CHAPTER – I

INTRODUCTION

1. INFRASTRUCTURE

Infrastructure plays a fundamental role in the development of regions. It is a broad concept; several definitions and descriptions have been used in the literature. Infrastructure is generally defined as the physical framework of facilities through which goods and services are provided to the public.

The term infrastructure, according to Jansson (2000a)[1], originates from the Latin word 'infra', which means 'situated below'. Originally, it was a military term referring to the static and physical foundation of the logistical organization such as roads, bridges, storage areas and pipelines. Presently, the term infrastructure is also used for non-military facilities and is considered as a basic need for societies to support further development[2]: it provides safety against natural threats and secures the provision of services such as long-distance communication and transportation. Seen from this perspective, infrastructure plays a fundamental role in the development of regions. A network-type structure can be considered for an infrastructure system comprising links and nodes (e.g., Cox, 1972)[3]. Examples of links are roads, railways and canals; nodes include railway stations, terminals, seaports and airports.

A study on the meaning and content of the term infrastructure has been carried out by Nijkamp et al. (2000)[4]. According to this study, infrastructure includes those real estate provisions which increase efficiency in the use of factors of production and meet the following requirements: infrastructure is directly productive, is characterised by stock features (capital good) and it has the character of a (semi-) public good (in this respect non-excludability and non-rivalry in consumption are often cited as characteristics of a public good). According to the Nijkamp et al. study, three categories of infrastructure can be distinguished. Physical network infrastructure includes elements such as transport infrastructure and public utilities, water management and industrial sites. Knowledge infrastructure and environmental infrastructure are the two other categories.

Infrastructure that makes more sense from an economic standpoint consists of large capital intensive natural monopolies such as highways, transportation facilities, water and sewer lines and communication systems. An alternative version that focuses on ownership defines infrastructure, as the tangible capital stock owned by the public sector. Its linkages to the economy are multiple and complex, because it affects production and consumption directly, creates positive and negative spill over effects and involves large inflows of expenditure.

Depending on the nature of the services delivered, infrastructure can be broadly divided into physical, social and financial categories, all three of which are highly desirable. The first of these consists of transport (railways, roadways, airways and waterways), electricity, irrigation, telecommunication, water supply, and the like. Physical infrastructure contributes to economic growth through lower transaction costs, and generates multipliers of investment, employment output, income and ancillary development. Social infrastructure, on the other hand, through enrichment of human resources in terms of education, health, housing, recreation facilities and the like improves the quality of life. This is primarily responsible for higher concentration of better human resources in a region and helps improve productivity of labour. Finally, financial infrastructure incorporating banking, postal and tax capacity of the population represents the financial performance of the state. These three taken together represent the relative income generating capability of a particular country/region.

Thus, generally speaking, we may say that infrastructure is a social concept of some special categories of inputs which contribute to economic development both by increasing productivity and by providing amenities, which enhance the quality of life. It takes a long period of time to create the facilities, the absence of which may result in lower productive efficiency of the population. The linkage between infrastructure and economic growth is multiple and complex, because not only does it affect production and consumption directly, but it also creates many direct and indirect externalities, and involves large flows of expenditure thereby creating additional employment.

1.1 Characteristics and Risks of Infrastructure Projects

According to ECMT, (1990)[5] and Wiegmans, (2002)[6], infrastructure has some special features like expectation of very long economic life of infrastructure, requirement of

large amounts of capital during the construction time, long and costly lead time for infrastructure development and commencement of construction, irreversible investments, long construction periods, uniqueness of infrastructure project, low level of operational (variable) cost compared to construction (fixed) cost, etc. These characteristics of infrastructure development and operation determine high initial investments, long pay-back period, no revenues during construction periods and creation of uncertainties and risks which, in turn, make infrastructure investment unattractive to the private investor. As a result, infrastructure has traditionally been a public domain, particularly in developing countries, partly on account of its perceived strategic importance to the economy, and partly because of the large investment cost and long pay-back periods. Although such projects were usually thought to have constituted serious disincentives to private investors, recent trends in privatization of major infrastructure projects have shown that this is no longer the case. Private financiers have shown themselves able to mobilise necessary funds to finance infrastructure projects and private sponsors are willing to accept both projects and county risks, provided that the institutional environment meets certain minimum standards and the projects are appropriately structured. Governments are assisting this process by creating new opportunities for private investors in an effort to bring more efficiency to project construction and operation and greater competition in the supply of infrastructure services, with better access to international capital markets.

1.2 Infrastructure and Economic Development

Infrastructure provision enhances the production and distribution network of key sectors in the economy and promotes overall economic growth. In the process they also tend to affect the cost structure and productivity in these sectors, thereby promoting growth and development in each of these sectors. Substantial research on interrelationships and dynamics of production and infrastructure in national and regional economies has been made. Although it is beyond the scope of this thesis to look into these works, we mention a few important of them.

