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CARGO MIX, THE SURVIVAL STRATEGY OF PORTS: A CASE OF MAJOR PORTS OF INDIA

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Abstract

Ports are economic entities that carry out cargo operation. Different types of cargo require different type of infrastructure. In long run ports face change in their cargo mix due to several reasons. For instance, export iron ore from India was banned in 2011, leading to change in cargo composition of ports such as Haldia. However, infrastructure meant for iron ore need not be applicable for thermal coal. This paper identifies the constraints in deciding on the cargo mix that the port would support and plausible course of action in this regard. Two ports, namely New Mangalore port and Haldia Dock Complex have been considered as case studies to identify their cargo mix, the shift in such mix and future course of action to offset the loss arising out of stoppage of flow of cargo for which the port was originally designed to handle. This paper aims at studying strategic and operational issues related to cargo mix of these two ports of India. This study makes two propositions in relation to cargo mix of a port.

Key Words: Cargo Mix, Infrastructure, Cargo Handling

Introduction

The sea ports across the world are cargo specific, that is, the ports are designed to handle specific type of cargo. For example port of Singapore is a container-handling port and does not handle any other type of cargo such as dry or liquid bulk. The growth of a port is dependent on the type of the cargo and the potential of the cargo to flow through the port. Major ports of India handled more than 50% of the cargo. The cargo mix of these ports suggests that one to two types of cargo constitute the major share. Some of these ports have been primarily based on handling single type of natural resource such as iron ore through New Mangalore port. In this port, iron ore constituted the major cargo. Natural resources are depleting in nature and hence may not be viable for the port in long run. Such ports are at present struggling to keep their operations viable. Hence if iron ore stops flowing through New Mangalore port, it has to look for other types of cargo to remain viable. This would mean that the existing facilities for handling iron ore should be used for other cargoes. Two ports, namely New Mangalore port and Haldia Dock Complex have been considered as case studies to identify their cargo mix, the shift in such mix and future course of action to offset the loss arising out of stoppage of flow of cargo for which the port was originally designed to handle. This paper identifies the constraints in deciding on the cargo mix that the port would support and plausible course of action in this regard. This paper aims at studying strategic and operational issues related to cargo mix of these two ports of India. The study has been carried out from three perspectives, namely, the port perspective, the carrier perspective and the shipper's perspective.

Sea Ports: Ports are the interface between land and sea. The primary function of a port is to provide efficient low cost inter and intra-modal transfer, storage, form change and control of cargo. A port is essentially an economic concept, and economic infrastructure that serves coastal and overseas traffic. It is a subsystem of total transport network and a meeting place of other modes of transport. It provides necessary infrastructure for effective handling of vessels. The role of a port varies with its geographical position, the hinterland and the market it serves and factors related to economy, global trends and other factors Oram, and Smith (1965). Notteboom & Rodrigue (2007) showed that traditional approach towards port governance based on regional requirements and the associated hinterland no more hold well and demand new approaches in synchronization with new patterns of freight distribution. On the other hand the findings from study by Slack (2006) suggest that the decision of shippers is more focused to price and service considerations of land and ocean carriers compared to perceived differences in the ports of entry and exit. He suggests that some important stakeholders in the North Atlantic container trade do not consider port infrastructures as an important factor. A study showed that the freight forwarders operating in Southeast Asian select ports based on the efficiency followed by the shipping frequency, adequate infrastructure and location of the port (Tongzon, 2009). Murphy et al., (1992), showed that the port selection criteria varies amongst the different stakeholders (Shippers - small and large, carriers, freight forwarders) of a port. Yeo, etal., (2008) concluded that in Korea and japan, the criteria for selection of ports include port service, hinterland condition, availability, convenience, logistics cost, regional centre and connectivity are the determining factors in these regions. Tongzon, J. L. (1995) provides an empirical basis for the significant role of terminal efficiency (container moves per hour) relative to other factors (such as capacity, container mix, location, convenience directness, flexibility and transit time, cost factors - freight rate, basic port infrastructure and other factors) in the overall port performance. Clark, et al., (2004) showed that improving port efficiency from the 25th to the 75th percentile reduces shipping costs by 12%. The factors that govern port efficiency include excessive regulation, the prevalence of organized crime, and the general condition of the country's infrastructure. They also showed that reductions in logistics inefficiencies in a country, from the 25th to 75th percentiles imply an increase in bilateral trade of around 25%. Murphy & Daley (1994) found out the different port selection criteria that include, shipment information, loss and damage, freight charges, equipment availability, convenient pickup and delivery, claims handling ability, large volume shipments, large and odd sized freight. Several literatures exists that discusses association of port service related and cost factors that influences decisions of shippers and shipping lines. Notteboom (2008) points that hinterland connections are key for competition and coordination among stakeholders.

