EFFICIENCY ACCOUNTING IN PORTS: IDENTIFYING THE KEY-PERFORMANCE INDICATORS

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Abstract

Ports are key economic entities in any global supply chain. IMO (International maritime Organisation, 2018) estimates that world's 90 percent of trade happens through maritime route. The ports in India have not been able to feature the top 20 twenty ports in the world. The rank of the country in ease-of-doing-business (100 out of 190 countries, in the report of EoDB – 2018; PIB, 2017) and logistics-performance-index (35 as in 2016, World Bank, 2017) is not impressive. The country planners are making all attempts to improve the scenario. One such attempt is the launching of Sagarmala project. However, similar investments have not yielded right results. Hence any investment needs to be directed towards the right cause. This paper identifies the dimensions of port performance and suggests the key-performance- indicators (KPI) to evaluate the decisions taken by the port planners and future decisions required to be taken by them. The result of the analysis shows that the port needs to take 4-C approach. These are the four dimensions namely, customer, cost, contribution and climate. The KPIs against these dimensions have been suggested and an integrated KPI proposed in this paper.

Keywords: *Port, Efficiency, Dimensions, Key-Performance- Indicators (KPI), Integrated KPI*

Introduction

India's merchandise export registered a compound-annual-growth-rate (CAGR) of 8.43 percent, during the period 2006-2007 to 2015-16 (MoC, 2017). On the similar line, the imports grew at the rate of around 14 percent during the same period. About 95 per cent of India's international trade by volume and 68 per cent by value moves by sea transport (MoS, 2016).

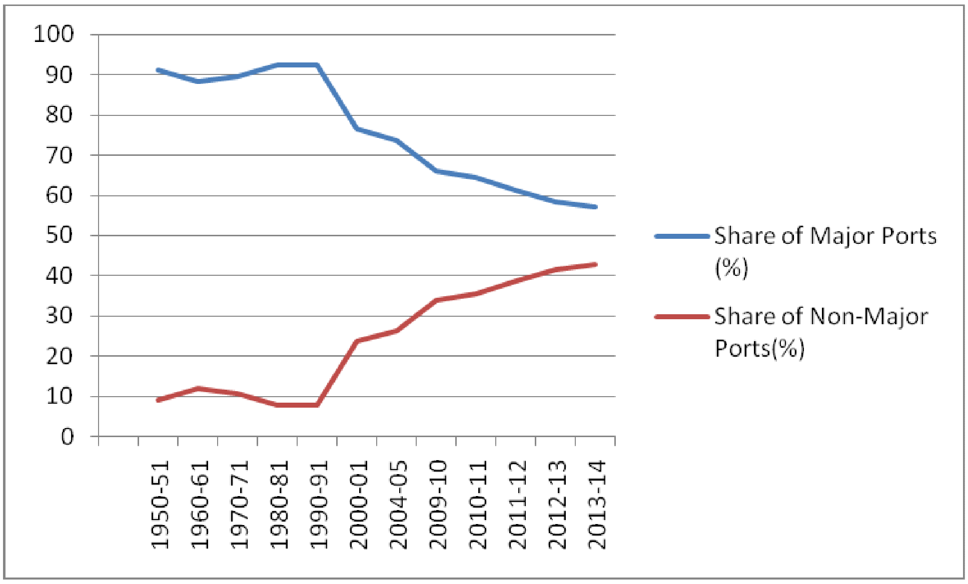
The government of India started the process of liberalization in the year 1991.Since this period the major ports of India started privatizing and outsourcing its operations. It is evident from the various privately managed terminals of major ports. For example, JNPT (Jawaharlal Nehru Port Trust) now includes two privately managed terminals, (namely, the NSICT and GTIPL) out of its three terminals. The total cargo handled by the Indian ports registered an impressive growth from 164.45 million tonnes in 1990-91 to 972.61 million tonnes in 2013-14.

However, the average turnaround time of vessels calling at major Indian ports is greater than 2 days and is higher than global average (East Coast Maritime Business Summit, 2017). The average turnaround time of vessels is an overall KPI (key performance indicator) that measures the efficiency of a port. Besides, all privately managed terminals are not performing at the level of desired level of efficiency (Dasgupta and Sinha, 2016).