After the Second World War relatively little consideration was given to the positive long-term effects of transport infrastructure. Many economists and politicians in the 1950s believed that active interventions would lead to regional development. The indispensable role played by social overhead capital - which is used to build up

infrastructure, in helping productive activities directly and indirectly, was recognized by the pioneers of development economics, viz. Fleming, 1955; Hirschman,1958; Myrdal, 1958. According to the theory of unbalanced growth (UG) by Albert O. Hirschman[7], no LDC has sufficient endowment of resources as to enable it invest simultaneously in all sectors of the economy in order to achieve balanced growth. Balanced growth is a doctrine previously advanced by Rosenstein-Rodan in his 1943 article on "Problems of Industrialisation of Eastern and South-Eastern Europe"[8] and developed by Ragnar Nurkse in his important study of *Problems of Capital Formation in Underdeveloped Countries*.[9] Developing Rostow's leading sector thesis, Hirschman maintains that "investments in strategically selected industries or sectors of the economy will lead to new investment opportunities and so pave the way to further economic development".[10] Hirschman identified convergent and divergent series of investments. Convergent series of investments are those projects that appropriate more external economies than they create while divergent series create more external economies than they appropriate.

But the neo-classical growth model, which dominated during the seventies and eighties, predicted regional convergence without public capital. Regional equity considerations became less important in the national policies. But, this thought underwent a change in the late 1980s and early 1990s. Infrastructure investments became one of the most frequent topics for economic research. The explosion of researches on the returns to infrastructure seemed to be connected in some way with a new trend in the literature: the new growth theory, which emphasized the role of increasing returns to scale in production. An intensive investment in knowledge, human capital or infrastructure can be regarded as explanation for the existence of increasing returns (Barro, 1990)[11]. According to the new growth theory, public infrastructure investments therefore were defended on efficiency grounds.

There are many studies which suggest that infrastructure does contribute towards a hinterland's output, income and employment growth and quality of life. Aschauer (1989,)[12] who examined the relationship between infrastructure and aggregate productivity in the U.S. economy initiated the interest in the key aspects of infrastructure development. In his article Aschauer estimates the production function for the USA using aggregated national time series data for the 1949 to 1985 period.

Aschauer concludes that there is a very strong and positive relationship between public capital stock in the USA and the level of output (measured as a level of private sector productivity). Following this, many studies have been undertaken which either used the production function or the cost function specification to study this relationship. Some of the important pioneering works include those by Munnel (1990, 1992)[13], Canning and Fay (1993)[14], Gramlich (1994)[15], Holtz-Eakin (1994)[16], Nadiri and Mamuneas (1994)[17], Holtz-Eakin and Schwartz (1995)[18], Esfahani and Ram´ıres, (2003)[19], etc.

Studies for the Indian economy concentrate upon the link of infrastructure with economic growth and the performance of infrastructure at the national and the state level. The studies also point out the inter-state disparities in infrastructure in India. Some of the important studies are Joshi (1990)[20], Ahulwalia (1991, 1995)[21], Anant et. al. (1999)[22], Mitra et. al. (1998)[23], Das & Barua (1998)[24], Ghosh and De (1998, 2004)[25]. Barnes and Binswanger (1986)[26], Elhance and Lakshmanan (1988)[27], Binswanger, Khandkur and Rosenwing (1989)[28], Datt and Ravallion (1998)[29], Sahoo and Saxena (1999)[30], Ghosh and De (2000)[31], Khondker and Chaudhury (2001)[32], etc. deal more directly with infrastructure and income.

In this thesis, we deal with physical infrastructure, maritime transport to be exact. We first take a look at how transport, as such, is necessary and important for the development of an economy and then the impact of maritime transport on it.

2. TRANSPORT

Transport infrastructure is usually regarded as a major incentive for economic development and investments in infrastructure are, for many (local) governments, a critical element of their policy. By definition, transport is a network which relies on connections, links and integration among modes. Transportation lies at the heart of the spatial-economic evolution of our economies. A well-functioning transport network is an important condition for the competitive position of regions and cities. Today, the most prosperous locations are found where transport nodes coincide with skilled labour markets and a high quality environment. Transport Infrastructure is extremely important in facilitating economic activity. Transportation improvements affect both economic development and productivity. There is a strong evidence that transport

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improvements result in economic development. In these circumstances, it is not surprising that economic development is correlated positively with transport facilities. "Pure" economic development effects are usually regional in nature and result from improved access to labour pools or to larger markets (NCHRP, 1998)[33]. While considering the economic development of different regions of a country, transportation infrastructure and the overall system may play a significant role in removing regional economic disparities. It makes possible economic activities, by giving access to resources and markets, which may not have occurred up to that point. Within the same country and under the same development policies, significant role for transportation implies that regions with better transportation infrastructure will have better access to the locations of input materials and markets and thus will, ceteris paribus, be more productive, competitive and hence more successful than regions with inferior transportation accessibility (Vickerman et al., 1995)[34]. Market grows because of improvements in transport. The market is originally local and small. Demand is restricted by the cost of getting goods into the village/city; supply is limited by the cost of getting goods into the village/city. Under these circumstances, markets only grow through increases in transport. The expansion becomes cumulative. Increased outlets for a commodity give rise to increased real income, which in turn raises the demand for other products. As new supplies of these come in the market, incomes in turn grow further. The linkage of markets by an improvement in transportation becomes part of a developmental process. Thus, transport infrastructure is essential in the optimization of the movement of raw materials and finished products in that it can provide producers of goods with routes to their markets, which are more direct, and therefore less costly in terms of time and operating cost. In this regard, it can be said that transport infrastructure is necessary for production processes to occur in any modern economy.

