Open Access | Original Research
International Journal of Social Sciences and Economic Review, 3(3), 2021 | PP: 13– 21
https://doi.org/10.36923/ijsser.V3i3.103

Congestion at Chittagong Seaport: Causes and Consequences. A case study in Malaysia

Redwan Ahamed Kabir[1], Khalid Helal[2]

Article History:

Received: 01-03-2021
Accepted: 17-08-2021
Publication: 30-09-2021

Cite this article as:

Kabir, R. A., Helal, K. (2021). Congestion at Chittagong Seaport: Causes and Consequences. *International Journal of Social Sciences and Economic Review*, 3(3), 13-21. doi.org/10.36923/ijsser.v3i3.103

Corresponding Author(s):

Redwan Ahamed Kabir
International Islamic University Malaysia, Jalan Gombak, 53100, Selangor, Malaysia. Email: rakabir@outlook.com

Abstract: The purpose of this study is to investigate the underlying causes of seaport congestion at Chittagong seaport, a critical gateway for international trade and a vital contributor to Bangladesh's economic growth. Seaport congestion is a pervasive issue that not only disrupts the flow of goods but also hampers the economic progress of nations reliant on efficient trade operations. To achieve the study's objectives, a survey-based research design was employed, utilizing convenience sampling to collect data from port employees. The data were analyzed using the SmartPLS 3.2.1 software, focusing on the Importance-Performance Matrix Analysis (IPMA) to identify key factors contributing to congestion. The findings reveal that information technology, equipment, and time management are the most significant factors influencing congestion at the port. The study concludes that enhancing the use of information technology and upgrading cargo-handling equipment are essential steps for reducing congestion. Furthermore, the study highlights the need for a holistic approach involving all stakeholders to improve the operational efficiency of the Chittagong seaport and, consequently, bolster the country's trade growth. The implications of this study are far-reaching, offering valuable insights for policymakers, port authorities, and industry stakeholders aiming to optimize seaport operations and support sustainable economic development.

Keywords: Seaport; Congestion; Partial least square-structural equation model; Equipment; IPMA; Chittagong

1. Introduction

International trade is crucial to global development, and seaports play a pivotal role in facilitating this trade by handling millions of cargo containers annually (Islam & Haider, 2016). Seaports are central to global trade, offering the most cost-effective means of transporting goods between countries via sea routes (Notteboom, 2006). Approximately one-third of global trade is conducted through sea routes, with seaports serving as the primary hubs for today's international trade (Zhang, Loh & Van Tahi, 2015). The highly competitive global environment necessitates a high level of efficiency from seaports.

Vessel delays are an inevitable aspect of global trade, influenced by a variety of factors that contribute to congestion at seaports (Nyema, 2014). Common causes of delays include ship accidents, fire incidents, and ship groundings (Lu, Shang & Lin, 2016). However, numerous factors beyond the control of shipping companies also contribute to seaport congestion (Welvarrts, 2017). These factors include operational inefficiencies, inadequate port infrastructure, capacity constraints, a lack of digitalization, and insufficient banking and insurance systems (Jeevan, Ghaderi, Bandara, Saharuddin, & Othman, 2015). Economic development is closely linked to robust infrastructure and connectivity, which enhance cooperation among partner countries and maximize benefits for developing nations (Jiang, Wan & Zhang, 2016). Seaport congestion, characterized by queuing and delays that extend the voyage time of freight-carrying ships, has significant negative consequences for logistics and supply chains (Yeo, Roe & Soak, 2007). These delays result in costs related to the loss of timely delivery, financial penalties, and other monetary losses due to breaches of trade and shipping agreements (Meersman et al., 2012).

Seaports are particularly critical to Bangladesh's trade, with 87% of the country's trade being handled by seaports, and the Chittagong seaport managing the majority of agricultural imports and exports (Islam & Haider, 2016). One of the major challenges faced by these seaports is the lack of deep-sea facilities. Chittagong seaport, in particular, suffers from inadequate infrastructure to handle the increasing volume of containers (Welvaarts, 2017). Despite development plans, the port still significantly lacks the necessary jetties, yard space, and equipment to manage the growing container traffic. With only 19 active docks, the port can accommodate only 15-16 vessels per day, leading to excessive waiting times (Islam & Haider, 2016). The shortage of gantry cranes has also been frequently highlighted. The Chittagong port has experienced severe congestion on multiple occasions, with reports often blaming importers, clearing agents, and forwarding agents for delays in the timeline

[1],[2] International Islamic University Malaysia, Jalan Gombak, 53100, Selangor, Malaysia. Email: rakabir@outlook.com

(Welvaarts, 2017). However, port authorities also face challenges in expanding jetties, yards, and other operational infrastructure.