The ports in India also experienced a significant growth compared to pre-liberalisation era. The total cargo handled by the major Indian ports registered an impressive growth from 164.45 million tonnes in 1990-91 to 606 million tonnes in 2015-16. However, the share of major ports has decreased from 972.61 million tonnes in 2013-14. Under the Sagarmala project the government of India plans to invest around 0.8 Million INR in next 10 to 15 years. One such project includes linking of major ports to the western dedicated freight corridor (Sagarmala, 2017).

Investments have been in the past as well, yet the growth is not in right direction. The Figure 1 below shows the drop in share of major ports from around ninety percent in the year 1950-51 to less than sixty percent in the year 2013-14. This drop is inspite the fact that the liberisation process started in early nineties in India.

Figure 1: Share of major ports vis-a-vis non-major ports of India



There is no sign of Indian ports being closer to the regional ports of Singapore or Colombo or Hong Kong or Port of Shanghai, in terms of cargo handling and efficiency. This is evident from Table 1 and Table 2. Table 1 shows port-wise container traffic in various major ports of India for the year 2012-13 whereas Table 2 shows container handled by top 10 container handling ports of the world in the year 2012. The container traffic is mentioned in TEU (Twenty Equivalent Unit), a twenty feet ISO marine container. As it is seen, the total container handled by all major ports of India (7.704 million tonnes) is far less than the container handled by the port positioned at number 10 in the world. As a consequence, most of the Indian ports are still being visited mostly by the feeder vessels or partially loaded. This involves a longer time for the entire supply chain and in turn has its effect on overall transportation costs and trade cost for the shippers.

Table 1: Major Ports of India - Port Wise Container Traffic (2012-13)

Port	Container Traffic (In ,000 TEUs)
Kolkata Dock System	463
Haldia Dock Complex	137
Paradip Port Trust	13
Visakhapatnam Port Trust	247
Chennai Port Trust	1540
Tuticorin Port Trust	476

Cochin Port Trust	335
New Mangalore Port Trust	48
Mormagao Port Trust	20
Mumbai Port Trust	48
Jawaharlal Nehru Port Trust	4259
Kandla Port Trust	118
TOTAL	7704

Source:Major Ports of India – A Profile: 2012-2013, IPA

Table 2: Top 10 Container Handling Ports of the World 2012

(In million TEUs)

Rank	Port	2011	2012
1	Shanghai	31.74	32.53
2	Singapore	29.94	31.65
3	Hong Kong	24.38	23.10
4	Shenzhen	22.57	22.94
5	Busan	16.18	17.04
6	Ningbo-Zhoushan	14.72	16.83
7	Guangzhou	14.42	14.74
8	Qingdao	13.02	14.50
9	Dubai	13.00	13.30
10	Tianjin	11.59	12.30

Source: Containerization International, 2012

This paper identifies the dimensions of port performance and suggests the key-performance-indicators to evaluate the decisions taken by the port planners and future decisions required to be taken by them.

Previous studies and recommendation

The studies, research and expert opinions have concluded so far that the factors affecting port efficiency are its size, competition – intra and inter port, technology adopted, infrastructure in-place and management/institutional structure. Some of these factors are interdependent and region specific. The salient findings may be drawn on comparable terminals and indicators. These are summarized (Dasgupta, 2015) below.

i. The operational performance of a port is generally measured in terms of the speed with which a vessel is dispatched, the rate at which cargo is handled and the duration that cargo stays in port prior to shipment or post discharge (Kek Choo Chung, 1993).

The performance parameter that indicates this aspect is the turn round time (TRT).

ii. Container terminal efficiency declines as the terminal becomes more congested (Farrel, **2009**).

The performance parameter that manifests congestion is the pre berthing delay (PBD).

iii. The number of berths and the capital deployed are the most sensitive measures impacting performance of most container ports (Yan and Liu, 2010).

This reflects the ports infrastructure dimension, resulting in capacity addition.

iv. Vessel turnaround time is highly correlated with crane allocation as well as the number of containers loaded and discharged (Yan and Liu, 2010).

