asia. Many countries are now planning to build up a regional port hub to facilitate and hasten SCM activities (Munim, Schramm 2018). Meanwhile, port–city relation has changed the urban and coastal structure. That's why, Wan *et al.* (2018) underlined the important role of the port in international shipping, which inevitably influences the global trade, as better port facilities and infrastructure are considered to be crucial nodes and catalyst of better logistics network (Song, Van Geenhuizen 2014; Wan *et al.* 2018). Lun & Hoffmann (2016) pointed out that the influential importance of intra-trade on the development of LSC may have an impact on the performance of the logistics network as well. Poor transport connectivity and inefficient LP continue to reduce the access of smaller and weaker economies to global markets, especially for developing countries, leading them to underperformance (UNCTAD 2017).

Empirical studies on Asian have intensified the importance of LP. Most of the works have focused on the multidimensional role of LP on trade and economy, while few have studied the interactions between LP and GCI. The studies conducted previously are related to the direct and indirect or mediating effects of LP on a particular economy. Works of Bookbinder *et al.* (2003); Önsel Ekici *et al.* (2019); Kabak *et al.* (2020); Khan *et al.* (2019); Liu *et al.* (2018b); Sharapiyeva *et al.* (2019); Clark *et al.* (2004) can be taken as the testimony. This created a research deficit and very few of them tried to blend shipping connectivity, PORT with global competitiveness to see the impacts on LP in Asia. Our study attempted to minimize this gap undertaking 28 Asian economies and 1 special administrative region (Hong Kong). The reason for selecting 29 economies is the lack of port facilities and activities in other economies. The study will sort out the combined impacts of shipping connectivity and global competitiveness on LP. It will pay particular attention to the implication of global competitiveness indicators and LSC for improving the LP in Asia. Furthermore, it will intensify the necessity of port facilities among the nations.

1. Literature review and hypothesis development

All studies done previously have focused on the impacts of the PORT, global competitiveness, and LSC at economic level. They showed how LSC and the PORT can improve economic growth at national level. But no research has yet empirically attempted to see the impacts on LP in mediating the PORT. Hence, our study is the first and foremost effort to observe the influence of global competitiveness and LSC on LP.

Global competitiveness is a widely used term that deal with the ability to achieve certain outcomes, such as a high standard of transportation, technological readiness, productivity and economic growth of a country (Sargsyan 2017). Most of the countries continue to trade using shipping nodes in the global shipping networks to reduce bilateral trade cost (Wilmsmeier, Hoffmann 2008). The competitiveness indicators have a degree of free and fair market of goods and services (Sargsyan 2017), those stimulate the structure of LSC, port infrastructure endowment (Wilmsmeier, Hoffmann 2008). Schøyen *et al.* (2018) conducted research on the contribution of logistics service and container liner connectivity on port efficiency. They used DEA to measure port efficiency in the context of liner connectivity. Wilmsmeier & Hoffmann (2008) investigated the interconnection between LSC and port infrastructure in the Caribbean, which has resulted in competition between shipping lines that makes shipping services less expensive and improves connectivity. Port characteristics have been studied by Wilmsmeier *et al.* (2006) and found the quality of ports and infrastructure has a significant and positive impact on LSBC. In other words, shipping connectivity, the PORT and global competitiveness are interconnected and impact improving LP.

Önsel Ekici *et al.* (2019) assessed how to improve LP by reforming the GCI. The study used PLS–SEM approach to test the significant impacts of the pillars of global competitiveness and suggested some policy implications related to LP. Global competitiveness indicators are the economic indicators of the country (Çemberci *et al.* 2015), and illustrate the major factors and institutions to determine the long-term growth and competitiveness of the countries (Önsel Ekici *et al.* 2019). The success of improving the LP of any country is highly dependent on competitiveness (Önsel Ekici *et al.* 2016). Because competitiveness has also a positive influence on the country's transportation, economy, and logistics services (Önsel Ekici *et al.* 2016; Chen, Hasan 2020). The implementation of flexible policies, public and private investments, the development of a regulatory regime for transport services, improvement of business environment and the expansion of national and international markets can bring great change to LP. Kabak *et al.* (2018) highlighted the importance of LP for both the national and international economy using global competitiveness indicators. They used BN to investigate the relationship between logistics network that mostly depends on the policies, services and investments, and global competitiveness. It was found that pillars of competitiveness directly and indirectly affect the success of LP and the competitiveness of a country. Thus, we hypothesized:

- H1a: global competitiveness has a positive impact on LSC;
- H1b: global competitiveness has a positive impact on LP;
- H1c: global competitiveness has a positive impact on PORT;
- H1d: global competitiveness has a positive impact on LP in mediation of LSC;

- H1e: global competitiveness has a positive impact on LP in mediation of PORT;
- H1f: global competitiveness has a positive impact on LP in the mediation of LSC and PORT.

Lam *et al.* (2011) examined the liner shipping network and port connectivity of 4 major ports in East Asia. Their study identified shipping capacity, trade routes, and geographic regions are connected to the ports and shipping network, suggesting policies and research implications related to smart port planning and the development of supply chain systems. Jiang *et al.* (2015) developed 2 scientific models to compute port connectivity, which helped improving overall LP. The importance of LP has been identified using a novel scenario based analysis by Kabak *et al.* (2018). Maritime relations of bilateral LSC and LSC are crucial determinants of bilateral trade (Fugazza, Hoffmann 2017). The predominance of bilateral trade and maritime transhipment operations in hub ports has accelerated the intensification of smart LP. Lin *et al.* (2020) demonstrated a spatial analysis of LSC, which made it possible to identify the geographic ripple of transport infrastructure. However, the growth of trade and the need for competitiveness in the global market significantly force ports to facilitate SOLP (Pavlic *et al.* 2014; Rashidi, Cullinane 2019). Therefore, we hypothesized here:

- H2a: LSC has a positive impact on LP;
- H2b: LSC has a positive impact on PORT;
- H2c: LSC has a positive impact on LP in the mediation of PORT.

Beysenbaev & Dus (2020) developed a proposal to modify LP by applying qualitative and quantitative assessment of logistics efficiency of 159 countries. Gordon *et al.* (2005) added that combination of port facilities like govt. support, more investments, flexible policies, and excellence in technological readiness can bring sustainable port competitiveness, which leads to outstanding performance. Yeo *et al.* (2008) established that PORT, connectivity and port accessibility significantly contribute to the development of LP. Using the gravity method, port's connectivity was studied to access the density of connectivity and the importance of accelerating policy and management of marine transportation of national logistics (Zaman *et al.* 2015). The efficiency of ports for bilateral trade, trade liberalization and infrastructure reduce artificial barriers (Clark *et al.* 2004; Dare *et al.* 2019) and logistics infrastructure has been playing an increasingly significant contribution to economic development (Qi *et al.* 2020), because global supply chain activities have increased pressure on the maritime haul, port operations and inland freight distribution (Notteboom, Rodrigue 2005). Port maritime connectivity is essential to accelerate and expand the strength of national connectivity that will rebuild the logistics network and quality infrastructure (Rumaji, Adiliya 2019). Sharapiyeva *et al.* (2019) adopting SEM studied the impact of port transport-logistics infrastructure of 37 landlocked countries and found that the countries without access to the sea are inferior to other countries in terms of port infrastructure, logistics efficiency, and economic growth. So, it can be hypothesized:

- H3: PORT has a positive impact on LP.

2. Conceptual framework

We adopted the mediation path diagram (Figure 1) method using 3-stage integrated PLS–SEM with smart-PLS software. First, reliability and stability of latent factors are checked applying CFA. Next, we verified the direct effects of competitiveness, LSC and the PORT on our target variable. The mediating effects of the variables were checked in the second step, and an IPMA was added in the final step to clarify the importance of the factors that will determine the most influential factors for improving LP in Asia.

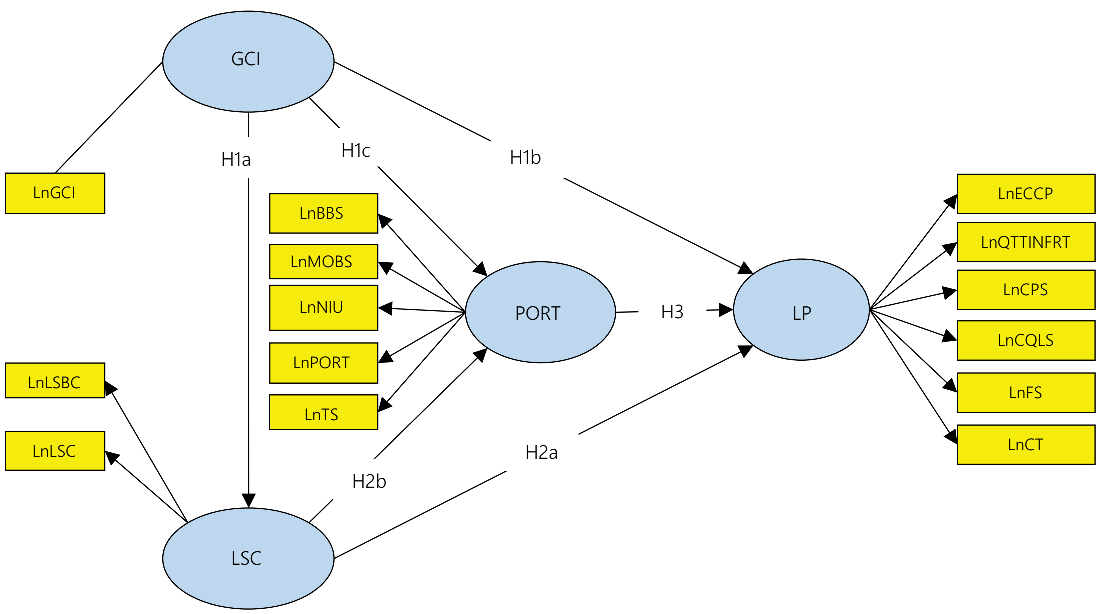

Figure 1. Framework of PLS–SEM mediation path diagram analysis

3. Data sources and methodology

This study focused on 28 Asian countries and 1 special administrative region (Hong Kong) (Appendix A). The reasons of selecting 29 economies are port facilities and the availability of data. We collected data on different variables from the WB database. Data on the GCI were extracted from annual publications by the WEF.