Other benefits from transport improvements may include increased trade and competition from imports, in turn leading to improved production efficiency, downward pressure on consumer prices and reduced seasonal price fluctuations. The linkages between transport and trade are very strong, and good transport is essential for competing in the modern global economy. In the world economy today, where the globalisation of trade is closely associated with the fragmentation of production among different countries, transportation costs are of central importance. The regionalism

movements of the 1960s and 1990s played an important role in this globalisation process, the latter of which has led to such large trading blocs as the European Union, NAFTA and MERCOSUR. These regional integration agreements have brought about an expansion of trade, a general reduction of tariff rates, and the adoption of outward-oriented strategies by many developing countries. Globalisation depends on the trade of raw materials, parts and finished products. The substantial diversity, availability and affordability of goods in the global economy depend much on the capacity to transport them. Transportation as a part of the integrated global supply chain is affected by many variables that lay both inside and outside the sector itself. The international trade environment is one of the most significant of these variables and with its continuous growth in recent years, the transport industry has experienced the need to supply ever increasing numbers and quality of services in all areas of the world. From the internationally exporting manufacturers' point of view, transportation is an unavoidable part of the total manufacturing cost of their product. Considerable efforts are continuously made to reduce such costs, mainly because imported goods have to compete with locally manufactured goods not only in terms of quality but also, perhaps more importantly, price.

Better accessibility and mobility also plays a significant role in human resource development of a region. Transport affects the efficiency of the labour market and labour participation rates. This shows that transport acts as a catalyst for the development in its role as a facilitator of economic activity. There seems to be a clear positive correlation between transportation infrastructure endowment or interregional accessibility and the level of economic indicators such as, GDP per capita (Beihl, 1986)[35] etc. Studies that identify and measure transportation investment's impact on economic development have been proposed in Perera (1990)[36], Seskin (1990)[37], Buffington et al. (1992)[38], Weisbrod and Beckwith (1992)[39] and Berechman (1994)[40]. There are also regional studies addressing the impact of transportation infrastructure on local regional economic development. All these factors have encouraged some countries to take a more pro-active approach towards transport planning, with investment preceding rather than following demand.

Transportation is one of the least visible, but critical components of the global economy, supporting a wide array of movements of freight between nations. It is

virtually inconceivable in today's economy for a firm to function without the aid of transportation. Transportation is an essential and a major sub-function of logistics that creates time and place utility in goods. In fact, the backbone of the entire supply chain is the transportation management that makes it possible to achieve the well known seven R's- the Right product in the Right quantity and the Right condition, at the Right place, at the Right time, for the Right customer at the Right cost. As a consequence, international transportation has attained even greater importance, and may now rightly be considered one of the pillars of the global economy.

One of the core concepts in transport and economic geography states that transportation is a derived demand, both for passengers and freight transport alike. This assumption is reflected in the conventional literature which underlines that transport exists because it '…is the expression of a spatially differentiated function of supply and demand and is thus considered to be "derived" from other activities.' The basic idea behind transport as a derived demand is that transport itself is not necessary unless required. There must be at start a functional complementarity, implying a supply/demand relationship. For instance, elements of a supply chain are integrated with another, notably through a supplier/customer relationship which regulates this demand. Demand for transportation of a unit is thus derived from a supply at an origin and a demand at a destination, a concept better known as spatial complementarity. It states that if a location produces/generates a surplus that another location requires, then an interaction (and thus transportation) is possible because a supply/demand relationship has been established between those two locations and a market can thus exist. The same goes in the other direction of the interaction, which creates a situation of reciprocity common in many spatial flows such as commuting, tourism or international trade. Transportation cannot exist on its own and cannot be stored.

However, this perception about transportation changed drastically during 1990s. Recent developments in logistics and supply chain management underline a paradigm shift in the consideration of freight transport as a derived demand. A large number of logistics companies emerged, which provided not only transportation solutions, but also marketing, sourcing and other business supporting operations. Such companies started to offer value-added services in the supply chain and it was no longer viewed as a part of the production cost. The development of multimodal transportation and the

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formation of improved transport corridors can also be viewed as variables in the global supply chain. Numerous developments in transportation technology and industry's need to introduce Just-In- Time delivery services (JIT) raised the profile of multimodal transport solutions (Rodrigue, 2003)[41]. The formation of improved transportation corridors to enhance the capabilities of the transport industry to deliver JIT services was a consequence of developments during this period. In many sectors of activity, the functions of production, consumption and transportation have become embedded to the point that it is difficult to tell them apart.

