European Journal of Business and Management
ISSN 2222-1905 (Paper) ISSN 2222-2839 (Online)
Vol.9, No.3, 2017

Jawaharlal Nehru Port Trust (JNPT): A Leading Container Port in India

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Abstract
Container ports are complex organizations hosting multiple simultaneous activities, e.g. tugging, pilotage, mending, etc., but container handling is the principal function of a container port, with handling constituting over 80% of the charges faced by a carrier bringing a container vessel to a port for loading and unloading (Tovar, Trujillo and Jara-Diaz, 2004). Because of various activities that take place in a container port, agents involved in container ports are diverse: port authorities, terminal operators, tug boats, freight forwarders, consigners and consignees etc. Container transport within the port can be handled by a port authority, a terminal operator or inland logistics companies. For instance, a port authority's objective could be to create and maintain the labour capacity, whereas the terminal operator's objective could be to maximize the profit, and the inland logistics company's objective could be to improve service reliability. Physically, a container port consists of one or more container terminals. In order to transport containers from ship to shore and within the port, the required facilities include berths for ships to park, area for container stacking and storage, and handling equipment to upload and unload containers. Among those facilities, the container handling equipment differentiates container ports from other ports. There is a vast variety of container handling equipment, but they can be classified into two main groups: quay cranes and yard handling system. On the quayside, containers are transported between ship and shore and container quay cranes are the main equipment used for ship loading and unloading. It can be either mounted on the ship (ship-mounted cranes), or located on the quay, ship-to-shore (STS) cranes; the latter is widely used in container ports and terminals. On the yard side, containers are transferred to land transport modes or are arranged to be loaded on to other ships. Two types of activities occur in the yard area: stacking of container and horizontal transport. The container ports facilities are required to be of the scale matching the container cargo traffic handled by the port. This study is having the objectives of carrying out trend analysis for JNPT port and also to forecast capacity of cargo traffic for the JNPT port.

1. Introduction

The container port has been evolved to improve handling efficiency, primarily port handling efficiency and handling between different transports modes. Standardization of cargo handling therefore requires highly specialized facilities. The facilities of a container port are the same, regardless of their size and regulatory policy. The World Bank classifies port assets into four different categories: basic port infrastructure, operational infrastructure, superstructure, and equipment. Before containers are moved away they are stacked in the yard area of the port. Stacking equipment for containers includes Straddle Carriers, Rubber Tired Gantry Cranes (RTGs), Rail Mounted Gantry Cranes (RMGs), Reach stackers, and Stackers for Empty Containers. Horizontal terminal transport is the movement of containers between the ship to shore cranes, the stacking area, and the landside operation. Equipment for horizontal transport includes trucks, trailers, straddle carriers, automated guided vehicles (AGV), and reach stackers. In addition to the handling facility, terminal size, berth length, storage and trained labour are all important to the operation of container handling. A container port can be seen as the collection of its container terminals in terms of physical structure.

JNPT was established on 26th May 1989 with the goal of creating a world-class port in India. It is located at latitude $18^0$56'43" north and longitude $72^0$56'24" east along the eastern shore of Mumbai harbour off Elephanta Island, Navi Mumbai. The port is having draught up-to 12.50 meters and land area of 2584 hectares. JNPT handles containers, liquid bulk & general cargo. It has three dedicated container terminals namely Jawaharlal Nehru Port Container Terminal (JNPCT), Nhava Sheva International Container Terminal (NSICT) & Gateway Terminal India (GTI). The Port is ISO 9001:2000, 14001 2004 & OHSAS 18001 2007 certified and ISPS compliant. It is ranked 34th among top 100 container ports in the world and handles more than 50% of total containers handled by all Major Ports in India. The port is connected with 24 Container Freight Stations (CFSs) and 34 Inland Container Depots (ICDs) destinations. JNPT port handled 62.33 million tonnes of total cargo during the financial year 2013-14, in which the containerized cargo was 55.23 million tonnes and liquid cargo was 6.28 million tonnes and remaining 0.82 million tonnes of dry bulk and break bulk cargo. The container

traffic handled by the port is 4.16 million TEUs during the financial year 2013-14. Out of the total traffic of 4.16 million TEUs, the share of JNPCT was 1.31 million TEUs, the share of NSICT was 0.97 million TEUs, and remaining 1.88 million TEUs were contributed by GTI.

The designed channel depth is 13.1 meter in JNPT channel & 14.2 meter in outer harbour channel (Below Chart Datum). Channel width is 370 meters at straight reach, 460 meters at the berths. Depth at berth is 16.5 meters (Below Chart Datum). The anchorage berth is 600 meters, 2000 meter of quay length for container berths, 445 meters of quay length of Feeder Container / Cement / Project Cargo Ships and twin berths for the liquid cargo jetty.

Mumbai Port Trust (MPT) clearly enjoyed an edge over other Indian ports with respect to both infrastructure and performance even in the pre-reforms period, i.e, July 1991. However, it suffered from some of the inherent drawbacks ailing the Indian port sector that prevented it from achieving world standards in port efficiency. As the most modern among Indian ports, and also the one with the least labour problems, JNPT was the natural choice as a test case in privatization of port operations. With the creation of a new private terminal and the follow-up measures undertaken thereafter, JNPT has demonstrated its capability to enhance efficiency of the public terminal through the introduction of private terminals competition.

JNPT is the number one seaport of India in terms of container handling and is well connected by rail and road. Excellent facilities are available for handling container and other cargo in three container terminals shallow draught berths and one liquid terminal, (JNPCT, NSICT, GTI SDB and BPCL), 24 Container Freight Stations in operation, 34 Inland Container Depots well connected with the port, a full-fledged Custom House that operates 24x7, leading banks, shipping lines /agents, CHAs, trading houses and other authorities too function at JNPT. Other infrastructure such as airport, hotels and recreation centres are also available in the vicinity.

