ISSN 0554-6397
UDK: 004.032.26
Review article
Received: 6th March 2020

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An Examination of Port Choice Indicators and Critical Transportation Parameters as a Basis for Port Selection

Abstract

In view of the growing international trade in Sub Saharan Africa, and very few studies done on the determinants of port choice from the Sub Saharan African port users perspective, this paper proves that efficiency is one of the critical determinants of port selection. Efficiency is a critical transportation parameter. The kernel of the paper is to examine port choice indicators and critical transportation parameters as a basis for port selection. Fifty-one business representative from Sub Saharan African countries responded to the questionnaire to indicate what they consider as critical in their importation and exportation of shipment via ports in Sub Saharan Africa. The paper established that critical transportation parameters and key port indicators are determinants in the choice of ports.

Key words: critical transportation parameters, port, choice, Sub Saharan Africa, linear regression

1. Introduction

Business organisations rely on the maritime supply chain for the importation of raw materials or exportation of finished products to other organisations outside the country. It is imperative to determine from businesses that make use of Sub Saharan African ports what they consider as key port choice indicators and what parameters they consider critical to the transportation of their consignments via sea. Critical transportation parameters are variables that are crucial to the seamless flow of a maritime supply chain.

This paper examines the responses from business organisation. Fifty-one respondents cutting across various organisation responded to the questionnaire. The business organisations include those focusing on manufacturing, food and beverages, services, technology, clothing and textiles, health care, humanitarian relief, agriculture and auto care. The criteria for selection was based on business organisation that were involved in international trade. The purpose of the questionnaire was to identify what these businesses consider as critical transportation parameters. Also to ascertain the importance of efficiency to their businesses, simple linear regression model established the relationship between port choice and critical transportation. Simple linear regression is a powerful tool because it brings down the association of two variables to the purest form by expressing one variable as a function of another, that is in an equation, and by having no power terms in this equation it can be represented by a straight line [6]. The most important of the critical transportation parameters were determined. Simple linear regression is applied to determine the key indicators for ports' selection amongst the stakeholders. This paper evaluates the factors that affect the choice of ports from the Sub Saharan African perspective. Policy implications are derived for port authorities and port operators. The subsequent sections will review the background, methodology, the research results and the final section will end with a discussion and conclusion.

2. Background of study

Transportation bridges the buyer-seller gaps hence, allowing organizations to extend the reach of their supply chains beyond local supplier capabilities and market demand [3]. Trade and transport are inextricable linked, hence efficient transport services are prerequisites to successful trading [8]. The shipper's choice of a port in the modern world is based on the existence of a perfect supply chain attached to the port [9]. An efficient port is a seaport that is competent in operations [4]. The efficiency of sea-port operations is determined by dwelling time of a vessel's stay in a port, quality of cargo handling and quality of service to inland transport vehicles during passage through the port [2]. Quality of cargo handling, in the form of berth throughput and quality of service to the inland vehicle are dependent on port infrastructure [4]. Several journals have been written on the issue of port selection, however, this paper views the determinants of port choice from the perspective of businesses that makes use of the ports in Sub Saharan Africa. [11] opined that the decision to route consignment via the port lies ultimately with the shipper. [11] examined the factors that influences port selection amongst South East Asia freight forwarder. The paper stated that port efficiency and shipping frequency were important to the south eastern freight forwarder. [8] examined the criteria for port selection amongst shippers in Nigeria. For the Nigerian shippers, documentation process were important parameters in the determination of port choice. [14] focused on port choice strategies for Qingdao, Tianjin and Dalian which are three major ports in China. [10] examined port choice in the context of port

performance. This further buttresses the notion that there are underlying factors that determines port selection. For instance, factors such as cargo dwell, quality of cargo handling equipment applies to berth throughput; quality of service concerns port infrastructure; the quay length; the number of quayside cranes are all important factors in port selection [12].