Transportation systems and modes are usually divided into three types by the surface they travel: land (road, rail and pipelines), water (maritime shipping) and air (aviation). This research concentrates on maritime transport, as mentioned before.

3. MARITIME TRANSPORT

Shipping is one of the truly global industries and its prospects are closely tied to the level of economic activity in the world. In some cases though even the opposite is true; world economic growth depends on shipping. The maritime shipping industry is fundamental to international trade because it is the only practicable and cost effective means of transporting large volumes of many essential commodities and finished goods. Access to unrestricted maritime transport services is crucial for economic development and investments. Safe, reliable and cost-effective transport services are vital to trade and economic development; they contribute to employment, and are a key factor in investment decisions. With internationalisation and globalisation, maritime shipping has obtained a central role in world trade.

Globalisation and regionalism, the major trends in today's global economy, have led to a greater integration of the world economy. This, in turn, has greatly stimulated the development of international trade. In the majority of countries, most international trade (export/import), and in some cases also large shares of domestic trade, is done through maritime transport. For long-haul shipments, there are no alternative transport modes to ships, with the exception of high value and small volume cargoes, for which air transport offers speed as its advantage. This is so because ships are basically compatible with the environment. Fuel-consumption per ton and mile is about one fifth

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for a ship as compared to a truck, or about one twentieth of that of airfreight. Traffic on land is getting more crowded and the oceans are wide. Given these issues, it is hardly surprising that in terms of weight, about 96 per cent and in terms of volume, about 77 per cent of the world trade is carried by maritime transportation.

Maritime transport has been regarded as "one of the world's most international industries" (Stopford, 1997, p. 2)[42] due to its unique features. It is not rare to see in this industry a ship being owned by a Greek citizen, registered in Panama, chartered by an American company, insured in Britain, managed by a shipping management company registered in Marshal Island, crewed by Philippine seamen with a Norwegian captain, involved in cargo transport between China and Europe, and served at a terminal in the Port of Rotterdam by an operator whose headquarter is in Hong Kong.

It is not only in recent times that maritime transport has gained such prominence and popularity, it has been so since medieval times. A brief look at the maritime history would reveal to us succinctly the relevance maritime transport enjoyed in the ancient times as well as the near past.

3.1 Maritime History

It is commonly claimed that the wheel is the greatest invention in history. Yet, common sense suggests that water transport was a reality before wheeled vehicles became important, something which is confirmed by archaeology. Water transport with a history of more than 5,000 years is an integral part of civilization itself, and the world of shipping has a unique place in the history of mankind. Without it the world might have been nothing more than a quilt of isolated tribes confined to survive on whatever local resources they could find. It is difficult to even imagine that science and knowledge could develop very far in a world without water transport.

The first development of major sea routes on a regular basis took place during the Renaissance and expanded rapidly during the industrial revolution. The following quote from Sir Walter Raleigh, succinctly sums up the prevailing view on shipping as the 17th century began:

> *He who commands the sea, commands the trade routes of the world. He who commands the trade routes, commands the trade. He who commands the trade, commands the riches of the world, and hence the world itself.*

—Sir Walter Raleigh

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In Sir Walter Raleigh's time, there could be little doubt that the glue that held the British Empire together was the network of ocean-going ships that served as virtually the only means of communication, trade, and transport between England and her colonies. The relative power of different points in the Empire was inseparable from their position within this network.

Shipping was not only for adventurers and traders. It attracted the interest of Kings and Emperors, of philosophers and intellectuals. What Adam Smith (1776) did for our understanding of markets and industry late in the 18th century, Richard Hakluyt (1589) had done for trade and shipping two centuries earlier. His monumental treatise *The Principal Navigations, Voyages, Traffiques and Discoveries of the English Nation* (1589-1600) was written to be useful to merchants and entrepreneurs and to influence the direction and nature of public policy and indeed played a significant role in 16th century England.

Shipping was seen as much more than a means of transport, and was linked to broader concepts of technology and growth. Francis Bacon (1605) observed in *Advancement of Learning*, "The proficience in navigation and discoveries may plant also an expectation of the further proficience and augmentation of all sciences". Almost three centuries later, Emerson (1870), the American poet and philosopher, expressed similar thoughts: "The most advanced nations are also those who navigate the most".