2. Literature Review

2.1. Seaport Operations & Congestion

Transportation of trade goods by sea remains the most common mode of global trade today. The shipping industry adheres to international maritime standards, which recognize seaports as gateways to international trade. Seaports serve as focal points for the movement of goods by land, utilizing rail and road networks. They also initiate commercial activities such as banking services, freight forwarding, and clearing, all of which boost economic activities. Seaports act as hubs of distribution where goods are consolidated and cargo services generate trade value. Effective port operations are crucial for multiplying economic activities and creating jobs (Jeevan et al., 2015; Nyema, 2014).

Moreover, port operations help control the movement of goods in and out of a country. Customs authorities manage these movements according to the prevailing laws and regulations (Luo & Yip, 2013). Documentation plays a critical role in facilitating the movement of goods, thereby supporting the country's economic activities and providing a source of revenue for governments (Islam & Haider, 2016). Seaports also facilitate the loading and unloading of goods containers, docking of ships, and temporary storage of goods (Nyema, 2014).

Port congestion refers to delays or extended queuing times experienced by cargo ships at seaports, which increase the overall voyage and docking time (Jiang et al., 2016). Key indicators of port congestion include ship waiting times to dock, operational delays, storage delays, and the total transactional time from import to customer delivery (Nazemzadeh & Vanelslander, 2015). Port congestion imposes significant costs on logistics, supply chains, and the environment (Luo & Yip, 2013).

2.2. Factors Causing Congestion Seaport

Seaport congestion is a global issue affecting many ports. Several key factors contribute to this problem. One major issue is the shortage of ship berths, which are the areas where ships dock to load or unload containers (Yeo et al., 2007). Limited berth capacity increases the waiting time for ships to dock. Additionally, delays in loading or unloading containers, termed "ship work congestion," further exacerbate the issue (Nyema, 2014). Inefficient labor and outdated equipment also contribute to congestion at seaports (Luo & Yip, 2013). In some cases, mismanagement or accidental blockage of seaport entry or exit routes can lead to queuing or bunching of ships, forcing them to overstay in port facilities.

Other factors contributing to seaport congestion include industrial actions by port labor, lack of equipment, delays in documentation, and insufficient storage capacity (Meersman et al., 2012). Corruption is another significant issue, particularly at the Chittagong port, where bribery is a common practice to expedite goods clearance. Political interference through labor unions further complicates port operations, leading to delays and, in some cases, halting operations altogether (Mahmud & Rossette, 2007; Islam & Haider, 2016). Incompetent management and unethical practices by labor, such as damaging containers for parties unwilling to offer bribes, also contribute to inefficiencies (Islam & Haider, 2016).

Infrastructure insufficiencies present a significant hurdle for seaport operations. The limited container handling capacity restricts optimal port operations and contributes to congestion (Yeo et al., 2007). Additionally, operational inefficiencies stem from factors such as outdated equipment, inefficient labor, and bureaucratic red tape within government agencies handling cargo. Sustainable growth in seaport operations is only achievable through consistent cooperation among stakeholders (Lu et al., 2016).

Port congestion is a universal phenomenon primarily associated with increased waiting times due to ports operating beyond their capacity (Nazemzadeh & Vanelslander, 2015). For example, the Canadian west coast faces congestion issues primarily due to increased shipments from Asia, leading to challenges in goods transportation (Ke, Li & Hipel, 2012). Key issues include a shortage of terminals and labor. Insufficient rail and road infrastructure also contribute to congestion as trade volumes increase, but expansion efforts have not kept pace (Nyema, 2014). Strategic port expansion and improvements in operational efficiency are necessary to reduce congestion.