3. Methodology

The linear regression model enabled the determination of the relationship between port choice and critical transportation parameters. Simple linear regression is a process of describing a correlation with the line that best fits the data points [1]. Regression analysis is a branch of statistical methodology concerned with relating a response (Y, the dependent variable) to a set of independent or predictor (X_i,…, Xn) variables [7]. The dependent variable, Y, is influenced by (or responds) to the independent variable, X [13]. In this case the port choice is dependent (Y) on the critical transportation parameters (X).

Next, the null and alternative hypotheses are set as follows:

- Null hypothesis H_0: There is no relationship between port choice and critical transportation parameters.
- Alternative hypothesis H_1: There is a relationship between port choice and critical transportation parameters.

4. Research results

Port selection plays an important role in global logistics. The port must be appropriate for the cargo that is transported, because selecting the wrong port can lead to additional expenses and delays [5]. The first part of the research was for the respondents to select key indicators for port selection as they are necessary. This section examines what the key indicators for port selection are. A list of variables was given and the respondents asked to indicate on a Likert scale of 1-4 what indicators determine their choice of ports. The interpretation of the figures 1-4 are: One stands for totally unimportant; Two stands for unimportant; Three stands for important and Four stands for very important. Initially, the respondents were asked, what are the key indicators for the selection of port. These indicators include: the maritime traffic, vessel traffic, market share, load rate, investment, value adds, employment, carbon footprint, environmentally compliant, intermodal connectivity, custom clearance, ship turnaround time, availability of port community systems, corporate social responsibility, port safety and port security. Based on the mean, Figure 1 indicates that port security, safety, customs clearance and ship turn around are the key indicators in port selection. Port security is indicative of the fact that businesses do not want their shipment damaged or in any way compromised by ‘wharf rats’. It is necessary for ports to pay close attention to the level of security and safety at the ports. Safety also implies the need to

prevent terrorist attacks at the port or even bomb explosions at the terminals. Customs clearance can be a bottle neck in the supply chain, if the necessary documentation is not in place, the container may experience a 'custom stop'. Delays may occur as a result of customs stops. These occur when customs officials want to verify the content of a shipment. Customs will stop a shipment if there are discrepancies between the information supplied via the system and the hard copy information. There are two types of customs stops. Paper stop: Goods are allowed to move, but customs need to inspect the paper work and shipment stop: Customs actually inspect the goods. Maritime traffic is the volume of movement in and out of the port. A port is a very busy entity. Due to the complex nature of the ports, human traffic and vehicle traffic can be considerable. Vessel traffic is the number of vessels berthing at the port. The more ships, the greater the tendency for port congestion. This occurs when the demand for berthing space is more than the supply of berths and other port facilities. Market share has to do with whether the port is a market leader. Load rate refers to the rate containers are loaded and unloaded from the ports.

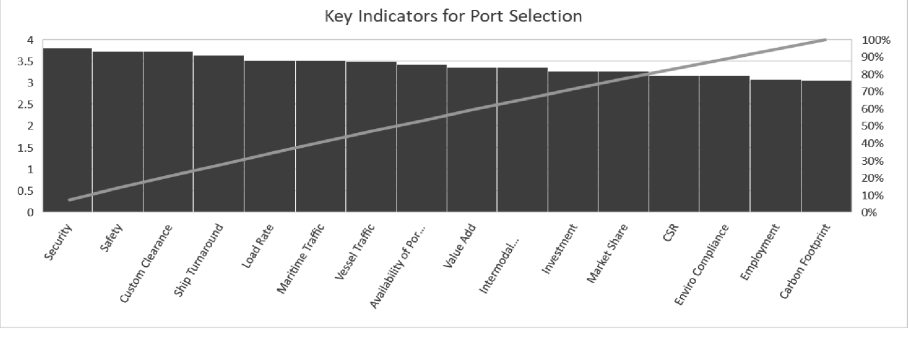

Figure 1: Key indicators for port selection based on the survey
Source: Authors' calculation