The type of infrastructure varies with respect to the cargo and the vessels carrying cargo. Infrastructure requirement for different types of cargo include equipment as shown in Table 1:

Table 1: Equipment Requirement for Different Types of Cargo

S. No.	Cargo	Infrastructure
1.	Dry Bulk	Tipplers, Conveyors Stacker -cum-reclaimers, grab and similar equipment.
2.	Liquid Bulk	Unloading and loading arms comprising pumps and pipelines; and storage tanks and similar equipment.
3.	Containers	Mobile harbor cranes, quay cranes, Rubber Tyred Gantry cranes, Rail Mounted Gantry cranes, Reach stackers, Straddle carriers, fork lifts and similar equipment.
4.	General cargo	Quay and yard cranes, fork lifts and similar equipment.

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The storage requirement varies with type of cargo. Table 2 below provides a general view of such storage requirement at ports for different types of cargo.

Table 2: Storage Requirement for Different Types of Cargo

S. No.	Cargo	Storage infrastructure	Space Requirement
1.	Dry Bulk	Open yards or top Closed warehouses	High to Moderate depending on stackability. For example coking coal can be stacked to greater heights compared to thermal coal
2.	Liquid Bulk	Tanks	Moderate
3.	Containers	Concrete yards	Low to Moderate depending stacking heights
4.	General cargo	Warehouses of different types, Closed, semi-closed, temperature controlled, and similar types. Open yards for cargo such as logs, steel and project	Low to Moderate

Carrier perspective

The size of ships varies with the type of cargo. The general cargo carriers are the smallest ones and are never as big as container carrier. Container carriers are smaller than dry bulk carriers and dry bulk carriers are not bigger than crude carriers. Bruun (1989) established the relationship between the size of the vessel with fixed and variable cost associated with carriage of cargo and time at sea and port.

$$Dopt = \sqrt{[(A/V)*\{(U+S)/T2\}+U]*(1/R)} \quad (1)$$

where

D=The ship's deadweight

U+WD=Ship's fixed cost per day (U AND W are two constants)

S+GD=Ship's variable costs, excluding port expenses (S and G are constants)

RD2 = Ship's running cost per day in port (R=constant)

T1=Number of days at sea

T2=Number of days in port

T1=A/V, where

A = Distance covered in miles

V=Speed in knots

Equation 1 reveals:

1. Less time the ship lies in port (t2 is small), larger will the optimum shipment's size.
2. If port turn rounds in a certain trade are slow, then the smaller the optimum shipment will be.
3. If the cargo, a ship will carry in a certain trade is difficult and time consuming to handle in port (e.g. timber), the optimum size of the ship will be less than for the carrying of other easily handled cargos.

4. But in as much as the cargo is easy to load on board and to land and in as much as there are no narrow limits on the handling capacity of the shippers and the receivers (e.g. oil, ore), the most economic size of ship for the relevant steaming distance will be considerably greater.
5. Wherever port expenses are steeply progressive with the ship's size, the smaller the optimum ship's size will be.
6. The longer the steaming distance is, the larger the optimum ship will be – other things remaining unchanged
7. But in as much as the cargo is time consuming to handle in port, port turn rounds are slow, it may be that on long steaming distance one uses a smaller ship than on a shorter distance, where the time in port is short.
8. Wherever the steaming distance is 'a', and the time spent in port t2 are given, a raised (high) speed for the ship (v knots) make a smaller dimension of ship (in dead weight) more economic.

Shippers' Perspective

The objective of a shipper is to minimize the logistics cost. The logistics cost comprises cost of transfer of goods from hinterland to a given port. A shipper would prefer a port with lowest cost. However, a port has a constraint in terms of total cargo it can handle per annum, i.e., the capacity. Thus, in event of cargo flow exceeding a particular port's capacity would then move through other ports. The objective function is expressed in terms of equation 2.

$$\text{Min } Z = \sum_{i€K}\sum_{j€L} C_{i,j}\,(Q_i, {}_{j€L} X_{i,j}(Q)/Q_i) \times X_{i,j}(Q)x \qquad (2)$$

Equation 2 refers to the objective of minimizing the logistics cost between all hinterlands and ports.

Subject to: $0 \le Q_i \le W_i$ for all $i€K$ (3)

Where

Q_i -The capacity of Port i set by the port planner, $i \in K$; Q is the vector composed of all Q_i's;

Z – The total generalized logistics cost between all hinterlands and ports;

K – The set of all ports in this problem;

L – The set of all hinterlands in this problem; (For simplicity, from here on, “hinterland” means to all shippers within a hinterland region.)

$X_{i,j}$ – The quantity of freight that is transported between Port i and Hinterland j, where $i€K$ and $j€L$;

$C_{i,j}$ – The logistics cost per unit freight between Port i ($i€K$) and Hinterland j ($j€L$), which

is a function of Q_i and $\Sigma, {}_{j€L} X_{i,j}(Q)/Q_i$

W_i – The maximum capacity constraint of Port i ($i \in K$), which is usually determined by the physical and geographical restrictions; (Feng, Wang,Zhang,Jiang, 2011).