The LP consists of 6 indicators based on the customs clearance process, QTTINFRT, competitively priced shipments, quality of logistics services, ability to track and trace and FS. Erkan (2014); Chen & Hasan (2020); Munim & Schramm (2018); Liang & Liu (2020) and Çemberci *et al.* (2015) used the same datasets in their study. The overall performance score reflects perceptions of a country's LP ranging from very low (1) to high (5). The performance score is obtained through surveys conducted by the WB.

The GCI presents the report of competitiveness on the individual country every year. It assesses the capacity of countries to provide a high level of welfare, using the resources they have (Sharapiyeva *et al.* 2019). It presents the information on the competitiveness score combining 12 indicators of competitiveness such as macroeconomic stability, ICT adaptation, labour market efficiency, market openness, financial market development, infrastructure, technological readiness, education and training and so on. The score is measured on a Likert scale 1…7; 1 – for low and 7 – for the high. Çemberci *et al.* (2015); Hasan & Chen (2020) and Sharapiyeva *et al.* (2019) used the same set of variable in their study as well.

Transport connectivity is a crucial determinant of LP. To measure shipping connectivity, we adopted LSC index and LSBC index. LSC score shows how well countries are connected to global shipping networks. The index is calculated by UNCTAD on the basis of 5 components of maritime transport sectors: the number of ships, container transport capacity, maximum vessel size, services and the number of companies that deploy container ships in a country's ports. The maximum values are 100 for the country with the highest average index (UNCTAD 2020). On the other hand, LSBC index indicates a country pair's integration level into global liner shipping networks. However, the index is an extension of UNCTAD's country-level shipping connectivity and it is based on a proper bilateral transformation. LSBC is measured on the basis of 5 components- number of transhipments, direct connections common to both countries, common connections per pair of countries with one transhipment, level of competition in services and size of the largest ship on the weakest route connecting one country to another (UNCTAD 2020). A correlation matrix of latent variables and Pearson's heat map is presented in Appendix B and Appendix C, respectively.

The PORT measures business executives' perception of their country's port facilities. Data are measured on Likert scale 1…7, where 1 represents the lower PORT and 7 – for the best. As smart port and infrastructure are interrelated to the facilities of communication infrastructure and transportation (Liang, Liu 2020), the NIU (% of population), BBS (per 100 people), MOBS (per 100 people) were also taken into account in our study.

As the variables of the study such as LP, PORT and LSC are hard to observe directly, it is necessary to use multiple explicit observations to measure the latent constructs indirectly (Liang, Liu 2020; Munim, Schramm 2018). Most of the previous studies used a set of observed variables in the empirical analysis and this lead them to use SEM (Green *et al.* 2008; Liang, Liu 2020; Munim, Schramm 2018; Sharapiyeva *et al.* 2019). SEM is a powerful multivariate technique increasingly used in scientific experiments to test and evaluate multivariate causal relationships (El-Sheikh *et al.* 2017; Fan *et al.* 2016; Hox, Bechger 1998). However, we also used latent constructs along with their observed factors, which motivated us to adopt a complex PLS–SEM mediation path diagram analysis. SEM is different from other statistical techniques because it can

Table 1. List of observed variables

Latent construct	Indicator	Abbreviation of variable
LP	ECCP	LnECCP
	QTTINFRT	LnQTTINFRT
	CPS	LnCPS
	CQLS	LnCQLS
	FS	LnFS
	CT	LnCT
GCI	GCI	LnGCI
LSC	LSC	LnLSC
	LSBC	LnLSBC
PORT	PORT	LnPORT
	BBS (per 100 people)	LnBBS
	MOBS (per 100 people)	LnMOBS
	NIU (% of population)	LnNIU
	TS (per 100 people)	LnTS

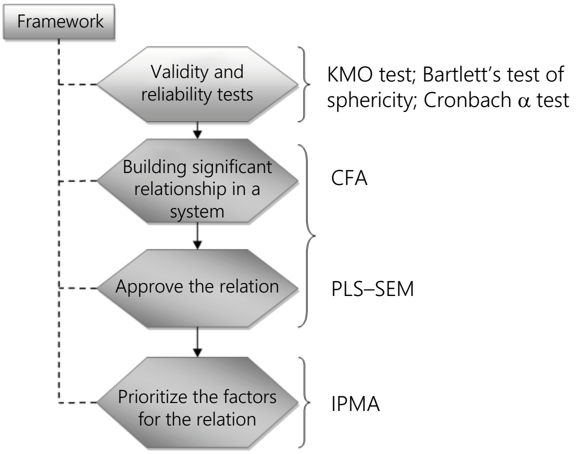

Figure 2. Research framework (conception based on Önsel Ekici *et al.* (2019))

measure the direct and indirect effect on putative causal relationship using a path diagram (Fan *et al.* 2016). Since it is difficult to measure the direct impacts of the latent constructs, this motivated us to use complex PLS–SEM composed of several observed factors as well. In addition, PLS–SEM allows estimation of very complex models with many constructs and indicator variables, especially when prediction is the goal of analysis (Sarstedt *et al.* 2017). It allows flexibility regarding the data requirements and the specification of relationships between the constructs and observed indicators, which result in an excellent approximation of common factor models, while factor-based SEM can't do it due to its methodological limitations (Sarstedt *et al.* 2017). A research framework is figured outlying the steps involved in the methodology (Figure 2).

The PLS–SEM path diagrams will measure the direct and indirect effects of latent factors on LP. PLS–SEM works well with small sample size (Wu *et al.* 2012) and it not only estimates the total effects of every individual factors score, but also decomposes the total effect into direct and indirect effects (Önsel Ekici *et al.* 2019). SEM is often visualized by a graphical diagram (Hox, Bechger 1998). The reasonable sample size for a complex SEM should be greater than 100 (Kline 2023) or about 200 (Hox, Bechger 1998). The sample size used in this study was pooled from 6 years (i.e., 2007, 2010, 2012, 2014, 2016, 2018), generating 174 observations, except for observations with missing values. A list of the latent variables presented in Table 1 and the data were transformed into log form to standardize the measurement. After estimating the significant path coefficients for the inner and outer models with their relevant *t*-values, we will continue to perform IPMA in the final stage to find the most important factors affecting target variable.

4. Empirical analysis and findings

4.1. Validity and reliability test

This section presents the result of the stability and reliability tests. Composite reliability, convergent validity, standardized residuals, discriminant validity, modification indices, and average variance are used to test the validity and reliability of datasets (Koufteros 1999). Descriptive statistics as well as Cronbach α score (Cronbach 1951) presented in Appendix D.

Cronbach α score is used to check the homogeneity and internal consistency of the latent variables. In general, an α scores greater than 0.6 is regarded as the effective reliability. Overall α score we obtained is 0.84, which is higher than the recommended level (0.6). It clarifies the data has reached a good standard. We have further checked normality by Q–Q plot presented in Appendix E.

In addition, KMO and Bartlett's test of sphericity were checked. KMO test is used to assess the sample adequacy and evaluates the correlations and partial correlations to validate whether the observations are likely to coalesce on components (Hasan, Chen 2020; Liang, Liu 2020). The measured KMO value is 0.91 and the χ^2 value is 2012.19. Since KMO value is greater than 0.70, this satisfies the level of adequacy and validity of the observations. Bartlett's test of sphericity is significant at 5% level, which is required for validation and necessary to adapt FA. PLS–SEM assessment generally follows 2 steps, the 1st step is to check the reliability and validity of the measurements and an assessment evaluate the structural model estimates in the 2nd step (Hair *et al.* 2011). Therefore, the rest of the paper is designed according to the recommendation of Hair *et al.* (2011).

4.2. CFA

SEM is a combination of CFA and path analysis (Fan *et al.* 2016; Hox, Bechger 1998). It is necessary to perform CFA for all latent constructs involved in the model before running SEM (Awang 2012) to obtain both model parameter estimates and the predicted factor scores (Liu *et al.* 2018a). In order to determine how well the predictor variables explain the direct and indirect path impacts on the outcome variable in mediation analysis, a CFA was conducted. Standardized factor loadings, model fit indices and GFI are considered to be the key statistical tools for an acceptable measurement model (Koufteros 1999).