The second aspect of the research was on what the businesses consider as Critical Transportation Parameters (CTP). Criticality means parameters that cannot be waived aside in the seamless flow of a maritime supply chain. The critical transportation parameters included costs, port operations quality, port location, speed, time, service efficiency, port facilities, port information system, hinterland connections and port congestion. The responses on a Likert scale of one to four were used to determine what critical transportation parameters are important to businesses. The interpretation of the figures1-4 is: One stands for totally unimportant; Two stands for unimportant; Three stands for important; Four stands for very important. Using the mean of the sample, the results in Figure 2, show that efficiency is one of the critical transportation parameters for businesses. The first three most important of the transportation parameters are service efficiency, costs and time. The next three most important are port congestion,

port facilities and speed, while hinterland connection ranks lowest.

The fact that efficiency ranks first buttresses the fact that efficiency is a critical transportation parameter, hence supporting previous research.

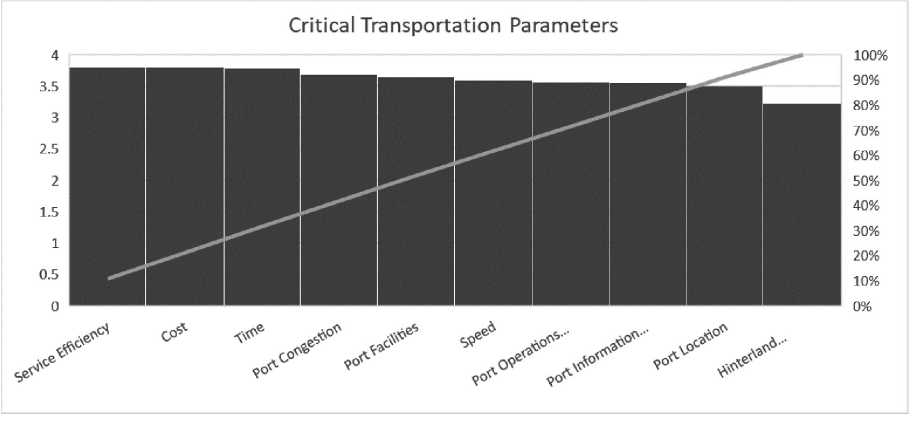

Figure 2: The critical transportation parameters based on survey
Source: Authors' calculation

The study then looks at the relationship between port choice indicators and critical transportation parameter where port choice indicators is the dependent variable and is denoted by *Y* and the critical transportation parameters are denoted by *X*, the independent variable. Simple linear regression is an approach for modelling the relationship between the dependent variable *Y* and one or more explanatory variables, *X*. Since there is only one explanatory variable, this is known as simple linear regression. In this instance, the port choice is the dependent variable *Y* while the explanatory variable *X* is the critical transport parameters. It was critical to know the relationship between port choice and transport parameters. The predictor is the transport parameters whiles the port choice are the dependent variable.

Table 1 indicates the result from the respondents with regards to what they consider as critical transportation parameters. For instance, with regards to costs 79.6% of the respondents considered costs as very important.

Table 1: Critical transportation parameters

		Totally Unimportant	Unimportant	Important	Very Important	Total
Costs	Count	0	0	10	39	49
	Share	0.0%	0.0%	20.4%	79.6%	100.0%
Port Operations Quality	Count	1	3	12	33	49
	Share	2.0%	6.1%	24.5%	67.3%	100.0%
Port Location	Count	1	3	15	29	48
	Share	2.1%	6.3%	31.3%	60.4%	100.0%
Speed	Count	3	0	11	35	49
	Share	6.1%	0.0%	22.4%	71.4%	100.0%
Time	Count	0	1	8	39	48
	Share	0.0%	2.1%	16.7%	81.3%	100.0%
Service Efficiency	Count	0	0	10	39	49
	Share	0.0%	0.0%	20.4%	79.6%	100.0%
Port Facilities	Count	2	0	11	36	49
	Share	4.1%	0.0%	22.4%	73.5%	100.0%
Port info system	Count	2	3	10	34	49
	Share	4.1%	6.1%	20.4%	69.4%	100.0%
Hinterland connections	Count	3	5	20	22	50
	Share	6.0%	10.0%	40.0%	44.0%	100.0%
Port Congestions	Count	0	4	8	38	50
	Share	0.0%	8.0%	16.0%	76.0%	100.0%

Source: Authors' calculation

Table 2 indicates the result from the respondents with regards to what they consider as key port choice indicators. For instance, 62.20% of the respondent considered maritime traffic as very important and 6.70% considered maritime traffic as unimportant.