The above studies show that infrastructure play a significant role in selection of ports. Different types of cargo require different types of equipment. Equipment for similar cargo may vary in terms of handling. That is, a conveyor system for loading cargo such as coal will be different from conveyor system for unloading of coal from ship. Besides, the size of ships varies with type of cargo. The size of ship manufactured depends also on the ease of its handling cargo in a port. That is, the size of ships is larger for liquid cargo than for dry bulk cargo, as liquid is easier to handle compared to dry bulk cargo. A shipper would always prefer a port with lowest cost. In this paper an attempt has been made to show the importance of cargo mix and its relevant infrastructure on performance and prosperity of a port. So far no significant study has been made in this context to relate cargo mix with port performance.

Cargo Mix in Indian Ports: Case studies

Introduction

Given the type of cargo, the growth varies with effectiveness of ports with respect to its competitors, effectiveness of supply chain in which port are a part of the network; and the total cost of handling cargo at the port. Ghosh, Ravichandran,and Joshi (2011), suggested that in terms of cargo composition, India's basket over the years has diversified from the traditional crude oil and iron ore to other cargo categories including coal, petroleum, oil and lubricants (POL) and containers. In 2009-2010, of the total traffic handled at major ports, POL accounted for the maximum at (31%) followed by containers (18%), iron ore (18%) and coal (13%), shown in Table 3.

Table 3: Key Cargo Categories and Percentage Share

Cargo volumes all ports (MMT)	2009-10 Actual	Percentage of total Traffic
Coal	113	13
POL	320	38
Iron –ore	149	18
Containers	116	14
Others	151	18
Total Cargo	849	100

Source: IPA, Major Ports in India – A Profile (2012)

The cargo composition at the end of 12th Five year plan is shown in Table 4. It demonstrates the changing composition of cargo mix in the country. In some cases there is decreasing trend, for example, iron ore. Even if cargo is expected to grow, this does not assure flow of cargo through a particular port. The cargo may be handled at any port, of the country, that appears to be viable in terms of volume and interest of the trader to route the cargo through the port. For example crude oil that moved through Haldia now is moved through Paradip port. Its oil jetties are left redundant.

Table 4: The Cargo Composition at the End of 12th Five Year Plan

Commodity	Major Ports	Non-Major Ports	Total	Percentage of total Traffic
POL (incl. LNG)	249.49	230.7	480.19	27
Iron Ore	112	78	190	11
Fertilizer & Fertilizer Raw Material	22.57	8.6	31.17	2
Coal	158.1	280.9	439	25
Containers	268.5	100	368.5	21
Others	135.4	117	249.4	14
Total	943.06	815.2	1758.26	100

Source: Commodity-wise Traffic at Indian Ports by the end of Twelfth Five Year Plan (2016-17) retrieved from https://data.gov.in/node/95512/download, 21.01.2018

This paper aims at studying such strategic issues related to cargo mix of two ports of India namely the New Mangalore port and Haldia Dock Complex.

New Mangalore Port

The minor port of Mangalore, till 1980, was one among the 19 ports in the state of Karnataka. It had long maritime history. A number of committees were appointed to suggest ways and means for the development of the minor port into a major one. The important ones among them are the Ports technical committee in 1946, the West coast major ports development committee in 1948 and the Intermediate Ports Development Committee in 1958.The last Committee, after a detailed study of the economic, engineering, navigation and traffic aspects relating to the Karnataka ports recommended Mangalore for development as a deep sea all-weather port. The reasons for its recommendations for Mangalore were the availability of infrastructural facilities, existence of rich mineral deposits and other resources in the hinterland and long maritime tradition (Ray, 1993). In 1979-1980, that is, before constitution of the port trust board in 1980, it handled 9.02 lakh tonnes of cargo. Comparative traffic for the years 1981-82 and 1991-92 shows five time increase from 16.43 lakh tones to 82.74 lakh tones. In 2001-02, it rose to 175.01 lakh tones and touched the figure of 329.41 lakh tones in 2011-12.

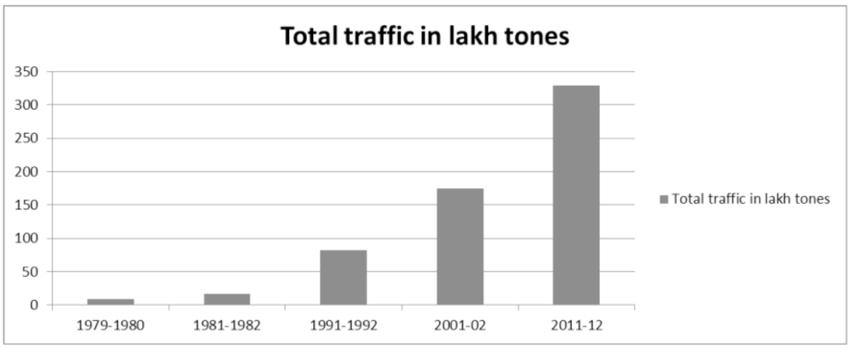

Figure 1: Total traffic handled in Mangalore Port over the years

New Mangalore is basically a bulk commodity port. Bulk cargoes like iron ore, crude, POL products, and coal constitute 90% of the total traffic projected in the Master Plan, which was prepared by the Indian Port Association and was ready by 1985. The share of the other cargo is only 10%.

