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SELECTED CONTAINER PORTS OPERATIONAL EFFICIENCY AS DETERMINANT OF MARITIME TRANSPORT COST

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Abstract

This paper examines the determinants of waterborne transport costs, with particular emphasis on the efficiency at port level. Its main contribution is to generate statistically quantifiable measures of port efficiency from a survey of eight selected ports of South Asia ports, and to estimate a model of waterborne transport costs, including the previously generated port efficiency measures as explanatory variables. In order to incorporate different port efficiency measures from the survey, we use principal component analysis (PCA). Our estimations show that the specified variables in the model explain a great proportion of the change in waterborne transport costs. With regard to port efficiency, the result is especially important for one of the port efficiency measures obtained through PCA with an estimated elasticity equivalent to that of distance. It is essential to identify best practices and shortcomings and learn from both for successful benchmarking. Economic globalization have main features of improvement in international trade through progress in telemetric, standardisation, more reliable faster and cheaper transport services and trade liberalization. South Asia also held intraregional trade by sea, for example Colombo port of Sri Lanka act as hub port (Herrera Dape et al, 2016) for trade and transhipment between India and Pakistan, between the Bangladesh and Pakistan via sea.The research also covered to productivity changes due to variables of maritime transport cost which are containerization, trade imbalance, freight rate, competition, oil and distance.

Methodology: *The research is quantitative in nature, parametric and non-parametric method is used to analyse the data, operational efficiency is evaluate through DEA(data envelopment analysis) and effect of maritime transport cost analyse through common cost equation, regression is also done on the bases of maritime transport cost variables calculations and computations are done by use of SPSS.*

Findings of the Research: *The research indicates that reduction in maritime transport cost increased port operational and economic efficiency, all variables of maritime transport cost also effect to efficiency variables, productivity changes in performance attract to more customers and port users.*

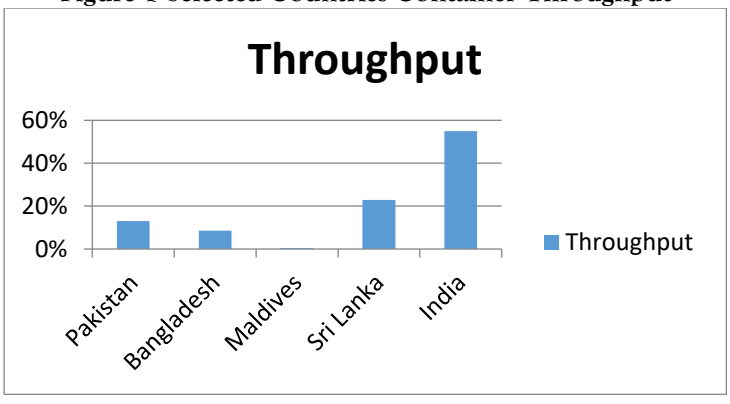
Implication of the Research: *The research would be helpful for managers of selected ports particularly for Pakistan(KPT), who looking for forward and*

backward integration of ports and reduction in average stay per vessel, it also helpful to customer support centres of selected ports in reduction of overall cost of operation

Introduction and Background of the Study

Economic growth of Pakistan is contributed 66.5 billion dollars by sea,31% GDP of country based on sea trade, 99 percent gasoline commodities handled by PNSC, foreign exchange companies handled 93% cargo of Pakistan. 80% cargo of Pakistan carried by foreign shipping remaining seven percent is carried by national shipping corporation which comprises on 20 vessels (Aftab et al, 2017).Maritime transport is the backbone of international trade because it undertakes the international transportation of cargo over water transportation networks. Pakistan have significant delivery courses due to its favourable geographic location, Karachi port have direct access to strait of Hurmez (Port, 2018). Karachi port trust comprises on two container terminal which does not have modern equipment to handle containerised cargo (Saeed et al, 2010).Economic growth is depend critically on trade and ports are crucial for trade, Global trade is handle through ports 80% by volume and 70% by value. Logistic cost is very important and indicated that cost of transportation recorded 6.5 percent average generated revenue by market and 44 percent comprised on logistic cost. Port services providers are committed to maintain competitiveness through cutting edge technologies; it is happened due to increase demand of customers. Market structure has changed, transferred from monopoly to fierce competitive environment, it happened due to liner shipping demand for successful operation of company (Liu et al, 2014).Sea transport is very important which is being carried more than 8.17 billion ton in recorded in 2008, the quantity is near about 80 percent of world trade (UNCTAD, 2009). There are many weaknesses at south Asian container ports but the key bottleneck is transport (Munisamy et al, 2011). Infrastructure is essential to compete in the global economy. The most problematic factor for doing business in this region is inadequate infrastructure except Sri Lanka. This research paper is an assessment of south Asian container ports on the base of port performance and its effect on maritime transport cost. This report also provides an opportunity and benefits for local and international stockholders, investors, and transporters. Ports are advanced more and regionalization of ports introduced in the management of ports, regionalization is introduced by Nottebom and Rodridge in 2005, transport process and logistic integration of ports provide understanding of port regionalisation(Monios, 2016),Global supply chain is increasing day by day and also putting pressure on maritime haul including inland freight distribution and port. Previous review papers have made it obvious that existing maritime transport research primarily emphasizes research themes, topics, and general methodologies, not particular data analysis techniques.

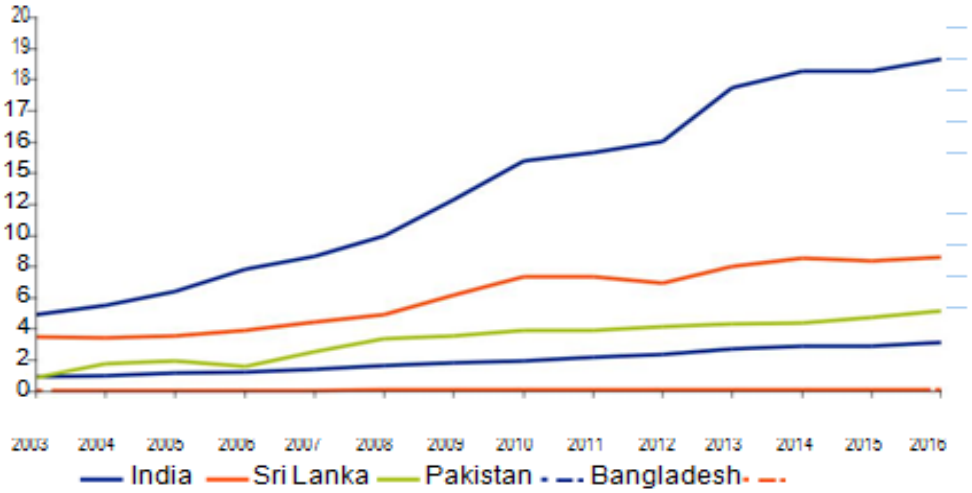
Figure 1 Selected Countries Container Throughput