Table 2: Key Port Choice Indicators

		Totally Unimportant	Unimportant	Important	Very Important	Total
Maritime Traffic	Count	1	3	13	28	45
	Share	2.20%	6.70%	28.90%	62.20%	100.00%
Vessel Traffic	Count	2	2	13	28	45
	Share	4.40%	4.40%	28.90%	62.20%	100.00%
Market Share	Count	2	5	16	20	43
	Share	4.70%	11.60%	37.20%	46.50%	100.00%
Load Rate	Count	1	1	16	25	43
	Share	2.30%	2.30%	37.20%	58.10%	100.00%
Investment	Count	1	8	13	21	43
	Share	2.30%	18.60%	30.20%	48.80%	100.00%
Added Value	Count	1	7	11	24	43
	Share	2.30%	16.30%	25.60%	55.80%	100.00%
Employment	Count	1	11	15	16	43
	Share	2.30%	25.60%	34.90%	37.20%	100.00%
Carbon Footprint	Count	2	10	16	16	44
	Share	4.50%	22.70%	36.40%	36.40%	100.00%
Environmental compliance	Count	2	6	19	17	44
	Share	4.50%	13.60%	43.20%	38.60%	100.00%
Intermodal Connectivity	Count	1	5	15	22	43
	Share	2.30%	11.60%	34.90%	51.20%	100.00%
Custom Clearance	Count	1	0	9	35	45
	Share	2.20%	0.00%	20.00%	77.80%	100.00%

Ship Turnaround	Count	1	2	9	33	45
	Share	2.20%	4.40%	20.00%	73.30%	100.00%
Availability of Port Community System	Count	1	4	15	25	45
	Share	2.20%	8.90%	33.30%	55.60%	100.00%
CSR	Count	1	6	22	15	44
	Share	2.30%	13.60%	50.00%	34.10%	100.00%
Safety	Count	1	0	9	35	45
	Share	2.20%	0.00%	20.00%	77.80%	100.00%
Security	Count	1	0	6	38	45
	Share	2.20%	0.00%	13.30%	84.40%	100.00%

Source: Authors' calculation

With the use of SPSS, the linear regression was done to test the hypothesis that there is no relationship between the key port choice indicators and critical transportation parameters Firstly, simple linear regression requires a reliability test. A reliability test was conducted to understand the internal consistency. The Cronbach's alpha testing for reliability was done for both the critical transportation variable and the key port choice indicators and the results are reported in tables 3 and 4. The internal consistency reveals 0.770 for critical transportation parameters and 0.779 for key port choice indicators respectively. These values indicate a high degree of internal consistency between the variables hence, the variables correlate well.

Table 3: Reliability test

Reliability Statistics for Critical Transportation Parameter		
Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
0.770	0.779	10

Source: Authors' calculation

Table 4: Reliability test for Key Port Choice Indicators

Reliability Statistics		
Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
0.779	0.803	9

Source: Authors' calculation

For a simple linear regression, it is imperative that a scatter plot is be done. A scatter plot illustrates the idea behind regression as the scatter plot represents a pair of data values from the two random variables *X* and *Y* [13]. The pattern of the scatter points indicates the nature of the relationship which is represented by the straight line that is calculated by the regression analysis [13]. Figure 3 displays the scatter plot.