The average output per ship berth day (AOPSBD) is the parameter that reflects the impact of crane and moves per crane on vessel turnaround time.

v. Variations in port efficiency are linked to excessive regulation, the prevalence of organized crime, and the general condition of the country's infrastructure (Clark et al,2004). They found that besides distance and containerization, the efficiency of ports is also important in determining maritime transport costs.

The pre berthing delay and post operation time prior to departure or the non-working time reflect the delay owing to regulations and other factors. These time durations are reflected in TRT.

vi. Larger ports produced higher efficiencies (Martinez-Budria et al. 1999).

Port's size is reflected in terms of number of berths and/or cargo throughput per annum of the port.

vii. Large-scale production tended to be associated with higher efficiency (Wang and Cullinane 2006).

Cargo throughput and vessels handled reflect scale of production for ports.

A study published by UNCTAD (1981), though some decades back, revealed certain universal realities and provides food for thought for redefining the efficiency of the port. These may be summarized as given below:

The port performance levels will be different depending on whether ships, cargoes or inland transport vehicles are served. Thus a port, at least in theory, mayoffer a very satisfactory service to vessel operators and at the same time be judged inadequate by cargo interests or inland transport operators (or vice versa). It is obviously more likely that poor performance will not be limited to one group of port users, but rather pervade all services offered by the port. The important lesson to learn from this is that port performance cannot be assessed on the basis of a single value or measure. In fact a meaningful evaluation of a port's performance will require sets of measures relating to:

a. The duration of a ship's stay in port;
b. The quality of the cargo-handling;
c. The quality of service to inland transport vehicles during theirpassage through the port.

The complicating factor is the strong interrelationship that exists between the three sets and between the various performance measures in each. Thus it is virtually impossible and certainly inappropriate to study each of these in isolation. The factors that influence performance of terminals include:

a) Balance (or lack of balance) between the various subsystems at a terminal;
b) Motivation and quality of container terminal personnel;
c) Size and type of vessel;
d) Total number of container exchanges per call;
e) Place of terminal in "port of call" sequence;
f) Number, type and capacity of cranes employed on a vessel;
g) Stowage distribution pattern over the bays of the vessel; Stowage position in the bays (under deck/on deck).
h) Total tonnage to be discharged/loaded per vessel call;
i) Consignment sizes (average tonnage per B/L);
j) Working method selected by stevedore and quay cargo-handling company (including selection of stevedoring tools);
k) Size of the gang or degree of automation;
l) Type of lashing and unlashing of containers
m) Weather conditions;
n) "Port of call" sequence in a given range.

There should be similarity between the operations to compare the performance of a port or terminal. For example, stating that terminal A achieved 2,500 tonnes per 24 hours loading structural steel of 12 metre lengths and terminal B only 1,500 tonnes clearly marks the latter port as far less efficient than the former. However, if further evidence were provided, such as the fact that terminal A loaded in 50,000 DWT(Dead Weight Tonnage) bulk carriers with large hatch openings and terminal B in conventional 15,000 DWT vessels, and that the average B/L size for A was 20 tonnes and for B just about 1 tonne, then the superior output of A could justifiably be questioned. Further, according to the law of diminishing returns, a cut-off output figure can be determined at which the highest productivity level, in a given operational framework, isobtained."

Thus, from studies done so far we can conclude that the efficiency of the ports needs to be measured against a benchmark terminal or port operating under similar conditions. Say for example, a feeder port handling containers can be said to be performing as per desired level if it matches the best performing terminal or port operating under similar environment. Thus, container terminals of port of Kolkata should not be compared with terminals of Jawaharlal Nehru Port.