Source; compiled by author based on World development indicator database, Maldives port authority

Operation. Global container port traffic is very vast and south Asia is minor player in this business, now a day's its importance is increasing due to interest of some big countries, Its market share in 2000 was 2.1% and increased to 2.9% in 2013, South Asia region comprises on Pakistan, India, Bangladesh, Sri Lanka, Maldives and India is a biggest player in this region in container market(Herrera Dape et al, 2016),it was moving 10 million 20-foot equivalent units in 2013, Sri Lanka is a next player in container market with throughput of 4 million TEUs, Pakistan with 2.6 million TEUs and Bangladesh with 1.6 million TEUs, Among the above four countries Bangladesh handle smaller volume of cargo, according to world development database Maldives handled less than 100,000 TEUs in 2013.

Figure 2 Container traffic at selected Ports



Sources: Maldives Port Authority for Maldives; World Development Indicators database for all other countries

Success of Mumbai (JNPT) and the heavy congestion there, have led to substantial investments in recent times by private players in the ports of Mundra (Kandla), Tuticorin and Kochi (Cochin). P&O Ports operate one terminal at Mumbai, and have obtained the license to develop, operate and manage the container terminal at Chennai (Madras). DP World with United Liner Agencies developed Visakhapatnam (Vizag) as a deep-water eastern gateway terminal on the Bay of Bengal coast of India. In the last couple of years, several liner companies have started weekly and biweekly services linking India.

Selected Container Ports and Structure

South Asia have 20 but all ports are dealing with containers only about 20 of them handle 9600 TEUs of containers annually, Containers ports of south Asia handle cargo going or coming from hinterland except port of Colombo. Two container ports are located in Pakistan, report comprised on following 8 ports of South Asia.

Table 1 Ports Included in the Analysis

COUNTRY	CONTAINER PORTS
Pakistan	KPT (Karachi port trust)
Bangladesh	Chittagong
Sri Lanka	Colombo
India	Kandla, Kolkata, JNPT, Mumbai, Mundra

Source; compiled by author

Table 2Containerised Cargo Volumes

Share in percentage of container handling annually.

KPT	26%
JNPT	90%
COLOMBO	89%
KANDLA	2%
KOLKATA	25%
CHITTAGONG	22%
MUMBAI	2%
MUNDRA	41%

Source; Compiled by author based on data from SLCB, Port Authorities and Association of Indian ports

Pakistan

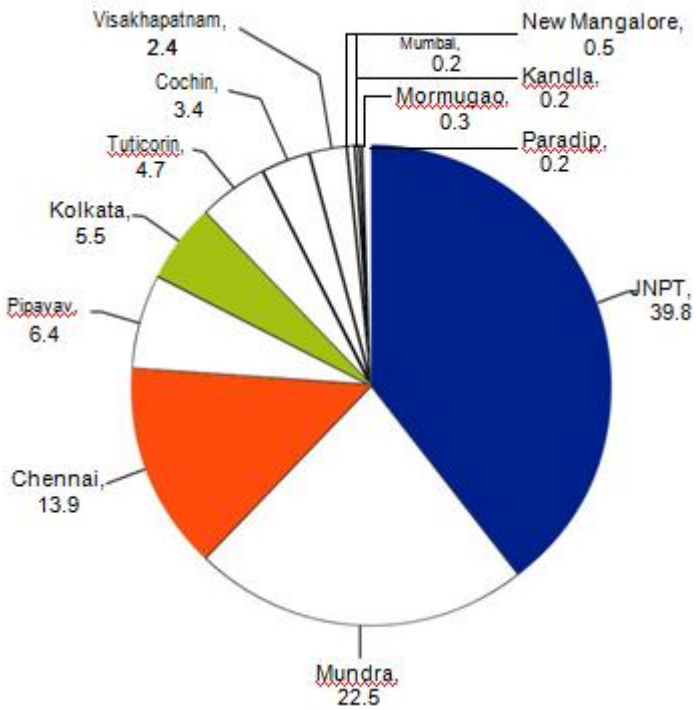
Karachi port handles general cargo, bulk, containers and biggest port of Pakistan was opened in 1854. Port Qasim was built with purpose to specialize in bulk but now one container terminal is located at Qasim port with name of Qasim international container terminal was opened in 1995, Third port Gawadar was opened in 2007 and now it is attracting to international cargo. Total throughput is almost handling by two ports 61% handled by Karachi port and 39% handled by Qasim port,(KPT, 2018) / (Qasim, 2017). Karachi Port Trust makes no warranty that the service will meet your requirements, or that the service will be uninterrupted, timely, secure, or error free; nor does Karachi Port Trust make any warranty as to the results that may be obtained from the use of the service or as to the accuracy or reliability of any information obtained through the service. Two container terminals Karachi International Container Terminal and Pakistan International container terminal are located simultaneously on west and east zone of KPT considered as old terminal and new induction of SAPT strengthen to port operation. Qasim port and KPT dredged recently and now capable to handle a vessel having draft of 13.5m

India

Central and state government rights over ports are defined clearly in 1908 act of India. Over 90% of India's total trade volume (77% in terms of value and 97% of its international trade volume) is carried over sea [60]. The Indian peninsula, situated in the Indian Ocean, is also strategically located between the Atlantic Ocean in the west and the Pacific Ocean in the east, with a 7000 km long coastline, and 12 major and 148 operable minor and intermediate ports. Ports are differentiated in India into two categories major and non-major ports, major ports of India are administrated under the act of 1908 and major port act of 1963 and regulated by the central government of India through board of trustees. The rights and authorities of board of trustees are limited by ministry of shipping, non-major ports are managed by state government of India under the port act and state maritime board is responsible to implement and formed policies, tariff setting is most important on major ports as compare with minor ports and the task is perfumed through TAMP(Tariff Authority for Major Ports) (India, 2016) , India is forming biggest peninsula in the world, has a coastline spanning 7516.6 kilometre(Rao, 2015). Coal handlings ports of India only accommodate to smaller Panamax vessel of 75,000 DWT and it is essential to build deep draft ports to 18m to accommodate capsize vessels (Hindubusiness, 2017). Only Gangavaram port is getting capsize vessels and attracting more and more vessels (Chohadary, 2016), port has its overall expansion planning from 10 million to 25 million ton in future.