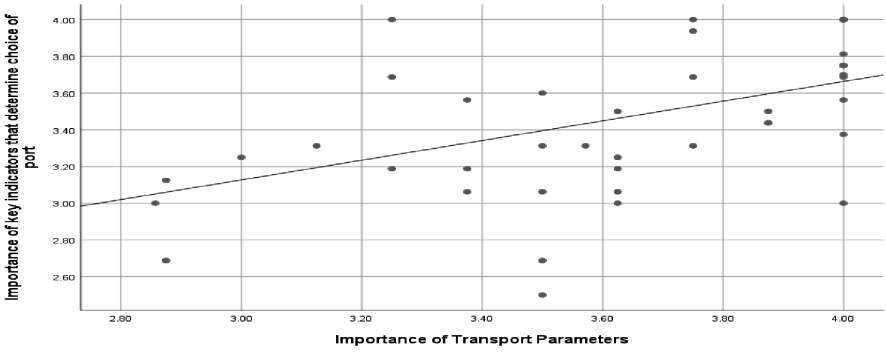

Figure 3: Scatter plot diagram displaying CTP and port choice indicators
Source: Authors' calculation

The scatter plot diagram is used for checking linearity. Figure 3 indicates the linear relationship between the importance of transportation parameters and key indicators that determine port selection. Thirdly, the Shapiro-Wilk (S-W) test is used to test normality. So if the value of the S-W test is greater than 0.05, the data is normal. If the value is below 0.05, then it shows that the data deviates from a normal distribution. Normality is one of the assumptions for simple linear regression and is illustrated in Table 5.

Table 5: Tests of Normality

	Shapiro-Wilk		
	Statistic	**df**	**Sig.**
TP_ Critical Transport Parameters	0.823	50	0.000
Choice port parameters that determine choice of port	0.827	46	0.000

Source: Authors' calculation

Pearson's correlation analysis is used to measure the strength of the relationship between the *X* and *Y* variables. Using SPSS, the Pearson correlation coefficient is 0.563, which shows a medium strength of association in Table 6.

Table 6: Pearson Correlation Coefficient

		TP Critical Transport Parameters	Choice port parameters that determine choice of port
TP Critical Transport Parameters	Pearson Correlation	1	.563**
	Sig. (2-tailed)		0.000
	N	49	44
Choice port Parameters that determine choice of port	Pearson Correlation	.563**	1
	Sig. (2-tailed)	0.000	
	N	44	45

Source: Authors' calculation

The linear regression was done on the scatter plot. The equation $Y = 0.563X + 1.519$ describes the statistical relationship between one or more predictor variables and the response variable. The implication of the equation is that critical transportation parameters – *X* determine the selection of port – *Y*. The simple linear regression also indicates that there is a relationship between the importance of port choice and critical transportation parameters.

The regression model in Figure 4, illustrates the linear relationship between the critical transportation parameters and the choice of ports. The equation $Y = 0.563X + 1.519$ illustrates that port choice is a function of critical transportation parameters. Therefore,

ports that improve on their critical transportation parameter will be amongst the ports selected by maritime stakeholders.