2. Objectives of the Study

The main objectives of the study are as follows.

i) To measure the growth of JNPT port's throughput in terms of tonnage for exports, imports and total cargo handled during the time period 1993 to 2014.
ii) To measure the growth of JNPT port's throughput in terms of TEUs for exports, imports and total cargo handled during the time period 1993 to 2014.
iii) To forecast the cargo traffic of JNPT port for the years 2030 in terms of TEUs.

3. Review of Literature

Levinson (2006)[1] stated that the container ports are important for multimodal transportation and reduction in freight as the transportation of cargo in containers can be interchanged between ships, trains, and trucks with standardized handling equipment, and without re-handling the contents. The container is at the core of a highly automated system for moving goods from anywhere, to anywhere, with a minimum of cost and complication on the way. The container made shipping cheap and by doing so changed the shape of the world economy. Containers ports have greatly reduced the cost and time which required packing and moving cargoes; and also have made intermodal possible, thereby supporting the growth of new patterns of global production and distribution. **Ramanakumar K. Srinivasan M. (2009)**[2] have stated that in Chennai alone, around 90 per cent of the cargo like newsprint, wood pulp and nylon for the tyre industry, which used to ship in break bulk are now being containerised. The 12 major ports, placed under the Union List of the Indian Constitution, are statutory bodies (trusts) administered by the Government of India under the **Indian Ports Act, 1908**[3] and the **Major Port Trust Act, 1963**[4]. The Indian Ports Act (1908) lays down rules regarding safety of shipping and conservation of ports for the entire port sector and regulates matters pertaining to the administration of port duties, pilotage and other charges. The Major Port Trust Act (1963) lays down the institutional framework for the major ports in India. Accordingly, each major port is governed by a Board of Trustees appointed by the Government of India. The composition of these Boards reflects greater government representation compared to private interest groups. The trustees exercise limited power and are bound by directions on policy matters and orders from the Government of India. The port trusts are expected to serve public interest rather than maximising profits or revenues, while at the same time, ensuring optimum deployment of assets. The 12 major ports in India together handled 7.704 Million containers (TEUs) in the year 2012-2013. The details of containers handled by each container port are given as per the official website of The Indian Ports Association. **K. Balasubramaniam (1997)**[5] has stated that the nation's road, rail, and sea transport system is deficient in many ways and the

[1] Mark Levinson (2006), 'The Box', Princeton University Press, Princeton, USA, 2006.
[2] Ramanakumar K. & Srinivasan M. 2009, 'Containerization is on the Fast Track in India', *Journal of Contemporary Research in Management,* January - March, Pg 52.
[3] https://india.gov.in/acts-and-rules-ministry-shipping
[4] https://india.gov.in/major-port-trust-act-1963.
[5] K. Balasubramaniam 1997, "Indian Port Paradox," Containerization International p.71.

performance of Indian ports is well below acceptable international norms. A recent scrutiny of Indian ports emphasized the need to transform the Trust Ports into "landlord ports". This greater autonomy and increased private sector participation will result in Ports becoming islands of excellence as opined by **(G. De Monie (1995)**[1]**. G. De Monie (1995)**[2] stated that one of the problems with Indian Ports includes their physical configuration and proximity to urban development centres. He has further pointed out that the major problem is of old port facilities and equipment, absence of equipment maintenance, lack of coordination of port activities, draft restrictions that preclude the handling of modern container vessels, and a virtual nonchalant attitude towards the changing nature of international trade and technological advances. **B. Jaques (1995)**[3] stated because of the uncertainty associated with container movements in Indian ports in general, the major container operators resist sending their main-line (mother) vessels to India. Thus, Indian exports and imports are typically carried by feeder vessels through trans-shipment centres in Colombo, Singapore, and Dubai. A study placed in the **Indian Parliament in March 2012 by the Comptroller and Auditor General of India (CAG)**[4] highlighted that cargo handling services at ports were inefficient. A predominant number of berths did not have the dedicated facilities necessary for the quick handling of cargo. Around 55 per cent of the equipment available at all ports, except at the Jawaharlal Nehru Port Trust (JNPT), were running beyond their rated economic lives, resulting in low utilization. **Sundar, S. (1998)**[5] stated that inefficient port services raised transport costs of exports and imports. It was estimated that the annual incidence of various factors like demurrage charges, transhipment costs, pre-berthing delays and vessel turnaround time made exporters even less competitive in global markets. High cost imports adversely affected domestic producers who used imported raw materials and equipment as well as domestic consumers. In particular, higher costs of imported inputs had strong effect of raising production costs across the board, with its consequent adverse effects on the entire national economy. **Amit Ray (2004)**[6] stated that inefficiency of Indian Ports often contributed to their revenue earnings in the form of demurrage charges on cargo stored for a long time on port premises. This represented nothing but a rent earned by the inefficient port system. Indeed, many of the ports recorded high operating surpluses, often overestimated due to the fact that depreciation and user-cost of capital were not adequately taken into account. Consequently, wide variations were observed in efficiency among the 13 major ports of India. The average pre-berthing time on port account varies between 0.4 hours and 23 hours. The average turnaround time also varies between two to five days. In contrast, the turnaround time at globally competing ports like Singapore and Hong Kong is between four and six hours **(Maritime Agenda 2010-2020)**[7]**.** In 1994, the **Ministry of Surface Transport (MoST) of the Government of India**[8], which was the nodal agency overseeing the Indian port sector, published a policy document specifying the broad contours of desired reforms in the sector. The document highlighted the intention of the government to create a more conducive atmosphere for privatizing key port facilities and amending the governing rules, regulations and procedures accordingly. The document, however, refrained from adopting an aggressive posture towards reforms by specifying that involvement of private initiative will not entail changes in the existing labour laws, and by capping the tariffs charged by private operators within limits specified by the government. Private sector participation was being essentially sought in areas where the former could offer attractive rates of return on the port assets leased out and also assure no retrenchment of labour over a given period of time. A clearer direction to India's port reforms was provided by **World Bank (1995)**[9]. The report drew attention to the various inefficiencies prevailing in India's port sector and emphasized upon the nature of reforms required in various segments for turning around the sector. Apart from indicating the required legislative changes and relevant reforms relating to port labour, the World Bank report spelt out the modalities for private sector involvement in Indian ports. A study for the 'Asian Development Bank' identified the following major frustrations in the context of privatization in India such as the absence of a firm national consensus in favour of privatization that sent conflicting signals to likely bidders especially from abroad , the suspicion that privatization efforts are pursued primarily to seek funds rather than in response to policy objectives. There is no intention on the part of the government to alter the antiquated labour laws **(Techno Economic Policy Reforms in the Indian Ports and**