IEER
Institute for Excellence in Education & Research

Figure 3 Indian Ports Container Throughput



Source; Indian transport, road and highway ministry

Bangladesh

Bangladesh has two major ports Mongla and Chittagong. Development of port facilities at Chittagong, Bangladesh's largest port has been slow. The Chittagong Port Authority (CPA) has completed only one fully specialized terminal, the Chittagong Container Terminal, and it handles only a third of total traffic. these two ports are managed under the guideline of ministry of port and shipping which also deals some regulatory rights also, Chittagong port is working at its high degree of readiness and handles import and export operational activities (CPA, 2018), the port have major challenge of congestion which is recorded 84.3 hours between January and July, The annual handling was 54.78 million in 2014-2015.

Sri Lanka

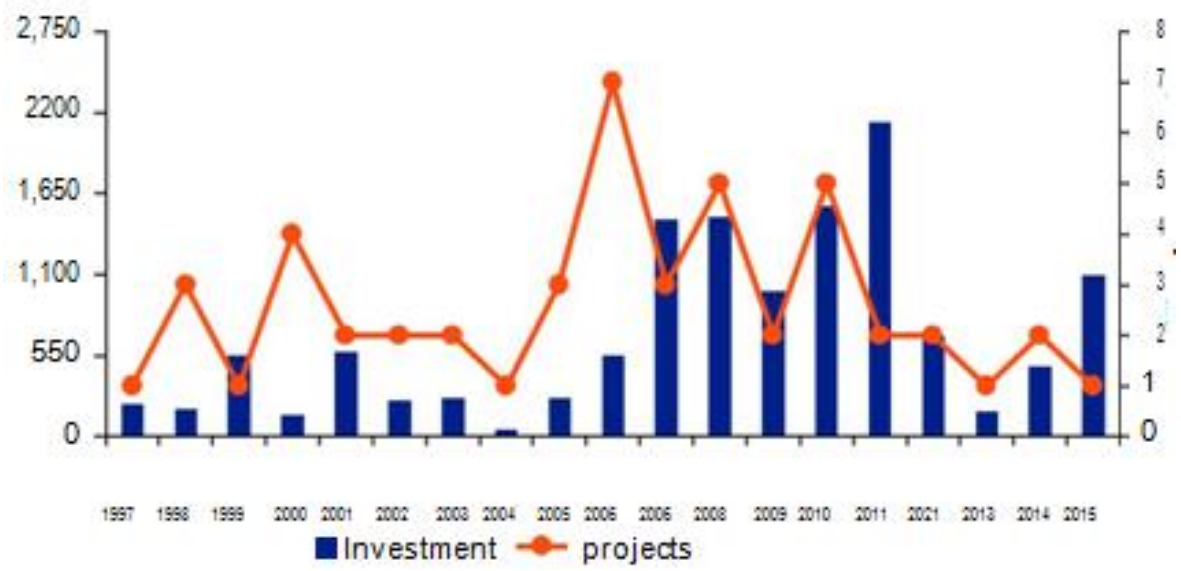
All commercial ports of Sri Lanka is managed by SLPA (Sri Lanka port authority). The organization was formed in 1979 through an act of parliament. The organization granted much concession for container ports, ministry of port and aviation is monitored activities of SLPA which also settled its own tariff and the tariff in concession agreement, the ministry of environment and natural resources also works to prevent the ports from marine pollution,(SLPA, 2018).

Problem Statement

Cost of import or export of container from selected ports is high as compare with other ports, moreover Karachi Port Trust makes no warranty that the service will meet your requirements, or that the service will be uninterrupted, timely, secure, or error free but the companies are more cautious to cost cutting. According to 2014 logistic performance index, south Asia is ranked low as compare with East Asia and importing or exporting of container's cost in south Asia is doubled then cost in east Asia(Marti et al, 2014). In south Asia 75% import and export handled through sea and this figure of cost matter in south Asia heavily, Research is already done by Matias Herrea Dape and Anchor Suarez-Aleman for completion of task of World Bank and the research of both experts related competitiveness of south Asian container ports, report not properly covered the

effect of maritime transport cost at port efficiency.

Figure 4 Investment at Selected Ports



Source; ppi database

RJ Sanchez et al referred that transport cost influenced by number of variables and demand of transport dependent on trade so control on transport cost is complex issue. In the past an estimation by Gorman showed that, expenditure on transport increased from 9.5% to 10% and inventory cost increased from 4.3% to 3.5 % (Sanchez et al, 2003). Time is effect to international trade, in the future competition will exists on the bases of supply chain (Huong et al, 2017).

Research Questions and Objectives

South Asia comprises on 14 largest container ports and 98% tariff handled through these 14 ports (org, 2017). The research paper examines the operational performance and maritime transport cost effect on performance of 8 out of 14 ports, offered suggestions and lesson in the perspective of Pakistan maritime business. In the report performance is calculated via formula. The report also used econometric technique to calculate the efficiency on container ports. The report offered benefits and opportunities for investors and stakeholders particularly to bring improvement at port facilities.

In the research paper one of the container port performance and maritime transport cost option has been studied quantifiably through methodical approach in calculating performance and maritime cost with environmental and economic aspects of the research that will bestow strategy makers, policy makers, bases in conducting briefed analysis for acceptability and rejection of research. The report highlights lesson for Pakistan after analysis of competitive ports.

The report answers 3 specific questions.

Q.1 Have South Asian ports become more productive?

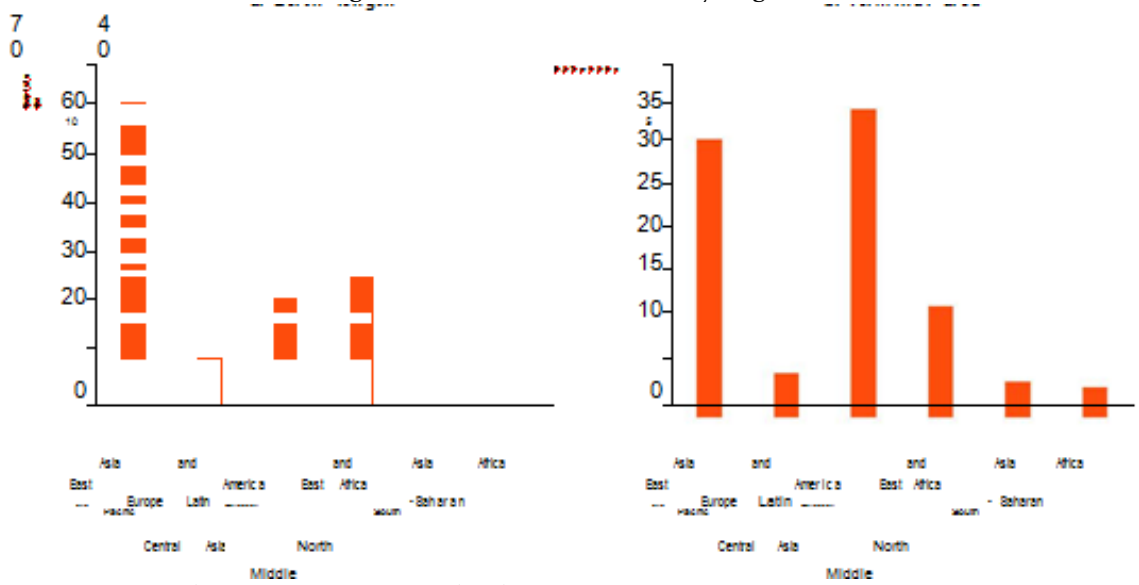
Q.2 how do increase in port efficiency affect transport cost?