In his *Wealth of Nations*[43], Adam Smith put great stress on the relationship between geographic location and international trade. Smith observed that a more extensive division of labour was likely to develop first along sea coasts and navigable rivers, where transport costs were especially low:

> *As by means of water-carriage a more extensive market is opened to every sort of industry than what land-carriage alone can afford it, so it is upon the sea-coast, and along the banks of navigable rivers, that industry of every kind naturally begins to sub-divide and improve itself, and it is frequently not till a long time after that those improvements extend themselves to the inland part of the country.*

He stated the access to water transportation as an important catalyser of economic growth. In The Wealth of Nations, he explains it in the following way:

"A broad-wheeled waggon, attended by two men, and drawn by eight horses, in about six weeks' time carries and brings back between London and Edinburgh near four ton weight of goods. In about the same time a ship navigated by six or eight men, and sailing between the ports of London and Leith, frequently carries and brings back two hundred ton weight of goods. Six or eight men, therefore, by the help of water-carriage, can carry and bring back in the same time the same quantity of goods between London and Edinburgh, as fifty broad-wheeled waggons, attended by a hundred men, and drawn by four hundred horses.[...] Since such, therefore, are the advantages of watercarriage, it is natural that the first improvements of art and industry should be made where this conveniency opens the whole world for a market to the produce of every sort of labour, and that they should always be much later in extending themselves into the inland parts of the country."

Although written in the 18th century these words remain valid as shipping continues to handle the major stake of the world trade.

These fragments of maritime history remind us that there is something so profoundly fundamental about maritime transportation that it has no direct parallel in other industries. Shipping has shaped and formed not only entire economies and world trade, but also cultures and cooperation between peoples. Merchant shipping developed and existed for centuries as a political, military and economic instrument.

The systematic growth of maritime shipping in recent times has been fuelled by several things. First of all, increase in energy and mineral cargoes which has been derived from the growing demand of the developed economies (mainly Europe, North America and Japan), and also increase in importing raw materials to China. Secondly, containerisation has permitted marine transportation to still have economies of scale and low-cost status when compared to e.g. railways. Thirdly, technical improvements in ships (e.g. bigger container vessels) and maritime terminals have facilitated the flows of freight. Lastly, globalisation, along with international division of production and trade liberalisation, has also been an important factor in the growth of maritime transportation. (Rodrigue, 2006)[44].

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Shipping industry can be divided into two segments by the nature of the shipping they are conducting: liner shipping having scheduled services and tramp shipping operating on spot deliveries. Liner shipping industry and its regulation is very different compared to other observed transportation industries. This is because the liner shipping has been, since 1875, regulating self supply and setting prices in their conferences.

Four general types of ships are employed around the world. Firstly there are passenger vessels which can be divided to passenger ferries and cruise ships. Second category is bulk carriers which carry either dry (typical size is from 100 000 to 150 000 dwt) or liquid bulk (typical size is 250 000 to 350 000 dwt). Traditionally general cargo ships have been less than 10 000 dwt in capacity, because of their very slow loading and unloading. Nowadays these vessels have been mostly replaced by much larger container ships which can also be loaded much more efficiently. Roll-on-Roll-off (RO-RO) vessels are designed to allow cars, trucks and trains to be loaded directly on board. The largest RORO vessels are used to transport cars from assembly plants to main markets. (Rodrigue, 2006). This thesis will take only container shipping into consideration.

3.2 Containerisation

Just after the Second World War economic landscape of consumer goods was characterised by a tremendous fragmentation whereby production was located as close as possible to the markets. By the end of the twentieth century this was hardly ever true. In almost every trade involving consumer goods nowadays, the distance between the production line and the end client can be measured by the distance between continents. The classic economic theory of the "competitive advantage" articulated by the 19th century economist David Ricardo assumed a world of insignificant transportation costs. While this would certainly not be true for the following 150 years, it has come to a point through technology, innovation and the containerised trade, that the world is experiencing this reality for a vast array of commodities and finished goods. The containerised trade is certainly the innovation that allows the classic economic theory to be put to the test. So far it seems quite evident that production is shifting to places of greater competitive advantage of some sort while the general arbitrage principles have allowed the fast economic development of areas that could

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not possibly expect to base their growth on local demand. Millions have benefited by free world trade and to the extent that further deregulation will continue diminishing those remaining trade barriers, the containership industry should be expected to crowd out many of the old fashioned transportation means.

Containerised freight refers to cargo of all types that is shipped in standardized metal "boxes." These boxes have the dual advantage of standardizing the loading and unloading process while at the same time allowing for a much more streamlined transition between different modes of transportation. Shippers lock and seal their containers at the point of origin such that they can travel to their destination with only a single inspection and a single bill of lading, thus greatly reducing travel time and costs. Prior to containerisation, general cargo was loaded and unloaded from ships in individual parcels of varied shapes and sizes. Thus, containerisation has revolutionised freight transportation. The significant advantages afforded by this system have led to rapid and broad adoption worldwide. From its inception in 1956, containerised cargo had grown to 440 million "twenty foot equivalent units" or TEU's.

