

A Study on Impact of International Container Vessels during and Post Pandemic

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Abstract

The international trade is totally relying on shipping, more than 90% of the international trade is dependent on shipping. The dependence of shipping in the international trade is due to its low-cost transportation. The container ships are more popular in the international trade, as the containers are easy to handle at ports, reducing the turnaround time for ship, reducing the dwell time of cargo, containerization provides better security for the cargo, also used in multimodal and intermodal transportation and also facilitating liner trade.

The outbreak of COVID virus has put the entire world shipping industry in mess, causing great havoc to all economies. This paper analysis the impact of COVID on the traffic of international container vessels and also, how the impact has affected the growth of world container port throughput. If the world container port throughput is affected, then the traffic of container vessels is also affected. The traffic of the world container port throughput is linked with number of container ships around the globe and with container ships in dead weight. The Study is analysed, with 10 years' data (2011-2020) taken from secondary sources. The data is analysed using DEA-Efficient Frontier. The efficient frontier signifies an efficiency mark in the entire set of decision-making units (DMU). Each year is considered as a decision-making unit, to find out the efficiency year-on-year, in the first model comparison was made keeping world container port throughput as output (O) and number of ships globally is assigned as input (I). In the second model efficiency was compared with world container port throughput as output (O) and container ships dead weight as input (I). The Relative efficiency is also calculated, that is, by dividing efficiency of DMU's by the best efficient DMU. Before applying DEA, it is ascertained that the world container port throughput is correlated with number of container ships around the globe and similarly world container port throughput is correlated with container ships in dead weight. To study the impact of growth of world container port throughput, compound annual growth rate (CAGR) is calculated on a year-on-year basis. The traffic of the world container port throughput has declined in 2020, the efficiency and the relative efficiency calculated also shows a downward trend. The compound annual growth rate also shows a negative growth in 2020. This reflects that the world container port throughput

has declined in 2020, which means the traffic of container vessels throughout the world has suffered enormously, essentially due to the impact of COVID virus.

Key Words: Container Vessels, Container Port Throughput, COVID, Data Envelopment Analysis

1. Introduction and Background of the Study:

The global trade is completely relying on shipping, more than 90% of the international trade is dependent on shipping (Leivestad & Markkula, 2021). The dependence of shipping in the international trade is due to its low-cost transportation. The COVID 19 has an unprecedented challenge to maritime transport causing great havoc to all economies, due to which disruption caused to port traffic, port calls, liner trade causing slowdown in the seaborne trade(UNCTAD, 2020).

The container ships are most sought after, is due to the fact that container handling at ports became easy, optimum utilization of berth, ships turnaround time were reduced due to faster handling of containers than break-bulk cargos, lesser dwell time with better security for the cargo. Due to pandemic hit, container vessels were also affected significantly. The sudden drop in demand had an impact on global shipping especially containers (Notteboom et al., 2021).

This paper discusses the impact of COVID on international container vessels. If the world container port throughput is affected naturally the traffic of container vessels is also affected. The traffic of the world container port throughput in twenty foot equivalent (TEU) is allied to number of container ships around the globe. Further the world container port throughput is also linked with container ships in dead weight. The scope of this comparison, year on year, may yield the efficiency of container port throughput yearly this will lead to find out the impact of pandemic on international container Vessels.

This paper scrutinizes two research questions: (1) whether the COVID pandemic has an impact on the traffic of international container vessels (2) how the impact has affected the growth of world container port throughput. To analyse these questions, an effort is made, with 10 years' data (2011-2020). The data envelopment analysis is applied to find out the efficiency of world container port throughput with number of container ships as input, in the second model the efficiency of world container port throughput is calculated keeping container ships in dead weight as input. To investigate the impact of growth of world container port throughput, compound annual growth rate (CAGR) is calculated on a year-on-year basis. Before applying

DEA, it is ascertained that the world container port throughput is correlated with number of container ships around the globe and similarly world container port throughput is correlated with container ships in dead weight.

2. Literature Review:

During COVID container shipping lines got affected, during pandemic, container lines have attuned their strategies to manage them dip in container traffic, there was an impact of freight rate in the Asia-Europe sector. The shipping lines with all their alliance were aligned to adopt to blank sailing due to fall in demand(Notteboom et al., 2021).

The coronavirus has affected the global maritime sector including African maritime transport causing huge disruption to shipping and havoc to maritime transport, the pandemic hit has completely wrecked the global maritime transport. The shipping routes have been altered for survival, still the pandemic has caused maritime bankruptcies(Oyenuga, 2021).

Normally container ports operate with qualms due to many socio economic factors, COVID outbreak made more worse for container movement(Russell et al., 123 C.E.)

Due to COVID the cost of operation of freight forwarders and container transportation cost have gone up many fold causing disturbance to global logistics and last mile connectivity followed huge fall in demand for maritime transport(Nwokedi et al., 2021).