Q.3 what are the sources of productivity changes and their effect on Pakistan (KPT)?

1.5 Significance of Study

This research will help strategy makers and policy makers of south Asia, particularly to Pakistan ascertain feasible import and export of containers supply option by calculating performance and maritime transport cost, in this way they will also increase productivity at container ports of Pakistan. Previous research concluded that remarkable performance at SACP lacked due to unavailability of infrastructure. This result was only based on qualitative research.

Figure 5 Facilities Investment by Region



source; international containerisation year book

Scope of Study

According to some experts of World Bank performance analyses become an informative tool and established regulation for economy in infrastructure industry and it also affect to port industry (Defilippi, 2008). Another expert Talley referred to port as collection process which is essential to bring its outcome to its customers. India which is highest in ranking for containers throughput south Asia and moving to become leader in this region, with aim it invested heavily at JNPT(jawahar Lal Nehru Port Trust).

Additional Model for Further Research

Redevelopment of waterfront in Europe and America and pointed differences among the regions are responses of port cities and Carmona referred that planning of port city in the southern and Northern hemispheres. Transport globalization and port regionalization have many aspects of further research on performance and maritime cost effect for example interest of investors, ports competitiveness on the bases of different regions. Ports infrastructure and effects on performance according to different regions is also valid research aspect.

Research Limitation

Effect of maritime transport cost and operational performance of eight south Asian container ports was the core aim of my study and it has been done through methodological approach due to following reasons. The research covered to 8 competitive container ports of one region and this vast domain and involvement of different stockholders, government regulatory authorities sea borne trade and maritime transport so realistic data gathering is not possible, in order to identify logical conclusion some assumptions in this report have been made by me.

Literature Review

Objective and Scope of Existing Literature

Clark et al pointed out that maritime transportation cost decreased 12% by increasing port efficiency from 25% to 75% (Clark et al, 2004). The important difference is either the research covered the performance of port or terminal. Port efficiency is not totally depending upon its container terminal's operation. The past research made by experts with regard to container ports like Barros 2005, Trujillo and Tovar 2007, Gonzalez and Trujillo and Est. ache depicted that all operation is performed by port authorities. However some researches were less ambiguous in terms of agent activities and infrastructure studies these research are included Yan and Liu 2006, Tongzen and Heng 2005. It is acceptable that the researches on port level relate to the performance of port authorities and performance of container ports belongs to the efficiency of stevedores. The

selection of port and terminal location is another aspect but selections of ports in past researches are different for example Song and Gary in 2002 selected 15 Asian ports and Trujillo and Tovar 2007 selected 22 European ports. The some experts made country specific research like Liu (1995) covered 28 ports of UK, Gunzalez and Trujillo five Spanish port authorities. One important factor which affect to performance is ownership and its related activities autonomy, decentralization, and privatization introduced by UK in 1980 and two of them deregulation and privatization implemented by different region and countries to boost up the performance of ports(Song et al, 2005).

Table 3 Literature Regression Results

Author/year	*Period*	*Distance*	*Imbalanc between import and export*	*Value- weight*	*Container*	*Weigh*	*Volume*	*Efficiency*
Blonigen and Wilson (2008)	1991–2003	0.13*** 0.21***	Imports (–0.00 Exports (–0.00	0.55***	–0.04***	0.91**	0.00**	–0.09, –0.06[a]
Fink and others (2002)	1998	0.33***			–0.07**		–0.02*	
Micco and Perez (2002)	1995–99	0.17***		0.55***	–0.02		–0.04**	–0.07***
Sánchez and others (2003)	2002	0.09		0.54***	–0.02			0.03, –0.06, 0.00[b]
Limao and Venables (2001)	1998	0.38**						
Wilmsmeier, Hoffmann, and Sánchez (2006)	2002	0.35***	0.00	0.34***		–0.09**	–0.02**[c]	–0.38***
Clark, Dollar, and Micco (2004)	1998	0.18***	–0.07**	0.55***	–0.03**		–0.04**	–0.06***

a. The first result compares the Port of Oakland with the most efficient port in the United States (Richmond-Petersburg), where port charges are about 9 percent lower. The second result compares the Port of Rotterdam with the most efficient port outside the United States in the sample considered by the authors (Zeebrugge, Belgium), where port charges are 6 percent lower. b. The results are related to time inefficiency, productivity, and stay per vessel, respectively. c. The result is for bilateral trade.
Significance level: * = 10 percent level, ** = 5 percent level, * = 1 percent level.**

Private Participation Associated with Different Outcomes.

Gulinane and Song made research on the container terminals of Republic of Korea in 2003 and found best supported evidence for hypothesis which stated that initiative of private sector participation and deregulations polices improved terminals performance. An analysis was made of 36 Europium and 4 Asian ports by comparing productivity which brought positive result by Noteboom, Coeck, Van den Broeck (2000). Gillinane and Song expertly concluded that private participation increased performance and productivity

Port Efficiency and Waterborne Transport Costs Relationship

Many researchers in the past pointed out relationship between maritime transport cost and port efficiency and incorporated variables as determinants of waterborne trade and economic development at ports. The factors which covered type of market, access to maritime services, transport insurance component, economies of

scale and distance see Fink et al 2000, Fuchsluger 2000, Limao and venables 2001, Peerez and Micco 2001, and Wang et al 2002. These studies covered proxies such as perception surveys, infrastructure indicator and GDP per capita and conclusion was made by using national data rather than port. SFA and DEA (Data Envelopment Analysis) was used for more detailed research on port efficiency (Valentine et al, 2001), (Ghosh et al, 2000),((Tongzon, 2001). To acquire the essential information for perfect conclusion they want to made difficult and broad quantitative comparison and did not link our knowledge to perfect data on international transport cost. The purpose of this research paper is to redefined by adding determinants which was missed in previous researches and affect to port efficiency, These determinants especially emphasis on eight container ports of south Asian.