2.3. Equipment

Cargo handling equipment is essential for seaport operations. This equipment includes cranes, forklifts, and trucks, which are used to load and unload cargo containers from ships and move them within the port (Welvaarts, 2017). Effective port operations rely heavily on the availability and condition of this equipment (Gidado, 2015). Cranes, in particular, play a crucial role in loading and unloading containers, while forklifts assist in moving and stacking them. A lack of proper equipment can significantly reduce a port's operational efficiency. Therefore, the following hypothesis is proposed:

Hypothesis (H1): *Port equipment has a positive and significant effect on perceptions of port congestion.*

2.4. Infrastructure

Operating a port beyond its infrastructure capacity is a primary cause of congestion (Moon, 2018). The value chain at the port level depends on the availability of adequate infrastructure, including land, storage space, cargo transfer facilities, and container handling capacity (Nazemzadeh & Vanelslander, 2015). Congestion arises when a port attempts to operate beyond its available capacity (Nyema, 2014). Strategic investments in infrastructure are necessary to enhance the port's handling capacity and overall operational performance (Meersman et al., 2012). Seaports play a critical role in creating value for traders, and insufficient infrastructure significantly reduces their efficiency. Therefore, the following hypothesis is proposed:

Hypothesis (H2): *Infrastructure has a positive and significant effect on perceptions of port congestion.*

2.5. Information Technology

Information technology plays an increasingly important role in all aspects of life, including port operations. It not only facilitates smooth port operations but also aids in future planning (Nyema, 2014). Research shows that operational inefficiencies due to a lack of information technology in terminal operations can lead to port congestion (Kia, 2000). Information technology is crucial for traffic management and for coordinating the entry and exit of ships at ports (Moon, 2018). The right investment in information technology benefits all seaport stakeholders and significantly improves the sustainability of port operations (Lu et al., 2016). Therefore, the following hypothesis is proposed:

Hypothesis (H3): *Information technology has a positive and significant effect on perceptions of port congestion.*

2.6. Labour

The way a seaport organizes and manages its labor force can significantly impact its performance and competitiveness (Aryee, 2011). Skilled and well-equipped labor ensures smooth port operations and promotes timely services. Labor is a vital operational component of seaport activities, particularly in vessel and yard operations (Jiang et al., 2016). Efficient labor practices contribute to high service quality, benefiting both the port and its stakeholders (Nyema, 2014). Therefore, the following hypothesis is proposed:

Hypothesis (H4): *Labour has a positive and significant effect on perceptions of port congestion.*

2.7. Time

Time is a critical factor in logistics, and the timely movement of goods can significantly impact the cost of container movement (Moon, 2018). Ports are central to the movement of goods from shippers to consignees and play a crucial role in cargo interchange and logistics operations (Jeevan et al., 2015). Reliable and efficient port operations reduce the time and cost of cargo movement, ensuring timely delivery of services (Nyema, 2014). Time delays in port logistics can lead to significant congestion (Moon, 2018). Therefore, the following hypothesis is proposed:

Hypothesis (H5): Time has a positive and significant effect on perceptions of port congestion.

2.8. Customs

The Customs department plays a vital role in administering a country's international trade. Competent and efficient customs authorities ensure compliance with national laws and international trade regulations (Moon, 2018). At the Chittagong port, customs authorities are responsible for the clearance and release of goods according to standard operating procedures (Islam & Haider, 2016). However, undue influence from stakeholders can delay the clearance process (Mahmud & Rossette, 2007). Revising customs rules and procedures can facilitate timely goods clearance, reducing congestion at seaports (Lu et al., 2016). Therefore, the following hypothesis is proposed:

Hypothesis (H6): *Customs authorities have a positive and significant effect on perceptions of port congestion.*

3. Research Methodology

This study employed a cross-sectional design and a quantitative approach to analyze factors influencing congestion at the Chittagong seaport. Data were collected through a structured survey administered to various seaport stakeholders. The collected data were analyzed using the Statistical Package for Social Science (SPSS) for fundamental analysis, and Partial Least Squares Structural Equation Modeling (PLS-SEM) was used for hypothesis testing.

3.1. Sample Size

The target population for this study comprised stakeholders of the Chittagong Seaport, including employees, workers, shipping agents, customs officers, and freight forwarding agents. G*Power 3.1 software was used to calculate the required sample size, with a power of 95% and six predictors, yielding a sample size of 146 for medium effect size. An interview-based survey was conducted to collect data from the sample. In total, data from 260 respondents were utilized for the final analysis.

2.3. Research Instrument

The questionnaire was designed in both English and Bangla languages to accommodate the respondents. Questions targeting the factors causing congestion—such as equipment, infrastructure, information technology, labor unions, time, and customs—were adapted from previous literature and dissertations. Specifically, items related to equipment, infrastructure, and customs were adopted from Nyema (2014) and Nazemzadeh & Vanelslander (2015). The items for information technology were supported by Kia (2000), while those concerning labor unions were affirmed by Aryee (2011). Additionally, time-related factors were explained by Moon (2018). A five-point Likert scale (ranging from "strongly disagree" to "strongly agree") was used for the dependent variable, as well as for all the independent variables.