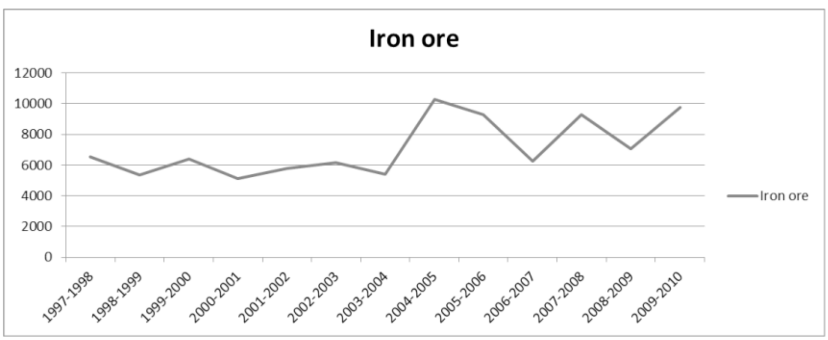

Figure 2: Share of Iron Ore Handled by the Mangalore Port

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The above data shows that as in 2010-2011, iron ore is one of the major export items from the port. Any restriction or ban on iron ore fines or lumps could impact ports and terminals. The ban on iron ore mining during the period July 2011 to April 2013, led to considerable drop in iron ore exports from the port. The volume of iron ore fines came down from 5.4 million tonnes in 2009-10 to 0.9 million tonnes in 2010-11

The cargo share of POL over the years is given below. In 1990-1991 oil traffic was just 0.6 MT (POL products) against the projection of 4.5 MT. This was because the refinery did not come up and there was no import of crude or export of POL products. Import of POL products continued

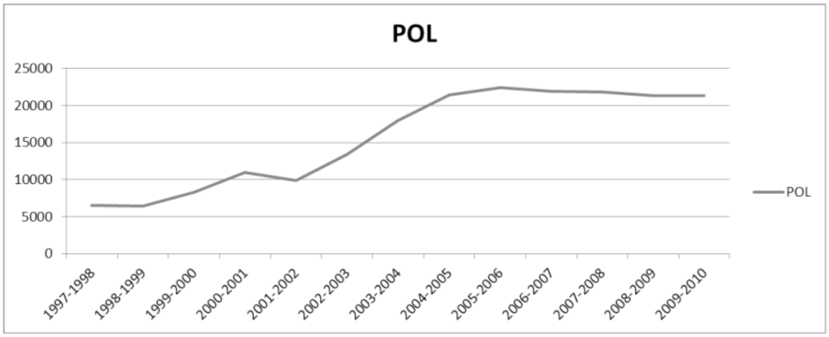

Figure 3: Share of POL Handled by the Mangalore Port

Coal also consttitutes the major part of the cargo mix. For the import of coal a separate jetty was constructed at the west of the ore berth. As the import of thermal coal, was very good, a coal berth with mechanical handling facilities should be developed, after viable linkage with coal fields and thermal plants

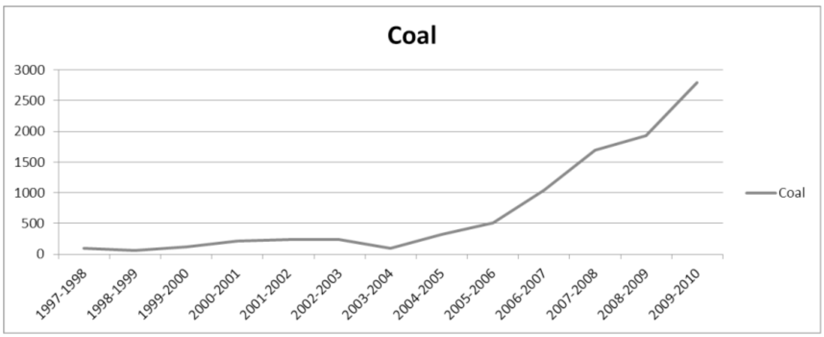

Figure 4: Share of Coal Handled by the Mangalore Port

In 1990 four additional berths were built for handling dry bulk and break-bulk excluding iron ore. Two additional berths were introduced in 1995 and 2000 respectively. Berth number 4 was used as container berth. (Ray, 1993)