Determinants of Maritime Transport Cost

(Hoffmann et al, 2003), (Limao et al, 2001)referred that if the maritime transport cost is doubled it decreased its trade 80% or more. Maritime cost have negative impact on trade flow but research less emphasised on port performance and productivity where ownership, privatization, custom duties, port dwell time, availability of berth play very important role. Statistical variation of transport cost affected 70% among the countries(Overman et al, 2001)due to geographic variables. The research did not incorporate to distance oil prices and speed in calculating maritime transport cost particularly on container ports. These variables affect to maritime transport cost and as well as to port efficiency and productivity. Micoo and Perez stated in 2001 that international carriage in Latin America and Caribbean in export to US recorded in custom duties 1.86% as compared to 4.45% which is more attractive custom duty.

RESEARCH METHODOLOGY

Data Collection and Tool

Basic sources used for collection of data are internet, email, direct contact with shareholders, investors, transporters, and yard owners of different ports, EDI (Electronic Data Interchange), electronic equipment's, newspapers, maritime transport cost statistic of different ports. Some other resources also used for better result like research papers, strategic steps and polices of different 8 container ports of the region regarding the port performance and maritime transport cost effectiveness. First, the DEA technique, formally developed by Charnes, Cooper, and Rhodes (1978), empirically measures the relative efficiency of multiple decision making units when the production process presents a structure of multiple inputs and outputs. The research is proved by econometric technique and the type of research is parametric approach based on latest development of (Serebrisky, 2012) because we used econometric model to prove the result.

Approaches and Design of Research

In maritime transport, the regression technique is often employed to address dependence and prediction between variables. By using regression techniques, other studies using the regression technique include Tongzon (2009) and Pantouvakis and Dimas (2010). Research data comprised on 8 regional container ports of south Asia, government authorities of different countries like India, Sri Lanka and including Pakistan are not willing to provide actual data related to performance of ports, primary resources are port performance annual reports, shipping reports, journal, and government based acceptable statistic data. Approach which we used for research is parametric approach due to econometric model and nonparametric because of mathematical programming with accepted methodological approach. Maritime transport cost is calculated by using several variables ranging from distance, oil prices, trade imbalances, trade volume, trade value, containerization, competition and infrastructure and port efficiency. Graphs, table and diagram are used to present the result wherever applicable and essential. Viability of data is analysed by comparing calculated data with existing data of south Asian container ports.

Data Analysis

The data was collected and compiled according to the OECD comrade UN database of maritime transport cost dataset and other resources are sea-distance.org, World Bank development indicators. DEA (Data Envelopment Analysis) is used to build up the

efficiency measures which capture efficiency and constant return by selected variables. We also used NETPAS to calculating and estimating waterborne transport and cost with sea routs of south Asian container ports. NETPAS is software which provides weather information and speed, time duration, distance between the south Asian container ports, all the function is possible by putting some input. Maritime transport cost is calculated via econometric technique by applying equation which derived from various resources. Port efficiency is also calculated by introducing econometric equation and focused on main task of maritime transport cost.

Operational Performance

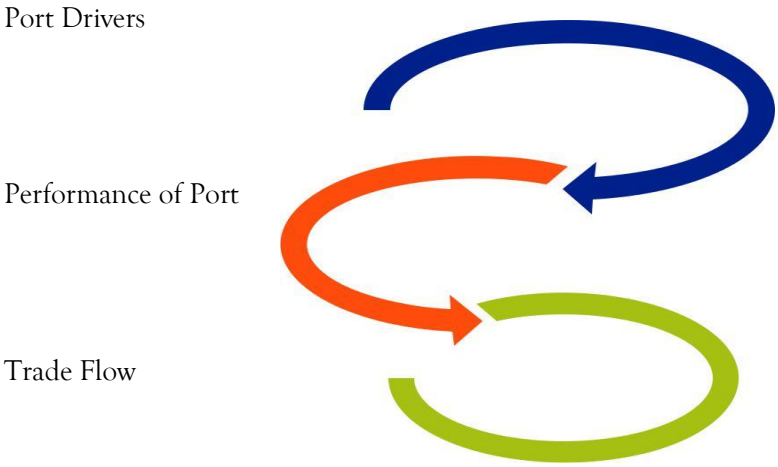
Indirect and direct cost is two different concepts indirect cost covered and related to capture opportunities, delay of ships, shippers confidence to choose port. Performance calculation is not possible without considering to time that is why we will calculate performance with time considering. We will used four metrics to calculate port performance which are as followed. The ship's time in port of a given vessel on a given call is an important concern in an efficient ship operation for shipping lines. The shorter it is, the better it is economically. Port time (or a ship's time in port or ship turnaround time) is the time duration between a ship's arrival at the entrance buoy and ship's departure from the same buoy. It can be categorised as the following times:

- Turnaround Time (TAT); total time ship spend at arriving port during loading and discharging of cargo
- . The time which ship has Waite to enter and secured to alongside the berth (WT), it is average time before to berthing.
- . The time which ship spent at birth but not working or receiving any services from port is idle time (IT) and not include in total time.
- . The time which include in total time and ship is being served by port is called non idle time (NIT).

RESULTS ANALYSIS

According to world development indicator data base South Asia enjoyed second highest economic growth of the world which was 6.8 from 2000 to 2012, and 1ST position was secured by East Asia with 8.6% growth rate in the world. Trade decreased 4% in East Asia and increased 18% in South Asia according to regional GDP, South Asia could not maintain the progress and declined soon after in 2015 to 2016 due to certain reasons, in 2014 recorded trade share was changed East Asia reached to 55% and South Asia declined to 47% of GDP, there are many factors affecting to business in South Asia, most problematic is unavailability of infrastructure which is on number 4thin world ranking except Sri Lanka on number 10th in ranking(Herrera Dape et al, 2016).(Arkolakis et al, 2012)Pointedout in 2012 that 75% trade of south Asia relies on sea transport as compare with 70% world average. Some other factors are transport and logistics , South Asia operate below the average in global average and in developing countries in the transport infrastructure(WEF2015).Export and import cost of container in South Asia is double as compare with East Asia, export of container is 46% higher and import of container is 59% higher according to doing business database 2014. For the export and import from south Asian ports to Europe and East coast united states it take 33 and 34 days for export and import simultaneously, this ratio in East Asia is just 20 and 22 days for import and export(Doing Business Database 2014).

Figure 6 Analytical Framework



Drivers of Maritime Transport Cost Effect to Port Efficiency

According to (Pantuso et al, 2014) global economy increased in 2000 to 2008 and containerized shipping and cargo carriage is also increased about 10%.