The Virus COVID-19 brought new disruption in operating the ships as the vessel has to undergo security check before berthing in ports, the chartering rates in container shipping market get disturbed due to change in traffic volume of containers, even cruise vessels had an impact(Yazır et al., 2020).

The entire global shipping sector was affected due to the influence of COVID. From the analysis it is found there is a drop in ship calls to 10.2% at EU ports in 2020 compared to the previous year. Still the shipping market has not picked up, the standing testimony is that, in January 2021, the number of ship calls at EU ports dropped by 6% when compared to the corresponding month in 2019(European Maritime Safety Agency (EMSA), 2021).

The growth of Global shipping markets got drastically affected due to COVID-19, equally fleet development also showed a sign of deterioration due to pandemic (Menhat et al., 2021)

The pandemic has hit so hard on global maritime transport and shipping business which has led to change in the strategy of shipping business and connected supply chain management.

The virus not only affected the shipping business and maritime transport but also the world trade (Hebbar & Mukesh, 2020)

The efficiency of six major container terminals in Malaysia was measured using frontier method of DEA, the study compared terminal equipment's with throughput (Mokhtar & Zaly, 2013)

The Covid 19 has affected the Nigerian supply chain as how it has affected the world, the country faces a huge shortage of essential goods, the unemployed problems started to increase, capacity were poorly utilized, the ports were disrupted to a larger extent due to pandemic (Babatunde & Ibrahim, 2020)

3. Model Derivation using Data Envelopment Analysis:

Data Envelopment Analysis (DEA) is a standardising technique used to evaluate efficiency (Tetteh et al., 2016), the efficiency of the output is measured based on the input used. In other words DEA is a benchmarking technique that evaluates operational efficiency (Munisamy & Singh, 2011). DEA is a flexible analysis method to evaluate efficiency. This input and output non-parametric model can also be adopted, if the relationship is unclear (Kaisar et al., 2006).

$$\text{Efficiency} = \frac{\text{Output}}{\text{Input}}$$

This paper analyses the data using DEA-Efficient Frontier. The efficient frontier signifies an efficiency mark in the entire set of decision-making units (DMU). The author uses DEA - Efficient frontier method to find out the efficiency of each year from 2011-2020 Each year is considered as a decision-making unit, to find out the efficiency year on year, in the first model, a comparison was made keeping world container port throughput as output (O) and number of ships globally is assigned as input (I). In the second model, efficiency is compared with world container port throughput as output (O) and container ships dead weight as input (I).

Relative efficiency is calculated by dividing the efficiency of DMU's, by the best efficient DMU.

i.e., **Relative Efficiency:**

$$0 \leq \text{Relative Efficiency} \leq 1$$

$$\frac{\text{Efficiency of DMU}_i}{\text{Efficiency of DMU}_{\text{Best}}}$$

To find out whether it is appropriate to compare the world container port throughput and number of ships globally, correlation was calculated, after ascertaining that the above two indicators are positively correlated, the DEA technique is applied. Similar calculation was also made

comparing world container port throughput and container ships dead weight which was also positively correlated.

4. Data Analysis and Interpretation

The data for the analysis were collected from the various sources and analysed, the following are the detailed analysis.

Year	Container Port Throughput in TEU (in Million) (x)	Number of Container Ships (y)
2011	584.33	4966.00
2012	618.16	5096.00
2013	648.92	5079.00
2014	680.53	5101.00
2015	692.43	5111.00
2016	703.52	5225.00
2017	757.12	5150.00
2018	795.74	5198.00
2019	811.22	5304.00
2020	775.00	5371.00

(Source of Data: UNCTADSTATS & statista.com)

R Calculation

$$r = \frac{\sum ((X - M_x) (Y - M_y))}{\sqrt{((SS_x)(SS_y))}}$$

$$r = 68464.583 / \sqrt{((53110.509) (125200.9))} = \mathbf{0.8396}$$

The author wants to know whether there is, any relation exists between world container port throughput and number of container ships before calculating DEA. So, correlation was calculated between the above two variables it is found that the $r = \mathbf{0.8396}$ meaning there is a strong positive correlation between the above two variables.

Year	Container Port Throughput in TEU (in Million) (x)	Container Ships in Dead weight tons (in thousands) (y)
2011	584.33	183691.41
2012	618.16	196820.99
2013	648.92	206322.14
2014	680.53	216199.14
2015	692.43	228229.99
2016	703.52	244398.64
2017	757.12	245683.48

2018	795.74	253632.59
2019	811.22	266087.20
2020	775.00	274856.49

(Source of Data: UNCTADSTATS & statista.com)

R Calculation

$$r = \frac{\sum ((X - M_x) (Y - M_y))}{\sqrt{(\sum SS_x)(\sum SS_y)}}$$

$$r = 20043784.381 / \sqrt{((53110.509) (8300401095.207))} = \mathbf{0.9546}$$

Before calculating DEA, it has to be ascertained whether there is any relation exist between world container port throughput and container ships in dead weight. Hence when calculating correlation between the above two variables it is found that the $r = \mathbf{0.9546}$ meaning there is a strong positive correlation between the above two variables.