To verify the unidimensionality of the measurement items, FA is adopted. Table 2 summarizes the result of CFA. The values of the squared multiple correlations, R^2 for all indicators except LnQTTINFRT, LnLSBC and LnMOBS, are above the recommended level of 0.50 (Bollen 1989; Koufteros 1999; Lu *et al.* 2007; Sharapiyeva *et al.* 2019). All standardized factor loadings are greater than or close to the recommended level 0.70 and statistically significant as well, although the values for 3 indicators are not up to the mark. TLI, CFI, better known as NNFI and NFI (Ainur *et al.* 2017; Bentler, Bonett 1980), RMSEA and SRMR were considered for the best model fit of CFA as well (Hox, Bechger 1998; Munim, Schramm 2018; Sharapiyeva *et al.* 2019). Both NFI and NNFI adjust for complexity of the model (Hox, Bechger 1998). If the model fits perfectly, the fitting indices should have the value 1; while the values 0.95 is recommended by Hox & Bechger (1998) and 0.90...0.95

Table 2. Summary of CFA

Construct	Indicator	Unstandardized factors loading	Standardized factor loading	Standard error	z-value	R^2
LP	LnECCP	0.157	0.90***	0.012	13.53	0.82
	LnQTTINFRT	0.255	0.55***	0.038	6.684	0.30
	LnCPS	0.114	0.84***	0.010	11.76	0.70
	LnCQLS	0.152	0.93***	0.011	14.31	0.87
	LnFS	0.105	0.84***	0.009	11.73	0.70
	LnCT	0.145	0.92***	0.101	14.01	0.86
GCI	LnGCI	0.110	0.85***	0.009	11.98	0.71
LSC	LnLSC	0.569	0.70***	0.066	8.60	0.50
	LnLSBC	0.116	0.47***	0.021	5.45	0.20
PORT	LnPORT	0.155	0.73***	0.016	9.68	0.54
	LnBBS	0.146	0.74***	0.116	9.86	0.55
	LnMOBS	0.229	0.50***	0.037	6.10	0.26
	LnNIU	0.775	0.70***	0.084	9.19	0.50
	LnTS	0.750	0.70***	0.090	8.34	0.50

Notes: CFI = 1, TLI = 1, RFI=0.94, NFI=0.99, NNFI = 1, RMSEA = 0.00, SRMR = 0.01, GFI = 0.99, MFI = 0.99; *** $p < 0.001$.

by Schermelleh-Engel *et al.* (2003). Both TLI and CFI are 1, NFI = 0.99, NNFI = 1; while RMSEA = 0.00 and SRMR = 0.01 indicate the good model fitness. RMSEA and SRMR should be less than 0.05 for the best fit (Hox, Bechger 1998). GFI and MFI are 0.99; while Bollen's RFI is 0.94, which means the estimated model predicates between 94…99% of the variance and covariance in the observed data. Finally, the result demonstrates a good fit according to the model fit indices of $\chi^2/df = 2.63 < 3$ within the required recommended level (Bollen, Long 1993).

Statistical significance of the factors loadings are examined to test for convergent validity through their z-values. Acceptable threshold levels of z-values should be greater than 2 or less than -2 as rules of thumb (Koufteros 1999). The z-values presented in Table 2 greater than 2 signifying all factors measure their respective construct and confirm the unidimensionality and convergent validity (Anderson, Gerbing 1988).

4.3. PLS–SEM path and mediation analysis

As the measurement model and the validity and reliability tests confirm the validity of the possible relationship in the system of the factors, we proceed with SEM, which follows a prioritize assessment – IPMA of the latent constructs. A consistent PLS algorithm was used to test the significance for the goodness-of-fit measures. Henseler *et al.* (2014) introduced the SRMR as a goodness of fit measure for PLS–SEM that can be used to avoid model misspecification.

The path coefficients between the latent constructs as well as their p-values (in parenthesis) and the loads of the outer model on individual latent factors are shown in Figure 3. The results show that indicators of LP, PORT, global competitiveness and LSC produce enough loads to be accepted. The loads of the 14 factors in the outer model of the latent construct (except LnQTTINFRT 0.65) are greater than 0.70 (Figure 3) and statistically significant as well. The t-values/z-values for all latent constructs are above the recommended level, t-values > 2 or t-values < 2. R^2 for LP is 0.70, which indicates that the estimated model can analyse 70% variance in the model. SRMR should be less than 0.08 for a good model fit and the NFI should be 0.90 or greater than 0.90 (Önsel Ekici *et al.* 2019). The SRMR for our estimated model is 0.06 and NFI = 0.90, those are the adequate testimony of a good model fit.

After confirming the fitness of the estimated model and outer model evaluation on individual latent constructs, we estimate the path coefficients of the hypothesized relationship as well as the significant level in the mediation analysis presented in Table 3. Before establishing mediation relationship among the indicators (hypotheses H1d, H1e, H1f, H2c), the direct path coefficients of the observed variables were measured.

According to the statistical significance of the path coefficients shown in Figure 3, the study determined the direct effects of hypotheses H1a, H1b, H1c, H2a, H2b and H3 to be accepted. Thus, LSC (LSC→LP, hypothesis H2a), global competitiveness (GCI→LP, hypothesis H1b) and PORT (PORT→LP, hypothesis H3) have positive and statistically significant impacts on LP. The effects of LSC and global competitiveness on the PORT are positive and meaningful as well.

The mediating effects of global competitiveness on LP via PORT is significant (GCI→PORT→LP, hypothesis H1e), while the mediation effect via LSC is significant too (GCI→LSC→LP, hypothesis H1d). Here again, the mediating effects of LSC on LP through PORT (LSC→PORT→LP, hypothesis H2c) and the effects of global competitiveness on LP through LSC and PORT (GCI→LSC→PORT→LP, hypothesis H1f) were statistical significant too.

In addition, AVE, composite reliability (Figure 4, Appendix H), Cronbach's α, ρ _A, VIF (Appendix F) and HTMT ratio (Appendix G) in consistent PLS–SEM algorithm were judged for model validation.

α scores of all latent constructs are above the recommended level 0.60. However, ρ is a better measure of reliability than Cronbach's α in SEM because it is based on the loadings rather than the correlations between the observed variables (Demo *et al.* 2012). Accepted level of ρ must be greater than 0.70 (Ravand, Baghaei 2016). The values of our model are higher than the accepted level (Figure 5, Appendix F). Composite reliability is also high, while the AVE for all constructs are greater than the recommended level 0.50 (Chin 1998; Fornell, Larcker 1981) demonstrated in Appendix F. Collinearity statistics (VIF) are lower than the recommended level, 10 (García *et al.* 2015; Miles 2005; O'Brien 2007). Therefore, the validity and reliability results of the latent construct incurred from PLS–SEM path analysis provide sufficient evidence for the model to be reasonably valid.