Containerisation has become the leading edge within much of the maritime trade and has developed rapidly in terms of capacity -- vessels and terminals have got bigger and more efficient within a relatively short period of time. The growth in capacity has imposed new requirements upon the industry and a new type of collaboration emerged - mergers and strategic alliances (Evangelista and Morvillo, 1999)[45]. Shipping alliances control approximately 85 per cent of container trade and are made up of all of the major liner shipping companies (Cario, 2002)[46]. These alliances link maritime and inland transportation systems, thereby creating economies of scale benefits. In turn, this has meant that as container ships have increased in size, they have access to only certain ports and this trend has been exacerbated by the development of hub and spoke liner feeder systems with large vessels serving a few strategic ports and a number of smaller vessels serving many other ports. The result has been a division of ports into global hubs, regional hubs, sub-regional and local ports (World Bank, 2002)[47], depending on their facilities and the hinterland they serve. In spite of what this classification suggests, each port still operates as a distribution centre (albeit of a different scale) within the global container supply chain.

4. PORTS

From the above sections, we can conclude that in recent decades maritime transport has indeed undergone important transformations with the increase of ship size and the development of containerised cargo transport. These changes forced ports to grow accordingly to meet the new needs arising from the larger number of containers handled by ships. However, not all ports have been able to increase both their mooring and storage capacity. Consequently, a substantial improvement of port operations efficiency is required for a large number of ports.

Ports consist of the facilities whose main function are the transfer of passengers and merchandise between sea and land and vice versa. The European Union (European Parliament, 1993) defines ports in terms of the area made up of a group of berths, docks and land area where service operations to ships and cargo are performed. This area encompasses not only the infrastructure (berths, storage areas, shipyards, etc.) but also the superstructure which consists of fixed units built on infrastructure (buildings, repair shops, etc.) such as mobile equipment (cranes, etc.). To access the port area we need maritime access infrastructure (access channels, navigation aids, etc.) as well as land access infrastructure (roads, railways and inland rivers).

Ports are economic and service provision units of a remarkable importance since they act as a place for the interchange of two transport modes, maritime and land, whether by train or road. Therefore, the essential aspect of ports lies in their intermodal nature. In this respect, the UNCTAD states that ports are interchangers of different transport modes and, thus, they are centres of combined transport.

As in other transport modes, port activity does not usually generate by itself but it arises as a consequence of the economic activity of a region. The economic relevance of ports arises from the fact that most of the foreign trade of a region is carried out by sea. As mentioned earlier, about 90 per cent (by volume) of the international trade of the world is performed by sea. The economic growth and the development of industrial production and trade generate a larger demand of maritime transport services, thus increasing port business which is highly affected by economic cycles. Ports are an important link in the logistics chain so the level of port efficiency affects – to a large extent, the country's competitiveness, since port efficiency results in lower

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tariffs for exports which, in turn, favour the competitiveness of country products in international markets. Therefore, in order to keep a competitive position in those markets, the countries need to work on the factors that affect the efficiency of their ports and draw continuous comparisons on the degree of efficiency among them and with the ports of other regions.

4.1 Efficiency of Ports

Transport costs are a barrier to trade. To a large extent, they are determined by the efficiency of port infrastructure. Poor port efficiency will increase import prices and reduce the competitiveness of the country's exports in world markets. Hence, port efficiency is a critical link between the domestic economy and the rest of the world. Lowering transport costs will, presumably, increase trade volume and, consequently, enhance the productivity of domestic factors of production, leading to higher growth rates.

As nations are becoming more global and their industries more exposed to the pressures of international competition, there is a growing realization that services supplied to their industries must be provided on an internationally competitive basis. Thus, there is a push amongst port authorities to improve their port performance and efficiency due to increasing competition between ports and growing pressure from shippers for lower port and shipping charges. Ports form a vital link in the overall trading-chain - their level of efficiency and performance determine to a large extent a nation's international competitiveness.

5. THE INDIAN SCENARIO

India is a developing country. After getting independence in 1947, it opted for a Social Democratic Government. With a predominantly Welfare state outlook, its stated objective was to uplift its poverty mired citizenry. In its zeal to achieve this objective, it not only ignored but downright turned its nose at market driven economy. The socialist welfare state experiment met with disastrous results by 1990 when the country tottered on the brink of bankruptcy. This state of affairs was reached in spite of the country being a leading global producer in several products and rich in resources.

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The country pulled back from the brink of bankruptcy by instituting economic reforms which led to India achieving 6-7 per cent GDP growth for the past 15 years and becoming the fourth largest economy in the world after the United States, Japan and China in the purchasing power parity. Currently, in addition to over 8 per cent GDP growth rate (with predictions of over 9 per cent GDP growth) and a low inflation rate with sustainable fiscal deficits, India is slated to become an economic superpower within the next ten years.

India, though a late comer to economic reforms, has fast caught up and is now very well integrated with the global economy as reflected by the impressive growth of both its exports as well as imports of over 20 per cent. Such continuous and high growth of EXIM trade leads to specific needs of multimodal transport and effective supply chain management - integration from the point of production to the point of consumption. Herein logistics plays a key function and transportation becomes a critical activity.