[1] De Monie 1995, "The Problems Faced by Indian Ports Today," Maritime Policy and Management, 22, No. 3, Indian Port Privatization Special Edition, p 235.
[2] G. De Monie 1995, "The Problems Faced by Indian Ports Today," Maritime Policy and Management, 22, No. 3, Indian Port Privatization Special Edition, p 235.
[3] B. Jaques 1997, "Unleashing A Giant," Sea Trade Review, p.7.
[4] http://www.cag.gov.in/sites/default/files/audit_report_files/Maharashtra_Report_3_2013.pdf
[5] Sundar, S. 1998, "Port restructuring in India", Tata Energy Research Institute (TERI), New Delhi.
[6] Amit S Ray (2004), "Managing Port Reforms in India: Case Study of Jawaharlal Nehru Port Trust (JNPT), Mumbai", Background Paper, World Development Report 2015, February 15, 2004.
[7] Maritime Agenda 2010-2020, Ministry of Shipping, Government of India, January 2011.
[8] Ministry of Surface Transport (MoST) of the Government of India, http://morth.nic.in
[9] World Bank (1995), www.worldbank.org

Shipping Sector (1993)[1]**. A. Bascombe (1995)**[2] stated that the decision by the Indian MoST (Ministry of Shipping Transportation to privatize port operation has met with resistance from the Port Trusts themselves and the powerful dockers' unions.

4. Research Methodology

The selection of variables is the key step in any research analysis. It is the precision of the analysis and estimation of parameters for the study. We examine the container traffic flow which is, the transport of containers from sea to land or back to sea again. To fulfill these functions, a port needs a variety of facilities, but particularly two kinds of facilities, i.e., infrastructure and equipment. These facilities are called as inputs to the container ports production. Infrastructure includes berth depth, berth length (or quay length), terminal area, yard space, storage and equipment includes number of handling machinery and handling capacity. The output of a container port is the number of containers handled in that port/terminal per annum. Twenty-foot equivalent unit (TEU) is the international standard measure used for container ports; thus, we adopt TEU as the output measure. According to the availability of data, the selected time period considered for the study is from 1993 to 2014 and it incorporates JNPT port. The details of time series data for this analysis are as follows.

i) Container Traffic Handled (Export) by JNPT port in tonnes ($CTH_{EX\text{-}JNPT(ton)}$).
ii) Container Traffic Handled (Import) by JNPT port in tonnes ($CTH_{IM\text{-}JNPT(ton)}$).
iii) Total Container Traffic Handled (Export & Import) by JNPT port in tonnes ($CTH_{TOT\text{-}JNPT(ton)}$).
iv) Container Traffic Handled (Export) by JNPT port in TEU ($CTH_{EX\text{-}JNPT}$).
v) Container Traffic Handled (Import) by JNPT port in TEU ($CTH_{IM\text{-}JNPT}$).
vi) Total Container Traffic Handled (Export & Import) by JNPT port in TEU ($CTH_{TOT\text{-}JNPT}$).

By trend, we mean a sustained upward or downward movement in the behavior of the dependent variables. Trend is slow and long run evaluation of the variable which we want to incorporate to the model. Here, the study will focus on models of deterministic trend, in which the trend evolves in a perfectly predictable way. Deterministic trend models are tremendously useful in practice. The study is assume a simple linear trend function of time, viz., $Y = \alpha + \beta T$, which provides a good description of trend. The variable time (T) is constructed artificially, which is called time trend or time dummy. Time equals to 1 in the first period of sample, 2 in the second period and so on. Thus, for a sample size of N, time (T) = (1,2,3,…., N-1,N). α is the regression intercept, it is the value of the trend at time (T) = 0. β is the regression slope; it is positive if the trend is increasing and negative if the trend is decreasing. The larger the absolute value of β, the steeper the trend's slope. The time (T) is independent variable and container traffic (throughput) handled by selected port is dependent variables. We have used the statistical package SPSS (version 13) for computing trend equations and drawing line diagrams. The details of time trend equations are as follows.