The Dimensions and KPIs (Key-Performance-Indicators)

So far the experts have emphasised on measuring efficiency of port from perspectives, namely, cargo mix, vessel mix (types of vessels and its sizes) visiting the port, infrastructure available, management style and financial dimensions. This approach does not lead to identifying the comparative performance of the port with the best in the region or world; and also suffers from the lack of integrated holistic approach. In this article a "4-C" approach has been proposed to meet the deficiency of the existing methods of measuring port performance. The 4Cs include:

i. **Customer**: Achrol, and Kotler, (1999) opines that in this century the salesperson or a marketing executive is an agent of a buyer rather being treated as the agent of the seller till recent past.

ii. **Cost:** Anderson (2006) cites strategic cost management as one of the key element to organisational success. It should be aligned and optimized keeping in view the full value chain and all stakeholders to ensure long run sustainable profits.

iii. **Contribution** (to market share (growth) of port and profit): Rust, and .Zahorik, (1993) gives a framework that aids decision makers to identify the elements that give customer satisfaction and the how much cost should be spent not only to enhance the customer satisfaction but also ensure benefits with respect to bottom line profitability. The authors thus bring out the relationship between customer, cost and market share dimensions.

iv. **Climate**: Several authors (Bocken, et al., 2014; WWF, 2012; Randers, 2012; (Constanza et al., 1997; Stubbs and Cocklin, 2008; Porter and Kramer 2011; and business model innovations can support a systematic, on-going creation of business cases for sustainability (Schaltegger et al., 2012)).

In other words, the efficiency should be judged in terms of providing the right service (as demanded by the customer), at the right cost with the right contribution (making the port economically viable in long run) and within the right climatic balance.The "right" values to the four components, namely, customer requirement, cost, contribution and climate, may be ideally set to those maintained by the industry leaders operating under similar conditions. For example, JNPT can emulate the values set by the port of Singapore. However, the limitations of a port to match the benchmarked operation will be in terms of inputs and process it puts in. The inputs refer to the skill, machine capabilities, storage space, equipment capacity and other resources required for handling the cargo. The output is the result of the inputs and the process followed. If the resources used by the port do not match that of the benchmarked port, then the outputs cannot be compared.

Or in other words a desired level of efficiency should be defined for the given set of inputs mobilised by the port. For example, a benchmarked port uses four numbers ship-to-shore gantry cranes (per vessel) capable of lifting two containers per cycle will result in 8 containers per move. If the cycle time per crane is two minutes, then the hourly output per vessel will be 240 moves per hour. In comparison to this if a port has only two cranes with performance similar to that of the cranes of benchmarked port, it can at the most have an output of 120 moves per hour. This does not mean that this port is less efficient compared to the benchmarked port. That is, can be said that given the resources the port is efficient. Hence, we need to look from two broad perspectives;

i. The input-output bundle of each port: whether this matches the benchmarked port.
ii. The time required by the port to achieve the desired throughput of the benchmarked port by increasing the resources leading to the maximum output level.

Thus, the premises on which the efficiency of port should be measured can be re-defined as:

i. Port efficiency should be measured in terms of resources it deploys
ii. The efficiency should be judged holistically from "4-C" perspective.
iii. Port efficiency should be measured in terms of timelag in reaching the benchmarked throughput per berth per commodity per day

Port efficiency – KPIs (The key performance indicators)

Traditionally the prime KPI for measuring the performance of the port is the turn-round-time (TRT) or also referred as the turn-around-time (TAT). It serves as the comprehensive indicator of port output as it is the sum of the pilotage time (inward and outward), pre-berthing delay (or the waiting time) and stay time at berth (comprising working as well as non-working time). However, this can be good indicator efficiency from the carriers (port customer) perspective. In view of defining the KPI from the "4-C" perspective, the KPIs can be listed as in Table 3 below:

Table 3: KPIs from the "4-C" perspective

Perspective	**Entities and/or Elements**	**KPI**
Customer	Carrier	TRT
	Shipper	Dwell Time
		Entry Time for exports
		Exit Time for imports
Cost	Carrier	Cost (Tariff) per Ton/TEU
		Cost (Tariff) per DWT

	Shipper	Cost (Tariff) per Ton/TEU
	Port	Cost (expenditure)per Ton
Contribution	Port	Revenue per Ton
Climate	Environment	Emission (ppm) per Ton