Table 1*:* Construct No. of items and sources

Variable	Items	Source
Equipment	5	Nazemzadeh & Vanelslander (2015) & Nyema (2014).
Infrastructure	6	Nazemzadeh & Vanelslander (2015) & Nyema (2014).
Information Technology	1	Kia & Shayan & Ghost (2000)
Labour union	1	Aryee (2011)
Time	3	Moon (2018)
Customs	4	Nazemzadeh & Vanelslander (2015) & Nyema (2014).
Congestion	1	Meersman et al., (2012)

Source: By the author

2.4. Assessment Of Common Method Variance (CMV)

In social science research, traditional approaches to data collection can sometimes introduce bias, leading to common method variance (CMV) issues (Podsakoff, Mackenzie, Lee, & Podsakoff, 2003). To assess the potential impact of CMV on the research constructs, Harman's (1976) one-factor test was employed. The results suggested that CMV was not a significant issue for this analysis, as the single factor extraction accounted for only about 28 percent of the variance, which is well below the proposed threshold of 50 percent.

2.5. Multivariate Normality

Testing for multivariate normality is essential when employing Structural Equation Modeling using Partial Least Squares (PLS-SEM), as it is a non-parametric statistical tool (Hair, Risher, Sarstedt, & Ringle, 2019). Following the advice of Peng and Lai (2012), an online tool called Web Power was used to confirm data normality. The test results indicated that the data set was non-normal, as the Mardia coefficient p-values were less than 0.05 (Cain, Zhang, & Yuan, 2017).

2.6. Data Analysis Method

The data collected from the respondents were analyzed using the Partial Least Squares Structural Equation Modeling (PLS-SEM) technique with the SmartPLS 3.1 software. PLS-SEM is a multivariate exploratory method for analyzing relationships between latent constructs (Hair et al., 2019). PLS-SEM allows researchers to work with non-normal and restricted data, making it suitable for complex analyses that do not require goodness-of-fit calculations as seen in covariance-based SEM (Chin, 2010).

The analysis in PLS-SEM was conducted in two phases. The first phase involved model estimation, where the reliability and validity of the research constructs were tested (Hair et al., 2019). The model quality was assessed using both traditional and newly developed approaches (Fornell & Larcker, 1981; Henseler et al., 2015). The second phase involved evaluating the correlations between the models and conducting systemic testing of the study model. The analysis used R^2, Q^2, and effect size f^2 to explain the changes in endogenous constructs caused by exogenous variables (Hair et al., 2019).

Importance-Performance Matrix Analysis (IPMA) was used to identify the exogenous model constructs that are comparatively high or low in importance and performance concerning the endogenous constructs (Chin, 2010). IPMA helps define and distinguish the structural aspects that can maximize the output of the endogenous construct from both management and academic perspectives. The analysis draws on the cumulative impact of the rescaled variable scores (Ringle & Sarstedt, 2016), where rescaling is defined as a score between 0 and 100 for each exogenous latent variable. The mean score of the exogenous latent variable represents the performance of the endogenous latent construct, where 0 indicates the minimum, and 100 indicates the maximum impact of the endogenous construct in terms of efficiency (Hair et al., 2019).

3. Data Analysis

3.1. Descriptive Statistics

The study collected data from individuals working as employees, terminal operators, or clearing and forwarding agents at the Chittagong seaport in Bangladesh. Among the respondents, 37.4% were between the ages of 20-29, 30.4% were between 30-39, 18% were between 40-49, and the remaining were 50 years or older. The majority of respondents, 48.1%, held a college degree, while 21.9% had a university degree. Respondents with primary and secondary school education accounted for 13.5% and 12.7%, respectively.

Regarding work experience, 42.7% of respondents had 1-4 years of experience, 39.6% had 5-10 years of experience, and the remaining respondents had more than 10 years of experience. Most respondents, 60%, were full-time employees, while part-time and contractual workers accounted for 17.3% and 22.6%, respectively. The data were collected from a representative sample of various occupations working at the seaport.