$CTH_{EX\text{-}JNPT(ton)} = \alpha_1 + \beta_1 T$ ---------- (1)
$CTH_{IM\text{-}JNPT(ton)} = \alpha_2 + \beta_2 T$ ---------- (2)
$CTH_{TOT\text{-}JNPT(ton)} = \alpha_3 + \beta_3 T$ ---------- (3)
$CTH_{EX\text{-}JNPT(teu)} = \alpha_1 + \beta_1 T$ ---------- (4)
$CTH_{IM\text{-}JNPT(teu)} = \alpha_2 + \beta_2 T$ ---------- (5)
$CTH_{TOT\text{-}JNPT(teu)} = \alpha_3 + \beta_3 T$ ---------- (6)

Here, α and β are the intercept and slope coefficient parameters for the linear time trend equations respectfully. The linear regression model will be used to forecast the container capacities for JNPT port by the year 2030. The linear regression analysis will incorporate the containers handled in numbers (TEUs) for the time period 1993 to 2014. The proposed 'Linear Regression Model' for forecasting the container capacity at JNPT Port by the year 2030 is as follows.

$CTH_{TOT\text{-}JNPT(teu)} = \alpha_1 + \beta_1 T$ ---------- (7)

Where, $CTH_{TOT\text{-}JNPT(teu)}$ is total cargo traffic in container numbers ('000 TEUs) handled by JNPT port during the selected time period of 1993 to 2014 (22 years) and α_1 and β_1 are the intercept and slope coefficient parameters for the regression equation respectfully.

5. Linear Time Trend Analysis

In time trend analysis we regress each of the trend indicator of container traffic handled by JNPT port in India over time. If the slope coefficient of the trend equation is positive then there is an upward trend in the dependent variable and in case of negative slope coefficient, there is a downward trend of the dependent variable. The 'Time' is independent variable and the dependent variable is the container traffic handled for Exports (loaded), Imports (unloaded) and Total cargo handled. The container traffic is measured both in terms of Tonnage (weight of containers) and TEUs (number of containers) handled. According to the availability of data, the selected time

[1] Asian Development Bank Report on Techno Economic Policy Reform in the Indian Ports and Shipping Sector, 1993.
[2] A. Bascombe 1995, "The Waiting Game," Containerization International, p. 89.

period considered for the study is from 1993 to 2014.

5.1. Export Cargo Handled by JNPT Port in Thousand Metric Tonnes

Here, the dependent variable is export cargo traffic in thousand metric tonnes handled by JNPT port during the selected time period. The explanatory variable for this linear time trend equation is Time (Years). The estimated linear trend equation is as follows.

$$CTH_{EX\text{-}JNPT(ton)} = -2710.51 + 1544.78\,T \quad \text{---------- (1)}$$

SE = 70.30, t = 21.98, p = 0.00

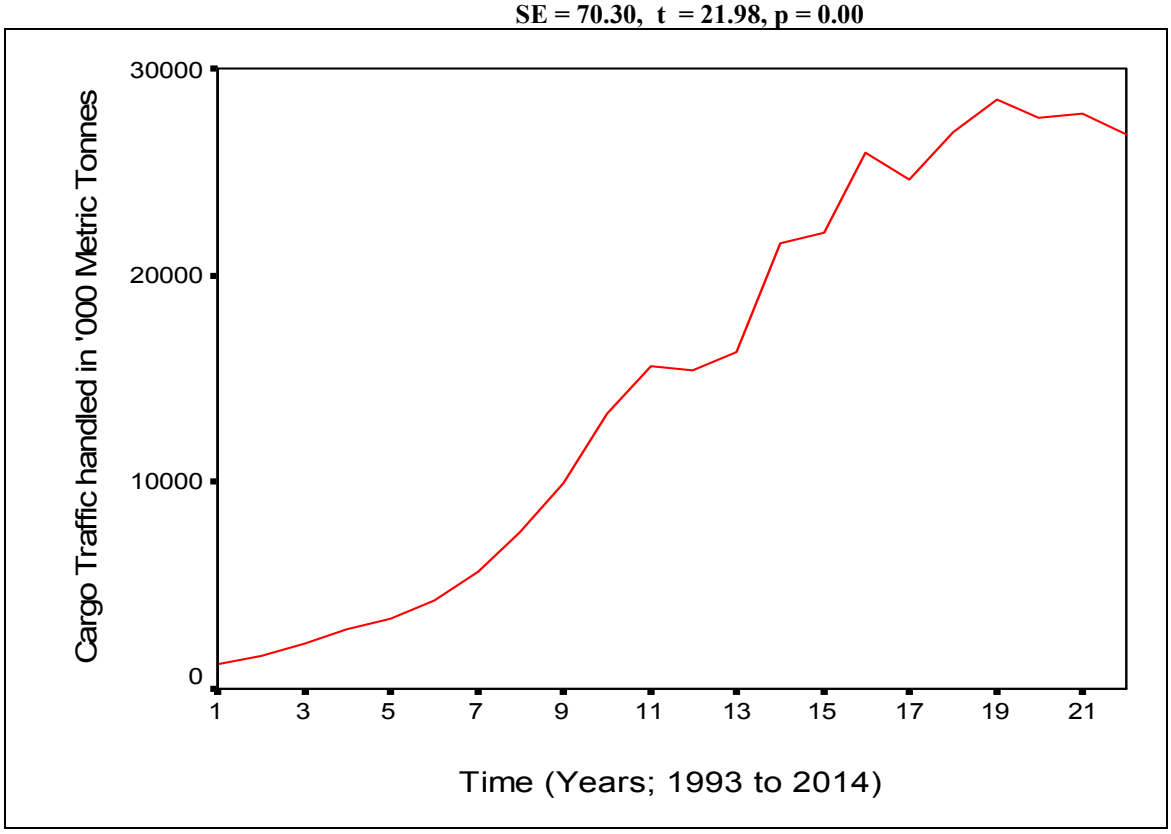

Fig. No. 5.1: Export Cargo Traffic Handled by JNPT Port ('000 Metric Tonnes, 1993-2014)

In the above equation (5.1), the estimated slope coefficient is positive (1544.78), which means that the export cargo traffic handled by JNPT port has an upward trend over time. The level of significance of the estimated result is 1 % (Two Tailed Test; p value is 0.00), which indicates that the result is highly significant. The line diagram in the above figure (5.1) shows three phases of growth over selected time period. The first phase is from1993 to 2000, where the growth is slow but steady. The second phase is from 2001 to 2006, which witnesses steady and good growth. Lastly, the third phase is from 2007 to 2014, which indicates a flatter and fluctuating growth rate. Overall, the trend is upward rising during selected time period.