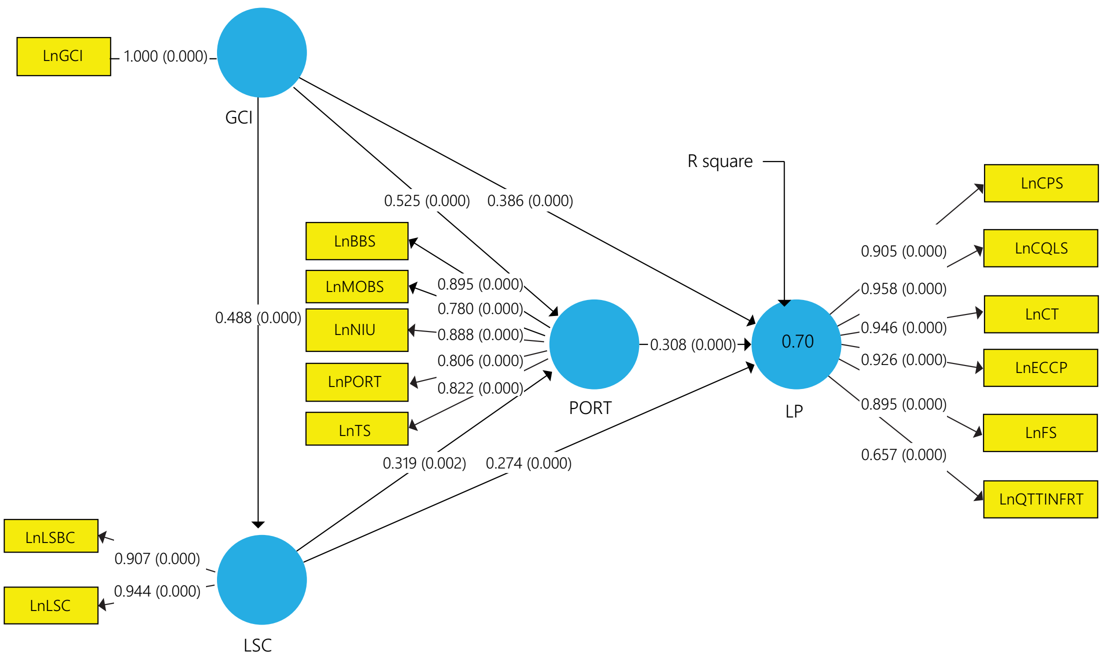

Figure 3. Result of PLS–SEM path analysis diagram with latent construct

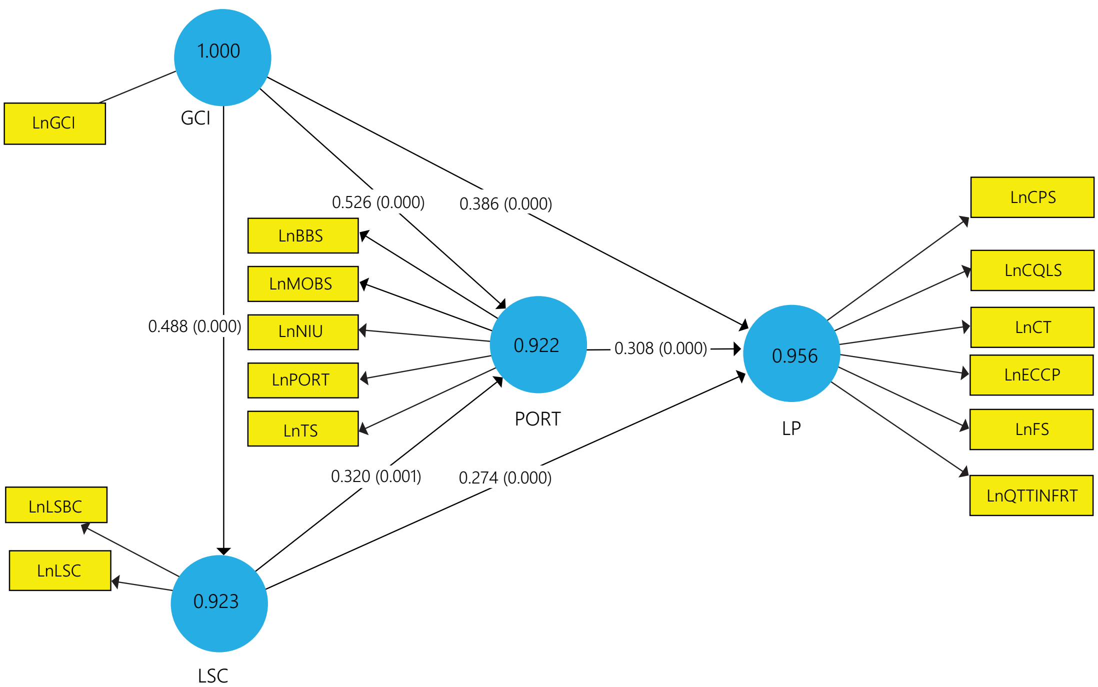

Figure 4. Composite reliability score of the model

Table 3. Result of PLS–SEM path analysis

Hypothesis	Path	Path coefficient	*t*-statistic	Standard deviation	Decision
H1a	GCI→LSC	0.488***	8.544	0.06	accepted
H1b	GCI→LP	0.386***	5.187	0.07	accepted
H1c	GCI→PORT	0.525***	5.749	0.09	accepted
H1d	GCI→LSC→LP	0.134***	4.729	0.02	accepted
H1e	GCI→PORT→LP	0.162***	4.464	0.03	accepted
H1f	GCI→LSC→PORT→LP	0.048*	2.01	0.04	accepted
H2a	LSC→LP	0.274***	5.140	0.05	accepted
H2b	LSC→PORT	0.320***	3.305	0.09	accepted
H2c	LSC→PORT→LP	0.098*	1.989	0.09	accepted
H3	PORT→LP	0.308***	3.717	0.08	accepted

Notes: NFI = 0.99, SRMR = 0.01; * $p < 0.05$, *** $p < 0.001$.

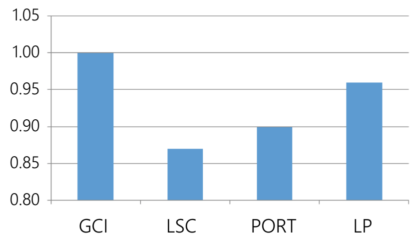

Figure 5. ρ_A of model validation

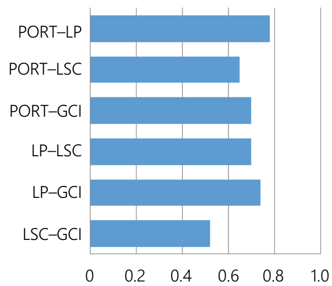

Figure 6. HTMT ratio of discriminant validity

In addition, we verified the discriminate validity, which is a prerequisite for the evaluation of PLS–SEM model (Hamid *et al.* 2017; Henseler *et al.* 2015). HTMT ratio, FLC and cross-loadings are 3 universal scales for determining the discriminate validity. HTMT ratio of correlations is a new and superior approach compared to 2 other methods (Hamid *et al.* 2017), which can achieve higher specificity and sensitivity rates (97…99%) (Henseler *et al.* 2015). HTMT ratio less than 1 is required (Figure 6) for the model to be accepted, although a threshold of 0.85 (Henseler *et al.* 2015; Kline 2023) has been suggested as rules of thumb. HTMT ratio and FLC is presented in Appendix G, and none of the score exceeds the recommended level signifying model validation.

5. IPMA

The IPMA is an extension of the PLS–SEM path model that displays the performance of each latent construct. The aim of IPMA is to sort out the most crucial factors affecting the target factor (LP) (Önsel Ekici *et al.* 2019). In this regard, the IPMA uses the importance (total effects *TE*) and the performance *P* to prioritize the factors.

The factors are ranked based on the overall score. Since the major concern of IPMA is to improve the performance of the factors those have relatively high importance but relatively low performance, the factors with lower overall scores have more importance. The factors are ranked in ascending order with respect to their overall scores (Kabak *et al.* 2020; Önsel Ekici *et al.* 2019). Importance performance score is obtained by dividing *P* by *TE* presented in Table 4 and Figure 7.

Table 4. Result of importance performance analysis

Latent construct	Performance *P*	Total effects *TE*	Performance importance *P*/*TE*	Ranking
GCI	57.32	0.729	78	1
LSC	59.70	0.373	160	2
PORT	66.34	0.308	215	3

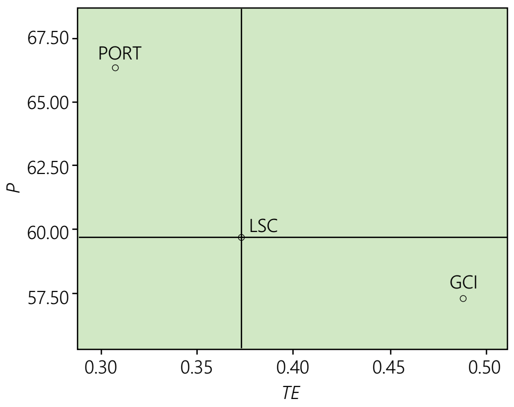

Figure 7. IPMA

6. Discussion and policy implication

A discussion on integrated results is presented in this section. We conducted this research in order to observe the impacts of LSC and global competitiveness on LP in mediation of the PORT in Asian. The development of smart LP is the demand of modern trade and economic activities, as growth in Asia largely dependent on the LP and advanced infrastructure level (Tang, Abosedra 2019). Asian countries have not yet been able to use their potential due to the lack of regional connectivity (Su *et al.* 2011). So, the study has the novelty to guide improving LP.

Path analysis in mediation of PORT has shown that shipping connectivity and global competitiveness has statistical significance and positive effects of improving LP. Empirical evidence derived from the SEM path diagram reveals that the direct and indirect effects of competitiveness and port and infrastructure accelerate operational and strategic change in LP as well, leading to increase competitiveness and yielding better connectivity. The study demonstrated that 70% variations of LP can be explained by latent factors. Therefore, PORT, global competitiveness indicators such as business sophistication, financial market development, goods market expansion, labour market efficiency, technological advancement, economic satiability and macroeconomic development have become the central theme for both developed and developing countries in Asia. Capabilities of competitively priced shipments, ability to track and trace consignments, quality transport and timeliness have changed the mode of logistics network and connectivity. Port infrastructures, performance of logistics and transportation facilities have increased bilateral trade among the nations. The loadings of all observations in the outer model have high significant values (Figure 3), which are the indications of the importance of latent factors to explain LP. Direct impacts of path coefficients of GCI→LSC (0.488^{***}), GCI→LP (0.386^{***}), GCI→PORT (0.52^{***}), LSC→LP (0.27^{***}), LSC→PORT (0.31^{***}) and PORT→LP (0.30^{***}) within the inner model are highly significant (note: *** $p < 0.001$). Again, path coefficients of the mediation effects of GCI→PORT→LP (0.16^{***}), GCI→LSC→PORT→LP (0.048^{*}), and LSC→PORT→LP (0.098^{*}) are important to be taken as dimension of the factors to be concentrated to improve LP as well (notes: * $p < 0.05$, *** $p < 0.001$).

Our findings are also similar to the study of Acar *et al.* (2015); Önsel Ekici *et al.* (2016, 2019) and Çemberci *et al.* (2015). It is clear from the analysis that LSC and global competitiveness in mediation of port infrastructure serve as the most influential factors. Results proved that shipping connectivity can connect countries, business, people and markets, enabling them to buy and sell goods on a scale; and today, it transports goods approximately one-third of the total value of global trade (WSC 2020). LSC is the most efficient mode of transportation for bilateral trade, and the most carbon-efficient mode of transportation that a single large container ship can handle over 200000 containers of cargo in a year, while an individual ship container transports as many as 10000 containers of goods in a single voyage (WSC 2020). This can minimize transportation costs, which are essential for efficient performance. This means that LP is greatly influenced by the LSC and Asian countries can focus on bilateral and integrated shipping connectivity. Again, the factors of GCI are crucial for LP in Asia, as the factors like technology, infrastructure, and labour market efficiency reduce shipment time and risk enabling consignments tracing and tracking flexibility (Chen, Hasan 2020). The flexible labour market in Asia promotes productivity and productivity leads to the development of trade- and transport-related connectivity. Extension of PLS–SEM; IPMA reveals important findings regarding latent factors. It confirms that more attention and importance should be given on GCI factors. The same result was obtained by Önsel Ekici *et al.* (2019) and Chen & Hasan (2020) highlighting technological readiness, market size, higher education and training, infrastructure and innovation to facilitate the improvement of LP. The IPMA specifies that global competitiveness factors are at the top of importance while LSC is second and the PORT stands at the end of the map. IPMA signifies that global competitiveness pillars like technological adoption assess the agility, infrastructure and connectivity brings productivity by connecting economic agents, easing distance and time, facilitating the flow of information, reducing costs, and expanding markets in global value chains. In addition, the qualities of port and infrastructure were found to be crucial in boosting LP, as port facilities constitute vital economic activity in the hinterland of coastal areas (Chen, Hasan 2020). Therefore, policy-makers must focus on the PORT and LSC to fasten and improve logistics capability.