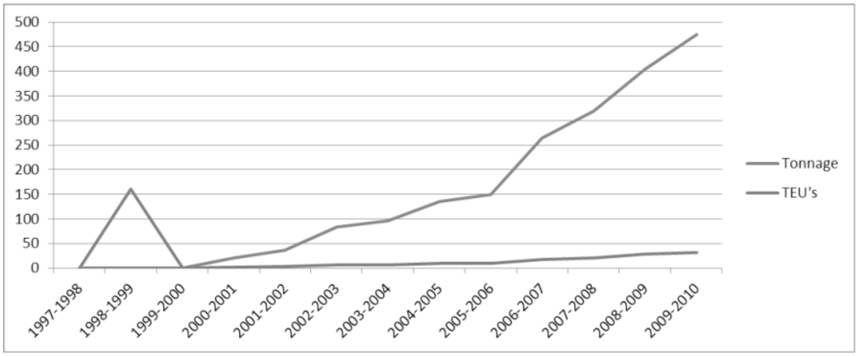

Figure 5: Share of Container Handled by the Mangalore Port

As on 2014 the iron ore terminal ready since 2010 never handled the cargo. The company then decided to convert the iron ore terminal to coal terminal with an estimated expenditure of 160 Million USD (Business Today, 03.01.2014). Iron ore handling in New Mangalore port reduced from 1.5 MMT (million metric tonnes) in the year 2014-15 to 0.5 MMT in 2015-16.

2.1.2 Haldia Dock

During the 1950s, the search was on for a suitable location of a port down the river Hooghly near the estuary which would not have the problem of navigability and would provide adequate draft for big vessels. Haldia is situated 104 km, from Calcutta and is near to the sea. Due to the increase in oil import through large oil carriers, a modern and deep drafted oil jetty was necessitated. Haldia was recognized as outlet providing facilities for large oil and ore carriers. It became operational in the year 1968, under the Kolkata Port Trust. Kolkata Port Trust, thus, had two dock systems, namely, the Kolkata Dock System (KDS) at Kolkata and Haldia Dock System (HDC) at Haldia. Table 5 shows the cargo handled vis-à-vis the capacity at Haldia.

Table 5: Cargo handling in Haldia Dock System

(Figures in the brackets denote number of berths. BJ=Barge Jetty)

Sl.No.	Cargo	Capacity in MMT (Million Metric Ton)	Cargo handled in 2009 - 10 MMT
1.	POL	17.00(3+2 BJ)	9.38
2.	Iron ore	6.00 (2)	7.684
3.	Coal	7.00 (2)	7.525
4.	Container	4.00(2)	2.010
5.	General cargo	12.7 (8)	6.399

The bulk of cargo composition was crude and POL (petroleum, oil, liquid) till few years back. This accounted for 45% of the total cargo. Haldia Dock Complex has four river side oil jetties which handle crude, POL products and liquid ammonia. Jetty No. 1 has connecting pipelines to Haldia refinery, Barauni refinery, and fertilizer plants of Hindustan Fertilizer Corporation and Hindustan Lever Limited. However the share of POL declined over the period of time. (Ray 1993). The share of POL handled by the Haldia Port over the years is given below.

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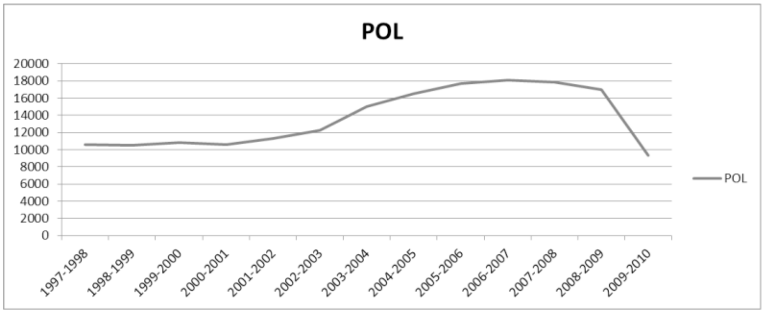

Figure 6: Share of POL Handled by Haldia Port

The Indian Oil Corporation Ltd. is a major client of Haldia Port. Although there was strong opposition, from the Kolkata Port Trust and the West Bengal government, but IOC decided to go ahead with the Paradeep-Haldia pipeline project to carry crude. This had affected both Haldia and Kolkata, docks. That resulted in the decline of the share of POL from 2005-2006 onwards.