5.2. Import Cargo Handled by JNPT Port in Thousand Metric Tonnes

Here, the dependent variable is import cargo traffic in thousand metric tonnes handled by JNPT port during the selected time period. The explanatory variable for this linear time trend equation is 'Time' (Years). The estimated linear trend equation is as follows.

$$CTH_{IM\text{-}JNPT(ton)} = -4581.23 + 1676.22\,T \quad \text{---------- (2)}$$

SE = 83.21, t = 20.15, p = 0.00

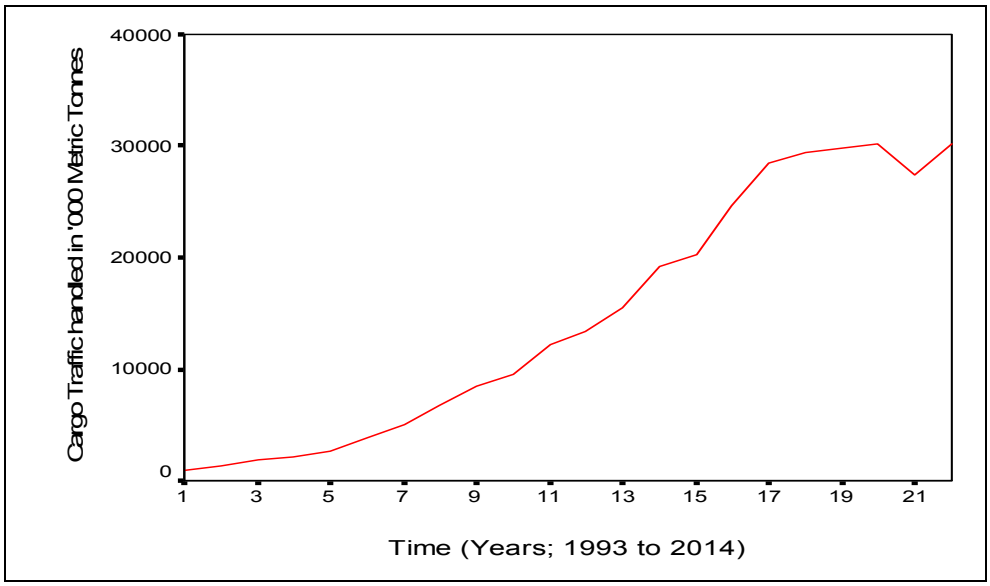

Fig. No. 5.2: Import Cargo Traffic Handled by JNPT Port ('000 Metric Tonnes, 1993-2014)

In the above equation (5.2), the estimated slope coefficient is positive (1676.22), which means that the import cargo traffic handled by JNPT port has an upward trend over time. The level of significance of the estimated result is 1 % (Two Tailed Test; p value is 0.00), which indicates that the result is highly significant. The trend of line diagram in the above figure (5.2) shows two phases of growth over selected time period. The first phase is from1993 to 2010, where the growth is steady upward sloping. The second phase is from 2011 to 2014, which witnesses flatter upward growth. Overall, the trend is upward rising during selected time period.

5.3. Total Cargo Handled by JNPT Port in Thousand Metric Tonnes

Here, the dependent variable is total (export plus import) cargo traffic in thousand metric tonnes handled by JNPT port during the selected time period. The explanatory variable for this linear time trend equation is 'Time' (Years). The estimated linear trend equation is as follows.