But policy-makers in Asia need to think about vicious circle of high transport costs and low services, which discourage trade and inter-connectivity. However, the mediating role of port and infrastructure leads to smart LP, as connectivity guarantees more choice, lower costs, higher speed and frequencies and direct and indirect income for port users. In other words, Asian policy-makers can utilize the corroborated benefits of shipping connectivity and global competitiveness in mediation of PORT. Countries like Bangladesh, Sri Lanka, India, Vietnam and Pakistan need to improve governance of port authorities, strengthen private sector participation and create a more competitive environment in port sector. Obviously, the policy-makers must focus on customs procedure, infrastructure building, shipping and port services, tariffs and terminal handling charges, minimize the costs associated with delays, loss of markets, customer choices as well. Individual country should strengthen the port community system, connect landlocked countries, enhance of regional connectivity and improve the performance of container ports. Efficient use of port facilities, as well as improved scale of operations is expected to increase in South Asia. Since LSC and bilateral shipping connectivity focus on the number of ships, maximum vessel size, container-carrying capacity, number of services, and number of companies that deploy container ships in a country's ports, the policy-makers and stakeholders have to deal with a wider range of policies, processes and procedures. Their concerns in the region should be spatial planning, training skills and resources, environmental and socio-economic sustainability of supply chain.

The contributions of the study are twofold. It will theoretically expand the frontier of knowledge in logistics research in Asian region and guide policy-makers together with the government to adopt pragmatic and effective policies-cum-measures to improve LP. For practical application, the findings of the study are vital in integrating national, social and economic policies for Asia. However, this will be challenging task to implement and focus on the facilitation of technological readiness, customs procedure, expansion of market size, infrastructure building, provide higher education and training and ensure the quality of port and services at a time. IPMA will lead them to take a quicker decision where to put more efforts and ensure sustainable and resilience LP in Asia.

Concluding remarks

In the context of rapid transformation of global trade, the importance of smart LP is increasing day by day. The LP of Asian countries is getting more attention in the regional logistics-hub. This paper delineated how LP in Asian can be improved using global competitiveness indicators and LSC in mediation of PORT. The empirical evidence revealed that LP of Asia in mediation of PORT is greatly influenced by global competitiveness indicators and LSC. The analysis showed that global competitiveness indicators (as GCI) are at the top of the importance-performance map. In other words, LP can be increased if the countries pay close attention to the 12 global indicators of WEF. However, shipping connectivity among the countries as well as the PORT needs to be focused on.

The study will increase the knowledge regarding regional LP both theoretically and empirically in a system by integrating and relating validity test. Secondly, the methodology, PLS–SEM and IPMA, applied to analyse the effects of global competitiveness indicators and LSC on LP in mediation of PORT will illuminate new roads for Asian policy-makers giving suggestions to be implemented of LP development.

The integrated results of this study are not applicable to each individual country; rather it is applicable only for the combined countries having port facilities. As a further suggestion, it is possible to see individual country LP by clustering them and recommend policies to be implemented. Therefore, our future study will investigate individual country performance and rank them in accordance to their score.

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Author contributions

Chen Yan-Chun: investigation, supervision, fund collection, reviewing, editing and validation.

Mohammad Kamrul Hasan: conceptualization, design, data collection, methodology, software use, writing- original draft preparation, interpretation and visualization.

Disclosure statement

The authors confess that there is no conflict of financial, professional, or personal interest to be declared.

Appendix A. List of countries

Bangladesh	Malaysia
Bahrain	Myanmar
Cambodia	Oman
China	Pakistan
Cyprus	Philippine
Georgia	Qatar
Hong Kong*	Sri Lanka
India	Saudi Arabia
Indonesia	Thailand
Iran	Singapore
Japan	Israel
Jordan	UAE
Kuwait	Vietnam
Lebanon	

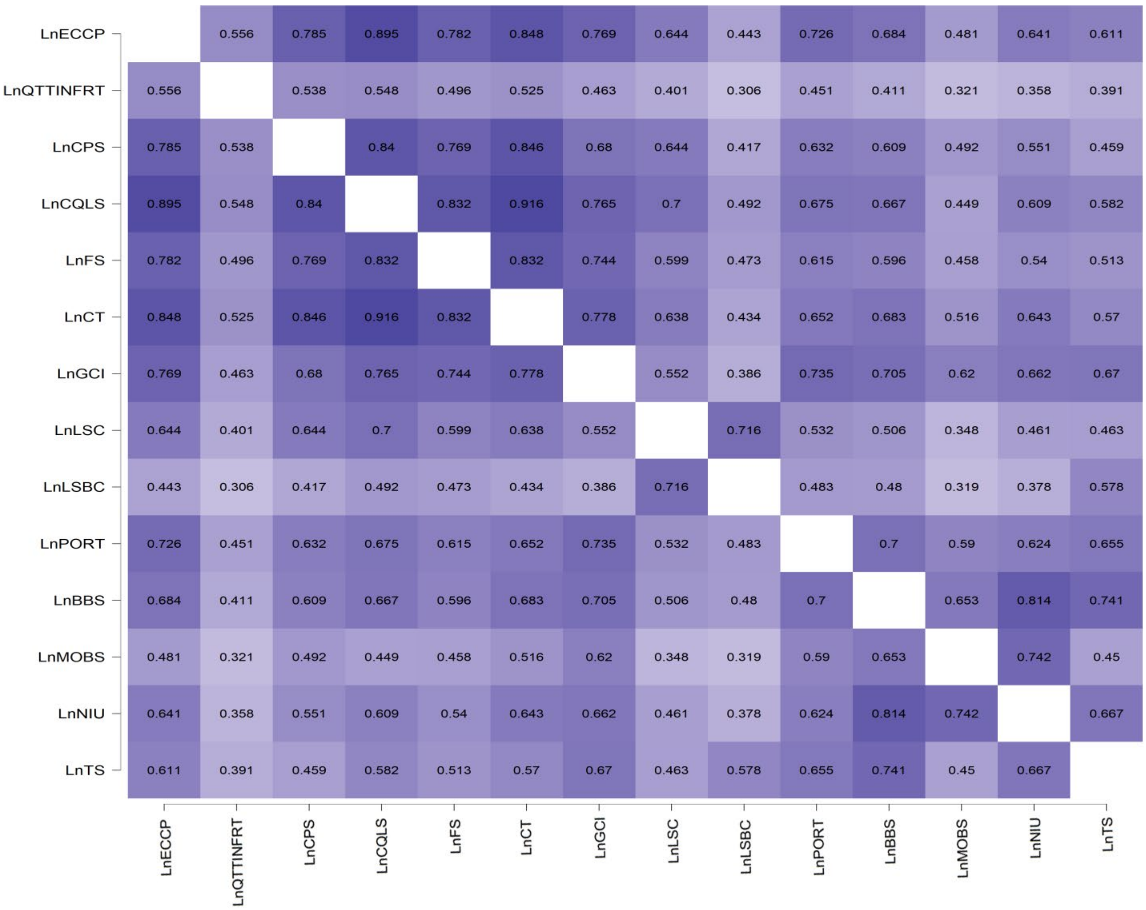
Note: * special administrative region.

Appendix B. Pearson's correlation matrix of latent variables

	LnECCP	LnQTTINFRT	LnCPS	LnCQLS	LnFS	LnCT	LnGCI	LnLSC	LnLSBC	LnPORT	LnBBS	LnMOBS	LnNIU	LNTS
LnECCP	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LnQTTINFRT	0.55***	–	–	–	–	–	–	–	–	–	–	–	–	–
LnCPS	0.78***	0.53***	–	–	–	–	–	–	–	–	–	–	–	–
LnCQLS	0.89***	0.54***	0.84***	–	–	–	–	–	–	–	–	–	–	–
LnFS	0.78***	0.49***	0.76***	0.83***	–	–	–	–	–	–	–	–	–	–
LnCT	0.84***	0.52***	0.84***	0.91***	0.83***	–	–	–	–	–	–	–	–	–
LnGCI	0.76***	0.46***	0.68***	0.76***	0.74***	0.77***	–	–	–	–	–	–	–	–
LnLSC	0.64***	0.40***	0.64***	0.70***	0.59***	0.63***	0.55***	–	–	–	–	–	–	–
LnLSBC	0.44***	0.30***	0.41***	0.49***	0.47***	0.43***	0.38***	0.71***	–	–	–	–	–	–
LnPORT	0.72***	0.45***	0.63***	0.67***	0.61***	0.65***	0.73***	0.53***	0.48***	–	–	–	–	–
LnBBS	0.68***	0.41***	0.60***	0.66***	0.59***	0.68***	0.70***	0.50***	0.48***	0.70***	–	–	–	–
LnMOBS	0.48***	0.32***	0.49***	0.44***	0.45***	0.51***	0.62***	0.34***	0.31***	0.59***	0.65***	–	–	–
LnNIU	0.64***	0.35***	0.55***	0.60***	0.54***	0.64***	0.66***	0.46***	0.37***	0.62***	0.81***	0.74***	–	–
LnTS	0.61***	0.39***	0.45***	0.58***	0.51***	0.57***	0.67***	0.46***	0.57***	0.65***	0.74***	0.45***	0.66***	–

Note: *** $p < 0.001$.