Table 2: Profile of the Respondents

	n	%		n	%
Education			**Age**		
Primary	35	13.5	20- 29 years of age	97	37.4
Secondary	33	12.7	30-39 years of age	79	30.4
Degree	125	48.1	40-49 years of age	47	18.0
University	57	21.9	50 and above of age	37	14.2
Total	260	100	Total	260	100
Work Experience			**Occupation**		
1-4 years	111	42.7	C&F agents	66	25.4
5-10 years	103	39.6	Labour union	65	25.0
11 years or more	46	17.6	Terminal Operator	64	24.6
Total	260	100	Freight forwarders	65	25.0
			Total	260	100
Jobs					
Full time	156	60			
Part-time	45	17.3			
Contract basis	59	22.6			
Total	260	100			

Source: Calculated by the author.

3.2. Validity And Reliability

Following the recommendations of Hair et al. (2019), we conducted and reported the SmartPLS results for the study's constructs. The reliability of the study's constructs was estimated using composite reliability (CR). The results indicate that all CR scores fall within the acceptable range, with the minimum value (CR) being 0.717 for the infrastructure construct. These results are reported in Table 2 and suggest that the model constructs are reliable.

To establish convergent validity, the Average Variance Extracted (AVE) for all constructs must exceed the threshold of 0.50, indicating the unidimensionality of each construct (Hair et al., 2019). The variance inflation factor (VIF) values for each construct, also reported in Table 2, are all less than 3.3, confirming the absence of multicollinearity issues among the model constructs. The results demonstrate that the constructs have acceptable convergent validity (see Table 2). Item loading and cross-loading analyses were conducted to validate the constructs' discriminant validity, and the results indicate that the study constructs have acceptable discriminant validity (see Table 3).

Additionally, the Fornell-Larcker criterion (1981) and the Heterotrait-Monotrait (HTMT) ratio test were utilized to confirm the discriminant validity of the study constructs. According to the Fornell-Larcker criterion, a construct must have a higher correlation with its own indicators than with other latent constructs to establish discriminant validity (Hair et al., 2019). The HTMT ratio should be less than 0.85 to provide evidence of discriminant validity (Henseler et al., 2015). The results in Table 3 confirm that the study has achieved discriminant validity.

Table 3: Reliability analysis

Variables	Number of Items	Composite Reliability	Average Variance Extracted	*Variance Inflation Factor*
Equipment	4	0.773	0.631	1.745
Infrastructure	2	0.717	0.560	1.910
Information Technology	1	1.000	1.000	2.096

Labour	1	1.000	1.000	1.721
Time	1	0.705	0.556	1.284
Customs	2	0.767	0.622	-
Port Congestion	1	1.000	1.000	

Source: By the author

Table 4: Outer Loading and Cross Loadings

	EQP	INS	ITN	LBR	TME	CUS	PCP
Fornell-Larcker Criterion							
EQP	0.794						
INS	0.066	0.748					
ITN	-0.005	0.118	1.000				
LBR	0.225	-0.112	-0.094	1.000			
TME	0.138	0.002	-0.089	-0.070	0.745		
CUS	-0.108	-0.041	0.078	0.161	-0.236	0.789	
PCP	0.156	-0.124	0.010	0.401	-0.272	0.215	1.000
Heterotrait-Monotrait Ratio (HTMT)							
EQP	-						
INS	0.850	-					
ITN	0.100	0.247	-				
LBR	0.670	0.247	0.094	-			
TME	0.499	0.171	0.146	0.148	-		
CUS	0.247	0.305	0.125	0.256	0.664	-	
PCP	0.236	0.236	0.010	0.401	0.341	0.343	-

Note: EQP: Equipment; INS: Infrastructure; ITN: Information Technology; LBR: Labour; TME: Time; CUS: Customs; PCP: Port Congestion.

3.3. Path Analysis

After confirming the model's validity and reliability, the model measurement phase was completed. This phase assessed the impact of factors such as entertainment, interaction, trendiness, and customization on value equity, relational equity, and brand equity. The adjusted R^2 value for the six exogenous constructs (i.e., equipment, infrastructure, information technology, labor, time, and customs) explains 23.6 percent of the variance in perceived port congestion.

Table 5: Hypothesis testing

Hypothesis		Coefficient	t-values	Sig.	r^2	f^2	Decision
H1	EQP ➔ PCP	0.134	2.905	0.002		0.022	*Supported*
H2	INS ➔ PCP	-0.093	1.443	0.075		0.011	Not Supported
H3	ITN ➔ PCP	0.023	0.458	0.323		0.001	Not Supported
H4	LBR ➔ PCP	0.327	4.978	0.000		0.127	*Supported*
H5	TME ➔ PCP	-0.238	4.014	0.000		0.070	*Supported*
H6	CUS ➔ PCP	0.115	2.036	0.021	0.253	0.016	*Supported*

Note: EQP: Equipment; INS: Infrastructure; ITN: Information Technology; LBR: Labour; TME: Time; CUS: Customs; PCP: Port Congestion.