Customer of port refers to the carriers and the shippers. The shipper, intending to export, faces delay in entry to the ports. This is directly suffered by the transporter engaged by the shipper. Moreover, the port advises the cargo to be placed in the port premises some days ahead of the expected date of shipment. This is dwell time of the export cargo. Higher the dwell time of cargo in the port less is marketable or useful shelf life of the cargo. In some ports this is as high as 15 days. The ports need to be efficient to handle same day arrival and shipment of cargo, especially for cargo arriving from ICD or CFS. In case of import cargo, the dwell time at yards or storage areas should be minimizedto enhance the useful shelf life. The port should have efficient cargo tracking and tracing system and faster clearance time. The port should preferably engage in direct delivery of cargo. Hence, entry and exit time at gates, and dwell time at port premises are two important KPIs from the shipper's perspective.

The port may be efficient, but the charges may be high owing to lack of competition or over-utilisation of resources or due to its tariff structure. In most of the ports the vessel has to pay for number of hours or days it stays in the port. One of the reasons of longer stay in port may be on account of ports' low productivity leading to increase in cost per DWT or per ton or per TEU. Similarly for shipper may have to shell out additional charges due to demurrages arising out of dwell time of import cargo.

The port may provide efficient service at the lowest cost but may not survive in long run or gets forced to increase its tariff owing to its high expenses per ton or TEU or DWT and inadequate revenue per ton or TEU or DWT. In that case the port cannot be said to be efficient.

In today's world of climate conscious citizens and nations, ports cannot remain passive to the growing needs of lower carbon emission and other pollutants. It must lay down the norms and system to control this bad output. The pollution level can be controlled by resorting to calling of ship with higher parcel load (meaning provision of adequate draft and efficient infrastructure to attract mother vessels), lower TRT , lower waiting time of inland carriers of cargo, less pollutant emitting equipment and machinery.

The Integrated KPI

The integrated key performance indicator (KPI) indicating the efficiency of the port from the"4-C" perspective is defined as sum of the ratio of all the values of port performance indicator and that of the benchmarked values. The benchmarked values can be obtained as follows:

i. The performance values of benchmarked port. In this case, however, it is required to see that the benchmarked port has similar operating conditions and matches in terms of the resources used by the port whose performance is being measured.
ii. The performance values obtained from customer survey.
iii. The benchmarked performance values obtained from optimization techniques such as Data Envelop Analysis (DEA). This is an objective approach which clearly defines the optimum performance to be achieved for a give set of inputs (resources) deployed by the port. In other words, it gives the input-output bundle that the port should strive for.
iv. The port may fix its own benchmark given its constraint to achieve the best or based on the assessed conditions of resources and best output it can provide. Say for example a port has acrane with age of 10 years and its life span is taken as15 years. The performance of a 10 year old crane may not be as that of 1 year old crane based on the principles of diminishing return. The port may then assess its output, say moves per hour, and compare the performance on the benchmarked values.

The computation of the integrated KPI is given in table 4 below. The lower the value of KPI better is the performance of the port. If the port performs as per benchmarked values the individual KPI values should lie between 0 and 1. If it exceeds 1 then the port can be said to be in-efficient with respect to the particular KPI. As regards the integrated KPI the maximum permissible value would be 10. Hence, the value of integrated KPI should vary between 0 and10. If it exceeds 10 then the port can be said to be overall in-efficient. The lower the value of **THE INTEGRATED KPI** better is the performance of the port. This is so because if all KPIs (except Revenue) listed below increases it defeats the objectives of an efficient port. Since increase in Revenue per ton or TEU or DWT is desired, the reciprocal of this KPI is taken for the purpose of arriving at the integrated KPI.