However, it is this very need for transportation that could pose the biggest problem for India in its path to realizing its goals. What could be one of the biggest hurdles is the limitations of its infrastructure, imposed by the lack of an efficient integrated multi modal transport capability. The infrastructure capability just is not able to match the export and manufacturing growth rates. The country's road, rail and sea transportation system leaves much to be desired and the port infrastructure is crumbling (Mukherjee, A. and Sachdeva, R., 2003)[48]. It is a catch situation as development does not take place due to lack of infrastructure which does not develop due to lack of financial resources which in turn leads to further lack of development. Several global corporations are hesitant to invest in India for several reasons of which lack of suitable infrastructure is the most important.

The Government has placed greater emphasis on private sector participation to address the issue of infrastructure shortfall in port sector. The new projects would give the shippers and carriers more choice ushering in more competitive freight transport environment, which will in turn increase the transport efficiency and reduce the costs. The land based leg will be faster with widening of National & State Highways. Liberalisation of rail services and opening of container train business to private sector participation is a step towards further improving the transport infrastructure in the Country. Development of dedicated freight corridors is also being put on a fast track.

Since this thesis is focusing on maritime transport, it is ports that would be discussed in this context here. India is not in top 25 liner shipping routes in terms of total TEU capacity of the vessels deployed for direct shipping services. There is a very high level of transhipment of containers at nearby ports (Colombo, Singapore, Klang). In India, presence of national lines, which is known to have a stabilizing effect on freight rates, is not significant. Shipping Corporation of India (SCI) is the only Indian shipping line operating worldwide services (niche services to USA, Europe, Far East). But on a more optimistic note, at the present stage of economic development, India's liner trade will certainly be a high growth area with some key industries/ sectors expected to grow at very healthy rates. India's potential to become a manufacturing hub augurs well for the liner trade of the country.

6. RESEARCH OBJECTIVES

The available literature on maritime infrastructure in India merely describes containerisation and multimodal transport in India and forecasts the growth rate of containerisation in India. There has been no attempt to scientifically study the efficiency and productivity of the Indian ports in context of containerised cargo. This thesis tries to cover the above mentioned lacunae.

The main purpose of this paper is to quantify the evolution of technical efficiency as well as productivity in port infrastructure service provision in the Indian ports involved in handling container traffic. The analysis focuses on container traffic for the following reasons. First, container traffic promotes the integration of different transport modes. The second reason is that the use of containers is still booming. The third reason lies with the fact that container handling requires specific infrastructure (area, mechanical devices, etc.) for which a large amount of public funds is devoted every year. Finally, it is a generalised opinion among researchers that the development of containers also carries a substantial improvement to port efficiency. For instance, Kim and Sachis (1986)[49] show that 85 per cent of the increase in total factor productivity of Ashod Port (Israel, 1966-1983) is driven by containerisation.

The thesis will also describe the macro economic background of India, comparing it with that of Gujarat. It further observes the movement of cargo from the Indian ports and describes the Indian ports with reference to containerised cargo. It then tries to

analyse the efficiency and productivity of the container ports in the country using Data Envelopment Analysis and the Malmquist Productivity Index.

Thus the problems this thesis undertakes to analyse are as under:

1. Identify and explore the critical role and growth of containerisation and its implications in the context of a global as well as Indian scenario.

2. Study the ports of India, with special emphasis on container handling ports.

3. Analyse the efficiency and productivity of container ports of India using Data Envelopment Analysis.

7. METHODOLOGY AND MODELS

Data Envelopment Analysis (DEA) is a linear programming (LP) based deterministic and non-parametric method for measuring the relative efficiencies of units where simple efficiency measures are difficult to obtain (Farrell 1957 and Charnes et. al., 1978) and which are characterised by multiple inputs and outputs. The units in any DEA assessment are generally homogeneous and independent units performing the same function, and it is of most use where there are a large number of units providing an 'identical' service in relative isolation (Szczepura et. al., 1992)[50]. DEA converts multiple inputs and outputs of a decision unit into a single measure of performance, generally referred to as relative efficiency (Donthu and Yoo, 1998, p. 91)[51].

DEA was first developed as a way of measuring service units by Charnes et. al., (1979)[52] and was based upon Farell's (1957)[53] idea of linking the estimation of technical efficiency and production frontiers. The model has since been added to and developed over the years. Between 1978 and 1992 over 400 articles, books and dissertations were published on DEA (Charnes et al., 1995)[54]. DEA has been successfully used to research and test the efficiency of multiple centres of inputs and outputs such as airports (Gillen and Lall, 1997 and De La Cruz, 1999)[55], local government authorities, courts, hospitals, general medical practitioners, bank branches, etc. Its application to the port industry would therefore be ideal due to the multi input - output nature of port activity.