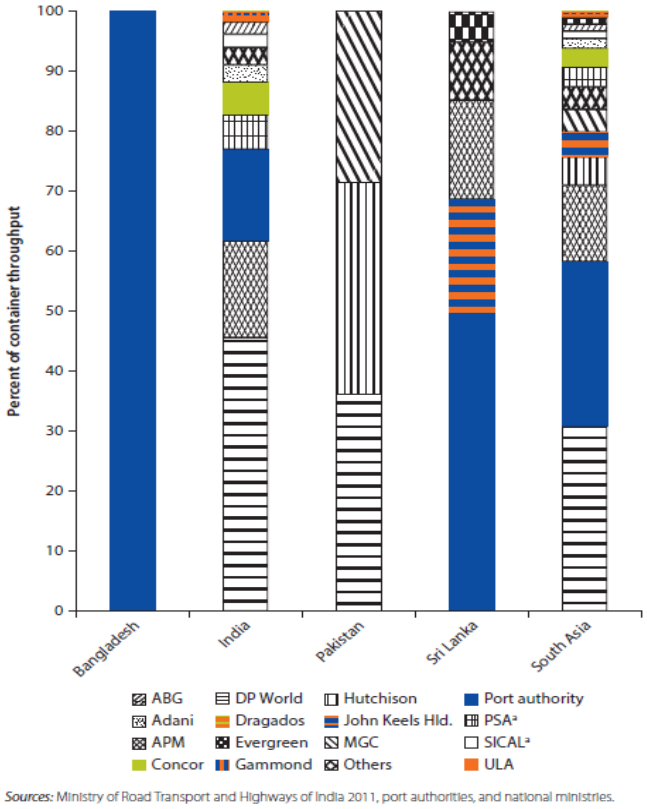


Figure 7 Selected Ports Operators

Containerisation

Commodities are carrying in large quantity through bulk and dry bulk carriers but box or container is great innovation and carry commodity in large quantity as compare with bulk and dry cargo. Bridgeman(Bridgman et al, 2014) suggested that, innovation in containerization did not decrease maritime transportation cost and it did not maintain one for one relationship. Containerization is not enough that companies use legal cartel for market powered(Bergeijk, 2009). One thing is

important that technology has once-off-effect and containerization is valuable innovation in technology.

Competition

Shipping companies operate with monopoly in selection of high volume routs these routes are filled with high mark ups due to price fixing and several agreements between the shipping companies. UN liner code has control over the cargo reservation and included in global barriers except maritime conferences and price-fixing agreements (Horn et al, 2010). According to world trade organization investment is not easy in the maritime sector of South Asia. Different barriers related to policies (Borchert et al, 2013) affect to transport cost near about 28% to 46%.

Oil & Distance

Direct costs are included time and fuel related to distance between the ports. Labour input increased after spending more days at sea and this time at sea is directly proportional to marginal cost of operation. According to (Atkinson et al, 2008) bigger ships take more time for loading and unloading at port and inverse relationship in size and cost of operation.

Trade Imbalance

Stated that Ireland export 40 percent more than import and Greece imports 60 percent more than export. Traders often bear highest cost if they receive empty containers from one country and send it back after loading from other country this could happened if country A import from country B but not export anything to country B. Trade between India and US affected when India bears 1,500 $ hauling container cost as compare with 2500 $ in opposite direction, It serve as proxy if the (Korinek et al, 2009)one leg of ships comprised on carriage of empty containers.

Trade Value and Volume

Trade value and volume absorb the abilities to change the freight rate between the different routes. Higher and lower cost effect to demand and supply of goods for example lower transportation cost attract to more demand of goods. Shipper charge more freight to high value goods due to higher insurance premium(wilmsmeier, 2017) Total transport cost have 15% share of insurance component.

Efficiency & Infrastructure

Ports are efficient which have lower handling cost and spent less time for loading and unloading(turnaround). All these activities are happened if cost is lower and port efficiency is the determinant of maritime transportation cost. Decrease in port efficiency decrease maritime transportation cost and increase in efficiency (hoffmann, 2017)), reduce cost as halving to distance amongst the ports.

Table 4 THC in Dollars/TEU

Karachi Port Trust	116
JNPT	96
Mumbai	110
Mundra	116
Kolkata	118
Kandla	109
Colombo	151
Chaittagong	86

Source;www.safemarine.com

Productivity Changes at Selected Ports

If we change input of any task output will automatically change, calculation of output become easy in one input and one output but it is difficult to calculate in multi type of input and output. One input and one output is comprised on straightforward computation but productivity of ports based on several inputs which covered different variables of performance. Computation of productivity on ports considered as total factor of production(TFP) and various sources effect to

productivity. To calculate productivity we use malmquist quantity index (Fare and others 1994), this index of total factor productivity changes comprised on data enveloped analysis(DEA) nonparametric approach. Different and detailed methodologies provided by Coelli and others in 2003 for TFP calculation. Suggested formula by Fare and others is as follows.

Equation 1Total Factor of Productivity Changes

$$TFPC_M = \frac{\text{EC}}{\text{TC} \times \text{PEC} \times \text{SEC}}$$

TFP=total factor of productivity,
TC = technical changes/ progress,
EC= efficiency changes,
Above mentioned formula is derived after further decomposition EC decomposed into PEC and SEC,
PEC= pure efficiency changes,
SEC =scale efficiency changes,

The input choose from literature review comprised on terminal yard, gantry cranes, RTGs and RMGs, number berth, equipment and human resource (Wang and Gulinnane, ji,2005), The data required for calculation is potentially sensitive, monetary value of net assets at selected port also effect to calculation , it could also(Chang, 1978) be included.