Table 4: Computation of Individual and Integrated KPIs

KPI	**Port – Performance (PP)**	**Benchmark Values (BV)**	**Ratio of PP/BV**
TRT	TRT_p	TRT_b	TRT_p/ TRT_b
Dwell Time	$(Dwell\ Time)_p$	$(Dwell\ Time)_b$	$(Dwell\ Time)_p$ / $(Dwell\ Time)_b$
Entry Time for exports	$(Entry\ Time\ for\ exports)_p$	$(Entry\ Time\ for\ exports)_b$	$(Entry\ Time\ for\ exports)_p$ / $(Entry\ Time\ for\ exports)_b$
Exit Time for imports	$(Exit\ Time\ for\ imports)_p$	$(Exit\ Time\ for\ imports)_b$	$(Exit\ Time\ for\ imports)_p$/$(Exit\ Time\ for\ imports)_b$
Cost (Tariff) per Ton/TEU	$(Cost\ (Tariff)\ per\ Ton/TEU)_p$	$(Cost\ (Tariff)\ per\ Ton/TEU)_b$	$(Cost\ (Tariff)\ per\ Ton/TEU)_p$ / $(Cost\ (Tariff)\ per\ Ton/TEU)_b$
Cost (Tariff) per DWT	$(Cost\ (Tariff)\ per\ DWT)_p$	$(Cost\ (Tariff)\ per\ DWT)_b$	$(Cost\ (Tariff)\ per\ DWT)_p$ / $(Cost\ (Tariff)\ per\ DWT)_b$
Cost (Tariff) per Ton/TEU	$(Cost\ (Tariff)\ per\ Ton/TEU)_p$	$(Cost\ (Tariff)\ per\ Ton/TEU)_b$	$(Cost\ (Tariff)\ per\ Ton/TEU)_p$ / $(Cost\ (Tariff)\ per\ Ton/TEU)_b$
Cost (expenditure)per Ton	$(Cost\ (expenditure)per\ Ton)_p$	$(Cost\ (expenditure)per\ Ton)_b$	$(Cost\ (expenditure)per\ Ton)_p$ / $(Cost\ (expenditure)per\ Ton)_b$
Revenue per Ton	$1/(Revenue\ per\ Ton)_p = R_p$	$1/(Revenue\ per\ Ton)_b = R_b$	R_p/ R_b
Emission (ppm) per Ton	$(Emission\ (ppm)\ per\ Ton)_p$	$(Emission\ (ppm)\ per\ Ton)_b$	$(Emission\ (ppm)\ per\ Ton)_p$ / $(Emission\ (ppm)\ per\ Ton)_b$
Integrated KPI		Total	Sum (of Values above)

Conclusion

The key performance indicators should encompass all dimensions of port operations and management. All businesses are customer driven hence this paper identifies the primary customers. These are the carriers and the shippers. The KPI associated with the customers of port vary and as such the general notion of measuring port efficiency in terms of turnaround time alone is not complete. It is obvious that serving customers in the right direction should lead to right contribution (to growth and profit) provided it provides the service at the right cost. Therefore this paper identifies the key performance indicators associated with cost and contribution. Any good output may be associated with bad output too. For example, increase in port activities will lead to increase in ship calls and entry and exit of vehicles. This is likely to lead to increase in emission levels and hence the ports nee to monitor the disruption in climate. In other words the ports should aim at doing sustainable business.

Individual key performance indicators will enable the port authorities to take the right corrective and investment decisions. However, the stakeholders may like to rank the ports with a single indicator. This study proposes an integrated KPI for ranking the ports. This can supplement the LPI where clarity about ports' efficiency and deficiency is missing. The paper emphasiseson a holistic approach in arriving at the new way to measure efficiency of the port.

This work can be extended to identify the correlation and association between the key performance indicators and propose a causal model to port planners for policy simulation and policy formulation.

References

1. Achrol, Ravi. S., and Kotler, Philip., (1999), "Marketing in the Network Economy, Journal of Marketing", Vol. 63, Fundamental Issues and Directions for Marketing, pp. 146-163 Published by: American Marketing Association
2. Anderson, Shannon. W., (2006), "Managing Costs and Cost Structure throughout the Value Chain: Research on Strategic Cost Management", Handbooks of Management Accounting Research,Volume 2, pp. 481-506
3. Bocken, N.M.P., Short ,S..W., Rana, P., and Evans, S.(2014), "A literature and practice review to develop sustainable business model archetypes", Journal of Cleaner Production, Volume 65, 15 February 2014, pp. 42-56