Table-3-Measuring Efficiency of World Container Port Throughput Year on Year using DEA with Number of Container ships in the world as Input				
Year	(O)Container Port Throughput in TEU (in Million)	(I)Number of Container Ships	Efficiency	Relative Efficiency
(a)	(b)	(c)	(d)=(b)/(c)	(e)=d/0.1531
2011	584.33	4966.00	0.1177	0.76863
2012	618.16	5096.00	0.1213	0.79239
2013	648.92	5079.00	0.1278	0.83460
2014	680.53	5101.00	0.1334	0.87148
2015	692.43	5111.00	0.1355	0.88498
2016	703.52	5225.00	0.1346	0.87954
2017	757.12	5150.00	0.1470	0.96033
2018	795.74	5198.00	0.1531	1.00000
2019	811.22	5304.00	0.1529	0.99908
2020	775.00	5371.00	0.1443	0.94257

Relative Efficiency:

$$0 \leq \text{Relative Efficiency} \leq 1$$

$$\text{Efficiency of DMU}_i / \text{Efficiency of DMU}_{\text{Best}}$$

To find out whether there is any impact of COVID on the traffic of international container vessels, the author has used world container port throughput and number of ships (world) as indicators. The analysis was made adopting Data Envelopment Analysis. While applying DEA, every year was made as decision making unit. Number of container ships throughout the world

was marked as input and world container port throughput was marked as output (single input and output model). In 2020 the world container Port throughput is around 775.00 million TEU's compared to 811.12 million TEU's in 2019, in fact the pandemic hit was at peak in 2020 and many countries suffered during this period, this indicates the container vessel movement globally got affected essentially due to pandemic. The efficiency and relative efficiency of 2018 was the highest, calculated based on the single input and output model. The efficiency during 2020 is 0.1443 compared to 0.1529 in 2019. The relative efficiency also plunged to 0.94257 in 2020 compared 0.99908 in 2019, This drop in efficiency and relative efficiency during 2020 confirms that the COVID has an impact on container vessel traffic.

Table-4-Measuring Efficiency of World Container Port Throughput Year on Year using DEA, with Container Ships (World) in Dead weight as Input				
Year	(O)Container Port Throughput in TEU (Twenty-foot Equivalent Unit) in Million	(I)Container Ships in Dead weight tons (in thousands)	Efficiency	Relative Efficiency
(a)	(b)	(c)	(d)=(b)/(c)	(e)=d/0.003181
2011	584.33	183691.41	0.003181	1.00000
2012	618.16	196820.99	0.003141	0.98733
2013	648.92	206322.14	0.003145	0.98873
2014	680.53	216199.14	0.003148	0.98952
2015	692.43	228229.99	0.003034	0.95375
2016	703.52	244398.64	0.002879	0.90492
2017	757.12	245683.48	0.003082	0.96877
2018	795.74	253632.59	0.003137	0.98627
2019	811.22	266087.20	0.003049	0.95840
2020	775.00	274856.49	0.002820	0.88639

Relative Efficiency:

$$0 \leq \text{Relative Efficiency} \leq 1$$

$$\text{Efficiency of DMU}_i / \text{Efficiency of DMU}_{\text{Best}}$$

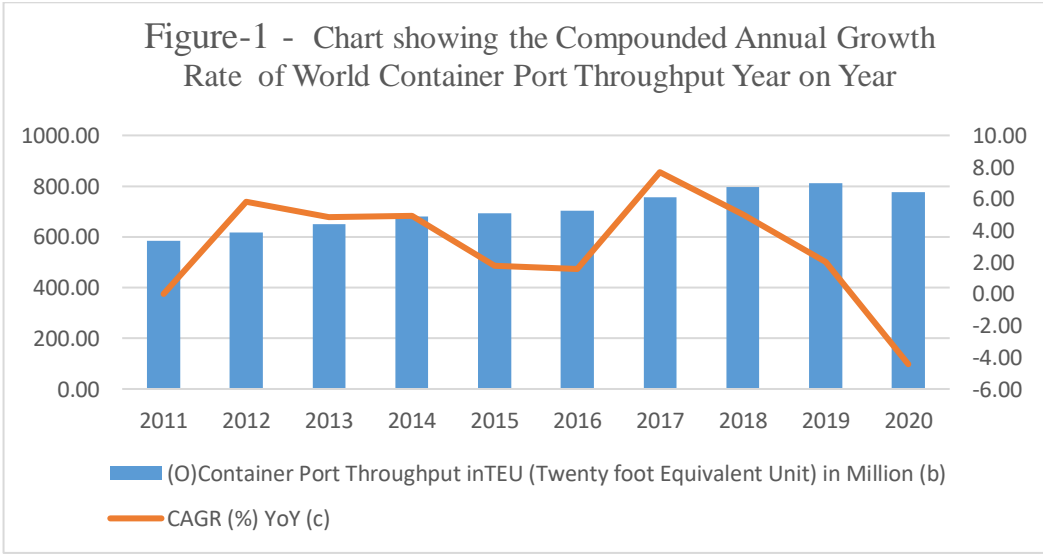
In the second model, the world container port throughput and container ships dead weight in tons is taken as indicators to find whether there is an impact of COVID on the traffic of container vessel globally. The analysis is made by using Data Envelopment Analysis. In the analysis every year was made as decision making unit. Container ships dead weight in tons (world) is taken as input and world container port throughput is marked as output (single input