4.4 Port Operational efficiency variables

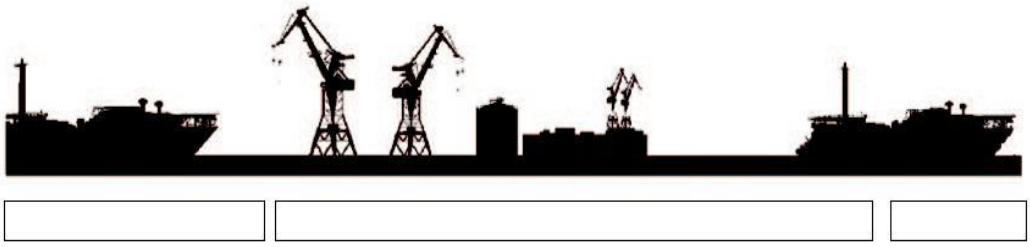
Operational efficiency of selected ports is calculated by following variables identified first by Richardo J Sanchez and Jan Hoffman,

- TAT (turnaround time)
- Congestion time
- SWT (general ship waiting time)
- Handling capacity at port
- Annual congestion
- Average stay per vessel
- Container average per vessel
- Container load rate per hour
- Bureaucratic turnaround time

Three factors effect to port efficiency incorporates in following table

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Figure 8 Performance Indicator in Port Operation



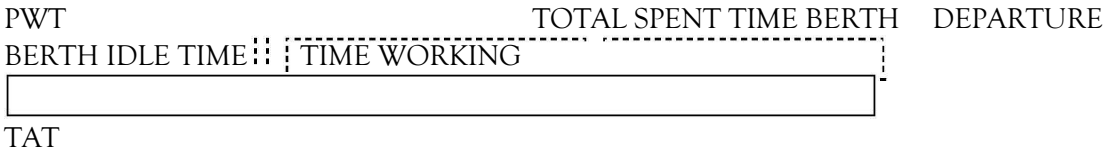
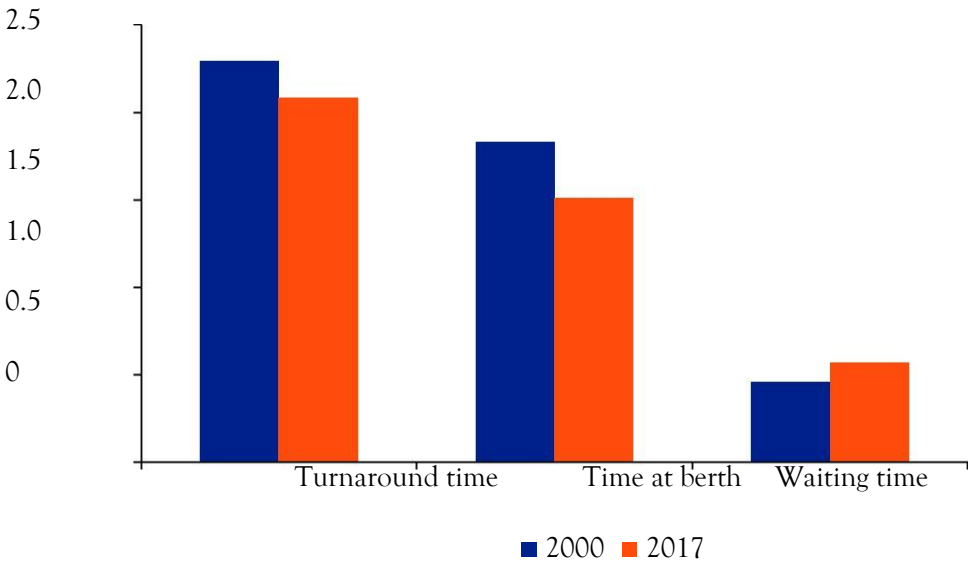


Figure 9 Average Time Spent in Days at Ports



Sources; Compiled by author based on port authority's websites.

Table 5 Port Efficiency Factors

Factor	variables
Per vessel stay at port,	Comprised on average stay per vessel
Efficiency in time,	Incorporate to 4 variables including general and bureaucratic turnaround time, ship waiting time, annual congestion time
Productivity,	Per vessel average container, hourly load rate of containers, handling capacity at port

Source; compiled by author based on RJ Sanchez et al.

Port efficiency measurement

The results indicate correlation of selected variables from -0.154 to 0.561 showed in below table

Table 6 Input & Output Data

Input						
Berth length	1.005					
Terminal area	0.699	1.003				
Refer points	0.659	0.700	1.004			
Quay cranes	0.793	0.810	0.756	1.005		
Yard equipment	0.801	0.701	0.603	0.841	1.005	
Total through p	0.585	0.721	0.625	0.801	0.783	1.005

Source; compiled by author based on calculation of SPSS

Selected nine variables correlated, container load rate in per hour, turnaround time and beurocratic turnaround time comprises on 60 percent variance intrinsically, fulfil Kaiser Criterion. Principal component analysis indicate three factors discussed in above table, first result

interpreting to time efficiency, second result indicating to productivity and last result comprised on average stay of ships at port, the variable of each factor is indicated in above table. The above table indicates great difference in productivity and same working of ports in time efficiency.

Maritime Transport cost effect.

We follow cost equation for maritime transport cost for eight selected ports in the research and use equation according to RJ Sanchez et al,

Equation 2 Maritime Transport Cost Equation

$$pijk = \phi(I,J,K) + mc(i,j,k)(1),$$

Above equation indicates cost in US dollar where marginal cost is assumed equal to waterborne transport cost, included as dependent variable of research,

= Maritime transport cost,
a = port of origin,
b = port of destination,
c = weight of commodity,
A = import country,
B = custom district in destination,
C = Product,
Mc = marginal cost
= mark-up

According to above equation mark-up is equal to (b,B) and marginal cost equal to (a.A), assumption for marginal cost

Equation 3 Cost Equation Step 2

$$mc_{abc} = \alpha_b CD_{c+} \lambda_C HS_c + \psi WV_{abc} + \gamma T_{abc} + \vartheta_{aB} + \rho Fl_{aew} + \omega PE_a \quad (2)$$

αb is effect of custom district, CDc dummy variable, ʎc is effect of product class or type, HSc dummy variable, ψWVabc indicate to insurance component, γTabc fraction of product in container, ϑaB distance between the foreign port and main port,ρFlaew regular services base on monthly transport between the ports, ωPEa port 'a' efficiency.

Maritime transport cost is effect by shipping company mark up, to evaluate mark-up we used formula,

Equation 4 Shipping Companies Mark-up

$$\phi(A,B,C) = \mu c + \psi^{PA} A_{AB}^{PA} + \psi^{CA} A_{AB}^{CA} \quad (3)$$

demand elasticity is also derived in above equation where it derive from demand of product, μc difference of demand elasticity, $\psi^{PA} A_{AB}^{PA}$ showed that price fixing agreement is existed between shipping lines A and B,$\psi^{CA} A_{AB}^{CA}$ indicates that no price fixing agreement and co-operative working is existed. Some terms are added in the above equation to compensate the error,($\in_{abc}$), dependent variable is discussed which adressed to transport cost for per ton of container export from selected eight ports to US port.