The standardized path values, t-values, and significance levels are depicted in Table 4. The path coefficient between equipment (EQP) and perceived port congestion (PCP) ($\beta = 0.134$, $p = 0.002$) indicates a significant and positive effect of EQP on PCP, providing statistical support to accept H1. The path coefficient for infrastructure (INS) and PCP ($\beta = -0.093$, $p = 0.075$) shows a negative but insignificant impact of INS on PCP, providing no statistical support for H2. The path coefficient for information technology (ITN) and PCP ($\beta = 0.023$, $p = 0.323$) is positive but non-significant, thus offering no statistical support for H3. The influence of labor (LBR) on PCP ($\beta = 0.327$, $p = 0.000$) is positive and significant, providing statistical evidence to support H4. The path coefficient between time (TME) and PCP ($\beta = -0.238$, $p = 0.000$) indicates a significant negative effect of TME on PCP, providing no statistical support to accept H5. Finally, the path coefficient for customs (CUS) and PCP ($\beta = 0.115$, $p = 0.021$) indicates a positive and significant effect of CUS on PCP, supporting H6. Path coefficients are shown in Table 4.

3.4. Importance-Performance Matrix Analysis (Ipma)

The outcomes of the IPMA, revealed in Table 5, show that information technology (ITN) is the most crucial factor for the performance of perceived port congestion (PCP), with a score of (0.084; 80.00). The second most crucial factor is equipment (EQP), with a score of (0.700; 61.709). The third most important factor is time (TME), with a score of (-0.559; 59.784). The fourth factor is customs (CUS), with a score of (0.380; 38.431). The fifth most significant factor is labor (LBR), with a score of (0.463; 37.051). Lastly, the sixth most significant factor is infrastructure (INS), with a score of (-0.275; 35.324).

Table 6: Importance-Performance Matrix

Target Construct	PCP	
Variables	Total Effect	Performance
EQP	0.700	61.709
INS	-0.275	35.324
ITN	0.084	80.000
LBR	0.463	37.051
TME	-0.559	59.784
CUS	0.380	38.431

Note: EQP: Equipment; INS: Infrastructure; ITN: Information Technology; LBR: Labour; TME: Time; CUS: Customs; PCP: Port Congestion.

4. Discussion

The study results provide strong support for the argument that equipment, infrastructure, information technology, labor, time, and customs are critical contributors to port congestion as perceived by various stakeholders at the Chittagong seaport. The effect of labor ($f^2 = 0.127$) on perceived port congestion (PCP) is significant and medium-sized. Equipment ($f^2 = 0.022$) and time ($f^2 = 0.070$) also have a small but significant effect on PCP. These findings align with Knemeyer (2006), who emphasized the importance of labor efficiency in seaport operations, noting that inefficiency in labor can lead to congestion. Similarly, the study corroborates Gidado (2015), who highlighted that adequate equipment is crucial for optimal seaport performance, with the lack of equipment at Chittagong seaport significantly contributing to congestion. Additionally, inefficiencies caused by multiple factors increase the time required for seaport operations, particularly for clearing goods, as reported by Jeevan et al. (2015), who found that inefficiency at seaports prolongs cargo processing times and leads to congestion.

Moreover, the effects of infrastructure ($f^2 = 0.011$), information technology ($f^2 = 0.001$), and customs ($f^2 = 0.016$) on PCP are less than small (Cohen, 1988). The study's findings are consistent with those of Yeo et al. (2007), who reported that port operations are significantly impacted by infrastructure capacity, with inadequate infrastructure leading to congestion as the port's handling capacity remains below the volume of containers arriving or departing. The role of customs authorities in causing congestion is also highlighted, particularly at Chittagong seaport, where information technology plays a significant role in addressing congestion. These findings align with Lu et al. (2016), who emphasized that information technology can facilitate seaport operations and help reduce congestion. Furthermore, customs staff can influence seaport operations, sometimes contributing to congestion. This observation is in line with Zhang et al. (2015), who stressed the importance of vigilant customs staff in facilitating smooth seaport operations. Efficient seaport operations are crucial for the country's trade and industry, making it imperative for customs staff to actively work towards reducing congestion rather than contributing to it.