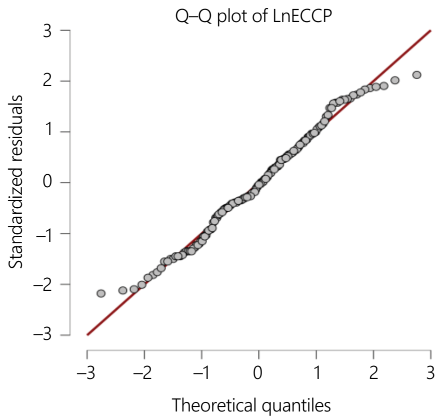
Appendix C. Pearson's heat map of the indicators

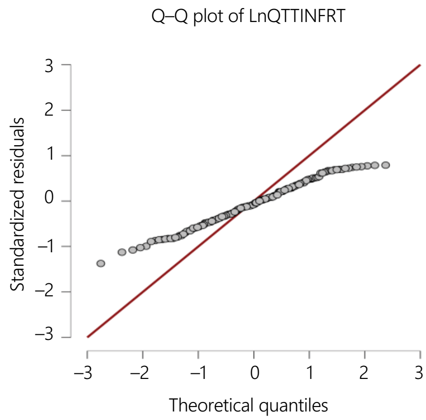


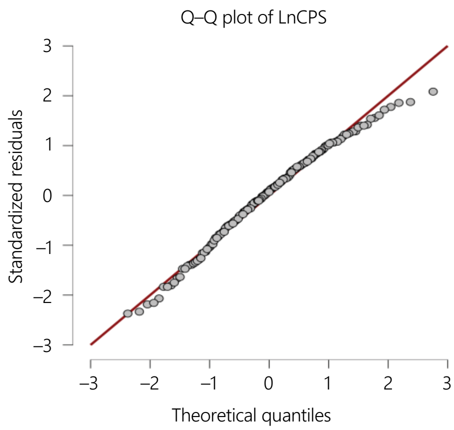
Appendix D. Descriptive statistics of variables

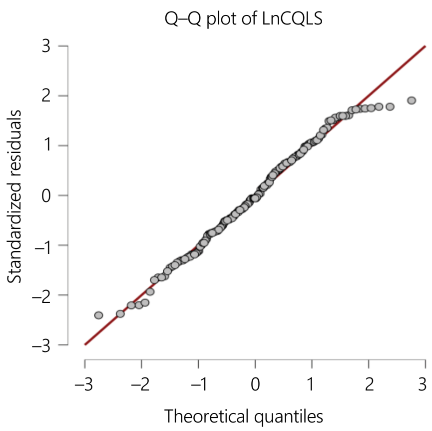
Variable	Mean	Standard deviation	Min	Max	Cronbach's α score
LnECCP	1.05	0.17	0.66	1.43	0.84
LnQTTINFRT	1.11	0.42	0.52	6.02	
LnCPS	1.11	0.15	0.55	1.43	
LnCQLS	1.10	0.17	0.69	1.44	
LnFS	1.25	0.13	0.73	1.51	
LnCT	1.13	0.17	0.45	1.45	
LnGCI	1.50	0.13	1.18	1.74	
LnLSC	3.44	0.88	1.21	5.02	
LnLSBC	–1.87	0.27	–2.56	–1.41	
LnPORT	1.48	0.22	0.88	1.48	
LnBBS	1.56	1.67	–4.34	3.73	
LnMOBS	4.59	0.72	–0.70	5.60	
LnNIU	3.47	1.20	–1.53	4.60	
LnTS	2.45	1.23	–1.29	4.14	

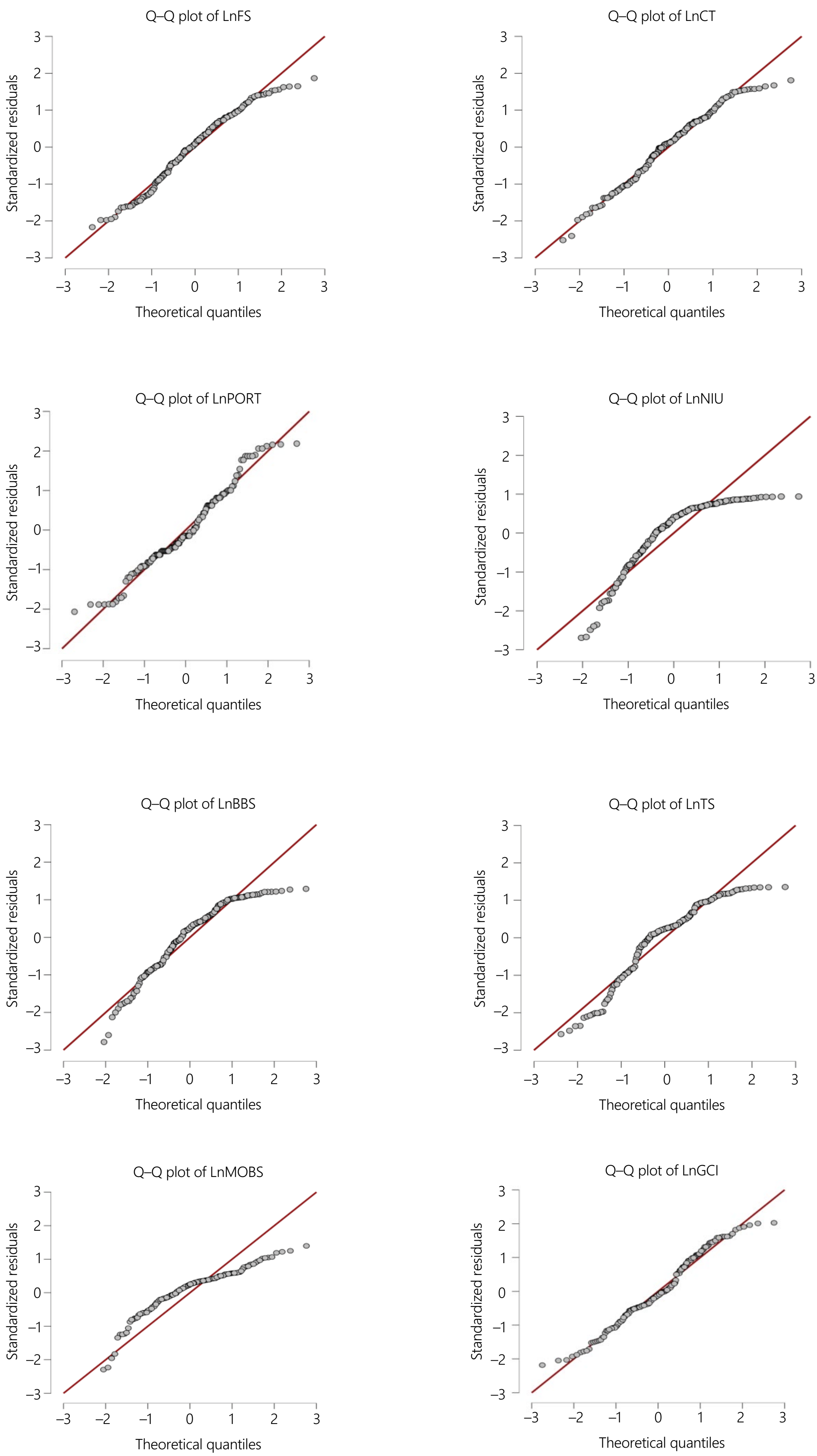
Appendix E. Q–Q plot of the variables

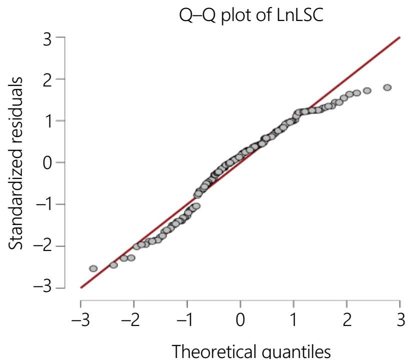


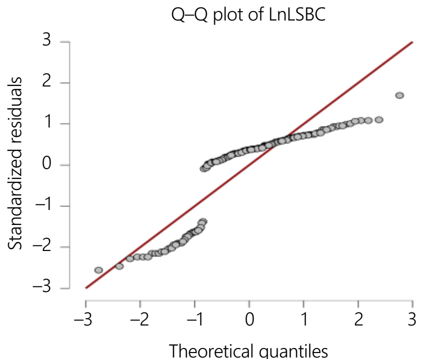







Q–Q plot of LnFS
Q–Q plot of LnCT
Q–Q plot of LnPORT
Q–Q plot of LnNIU
Q–Q plot of LnBBS
Q–Q plot of LnTS
Q–Q plot of LnMOBS
Q–Q plot of LnGCI
Standardized residuals
Theoretical quantiles
–3
–2
–1
0
1
2
3





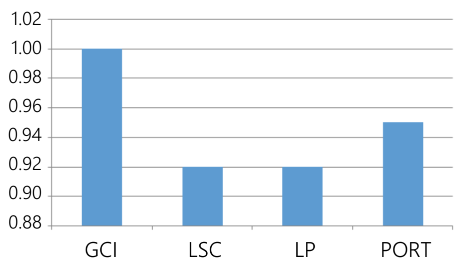
Appendix F. Construct reliability and validity results incurred from PLS–SEM path analysis

Latent construct	Cronbach's α	ρ _A	Composite reliability	AVE	VIF
GCI	1.00	1.00	1.00	1.00	> 10
LSC	0.84	0.87	0.92	0.85	
PORT	0.90	0.90	0.92	0.70	
LP	0.94	0.96	0.95	0.78	

Appendix G. HTMT ratio and FLC

	Latent construct	GCI	LSC	LP	PORT
HTMT ratio	GCI	–	–	–	–
	LSC	0.52		–	–
	LP	0.74	0.70	–	–
	PORT	0.70	0.65	0.78	–
FLC	GCI	–	–	–	–
	LSC	0.48		–	–
	LP	0.72	0.64	–	–
	PORT	0.68	0.57	0.72	–

Appendix H. Composite reliability graph



References

Acar, A. Z.; Bentyn, Z.; Kocaoğlu, B. 2015. Logistic performance development of the countries on the path along the new silk road, *European Transport \ Trasporti Europei* 59: 1. Available from Internet: http://www.istiee.unict.it/europeantransport/papers/N59/P01_59_12_2015.pdf

Ahmed, Md. T.; Khan, F. 2020. Trade logistics: a South Asian perspective, *The Financial Express*, 4 May 2020. Available from Internet: https://thefinancialexpress.com.bd/views/reviews/trade-logistics-a-south-asian-perspective-1583335280

Ainur, A. K.; Sayang, M. D.; Jannoo, Z.; Yap, B. W. 2017. Sample size and non-normality effects on goodness of fit measures in structural equation models, *Pertanika Journal of Science & Technology* 25(2): 575–586.