Transport cost determinants

variable	Coefficient	T	Coefficient	t	coefficient	t		
Distance	0.86868	2.2	0.044321	1.11	0.055729	1.12		
Value	0.522044	10.3	0.434214	10.3	0.512044	10.5		
Frequency	-0.108342	-2.1	0.018132	-1.44	-0.82345	-1.31		
Containerization	-0.002463	-0.15	-0.14169	-0.19	-0.21343	-0.21		
Agreements	0.078534	1.32	0.052187	0.43	0.038432	0.65		
Time efficiency					0.032731	1.12		
Productivity	-0.061231	-3.02						
Stay per vessel			0.001298					

Source; calculated by author based on calculation

RESULTS

Regression is performed; PCA (principal component analysis) built up result on some variables of maritime transport cost combines with three factors of port efficiency, variables and factors discussed in above chapter

Table 7 Input Data for Calculation

Variable	coefficient	t	coefficient	t	coefficient	t
Statistics	Berth Length	Terminal Area(m)2	T/R point	Quay Cranes	Equipment	Throughput
Minimum	95	3200	0	1	6	9600
Maximum	10500	5958726	7000	57	462	26935400
Mean	3645	692361	1026	13.5	77.6	234915.8
Std Deviation	3724	1193234	16848	18.5	110.5	4690012

Source; compiled by author

Table 8 Changes in Port Efficiency Factors

Stay per vessel			0.00791	0.02		
Efficiency in time					0.032592	1.07
Productivity	-0.053930	-2.45				

Source; compiled by author

Regressions of Maritime Transport Cost Variables

Distance

Our analysis indicated that one percent increase in distance also increase transport cost 0.06% percent, estimated elasticity of distance is not very high on 8 selected ports of South Asia, distance effect less to port efficiency when it comprised on large distance. Positive correlation is found between maritime transport cost and distance

Value per weight

Estimated coefficient of value per weight is indicated significant effect on maritime transport cost, result indicated that maritime transport cost increased 0.46% by the one percent increase in value per weight of commodity.

Frequency

In our research negative effect of frequency is found 1% increase in frequency decrease maritime transport cost one or half percent, RJ Sanchez et al stated that frequency of liners on same route decrease maritime cost and negatively effect to transport cost.

Containerisation

Containerisation is part technology, change in technology is brought fruitful results, in the 100% containerized cargo negative effect on maritime transport cost, it decrease maritime transport cost.

Agreements

Agreements between the companies significant to be 3.5% for maritime transport cost in which none of them turns out from agreement.

Regression of port efficiency factors

Productivity

Calculated coefficient indicated that productivity effect on maritime transport cost is negative, 1% increase in productivity decrease to maritime transport cost, port level efficiency at its peak decrease transport cost.

Time efficiency

It also not effect significantly to maritime transport cost, helpful to increase overall efficiency at port level

Average stay per vessel

It only depends upon variable, it increases if port is less efficient, and operator of liners also chose to earn more cargo from selected port (RJ Sanchez et al).

Impact of port efficiency on maritime transport cost and trade of selected ports

Three factors and nine variables of port efficiency including with variables of maritime

transport cost explains the export of eight selected ports of South Asia to US. Transport cost is more for higher weight per value commodities in kilogram, distance between the ports also increased cost, containerisation variable is neutral for port efficiency, Hummels 2007 stated that ''real gains from containerisation might come from unmeasured quality change in transportation services' 'it offered benefits in fast loading and unloading. Statistics of variables related maritime transport cost is presented below in the table,

Table 9 Maritime Transport Cost variables Results

Variable	Mean	standard deviation	minimum	maximum
Value per weight	1.04	0.87	-1.90	4.61
Distance	8.74	0.22	6.45	5.70
Trade imbalance	-0.29	0.21	-0.41	0.52
Containerisation	0.43	0.25	0.12	0.81
Weight	6.93	1.43	0.98	8.58
Efficiency variables	0.35	0.13	0.10	1.00

Source; compiled by author based on calculation.

Eight ports of South Asia are closed for export from south Asia to US, results are compared with studies of Limao and Venables who made research after selected port of Baltimore as export port, results we achieved about containerisation similar with Bridgman (2014) and RJ Sanchez et al 2003. Efficiency variables in the above table based DEA representing pure efficiency, scale efficiency and constant return to scale (CRS). Economies of scale is indicated in below table discussed only to pure efficiency.

Cost reduction to becoming more efficient

Some ports including Chittagong, JNPT, Mundra, Mumbai and Karachi port reduced their maritime transport cost in 2000-2007. Most efficient port sector in cost cutting is in the hand of Sri Lanka (Colombo port). Ports with minimum maritime and transport cost are more efficient and it also increase trade at the port, 10% reduction in maritime transport cost (Korinek et al, 2009) 8 % increase in trade. According to result Colombo port is more efficient, if Chittagong, KPT, JNPT, Mumbai and Mundra competing with Colombo port their trade would have been 0.6% to 9%. Indian container shipping is not more efficient due inefficiencies in infrastructure related with the container movement(rail, highway, ports) inefficiencies existed at Indian port due to port handling charges, highest lead time and costly transportation charges because inefficiencies 45% container traffic of India captured by other ports stated that Kelang(16%), Colombo(15%), Dubai and Salalah(14%) (Mukundan, 2007).

Conclusion and Recommendations

Conclusion

Container shipping business is more competitive as compare with past, ports attract to more customers in terms of efficiency and maritime transport cost. Tariff, port charges and terminal handling charges was important but today companies more considered to overall cost cutting of operation, they rely more on logistic performance of ports. KPT also have competitive freight and handling charges as compare with the competitor but port efficiency variables in terms of operational and economic performance KPT lacks in competitive environment, because shipping companies conceded more to indirect cost of operation e.g. confidence of customers, delay in operation and economic activities and loss of market. Operational improvement and efficient use of infrastructure enhance to total factor of productivity and efficiency of port, according to dissertation some ports improved their performance e.g.Jawahar LalNehru port, Qasim and Mundra, the ports which operating with high performance concentrate more on infrastructure and operational efficiency variables by reducing turnaround time, average stay per vessel and delays at port weaknesses are

existed at SACP but mainly transport effect to competitiveness of SACP.

6.2 Recommendation

Infrastructure is essential to compete in the global economy. All the selected ports except Colombo port of Sri Lanka did not perform more efficiently due to infrastructure. Companies divert their business due to infrastructure but their port selection choices effect more due to above variables, so it is important to concentrate more on logistical activities in terms of cost cutting via forward and backward integration of ports according to our research some variables directly effect to port performance and operational efficiency which are turnaround time, average stay per vessel and idle time so better ownership and cooperation of state government reduce all the variables, moreover proper management of tug gage, pilotage and use of infrastructure also enhance port efficiency. Trade imbalance, containerization and freight rate are some variables of maritime transport cost which directly effect to port efficiency, these costs are reduced through horizontal and vertical integration of ports, strong union at Karachi port trust oppose to privatization and major reforms at port, management should properly bargain with CBA and convinced them to compete in the international competitiveenvironm.

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