4. Clark. X, Dollar. D and Micco.A (March 2004), "Port Efficiency, Maritime Transport Costs And Bilateral Trade" Working Paper 10353, NBER Working Paper Series, National Bureau Of Economic Research, Cambridge
5. Costanza, R. D'Arge, R. De Groot, S. Farber, *(1997),* "The value of the world's ecosystem services and natural capital", Nature, 6630, pp. 253-260
6. Cullinane, K., Wang, T.F., and Cullinane, S., (2004). "Container Terminal Development in Mainland China and its impact on the competitiveness of port of Hong Kong", *Transport Reviews*, 24(1), pp. 33-56
7. Dasgupta, M.K., (2015), Analytics for Decision Making at Ports, *IJBAI*
8. Dasgupta, M. K., and Sinha, D., (2016), "Impact of privatisation of ports on relative efficiency of major ports of India", *Foreign Trade Review*, Vol. 51, Issue 3, 225 – 247
9. Farrel, Sheila (2009). "Factors Influencing Port Efficiency : A Case Study of Dar es Salaam", Retrieved from https://business.un.org/en/entities/13, accessed on 24.02.2018
10. Kek Choo Chung (1993), "The newsletter Transport No. PS-6 of Transportation", Water and Urban Development Department of World Bank
11. East Coast Maritime Business Summit, (2017) "Port strategy for India's Next Big Leap in Trade", February http://www.ecmbs.in/wp-content/uploads/Port-strategy-for-India.pdf, accessed on 22.02.2018
12. Martinez-Budria, Eduardo., Diaz-Hernandez, Joan., and Salazar-Gonalez, Jose. Juan (2011), "Measurement of returns to scale with quasi-fixed capital outputs: an application of dynamic DEA to infrastructure services in Spanish Ports", *SErieEconomica, Working Paper,* University of De La Laguna , ISSN:1989-9440, DT-E-2011-11
13. MoC, (2017), Trends In India's Foreign Trade, Annual Report 2016-17, http://commerce.gov.in/writereaddata/uploadedfile/MOC_636281140249481285_annual_report_16_17_eng.pdf
14. MoS, (2016), https://www.brookings.edu/opinions/indian-ocean-region-a-pivot-for-indias-growth/ accessed on 22.02.2017
15. PIB (2017), http://pib.nic.in/newsite/PrintRelease.aspx?relid=173116, accessed on 24.02.2018
16. Porter, M. Kramer, (2012), Creating shared value, *Harvard Business Review*, (February) (2011)
17. Randers, J. , (2012), A Global Forecast for the Next Forty Years, Chelsea Green Publishing, Vermont (2012), pp. 376

18. Rust, Roland. T., Zahorik, Anthony. J., (1993), Customer satisfaction, customer retention, and market share, *Journal of Retailing*, Volume 69, Issue 2, Pages 193-215
19. Sagarmala, (2017), Ministry of Shipping, Government of India, http://sagarmala.gov.in/sites/default/files/Sagarmala%20is%20a%20very%20ambitious%20%20project%20of%20the%20Indian%20Government_%20Rajive%20Kumar%2C%20Shipping%20Secretary%20-%20The%20%20Economic%20Times.pdf, accessed on 24.02.2018
20. Schaltegger, S., Lüdeke-Freund, F., Hansen, E.., (2012), Business cases for sustainability: the role of business model innovation for corporate sustainability, *Int. J. Innovat. Sustain. Dev*., Volume 6, Issue 2
21. Song, D.K., Cullinane, K., and Roe, M.S., (2001), "*The Productive Efficiency of Container Terminals: An Application to Korea and the UK"*, Aldershot: Ashgate.
22. Stubbs, W. , Cocklin, C., (2008), Conceptualizing a "Sustainability business model." *Organ. Environ*., Volume 21, Issue 2, pp. 103-127
23. UNCTAD, titled "Measuring and evaluating port performance and productivity" by G. De Monie, Director, Antwerp Port Engineering and Consulting
24. World Bank (2017), https://lpi.worldbank.org/international/global, accessed on 24.02.2018
25. Yan, J W Hong and Liu, J., 2010, "DEA models for identifying sensitive performance measures in container port evaluation" , *Maritime Economics & Logistics*, Volume 12, pp. 215-236