Anderson, J. C.; Gerbing, D. W. 1988. Structural equation modeling in practice: a review and recommended two-step approach, *Psychological Bulletin* 103(3): 411–423. https://doi.org/10.1037/0033-2909.103.3.411

Arvis, J.-F.; Ojala, L.; Wiederer, C.; Shepherd, B.; Raj, A.; Dairabayeva, K.; Kiiski, T. 2018. *Connecting to Compete 2018: Trade Logistics in the Global Economy*. World Bank. https://doi.org/10.1596/29971

Awang, Z. 2012. *A Handbook on SEM: Structural Equation Modelling Using AMOS Graphics*. 4th edition. Kelantan: University Technology MARA Press.

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. https://doi.org/10.1037/0033-2909.88.3.588

Beysenbaev, R.; Dus, Y. 2020. Proposals for improving the logistics performance index, *The Asian Journal of Shipping and Logistics* 36(1): 34–42. https://doi.org/10.1016/j.ajsl.2019.10.001

Bollen, K. A. 1989. *Structural Equations with Latent Variables*. Wiley-Interscience. 514 p.

Bollen, K. A.; Long, J. S. 1993. *Testing Structural Equation Models*. SAGE Publications. 308 p.

Bookbinder, J. H.; Tan, C. S. 2003. Comparison of Asian and European logistics systems, *International Journal of Physical Distribution & Logistics Management* 33(1): 36–58. https://doi.org/10.1108/09600030310460990

Chen, Y.-C.; Hasan, M. K. 2020. Model to improve the dimensions of logistics performance in Asian countries, *North American Academic Research* 3(7): 57–72. https://doi.org/10.5281/ZENODO.3930252

Chin, W. W. 1998. The partial least squares approach to structural equation modelling, in G. A. Marcoulides (Ed.). *Modern Methods for Business Research*, 295–336.

Clark, X.; Dollar, D.; Micco, A. 2004. Port efficiency, maritime transport costs, and bilateral trade, *Journal of Development Economics* 75(2): 417–450. https://doi.org/10.1016/j.jdeveco.2004.06.005

Cronbach, L. J. 1951. Coefficient alpha and the internal structure of tests, *Psychometrika* 16(3): 297–334. https://doi.org/10.1007/BF02310555

Çemberci, M.; Civelek, M. E.; Canbolat, N. 2015. The moderator effect of global competitiveness index on dimensions of logistics performance index, *Procedia – Social and Behavioral Sciences* 195: 1514–1524. https://doi.org/10.1016/j.sbspro.2015.06.453

Dare, T. O.; Aubyn, L. N. A.; Boumgard, T. 2019. *Analyzing, Evaluating and Improving the Logistics Performance Index (LPI) of a Country's Economy: Case Study: Nigeria, Ghana and Morocco*. MSc Dissertation No 1181. World Maritime University, Malmö, Sweden. 127 p. Available from Internet: https://commons.wmu.se/all_dissertations/1181

Demo, G.; Neiva, E. R.; Nunes, I.; Rozzett, K. 2012. Human resources management policies and practices scale (HRMPPS): exploratory and confirmatory factor analysis, *BAR – Brazilian Administration Review* 9(4): 395–420. https://doi.org/10.1590/S1807-76922012005000006

El-Sheikh, A.; Abonazel, M. R.; Gamil, N. 2017. A review of software packages for structural equation modeling: a comparative study, *Applied Mathematics and Physics* 5(3): 85–94. Available from Internet: http://pubs.sciepub.com/amp/5/3/2/

Erkan, B. 2014. The importance and determinants of logistics performance of selected countries, *Journal of Emerging Issues in Economics, Finance and Banking* 3(6): 1237–1254.

Fan, Y.; Chen, J.; Shirkey, G.; John, R.; Wu, S. R.; Park, H.; Shao, C. 2016. Applications of structural equation modeling (SEM) in ecological studies: an updated review, *Ecological Processes* 5: 19. https://doi.org/10.1186/s13717-016-0063-3

Fornell, C.; Larcker, D. F. 1981. Evaluating structural equation models with unobservable variables and measurement error, *Journal of Marketing Research* 18(1): 39–50. https://doi.org/10.2307/3151312

Fugazza, M.; Hoffmann, J. 2017. Liner shipping connectivity as determinant of trade, *Journal of Shipping and Trade* 2: 1. https://doi.org/10.1186/s41072-017-0019-5

García, C. B.; García, J.; López Martín, M. M.; Salmerón, R. 2015. Collinearity: revisiting the variance inflation factor in ridge regression, *Journal of Applied Statistics* 42(3): 648–661. https://doi.org/10.1080/02664763.2014.980789

Gonzalez-Aregall, M.; Bergqvist, R.; Monios, J. 2018. A global review of the hinterland dimension of green port strategies, *Transportation Research Part D: Transport and Environment* 59: 23–34. https://doi.org/10.1016/j.trd.2017.12.013

Gordon, J. R. M.; Lee, P.-M.; Lucas, 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. https://doi.org/10.1016/j.jsis.2004.10.001

Green, K. W.; Whitten, D.; Inman, R. A. 2008. The impact of logistics performance on organizational performance in a supply chain context, *Supply Chain Management* 13(4): 317–327. https://doi.org/10.1108/13598540810882206

Hair, J. F.; Ringle, C. M.; Sarstedt, M. 2011. PLS-SEM: indeed a silver bullet, *Journal of Marketing Theory and Practice* 19(2): 139–152. https://doi.org/10.2753/MTP1069-6679190202

Hamid, M. R. A.; Sami, W.; Sidek, M. H. M. 2017. Discriminant validity assessment: use of Fornell & Larcker criterion versus HTMT criterion, *Journal of Physics: Conference Series* 890: 012163. https://doi.org/10.1088/1742-6596/890/1/012163

Hasan, M. K.; Chen, Y.-C. 2020. Empirical study on the comparison of regional competitiveness of Asian countries in perspective of global competitiveness index, *North American Academic Research* 3(7): 33–56. https://doi.org/10.5281/ZENODO.3930242

Henseler, J.; Dijkstra, T. K.; Sarstedt, M.; Ringle, C. M.; Diamantopoulos, A.; Straub, D. W.; Ketchen, D. J.; Hair, J. F.; Hult, G. T. M.; Calantone, R. J. 2014. Common beliefs and reality about PLS: comments on Rönkkö and Evermann (2013), *Organizational Research Methods* 17(2): 182–209. https://doi.org/10.1177/1094428114526928

Henseler, J.; Ringle, C. M.; Sarstedt, M. 2015. A new criterion for assessing discriminant validity in variance-based structural equation modeling, *Journal of the Academy of Marketing Science* 43(1): 115–135. https://doi.org/10.1007/s11747-014-0403-8

Hoffmann, J.; Saeed, N.; Sødal, S. 2020. Liner shipping bilateral connectivity and its impact on South Africa's bilateral trade flows, *Maritime Economics & Logistics* 22(3): 473–499. https://doi.org/10.1057/s41278-019-00124-8

Hox, J. J.; Bechger, T. M. 1998. An introduction to structural equation modelling, *Family Science Review* 11: 354–373.

Hua, C.; Chen, J.; Wan, Z.; Xu, L.; Bai, Y.; Zheng, T.; Fei, Y. 2020. Evaluation and governance of green development practice of port: a sea port case of China, *Journal of Cleaner Production* 249: 119434. https://doi.org/10.1016/j.jclepro.2019.119434

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. https://doi.org/10.1016/j.tre.2014.10.012

Jouili, T. A. 2019. Determinants of liner shipping connectivity, *International Journal of Advanced and Applied Sciences* 6(11): 5–10. https://doi.org/10.21833/ijaas.2019.11.002

Kabak, Ö.; Önsel Ekici, Ş.; Ülengin, F. 2020. Analyzing two-way interaction between the competitiveness and logistics performance of countries, *Transport Policy* 98: 238–246. https://doi.org/10.1016/j.tranpol.2019.10.007

Kabak, Ö.; Ülengin, F.; Önsel Ekici, Ş. 2018. Connecting logistics performance to export: a scenario-based approach, *Research in Transportation Economics* 70: 69–82. https://doi.org/10.1016/j.retrec.2018.05.007

Karaman, A. S.; Kilic, M.; Uyar, A. 2020. Green logistics performance and sustainability reporting practices of the logistics sector: the moderating effect of corporate governance, *Journal of Cleaner Production* 258: 120718. https://doi.org/10.1016/j.jclepro.2020.120718

Khan, S. A. R.; Jian, C.; Zhang, Y.; Golpîra, H.; Kumar, A.; Sharif, A. 2019. Environmental, social and economic growth indicators spur logistics performance: from the perspective of South Asian association for regional cooperation countries, *Journal of Cleaner Production* 214: 1011–1023. https://doi.org/10.1016/j.jclepro.2018.12.322

Kline, R. B. 2023. *Principles and Practice of Structural Equation Modeling*. 5th edition. Guilford Press. 494 p.