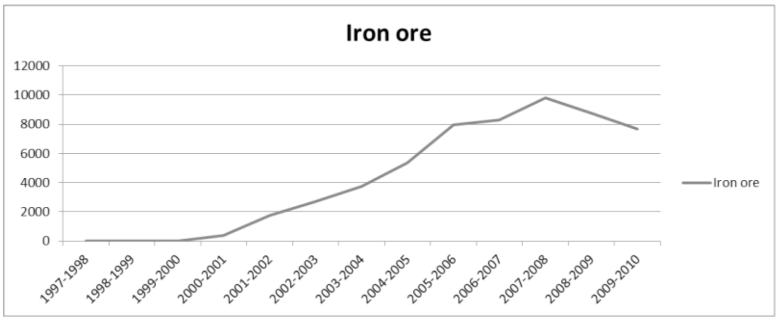

Figure 7: Share of Iron Ore Handled by Haldia Port

Iron ore handled by Haldia dock over the years are shown in the above figure. This cargo started flowing only after 2000 and started declining since 2008-2009. This decline is owing to reduction in imports of iron ore by steel makers of China. The demand for steel from Chinese manufacturers decreased due to economic slowdown. The decrease in demand of iron ore clubbed with ban of iron ore mining in India led to the reversal of flow of iron ore. Haldia Dock, primarily an iron ore exporting port started handling import cargo. The dock handled 0.86 MMT of iron ore as import cargo in the year 2015-16. The facility in Haldia dock was meant for handling export, and hence was rendered redundant for unloading operations.

Coal forms an integral part of the cargo mix. Thermal coal is shipped to Tamil Nadu. TISCO and SAIL mainly import coking coal in increasing quantity through their captive berths. Fig 10 shows the handling of coal over the years.

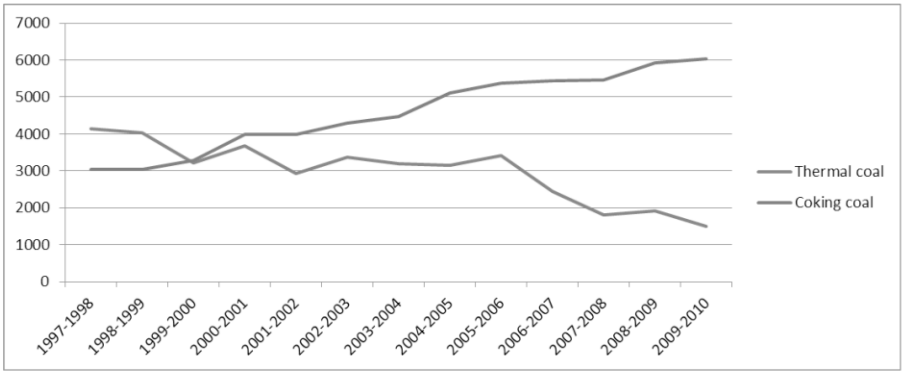

Figure 8: Share of Coal Handled by Haldia Port

The share of container handled by Haldia port is shown in the following table:

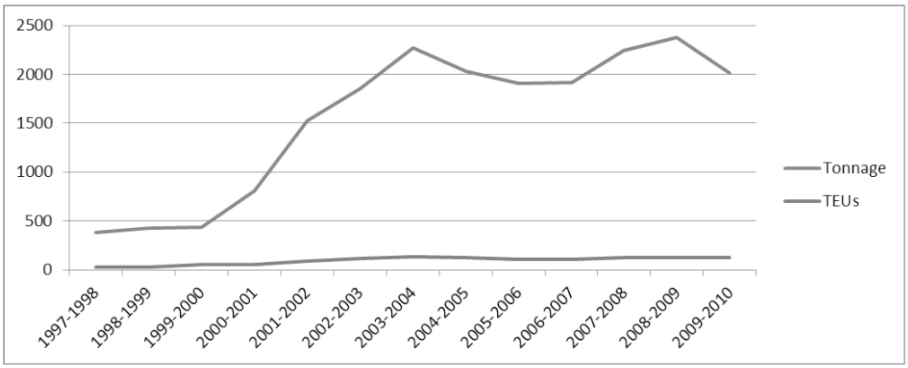

Figure 9: Share of Container Handled by Haldia Port

Analysis and Discussions

The case of New Mangalore port and Haldia dock discussed above can be analyzed from operational, economic, administrative and global perspectives.

Operational Perspective: Bulk cargo berths cannot be used for handling containers as their infrastructure requirements are different. Hence iron ore berths at New Mangalore would stand redundant once its exports from the port stop. It can be used for handling other bulk cargoes such as coal, however linkages with coal fields or appropriate infrastructure needs to developed. There are already coal handling facilities in the port and hence utilization of the iron ore berths for coal can only be partial. A long term strategy should be drawn up to ensure adequate return on assets (ROA). New Mangalore port has draft of thirteen (13) meters i.e. allowing bulk vessels to be handled at the port. New Mangalore port can accommodate ship of DWT up to 1 lakh tons. This would enable the port to accommodate coal carriers along with container vessel of Suezmax category. The existing equipment such as re-claimer and ship loader meant for iron ore handling can be used for coal handling, while addition equipment to suit the changed cargo mix need to deployed.