$$CTH_{TOT\text{-}JNPT(ton)} = -6974 + 3218.59\,T \quad \text{---------- (3)}$$

SE = 158.01, t = 20.37, p = 0.00

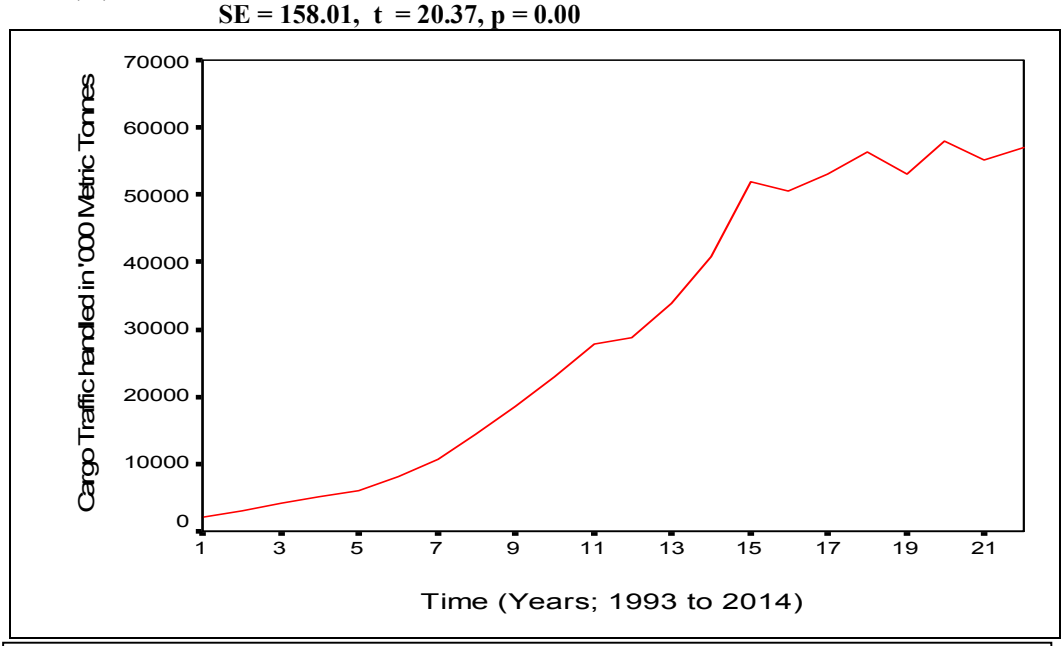

Fig. No. 5.3: Total Cargo Traffic Handled by JNPT Port ('000 Metric Tonnes, 1993-2014)

In the above equation (5.3), the estimated slope coefficient is positive (3218.59), which means that the total cargo traffic handled by JNPT port has an upward trend over time. The level of significance of the estimated result is 1 % (Two Tailed Test; p value is 0.00), which indicates that the result is highly significant. The trend of

line diagram in the above figure (5.3) shows two phases of growth over selected time period. The first phase is from1993 to 2008, where the growth is steady upward sloping. The second phase is from 2009 to 2014, which witnesses flatter and fluctuating upward growth. Overall, the trend is upward rising during selected time period.

5.4. Export Cargo Handled by JNPT Port in Thousand TEUs

Here, the dependent variable is export cargo traffic in container numbers ('000 TEUs) handled by JNPT port during the selected time period. The explanatory variable for this linear time trend equation is 'Time' (Years). The estimated linear trend equation is as follows.

$$CTH_{EX\text{-}JNPT(teu)} = -207.71 + 121.70\,T \quad \text{---------- (4)}$$

SE = 5.47, t = 22.27, p = 0.00

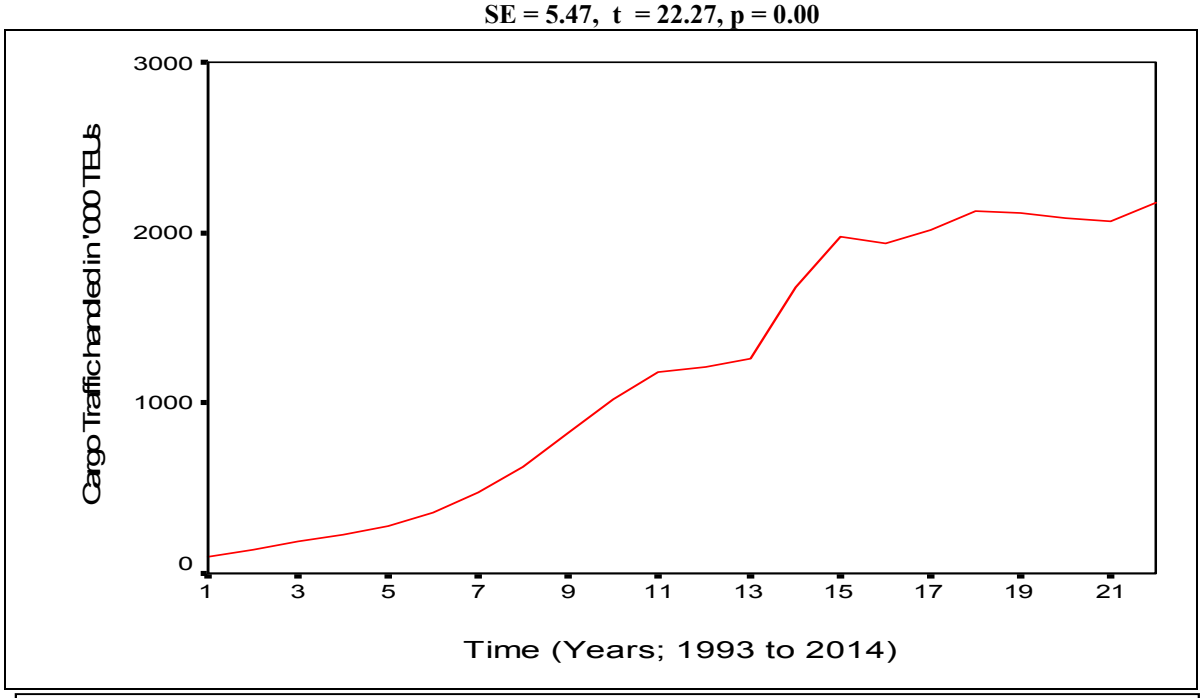

Fig. No. 5.4: Export Cargo Traffic Handled by JNPT Port ('000 TEUs. 1993-2014)

In the above equation (5.16), the estimated slope coefficient is positive (121.70), which means that the export cargo traffic in container numbers ('000 TEUs) handled by JNPT port has an upward trend over time. The level of significance of the estimated result is 1 % (Two Tailed Test; p value is 0.00), which indicates that the result is highly significant. The line diagram in the above figure (5.16) shows three phases of growth over selected time period. The first phase is from1993 to 2000, where the trend is slowly upward rising. The second phase is from 2001 to 2011, which indicates that the trend is steeper and increasing with mild fluctuating. The third phase is from 2012 to 2014, where the trend is flatter and slightly decreasing. Overall, the trend is upward rising during selected time period.