The Importance-Performance Matrix Analysis (IPMA) results reveal that the three most significant factors affecting PCP at Chittagong seaport are information technology (ITN), equipment (EQP), and time (TME). Identifying these factors is essential for tracking and addressing them to ensure smooth seaport operations.

5. Conclusion

Seaports Seaports serve as vital hubs for trade and commerce between countries. However, inefficiency and undercapacity are common issues that lead to seaport congestion. The performance of seaport operations reflects the efficiency of a nation's economy (Nyema, 2014), with efficiency becoming a key measure of trade performance. Multiple factors contribute to seaport congestion, and only multilateral and cohesive policy guidelines can enhance operational efficiency at seaports.

Effective policymaking, in collaboration with stakeholders, can improve seaport operations. Port authorities need to work closely with customs officials and labour unions to streamline operations and enhance port capacity through investments in equipment and infrastructure. In the era of technology, information technology can facilitate ship movements and cargo handling at ports. Investing in information technology benefits seaports in multiple ways, aiding both freight forwarders and customers. Enhanced use of information technology reduces the undue influence of customs officials and limits labour union manipulation. By strengthening the role of information technology, perceptions of seaport congestion can be significantly reduced.

6. Implications and limitaions

The implications of this study are significant for policymakers, port authorities, and stakeholders involved in seaport operations. By identifying key factors such as equipment, labor, time management, and the role of information technology as crucial contributors to seaport congestion, the study provides actionable insights that can inform targeted interventions to enhance operational efficiency at ports. Policymakers can use these findings to develop comprehensive strategies that address infrastructure deficiencies, improve labor efficiency, and leverage technology to streamline processes, ultimately reducing congestion and boosting the overall performance of seaports. Furthermore, the study underscores the importance of collaboration between port authorities, customs officials, and labor unions in fostering a more efficient and less congested port environment. These insights not only contribute to the smoother functioning of Chittagong seaport but also offer lessons that can be applied to other ports facing similar challenges, thereby supporting the broader goal of improving global trade logistics and economic development

Despite its strengths, this study has certain limitations. First, data were collected cross-sectionally from different stakeholders at Chittagong seaport. A longitudinal study involving data collection from various sources would provide deeper insights and broader generalizability. Second, the study focuses solely on one seaport. Investigating the same issues at other seaports would help generalize the factors causing congestion. Third, the sample selection could be expanded to include other seaport management teams and use focus groups to explore the sources of congestion from a management perspective. Triangulating these arguments would provide a more comprehensive view of the realities related to congestion at Chittagong seaport. Additionally, future research should explore the sustainability of seaports concerning the triple bottom-line paradigm.

Acknowledgement Statement: The authors would like to thank all participants and the reviewers for providing comments in helping this manuscript to completion.

Conflicts of interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding statements: This research has not received any funding.

Data availability statement: Data is available at request. Please contact the corresponding author for any additional information on data access or usage.

References

Aryee, J. (2011). Analysis of the role of port labour systems and reforms on the competitiveness of West Africa ports. *SSRN*. https://doi.org/10.2139/ssrn.2625137

Cain, M. K., Zhang, Z., & Yuan, K. H. (2017). Univariate and multivariate skewness and kurtosis for measuring nonnormality: Prevalence, influence, and estimation. *Behavior Research Methods, 49*(5), 1716-1735. https://doi.org/10.3758/s13428-016-0814-1

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

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/10.1177/002224378101800104

Gidado, U. (2015). Consequences of port congestion on logistics and supply chain in African ports. *Developing Country Studies, 5*(6), 160-167.

Hair, J. F., Risher, J. J. R., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review, 31*(1), 2-24. https://doi.org/10.1108/EBR-11-2018-0203

Harman, H. H. (1976). *Modern factor analysis* (3rd ed.). University of Chicago Press.

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

Islam, M. A., & Haider, M. Z. (2016). Performance assessment of Mongla seaport in Bangladesh. *International Journal of Transportation Engineering and Technology, 2*(2), 15-21.