Economic Perspective: The demand for a particular cargo can be seen from economic perspective

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as well. Say, for example, the Haldia dock may like to plan its future investments based on future cargo-mix of the port. It handles thermal coal meant for power plants in Tamil Nadu. Hence whether the cargo mix continues to remain unchanged can be studied from its future demand. The demand of electricity is increasing over the years in India. Figure 10 shows the demand for power over the years.

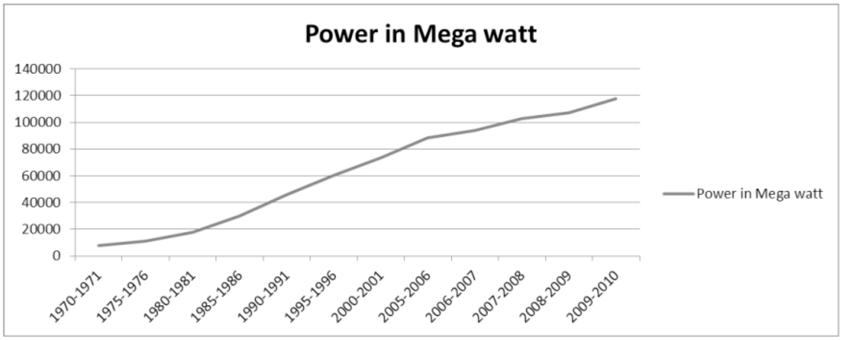

Figure 10: Demand of Thermal Power over the Years

As coal is one of the ingredients for the thermal power plant, so the flow of coal has to be increased to meet the demand. Figure 11 shows the demand for coal over the years.

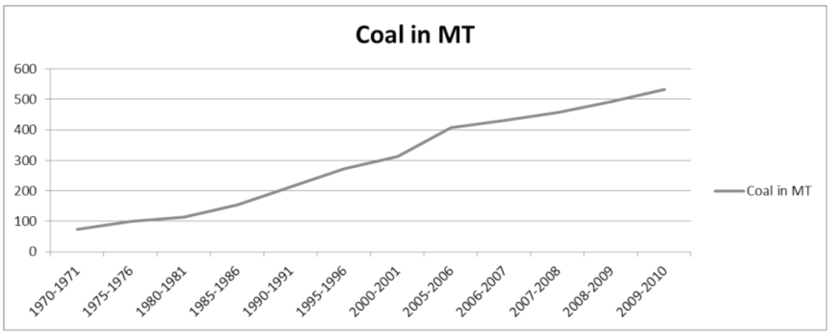

Figure 11: Demand of Coal over the Years

The demand for coal and demand for power has a strong correlation of 0.99.

Container is one of the important item of the cargo mix of the above two ports. The GDP (gross domestic product) reflecting country's economy bears an association with container handling in the ports. They have a strong corelation of 0.97. GDP of India has been increasing over the years justifying the expected growth in container handling. Hence, the ports may consider enhancement of their container handling facility.

Administrative perspective: New Mangalore operates under the aegis of Ministry of shipping, Government of India. Government of India can initiate action for creating coal and container handling facilities at New Mangalore port. However, Private Public Partnership can be explored for creating facility for cargo handling. In both the cases the entities will have to operate under the Major Port Trust Act 1963 and subsequent laws enacted regarding private participation in major ports of India. The cargo handling facility by either Government, private or jointly would have the basic objective of maximizing the stake holders wealth. The power plants and steel plants of Government of India are major stake holders of these operations. The ports should aim at fulfilling their requirements. However, the tariff cannot be freely set as the same on the cargo and vessel are regulated by the TAMP (Tariff Authority of Major Ports). It is a regulatory body under The Ministry of Shipping, Government of India, whose major objective is to ensure that monopoly of port services leading to excessive tariff at one end and inadequate return on operation of port facilities causing losses to authority are avoided i.e. it looks for rationalization of port charges. Hence, the private or government agencies or joint operations by them will have to operate under the constraints of Major Port Trust Act (1963) and subsequent amendments and major regulations of TAMP.

Global Perspective: Ports being interface for international trade, its activities are significantly determined by the global economy. In case of economic slowdown at national and global level, import and export of goods are affected. The ports may experience low utilization of its assets during economic slowdown. While, may fall short in terms of infrastructure and cargo handling at times of economic boom. In addition, change in technology, resolutions taken in global forums and un-toward incidents may lead to temporary or complete diversion of flow of cargo from a port.