5.5. Import Cargo Handled by JNPT Port in Thousand TEUs

Here, the dependent variable is import cargo traffic in container numbers ('000 TEUs) handled by JNPT port during the selected time period. The explanatory variable for this linear time trend equation is 'Time' (Years). The estimated linear trend equation is as follows.

$$CTH_{IM\text{-}JNPT(teu)} = -290.31 + 127.94\,T \quad \text{---------- (5)}$$

SE = 5.70, t = 22.46, p = 0.00

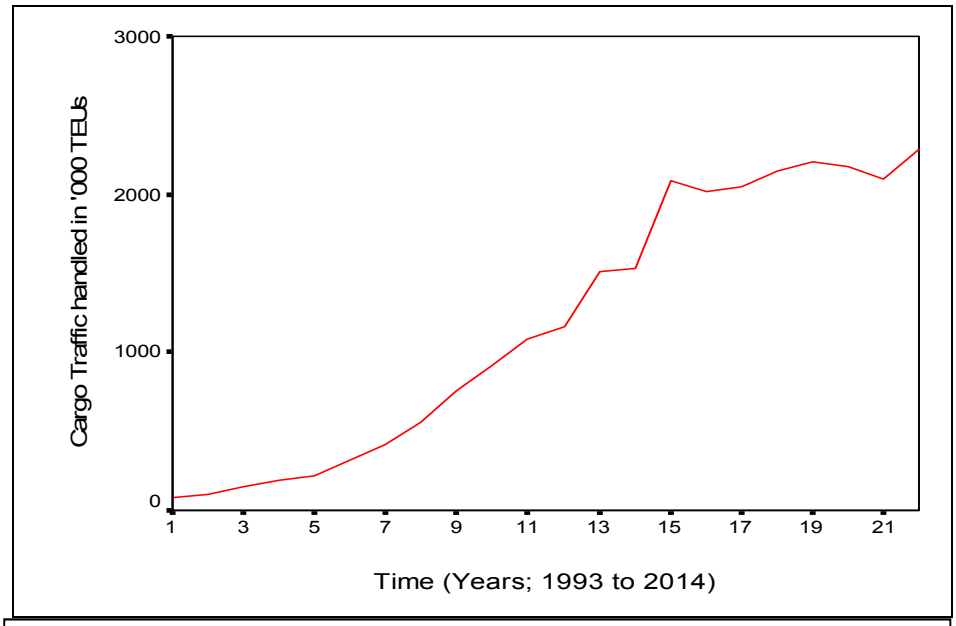

Fig. No. 5.5: Import Cargo Traffic Handled by JNPT Port ('000 TEUs, 1993-2014)

In the above equation (5.17), the estimated slope coefficient is positive (127.94), which means that the import cargo traffic in container numbers ('000 TEUs) handled by JNPT port has an upward trend over time. The level of significance of the estimated result is 1 % (Two Tailed Test; p value is 0.00), which indicates that the result is highly significant. The line diagram in the above figure (5.17) shows three phases of growth over selected time period. The first phase is from1993 to 2000, where the trend is slowly upward rising. The second phase is from 2001 to 2011, which indicates that the trend is steeper and increasing with mild fluctuating. The third phase is from 2012 to 2014, where the trend is flatter and slightly decreasing. Overall, the trend is upward rising during selected time period.

5.6. Total Cargo Handled by JNPT Port in Thousand TEUs

Here, the dependent variable is total (export plus import) cargo traffic in container numbers ('000 TEUs) handled by JNPT port during the selected time period. The explanatory variable for this linear time trend equation is 'Time' (Years). The estimated linear trend equation is as follows.

$$CTH_{TOT\text{-}JNPT(teu)} = -118.90 + 226.50\,T \quad \text{---------- (6)}$$

$$SE = 22.48,\ t = 10.08,\ p = 0.00$$

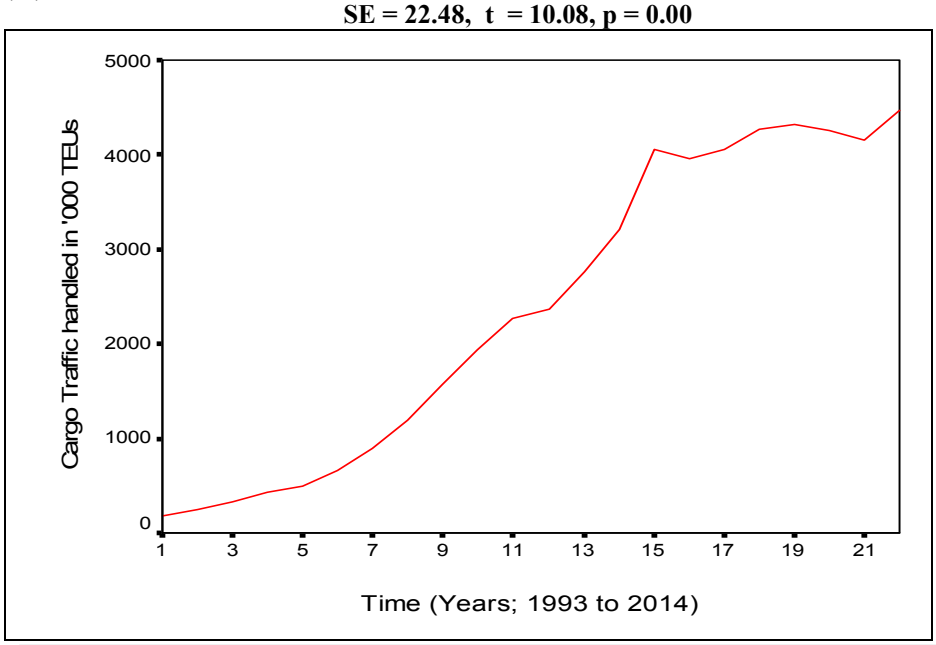

Fig. No. 5.6: Total Cargo Traffic Handled by JNPT Port ('000 TEUs, 1993-2014)