Jeevan, J., Ghaderi, H., Bandara, Y. M., Saharuddin, A. H., & Othman, M. R. (2015). The implications of the growth of port throughput on the port capacity: The case of Malaysian major container seaports. *International Journal of e-Navigation and Maritime Economy, 3*, 84-98. https://doi.org/10.1016/j.enavi.2015.12.008

Jiang, C., Wan, Y., & Zhang, A. (2016). Internalization of port congestion: Strategic effect behind shipping line delays and implications for terminal charges and investment. *Maritime Policy & Management, 44*(1), 112-130. https://doi.org/10.1080/03088839.2016.1237783

Kia, M., Shayan, E., & Ghotb, F. (2000). The importance of information technology in port terminal operations. *International Journal of Physical Distribution & Logistics Management, 30*(3/4), 331-344. https://doi.org/10.1108/09600030010326118

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement, 30*(3), 607-610. https://doi.org/10.1177/001316447003000308

Lu, C. S., Shang, K. C., & Lin, C. C. (2016). Identifying crucial sustainability assessment criteria for container seaports. *Maritime Business Review, 1*(2), 90-106. https://doi.org/10.1108/mabr-05-2016-0009

Luo, M., & Yip, T. L. (2013). Ports and the environment. *Maritime Policy & Management, 40*(5), 401-403. https://doi.org/10.1080/03088839.2013.797122

Mahmud, T., & Rossette, J. (2007). Problems and potentials of Chittagong Port: A follow-up diagnostic study. *Transparency International Bangladesh (TIB)*. https://www.ti-bangladesh.org

Meersman, H., Voorde, E. V. de, & Vanelslander, T. (2012). Chapter 4: Port congestion and implications to maritime logistics. In *Maritime Logistics: Contemporary Issues* (pp. 49-68). Emerald Group Publishing Limited. https://www.emerald.com/insight/publication/doi/10.1108/9781780523415

Michael, K. A. (2006). Logistics and supply chain management: Creating value-adding networks. *Journal of Business Logistics, 45*(1), 61-62. https://doi.org/10.2307/20713626

Moon, D. (2018). Port performance indicators (PPI) and analysis—Introduction. *World Maritime University*. https://issuu.com/worldmaritimeuniversity/docs/academic-handbook/31

Nazemzadeh, M., & Vanelslander, T. (2015). The container transport system: Selection criteria and business attractiveness for North-European ports. *Maritime Economics & Logistics, 17*(2), 221-245. https://doi.org/10.1057/mel.2015.1

Notteboom, T. (2006). The time factor in liner shipping services. *Maritime Economics & Logistics, 8*(1), 19-39. https://doi.org/10.1057/palgrave.mel.9100148

Nyema, S. M. (2014). Factors influencing container terminal efficiency: A case study of Mombasa entry port. *European Centre for Research Training and Development UK, 2*(3), 39-78.

Peng, D. X., & Lai, F. (2012). Using partial least squares in operations management research: A practical guideline and summary of past research. *Journal of Operations Management, 30*(6), 467-480. https://doi.org/10.1016/j.jom.2012.06.002

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Annual Review of Psychology, 88*(5), 879-903. https://doi.org/10.1037/0021-9010.88.5.879

Ringle, C. M., & Sarstedt, M. (2016). Gain more insight from your PLS-SEM results: The importance-performance map analysis. *Industrial Management & Data Systems, 116*(9), 1865-1886. https://doi.org/10.1108/IMDS-10-2015-0449

Vinzi, V. E., Chin, W. W., Henseler, J., & Wang, H. (Eds.). (2010). *Handbook of Partial Least Squares*. Springer-Verlag Berlin Heidelberg. https://doi.org/10.1007/978-3-540-32827-8_29

Welvaarts, W. (2017). Strategic master plan for Chittagong Port [Assessment]. *Asian Development Bank*. https://www.adb.org/sites/default/files/project-documents/45078/45078-001-tacr-en.pdf

Yeo, G.-T., Roe, M., & Soak, S.-M. S. (2007). Evaluation of the marine traffic congestion of North Harbor in Busan Port. *Journal of Waterway, Port, Coastal, and Ocean Engineering, 133*(2), 87-93. https://doi.org/10.1061/(ASCE)0733-950X(2007)133:2(87)

Ke, Y., Li, K. W., & Hipel, K. W. (2012). An integrated multiple criteria preferences ranking approach to the Canadian west coast port congestion conflict. *Expert Systems with Applications, 39*(10), 9181-9190. https://doi.org/10.1016/j.eswa.2012.02.086

Zhang, A., Loh, H. S., & Thai, V. V. (2015). Impacts of global manufacturing trends on port development: The case of Hong Kong. *The Asian Journal of Shipping and Logistics, 31*(1), 135-159. https://doi.org/10.1016/j.ajsl.2015.03.006