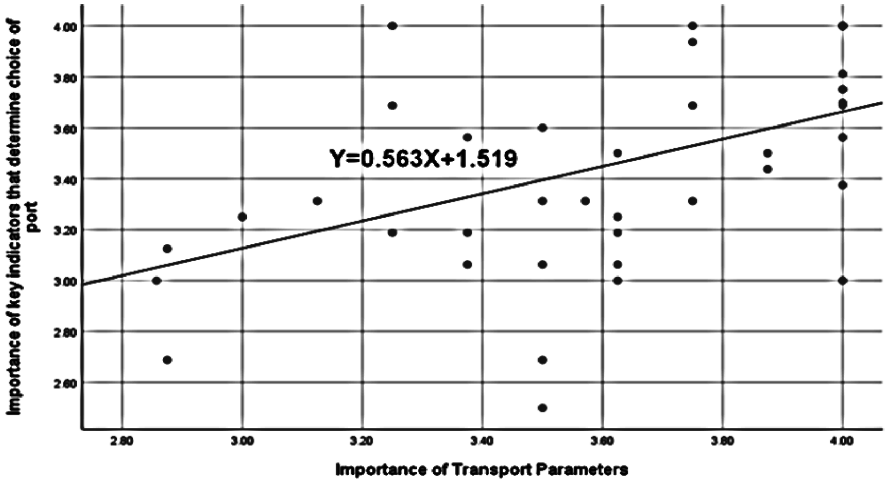

Figure 4: Simple linear regression
Source: Authors' calculation

The coefficient of determination R is an important indicator of the usefulness of the regression equation because it measures how strongly *X* and *Y* are associated [13]. The coefficient of determination is indicated in Table 7. Table 7 shows that there is a moderate linear relationship as R=0.563. The R-Square being approximately 32% indicates that the variability in port choice is due to its relationship with critical transportation parameters.

Table 7: Coefficient of determination

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.563[a]	0.317	0.300	0.3328

Source: Authors' calculation

The F-Test indicates that the linear regression provides a suitable fit amongst independent and dependent variables. In this case, Table 8 indicates that the F-Test is 19.457. With p- value being less than 0.001, the null hypothesis H_0 which states that there is no relationship between port choice and critical transportation parameters is rejected. This is because the p-value of 0.001 falls within the area of rejection. Also, there is a significant relationship between the port choice and critical transportation parameter.

Table 8: F-Test Statistics

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig (P-value).
1	Regression	2.154	1	2.154	19.457	.0001[b]
	Residual	4.650	42	0.111		
	Total	6.805	43			
a. Dependent Variable: Choice port Parameters that determine choice of port						
b. Predictors: (Constant), TP_ Critical Transport Parameters						

Source: Authors' calculation

The T-test is an inferential statistics tool used to determine if there is significant difference between the mean of the two sets of variables. It is an important tool in hypothesis testing. Table 9, shows that the data accurately reflects the relationship between the critical transportation parameters and port choice. Again based on the T-test, the null hypothesis is rejected and the alternative hypothesis is accepted. This is because there is no difference between the means and conclude that a significant relationship does exist between critical transportation parameters and port choice. Furthermore, a small p-value indicates a strong evidence against the null hypothesis.

Table 9: T-Test Statistics

Model	Unstandardized Coefficients			Standardized Coefficients	t	Sig. (P)	95,0% Confidence Interval for B	
	B		Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	1.519	0.444		3.422	0.001	0.623	2.414
	TP_ Critical Transport Parameters	0.563	0.122	0.563	4.411	0.000	0.291	0.782

Source: Authors' calculation

5. Discussion

The regression model illustrates that there is evidence to support a relationship between critical transportation parameter and port choice indicators. The critical transportation parameters were identified. Respondents that found critical transportation parameters important also found key indicators for port choice important. The first three critical transportation parameters included service efficiency, cost and time. This is not to state that other parameters are not important. The most important of key indicators in the selection of ports included are port security, safety and customs clearance.

A scatter plot was done to establish linearity. A simple regression model was developed to establish the relationship between the critical transportation parameters and the choice of ports. It was essential to understand the effect of critical transportation parameters on the selection of ports. The result of this plot is that critical transportation parameters do affect the choice of ports. Therefore, it is essential for ports to re-examine themselves vis-à-vis these critical transportation parameters and seek for improvement.

The representative of each business were asked what is the implication of the critical transportation parameter on the industry. Table 10 describes their responses in details.

Table 10: Implication of Critical Transportation Parameters (CTP) on the businesses

Sector	Implication on Business
Auto parts	The consequence of CTP is that customers operate on a 'just in time' system. This means that there must always be stock on hand for the customers. Though there may be buffer stock, any delay will still influence supply. Short supplying customers will always attract penalties. Increased stock levels affect cash flow. The critical transportation parameter in this case is time.
Health Care	The respondents from the healthcare sector stated that the impact of a default in any of the critical transportation parameters is felt on the customer at the end of the supply chain. In this sector, a delay is not affordable. Speed is most essential in the healthcare sector and the shipments involved are often large equipment and machines that can only be carried by sea.