Koufteros, X. A. 1999. Testing a model of pull production: a paradigm for manufacturing research using structural equation modeling, *Journal of Operations Management* 17(4): 467–488. https://doi.org/10.1016/S0272-6963(99)00002-9

Lam, J. S. L.; Yap, W. Y. 2011. Dynamics of liner shipping network and port connectivity in supply chain systems: analysis on East Asia, *Journal of Transport Geography* 19(6): 1272–1281. https://doi.org/10.1016/j.jtrangeo.2011.06.007

Liang, R.; Liu, Z. 2020. Port infrastructure connectivity, logistics performance and seaborne trade on economic growth: an empirical analysis on "21st-century maritime silk road", *Journal of Coastal Research* 106(sp1): 319–324. https://doi.org/10.2112/SI106-074.1

Lin, P.-C.; Kuo, S.-Y.; Chang, J.-H. 2020. The direct and spillover effects of liner shipping connectivity on merchandise trade, *Maritime Business Review* 5(2): 159–173. https://doi.org/10.1108/MABR-12-2019-0055

Liu, H.; Jin, I. H.; Zhang, Z. 2018a. Structural equation modeling of social networks: specification, estimation, and application, *Multivariate Behavioral Research* 53(5): 714–730. https://doi.org/10.1080/00273171.2018.1479629

Liu, J.; Yuan, C.; Hafeez, M.; Yuan, Q. 2018b. The relationship between environment and logistics performance: evidence from Asian countries, *Journal of Cleaner Production* 204: 282–291. https://doi.org/10.1016/j.jclepro.2018.08.310

Lu, C.-S.; Lai, K.-H.; Cheng, T. C. E. 2007. Application of structural equation modeling to evaluate the intention of shippers to use Internet services in liner shipping, *European Journal of Operational Research* 180(2): 845–867. https://doi.org/10.1016/j.ejor.2006.05.001

Lun, Y. H. V.; Hoffmann, J. 2016. Connectivity and trade relativity: the case of ASEAN, *Journal of Shipping and Trade* 1: 11. https://doi.org/10.1186/s41072-016-0015-1

Miles, J. 2005. Tolerance and variance inflation factor, in B. S. Everitt, D. C. Howell (Eds.). *Encyclopedia of Statistics in Behavioral Science* 4: 2055–2056. https://doi.org/10.1002/0470013192.bsa683

Munim, Z. H.; Schramm, H.-J. 2018. The impacts of port infrastructure and logistics performance on economic growth: the mediating role of seaborne trade, *Journal of Shipping and Trade* 3: 1. https://doi.org/10.1186/s41072-018-0027-0

Notteboom, T. E.; Rodrigue, J.-P. 2005. Port regionalization: towards a new phase in port development, *Maritime Policy* & *Management: the Flagship Journal of International Shipping and Port Research* 32(3): 297–313. https://doi.org/10.1080/03088830500139885

O'Brien, R. M. 2007. A caution regarding rules of thumb for variance inflation factors, *Quality* & *Quantity* 41(5): 673–690. https://doi.org/10.1007/s11135-006-9018-6

Önsel Ekici, Ş.; Kabak, Ö.; Ülengin, F. 2019. Improving logistics performance by reforming the pillars of global competitiveness index, *Transport Policy* 81: 197–207. https://doi.org/10.1016/j.tranpol.2019.06.014

Önsel Ekici, Ş.; Kabak, Ö.; Ülengin, F. 2016. Linking to compete: Logistics and global competitiveness interaction, *Transport Policy* 48: 117–128. https://doi.org/10.1016/j.tranpol.2016.01.015

Pavlic, B.; Cepak, F.; Sucic, B.; Peckaj, M.; Kandus, B. 2014. Sustainable port infrastructure, practical implementation of the green port concept, *Thermal Science* 18(3): 935–948. https://doi.org/10.2298/TSCI1403935P

Pettit, S. J.; Beresford, A. K. C. 2009. Port development: from gateways to logistics hubs, *Maritime Policy* & *Management: the Flagship Journal of International Shipping and Port Research* 36(3): 253–267. https://doi.org/10.1080/03088830902861144

Qi, G.; Shi, W.; Lin, K.-C.; Yuen, K. F.; Xiao, Y. 2020. Spatial spillover effects of logistics infrastructure on regional development: Evidence from China, *Transportation Research Part A: Policy and Practice* 135: 96–114. https://doi.org/10.1016/j.tra.2020.02.022

Rashidi, K.; Cullinane, K. 2019. Evaluating the sustainability of national logistics performance using data envelopment analysis, *Transport Policy* 74: 35–46. https://doi.org/10.1016/j.tranpol.2018.11.014

Ravand, H.; Baghaei, P. 2016. Partial least squares structural equation modeling with R, *Practical Assessment*, *Research*, *and Evaluation* 21: 11. https://doi.org/10.7275/D2FA-QV48

Rumaji, R.; Adiliya, A. 2019. Port maritime connectivity in South-East Indonesia: a new strategic positioning for transhipment Port of Tenau Kupang, *The Asian Journal of Shipping and Logistics* 35(4): 172–180. https://doi.org/10.1016/j.ajsl.2019.12.004

Sargsyan, A. 2017. Variety of approaches in assessment of global competitiveness, *International Journal of Economics* & *Management Sciences* 6(6): 479. https://doi.org/10.4172/2162-6359.1000479

Sarstedt, M.; Ringle, C. M.; Hair, J. F. 2017. Partial least squares structural equation modeling, in C. Homburg, M. Klarmann, A. Vomberg (Eds.). *Handbook of Market Research*, 1–40. https://doi.org/10.1007/978-3-319-05542-8_15-1

Schermelleh-Engel, K.; Moosbrugger, H.; Müller, H. 2003. Evaluating the fit of structural equation models: tests of significance and descriptive goodness-of-fit measures, *Methods of Psychological Research Online* 8(2): 23–74.

Schøyen, H.; Bjorbæk, C. T.; Steger-Jensen, K.; Bouhmala, N.; Burki, U.; Jensen, T. E.; Berg, Ø. 2018. Measuring the contribution of logistics service delivery performance outcomes and deepsea container liner connectivity on port efficiency, *Research in Transportation Business & Management* 28: 66–76. https://doi.org/10.1016/j.rtbm.2018.03.002

Sharapiyeva, M.; Antoni, A.; Yessenzhigitova, R. 2019. The impact of port transport-logistics infrastructure and LPI for economic growth: on the example of landlocked countries, *Pomorstvo* 33(1): 63–75. https://doi.org/10.31217/p.33.1.7

Song, L.; Van Geenhuizen, M. 2014. Port infrastructure investment and regional economic growth in China: panel evidence in port regions and provinces, *Transport Policy* 36: 173–183. https://doi.org/10.1016/j.tranpol.2014.08.003

Su, S.-I. I.; Ke, J.-Y. F.; Lim, P. 2011. The development of transportation and logistics in Asia: an overview, *Transportation Journal* 50(1): 124–136. https://doi.org/10.5325/transportationj.50.1.0124

Sy, B.; Villejo, S. J.; Lacaza, R. 2020. An analysis of the impact of ASEAN's logistics performance on trade flows using linear and non-linear methods in an augmented gravity model, *Logistics Research* 13(1): 5. https://doi.org/10.23773/2020_5

Tang, C. F.; Abosedra, S. 2019. Logistics performance, exports, and growth: evidence from Asian economies, *Research in Transportation Economics* 78: 100743. https://doi.org/10.1016/j.retrec.2019.100743

UNCTAD. 2017. *Review of Maritime Transport 2017*. United Nations Conference on Trade and Development (UNCTAD). 130 p. Available from Internet: https://unctad.org/system/files/official-document/rmt2017_en.pdf

UNCTAD. 2020. *Statistical Data*. United Nations Conference on Trade and Development (UNCTAD). Available from Internet: https://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx

Wan, C.; Zhang, D.; Yan, X.; Yang, Z. 2018. A novel model for the quantitative evaluation of green port development – a case study of major ports in China, *Transportation Research Part D: Transport and Environment* 61: 431–443. https://doi.org/10.1016/j.trd.2017.06.021

Wilmsmeier, G.; Hoffmann, J. 2008. Liner shipping connectivity and port infrastructure as determinants of freight rates in the Caribbean, *Maritime Economics & Logistics* 10(1–2): 130–151. https://doi.org/10.1057/palgrave.mel.9100195

Wilmsmeier, G.; Hoffmann, J.; Sanchez, R. J. 2006. The impact of port characteristics on international maritime transport costs, *Research in Transportation Economics* 16(1): 117–140. https://doi.org/10.1016/S0739-8859(06)16006-0

Wong, W. P.; Tang, C. F. 2018. The major determinants of logistic performance in a global perspective: evidence from panel data analysis, *International Journal of Logistics Research and Applications: a Leading Journal of Supply Chain Management* 21(4): 431–443. https://doi.org/10.1080/13675567.2018.1438377

WSC. 2020. *Benefits of Liner Shipping*. World Shipping Council (WSC). Available from Internet: https://www.worldshipping.org

Wu, W.-W.; Lan, L. W.; Lee, Y.-T. 2012. Exploring the critical pillars and causal relations within the NRI: An innovative approach, *European Journal of Operational Research* 218(1): 230–238. https://doi.org/10.1016/j.ejor.2011.10.013

Yap, W. Y.; Zahraei, S. M. 2018. Liner shipping alliances and their impact on shipping connectivity in Southeast Asia, *Maritime Business Review* 3(3): 243–255. https://doi.org/10.1108/MABR-05-2018-0018

Yeo, G.-T.; Roe, M.; Dinwoodie, J. 2008. Evaluating the competitiveness of container ports in Korea and China, *Transportation Research Part A: Policy and Practice* 42(6): 910–921. https://doi.org/10.1016/j.tra.2008.01.014

Zaman, M. B.; Vanany, I.; Awaluddin, K. D. 2015. Connectivity Analysis of Port in Eastern Indonesia, *Procedia Earth and Planetary Science* 14: 118–127. https://doi.org/10.1016/j.proeps.2015.07.092