In the above equation (5.18), the estimated slope coefficient is positive (226.50), which means that the total cargo traffic in container numbers ('000 TEUs) handled by JNPT port has an upward trend over time. The level of significance of the estimated result is 1 % (Two Tailed Test; p value is 0.00), which indicates that the result is highly significant. The line diagram in the above figure (5.18) shows three phases of growth over selected time period. The first phase is from1993 to 2000, where the trend is slowly upward rising. The second phase is from 2001 to 2011, which indicates that the trend is steeper and increasing with mild fluctuating. The third phase is from 2012 to 2014, where the trend is flatter and slightly decreasing. Overall, the trend is upward rising during selected time period.

6. Forecasting for Container Capacity of JNPT Port

The linear regression model has been used to forecast the container capacities for JNPT port by the year 2030. The linear regression analysis is done for the containers handled in numbers (TEUs) for the time period 1993 to 2014. JNPT is the biggest container handling port in the country, and handled container traffic of 4.49 million TEU in 2014-15, which accounts for about 55% of the total container traffic handled by the countries major twelve ports. The linear regression model is used for forecasting the container capacity required by the year 2030. Here, the dependent variable is total cargo traffic in container numbers ('000 TEUs) handled by JNPT port during the selected time period of 1993 to 2014 (22 years). The explanatory variable for this linear regression equation is 'Time' (Years). The estimated linear regression equation is as follows.

$$\mathbf{CTH_{TOT\text{-}JNPT(teu)} = -118.90 + 226.50\,T} \quad \text{---------- (7)}$$

$$\mathbf{SE = 22.48,\ t = 10.08,\ p = 0.00}$$

Here, the estimated value of intercept α is -118.90 and the estimated value of slope coefficient β is 226.50, which is highly significant (1 % level, two tailed test). By using this estimated regression equation, it is planned to forecast the future capacity of container growth for the year 2030. The study assumed that 1993 is the base year, which is equal to 1 and so on till the year 2014, which is equal to 22. The forecasted year is 2030 and the corresponding year value is 38 (1993=1, 1994=2, 1995=3,…..2014=22, 2015=23, ……..2030=38).

The forecasted capacity for JNPT port for the year 2030 is as follows.

$$CTH_{TOT\text{-}JNPT(teu)2030} = -118.90 + 226.50 \times 38$$
$$= -118.90 + 8607.00$$
$$= 8488.10$$

Therefore, the forecasted cargo traffic in container numbers for JNPT port in the year 2030 is 8488.10 thousand TEUs or 8.488 million TEUs.

Currently, the JNPT port is handling 4.490 million TEUs (in year 2015) and it needs to expand its capacity up to around 8.5 million TEUS by the year 2030.

The above estimation is based on the current average GDP growth rate of 6% per annum and if the growth rate will vary from the existing average GDP growth rate of 6%, then the estimated forecasted figure will also vary. The same forecasted cargo traffic in container numbers for JNPT port will be estimated on the assumed GDP growth rate of 6% - 2% = 4% and 6% + 2% = 8%.

If the assumed average GDP growth rate is 4%, then the expected cargo traffic in container numbers for JNPT port in the year 2030 is;

8.5 x 4/6 Million TEUs
= 5.7 Million TEUs

If the assumed average GDP growth rate is 8%, then the expected cargo traffic in container numbers for JNPT port in the year 2030 is;

8.5 x 8/6 Million TEUs
= 11.33 Million TEUs

The above calculation is based on simple arithmetic conversion rule and it further depends on government policies for international trade. If the government will adopt more export-led-growth strategies, then the forecasted container capacities will increase further.

7. Conclusion

The linear time trend analysis shows the trends in quantum of Exports, Imports and Total goods handled by the JNPT port over the selected years both in terms of Tonnage (weight of containers) and TEUs (number of containers) handled. All the slope coefficients of the equations no. 1 to 6 are positive which indicates that over time the trend is positive. Line diagrams for total cargo traffic handled in thousand metric tonnes show an upward rising trend. Line diagrams for cargo traffic in tonnage are showing a clear scenario regarding the change of curvature of the trends. The line diagram has changed its curvature two times. The first phase of line diagram is longer than second phase for total cargo traffic handled in thousand metric tonnes. Line diagrams for total cargo traffic in container numbers ('000 TEUs) also show the similar pattern of change of curvatures for JNPT port. The line diagram has changed its curvature three times. The second phase of line diagram is longer than

first phase and third phase has started from 2012 for total cargo traffic in container numbers (‘000 TEUs).
The linear regression model has been used for forecasting the container port capacity of JNPT port by the year 2030. The linear regression analysis is done for the container handled in numbers (TEUs) for the time period from 1993 to 2014. The expected container capacity of JNPT port by year 2030 is around 8.5 million TEUs. The linear regression equation is based on the years 1993 to 2014 in which the Indian economy grew at an average annual rate of 6% during this time period. However during the period from the years 2015 to 2030 if the GDP growth is at a higher rate of 8% per annum (forecasted) then the container capacity required at JNPT port will be much higher than the forecasted requirement of 8.5 million containers (TEUs) by the year 2030. The current container handling capacity of JNPT is at 4.5 million TEUs and this will have to be doubled by the year 2030.

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