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The DEA technique is a useful measurement of port efficiency because the calculations are non-parametric, they can handle more than one output and they do not require an explicit a priori determination of relationships between output and inputs, as is required for conventional estimations of efficiency using production functions.

The basic idea of DEA is to identify the most efficient decision making unit (DMU) among all DMUs. The most efficient DMU is called a Pareto-optimal unit and is considered the standard for comparison for all other DMUs. That is to say, a single firm is considered DEA Pareto efficient if it cannot increase any output or reduce any input without reducing other output or increasing other input. An efficient firm can enjoy efficiency scores of unity, while an inefficient firm receives DEA scores of less than unity. Here, efficiency is the ratio of the weighted sum of outputs of a firm to the weighted sum of inputs. The efficiency of any firm is computed as the maximum of a ratio of weighted outputs of firms to weighted inputs, subject to the condition that similar ratios, using the same weights, for all other firms under consideration, are less than or equal to one.

The DEA models most widely used in practice are the CCR (named after Charnes, Cooper and Rhodes) the BCC (named after Banker, Charnes and Cooper)[56] models. The main difference between the two models is in the assumption for returns to scale (RTS). In fact, the CCR model assumes constant returns to scale (CRS), whereas the BCC model allows for variable returns to scale (VRS). DEA models can be distinguished according to whether they are input-oriented or output-oriented (i.e. either minimising inputs for a given level of output, or maximising output for a given level of input). The present work uses output-oriented CCR and BCC models to analyse production of the maximum possible container throughput from a given fixed quantity of resources.

The DEA model used to analyse and compare the efficiency of container terminals of the Indian ports has a of total 12 ports, including 10 major and 2 minor ports which handle containers. As the facilities and scales of these ports are similar, selected DMUs are adequate for the analysis of this study. To apply DEA model, the common inputs and outputs of each container port need to be appropriately selected for the analysis because the selection of inputs and outputs is directly related with the validity

of the model. Labour and capital are two generic inputs for the analysis of efficiency. To quantitatively measure the labour and capital, we use the number of quay and yard equipments as proxies of labour and the total berth length and terminal area as those of capital. Container output in number of TEUs handled is used as the only output in this analysis as it is an index of competitiveness of a container port.

Since efficiency score of all DMUs that are effective in DEA are assigned as "1", it is not possible to rank effective units between each other. Andersen and Petersen (1993)[57] developed a super efficiency ranking technique for ranking efficient units. The basic idea is to compare the unit under evaluation with a linear combination of all other units in the sample, i.e. the DMU under evaluation itself is excluded. In other words, the model compares the analyzed decision making unit with the linear combinations of all the other decision making units. The methodology enables an efficient DMU to achieve an efficiency score greater than one by removing the constraint which relates to DMU in the formulation. The score reflects the radial distance from the DMU under evaluation to the efficient frontier estimated without that DMU in the sample. The approach provides an efficiency rating of efficient units similar to the ratings of inefficient units. The decision making unit that has the highest super efficiency score occurs in the first place. The other decision making units are ranked in descending order according to their super efficiency scores. This thesis also uses this model so as to rank the ports/terminals under study.

The next step this research undertakes is to hypothesise that the state-run ports/terminals, i.e. ports/terminals under the public administration and those under private/corporate administration do not differ significantly in their efficiency scores and whether this hypothesis is corroborated or not is verified with the help of the Z and P-values of the Wilcoxon-Mann-Whitney U-test.

With the help of the output oriented Malmquist Productivity Index (MPI), we then estimate Total Factor Productivity (TFP) change by accounting for technical and efficiency advances which incorporate data and information from two adjacent time periods. We further decompose the former Malmquist index of efficiency change into its two sub-components, scale efficiency change and pure technical efficiency change.

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8. DATA COLLECTION

This thesis will make use of only secondary data, The data regarding Indian ports and container movement in the country was taken from Basic Port Statistics, published by the Transport Research Wing, Ministry of Shipping, Road Transport and Highways and Major Ports – A Profile, published by the Indian Ports Association. Also, data through interactions with the authorised port personnel via telephonic conversations and emails have also been used. International data for ports and container cargo/ships/terminals/etc. have been taken from various sources, which have been cited wherever they have been used.

9. RESEARCH PATH

The thesis will progress in the following manner:

a. Chapter II is a literature survey of previous works undertaken in the field of port efficiency as well as Indian ports and maritime transport.

b. Chapter III provides an overview of the Indian economy: past, present and future. It gives a general picture of the Indian economy as well as a snapshot of the economy of Gujarat and provides a comparison vis-à-vis the national economy.

c. Chapter IV looks at containerisation globally, with a special focus on containerisation in India.

d. Chapter V discusses ports and the importance of their performance and efficiency.

e. Chapter VI describes in detail the methodology and models used in this thesis, viz. the Data Envelopment Analysis and the Malmquist Productivity Index.

f. Chapter VII analyses the efficiency of Indian container handling ports also presents the summary and conclusions of this study.

Endnotes

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