Conclusion

The above analysis leads to the following conclusions:

i. Ports need to earmark their cargo mix as different types of cargo require different infrastructure. Shift in cargo may lead to either complete or partial redundancy of assets. For example, oil jetties are not suitable for handling of dry bulk cargo, while conversion of dry bulk berth to container berth or vice versa, would require higher investments and significant restructuring; else efficiency would suffer.

ii. Demand of a cargo in a region is not the demand for the mode of transport. This can be observed from the case of POL transport from Paradeep to Haldia, which once moved by ships now being transported through pipelines. The port should draw up long term strategy to effectively utilize the oil jetties. Conversion of oil jetties to other category of cargo is a distant possibility. The future of iron ore also does not seem to be bright and as such the focus should shift to coal as the country is poised to increase its power generation from coal fired plants. The port should enhance its productivity and reduce turn round time to remain attractive to coal carriers. Or else inspite of demand for coal in that region or in the hinterland the cargo may not move by the port, instead make take alternate routes as in case of POL. Though the growth of containers are promising in the region, Kolkata port is already specializing in containers and being sister organization of Haldia may not allow Haldia Dock Complex to venture fully into container handling. In addition conversion of bulk handling berths to container berths would be a difficult proposition. Port also needs to construct concrete yards to sustain the container stacking and operation of container handling equipment. Haldia port should enhance marketing and sales promotion effort for utilizing the berth for handling chemical, liquidified gas such as LNG. It can act as a hub for eastern and northern region and also for land-locked countries such as Nepal and Bhutan.

iii. New Mangalore has the option of converting iron ore berths into other bulk handling cargo berths such as coal berths. The port can also explore the possibility of setting up container terminal to enhance container handling effectively. The viability of such recommendations can be assessed from the following perspectives.

iv. Change in national and global policies may lead to change in cargo mix of a port. Ports need to adopt flexible technologies to meet the change in cargo mix.

The above conclusions lead to the following propositions:

a. Cargo mix determines port infrastructure, capacity and performance.

b. Shift in cargo mix lead to change in infrastructure and viability of a port.

c. Scope for further work: A further study on these ports using optimization models may be carried out that will reveal the right cargo mix.

References

- Bruun P, (1989). Port Engineering, Vol I, Gulf Publishing Company.
- Business Today, (2014), (http://www.businesstoday.in/sectors/energy/ban-on-iron-ore-mining-and-exports-in-karnataka-goa/story/202008.html, accessed on June 8, 2018.
- Clark, X., Dollar, D., & Micco, A. (2004). Port efficiency, maritime transport costs, and bilateral trade. Journal of Development Economics, 75(2), 417-450.
- Feng. X, Wang. W, Zhang.Y and Jiang. L (2011). Optimization of Capacity of Ports within a Regional Port System", pp.1-14, presented in TRB Annual Meeting.
- Ghosh. A, Ravichndran. K, Joshi. N (2011). Indian port sector: Growth plans ambitious but uncertainty hangs over implementation, published in ICRA Rating Services.
- IPA (Indian Port Association), (2010). Major Ports of India - A profile: 2009 – 2010, New Delhi.
- IPA (Indian Port Association), (2011). www.ipa.nic.in, 01.08.2011, accessed on June 8, 2018.
- IPA (Indian Port Association), (2010). Major Ports of India - A profile: 2015 – 2016, New Delhi.
- IPA (Indian Port Association), (2010) Major Ports of India - A profile: 2016 – 2017, New Delhi.
- Murphy, P. R., & Daley, J. M. (1994). A comparative analysis of port selection factors. Transportation Journal, 15-21.
- Murphy, Paul R; Daley, James M; Dalenberg, Douglas R, (1992). Port Selection Criteria: An Application of a Transportation, Logistics and Transportation Review; Vancouver, Vol.28,Iss.3.
- Notteboom, Theo. E., & Rodrigue, Jean-Paul., (2007). Port regionalization: Towards a new phase in port development, Maritime Policy & Management, 32:3, 297-313, DOI: 10.1080/03088830500139885.
- Notteboom, T. (2008). The Relationship between Seaports and the Inter-Modal Hinterland in Light of Global Supply Chains, OECD/ITF Joint Transport Research Centre Discussion Papers, No. 2008/10, OECD Publishing, Paris, http://dx.doi.org/10.1787/235371341338.
- Oram, R. B., and Smith, N. Skene., (1965). Cargo Handling and the Modern Port , A volume in The Commonwealth and International Library of Science, Technology, Engineering and Liberal Studies, 161495th Edition, ISBN: 978-0-08-011305-0.
- Ray. A (1993). Maritime India: Ports and Shipping, pp.364-384, published by Pearl Publishers, Kolkata.

- Slack, Brian., (2006). Containerization, inter-port competition, and port selection, Maritime Policy & Management, 12:4, 293-303, DOI: 10.1080/03088838500000043.
- Tongzon, J. L. (1995). Determinants of port performance and efficiency. Transportation Research Part A: Policy and Practice, 29(3).
- Tongzon, Jose L, (2009). Port choice and freight forwarders, Transportation Research Part E: Logistics and Transportation Review, Volume 45, Issue 1.
- Yeo, G. T., Roe, M., & Dinwoodie, J. (2008). Evaluating the competitiveness of container ports in Korea and China. Transportation Research Part A: Policy and Practice, 42(6).