and output model). The efficiency and relative efficiency of 2011 was the highest, calculated based on the single input and output model. The efficiency during 2020 has declined to 0.002820 compared to 0.003049 in 2019. The relative efficiency also been dropped to 0.88639 in 2020 compared to 0.95840 in 2019. This witnesses a complete fall in the efficiency of container port throughput during 2020 which confirms that the COVID has an impact on international container vessel traffic.

Table-5-Measuring the growth of World Container Port Throughput Year on Year by using CAGR

YEAR	Container Port Throughput in TEU (in Million)	CAGR (%) YoY	CAGR (%) 2011 to 2018	CAGR (%) 2011 to 2019
(a)	(b)	(c)	(d)	(e)
2011	584.33	0.00	3.93	3.72
2012	618.16	5.82		
2013	648.92	4.85		
2014	680.53	4.94		
2015	692.43	1.76		
2016	703.52	1.59		
2017	757.12	7.68		
2018	795.74	5.02		
2019	811.22	2.01		
2020	775.00	-4.44		

(Source of Data: UNCTADSTATS & statista.com)



Measuring the growth of world container port throughput using CAGR is yet another method to find out whether the impact of COVID has affected the traffic of container vessel throughout

the world. The CAGR is calculated year on year by using online calculating tool. The CAGR for 2020 shows a negative growth of -4.44 % as compared to a marginal growth of 2.01% in 2019. The pandemic is quite high in most of the countries during 2020, during the period the traffic of container vessel globally has declined. The CAGR from 2011 to 2018 is 3.93, meaning there is a significant growth rate up to 2018, the CAGR when calculated from 2011 to 2019, also shows a growth rate of 3.72 though the growth from 2018 to 2019 was slightly less this is due to the fact that some of the western countries have felt the impact of COVID in the latter period of 2019. From 2019 to 2020 there is complete negative growth on container port throughput essentially due to the impact of COVID.

5. Conclusion and Discussion

After ascertaining a positive correlation between world container port throughput with number of container ships ($r = 0.8396$) and container port throughput with container ships in dead weight ($r = 0.9546$) the DEA is calculated between world container port throughput with number of ships globally. It is understood (table-3) the efficiency during 2020 is 0.1443 compared to 0.1529 in 2019. Further the world container Port throughput in 2020 is around 775.00 million TEU's compared to 811.12 million TEU's in 2019 this decline in traffic is due to the fact the pandemic was at its peak in 2020 and many countries suffered during this period. The relative efficiency also weakened to 0.94257 in 2020 compared 0.99908 in 2019, proving a low traffic of container vessel globally essentially due to COVID.

The calculation of DEA in the second model, between world container port throughput and container ships dead weight in tons, also shows there is an impact of COVID on container port throughput, that is, (table-4) the efficiency during 2020 is 0.002820 compared to 0.003049 in 2019. The relative efficiency also has dropped to 0.88639 in 2020 compared to 0.95840 in 2019 substantiating the impact of COVID on the traffic of container vessel which was sluggish globally. The CAGR for 2020 (table-5) shows a negative growth of -4.44 % as compared to a marginal growth of 2.01% in 2019. The CAGR from 2011 to 2018 is 3.93, meaning there is a significant growth rate up to 2018, the CAGR when calculated from 2011 to 2019, shows a growth rate of 3.72 though the growth from 2018 to 2019 was slightly less this is due to the fact that some of the western countries have felt the impact of COVID in the latter period of 2019. From 2019 to 2020 there is complete negative growth on container port throughput essentially due to the impact of COVID. Still the pandemic is continuing it is difficult to ascertain post pandemic reaction on container vessels. The above analysis reflects that the world container port throughput has declined in 2020, which means the traffic of container vessels throughout the world has suffered enormously, essentially due to the impact of COVID.

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