Freight, Clearing and Forwarding	In the logistics industry, the clearing and forwarding companies act as third parties. As such they are always under tremendous pressure to deliver on time due to the service level agreement signed. Speed helps in the turnaround of output and enhances the process. It allows he fast delivery of cargo to its proper destination. The end-user can access the shipment on time. Time is also critical. Inadequate facilities in a port cause a delay in the turnaround process. Demurrage is paying for shipment that spends extra time in the port. Delays result in financial loss. So, more efficient and faster service reduces costs.
Clothing and Textiles, Corporate Gifts	In this sector, delays occur when vessels are late and also, because of port congestion. This results in late deliveries to clients and missed deadlines. Late deliveries attract penalties and this influences profit.
Exporting Fruit	In the fruit industry, the maintenance of the cold chain is critical, because it ensures consistency in the fruit quality. Quality service reduces the logistics costs as well as the transit time. In terms of port community systems, data and document interaction between the port and the company is also important. If the fruit is not fresh or it is spoilt when it gets to the client, then integrity is at stake due to service delivery failure. This has cost and insurance implications.
Food and Beverage	A typical business load is between two to twelve 40ft containers in some shipments and up to twenty-three 40ft containers. The loading of such containers takes approximately 15 – 20 days. Delays occur when the transporter has to wait in the same queue to collect an empty container especially when the carrier is returning a full or empty one and vice versa. The process of returning a full container which involves queueing to collect another takes time. The time lapses are in some instances up to 3 - 4 hours, which delays the whole loading process.
Humanitarian	Timely offloading and delivery is important as the shipment is meant to save lives.
Liquefied Petroleum	Time is essential for high turnover.
Logistics	Delay adds costs to clients' supply chain making product prices to consumers higher.

Manufacturing	When deliveries are late, the clients run out of stock and alternative arrangements or alternative modes of transport lead to increase in cost. If the port is congested and the service is not efficient, it causes delays in vessels' sailing on time which makes customers anxious. It affects the time when the materials get to the clients, and it also determines when clients pay the supplier. Loss of productivity of truck and equipment causes additional costs and impacts on the businesses by affecting the profit margin, causing damage to sales and customers. Poor rail infrastructure also causes the delay of consignments to ports. Also, slow delivery means retailers and/or wholesalers are unable to fulfil orders. Time is of great importance to the clients that need the shipments.
Manufacturing of Paper and Pulp	Port delays are equal to delayed revenues and additional costs
Recycling and Environmental	Delays increase costs
Services	Poor service delivery causes goods not to be delivered on time.
Telecommunication	When transporting huge telecommunication equipment to the port, the port location is essential to minimise transportation securities
Mining	Speed is important
Electrical	Delays and costs have a direct impact on the business

Source: Authors' calculation

6. Conclusion

The examination of port choice indicators and critical transportation parameters is a prerequisite for port selection and therefore has strong policy implication. There is a symbiotic relationship between ports and businesses. It is important that port indicators and critical transportation parameters should be included in port planning initiatives. Port indicators such as Maritime Traffic, Vessel Traffic, Market Share, Load Rate, Investment, Value Adds, Employment, Carbon Footprint, Environmentally Compliant, Intermodal connectivity, Custom Clearance, Ship turnaround time, Availability of Port Community Systems, Corporate Social Responsibility, Port Safety and Port Security are important considerations for port users and port authority. Critical Transportation Parameters such as costs, port operations quality, port location, speed, time, service efficiency, port facilities, port information system, hinterland connections and port congestion play a very vital role in the selection of ports amongst businesses. All the indicators and parameters are important to port selection. A mean and standard deviation

analysis was done to ascertain which of the key indicators are important in the selection of ports. This was done to determine what parameters are considered critical specifically in the choice of ports. The regression model illustrates that there is evidence to support a relationship between critical transportation parameter and port choice. Ports serve as a gateway to a country's economy, therefore, development and improvement of ports have its impact on the economy of the countries involved.

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