GUJAR GIRISH CHANDRAKANT

Essays on Dry Ports

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For Jhai, Shobha and Rohan;
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Abstract

Due to several reasons, currently the global supply chains are getting stretched further away into the hinterlands from the gateway seaports. This single fact enhances the importance of dry ports. It would not be against logic, to state that in coming times, as a result of ever-growing quest for satisfying the customers, improving quality, cutting transaction costs the dry ports will assume greater importance than sea ports, hence a study of this phenomenon assumes importance.

Post financial crisis, India along with China and Brazil have acquired global attention due to consistent economic growth and most importantly its perceived ability to pull the world out of recession. There are quite a few similarities in all the three countries apart from demography produce and landmass. The chief amongst them is overwhelming quest for growth and suitable policies being adopted to satisfy the growth. It is but obvious that the dry ports will play a major role in the growth stories of all three countries.

This thesis looks at the dry ports in India from different perspectives such as locational analysis, role of government in development of dry ports and need for Public Private Partnerships (PPP), regulating dry port competition and role of regulatory authorities, environmental externalities and dry port efficiency, factors affecting dry port performance and lastly container security at dry ports. The contention behind the compilation of overtly disparate dry port related topics is that every aspect has a clear but subtle bearing on other for e.g. competition policy has an impact on dry port performance. Similarly container security and environmental impact are related to the overall efficiency of the dry port. The importance of location of a dry port cannot be over emphasized and is directly related to the dry port performance.

However there are dry ports and there are dry ports. Every dry port differs by way of size, infrastructure, purpose, customer profile, demand for certain services or lack thereof and so on and so forth. This makes comparison of different dry ports a hazardous task. Having recognized this, we have selected dry ports for our study, which are located in the same geographical region. For the purpose of spatial analysis we have selected dry ports situated in South India whereas for the purpose of environmental impact we have selected North Indian dry ports. The dry ports

situated in the JNPT region of Western India have been selected for performance and security analysis. The papers on government policies and regulatory legal regimes are of course applicable on pan India basis. Thus the thesis attempts, to simultaneously have, a broader perspective as well as specific focus. This has enabled us to draw appropriate inferences which could find wider applications.

While various studies exist on the analysis of location of dry ports in the western world, the study of this topic in the developing, newly-industrialized countries like India remains scarce. With such understanding, this thesis analyzes the importance of landside component with specific emphasis on the location of inland terminals (ICD) in Southern India. Using the transportation links between two major production bases (Tirupur and Coimbatore) and two major seaports (Tuticorin and Cochin) within the region, attention is paid to, whether the current scenario where all the shippers from different production bases ship their cargoes to their respective local dry ports is the optimal solution or what should be the optimal location of a dry port. We have further analyzed the location of dry ports by using the GIS technique and have arrived at a conclusion that the existing location of some dry ports is not optimal. Our conclusion has been validated by poor performance of dry ports in question for the past several years (chapters 2 and 3).

For the efficiency study of dry ports we have selected two outputs; carbon emissions (undesirable) and container security (desirable) and used the DEA method to ascertain the efficiency of dry ports located in the western and northern region of India. Our findings reveal that very few dry ports (mostly private) could be considered efficient from this perspective (chapters 5 and 7).

On analyzing the performance of dry ports in the JNPT region of India with the help of a regression model, it was noticed that except for two factors viz; manpower quantity and tariff rates, none of the other seven factors such as number and quality of equipment, customer relationships, size of the dry port or availability of rail connectivity had any significant impact on the dependent variable i.e the annual throughput. According to us this result has a bearing on the low value of the cargo carried in the containers (chapter 6).

In addition to desk research we have collected data from 52 dry ports located all over the country for over four years (2006-2011) by conducting over 200 structured interviews with various stakeholders involved. We have also made numerous site visits to each dry port. The data so collected was tabulated and analyzed using sophisticated software.

Our study reveals that government policies towards regulating the dry ports in India is partially biased towards public sector dry ports despite privately owned and operated dry ports being more efficient and better managed. Thus the government finds itself in a dilemma of implementing dualistic policies. On one hand it wishes the public sector dry port to be a major player in the industry so as to effectively influence the pricing policy of dry port services and thus protect the consumer while on the other hand it wishes to promote efficiency, competition, attract investors as well as managerial and technical knowhow. This has led to the creation of the vexing issue of excess capacities which are to a large extent underutilized resulting in waste and defeating the purpose for which they were created. According to us the solution lies in grasping the opportunities for constructing Public Private Partnerships for better management of the assets and minimizing waste (chapter 4 and 8).

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Chapter 1

Thesis Introduction: Role and Function of Dry Ports in India

1.1 Introduction

India, which is one of the fastest growing emerging economies in Asia, is currently facing a major challenge as it continues to pursue its economic growth while being saddled with an underdeveloped and inefficient land transport infrastructure that has not kept pace with rising demand. India's road network, which carries almost 90% of the country's passenger traffic and 65% of its freight, is highly congested. Although the density of the roads (0.66 km per square km of land) is almost identical to that of the US (0.65) and much greater than China (0.16), most of India's roads are narrow and congested, with poor service quality. Its railway network, carrying some 17 million passengers and two million tons of cargo per day, is inflicted with capacity constraints and operational inefficiencies. All these factors, together with subsidization of passenger traffic have raised India's freight tariffs to levels that are amongst the highest in the world (Dayal, R., 2007). However, the required investment and modernization of its railways have been hampered because India's development policies are often inconsistent with the political realities of its traditional consultative democracy (Haralambides and Gujar, 2011 and Ng and Gujar, 2009). In this context, the reinforcement of India's container ports and in particular its dry port sector represents an essential effort to overcome the high logistics costs which renders it exports uncompetitive.

Unlike the developed countries of the west, notably the US and Western Europe nations, India has traditionally never been a seafaring nation with high levels of maritime trade. As such, the need for containerization was not urgent until the late eighties. It was only after the 1991 financial crisis when the country's foreign currency reserves were almost exhausted that market reforms were introduced and foreign trade was actively encouraged. Subsequently foreign trade picked up and so did containerization (the annual throughput at the time was less than 1 million TEUs while the present throughput is in excess of 7.2 million TEUs).

It is a widely accepted fact that, for the consumers to avail themselves of the substantial benefits of containerization, the containers need to be transported to their doorsteps. For this purpose a special agency was created by the government of India in 1988 which was named Container Corporation of India Ltd. (CONCOR) and was designated the task of inland container transportation on a door–to-door basis. Moreover, work on container transportation between the gateway sea ports and dry ports was done under a customs bond submitted by CONCOR to ensure against leakage of revenue without payment of duty at the gateway port. Thus the cargo no longer need not be cleared at the gateway sea ports; instead it could be done at the dry ports. This implementation is the chief advantage of containerization and the dry ports were expected to optimize such advantages.

Thus as inland logistics centers, dry ports are playing an increasingly pivotal role in the multimodal transport network that sustains economic activity by delivering key inputs to local enterprises and facilitating their exports of raw materials, semi-manufactured products, and finished goods (e.g. Heaver, 2002; Sanchez et al., 2003; Notteboom and Rodrigue, 2005). As such, by relieving congestion at gateway sea ports (Slack, 1999; Rodrigue and Notteboom, 2010) and acting as a focal point of supply chains connecting different locations within India, dry ports promote regional development (UNESCAP, 2006). By 2010, more than 200 dry ports had been established throughout India. Over 60 of these were close to the main gateway sea ports, such as the Jawaharlal Nehru Port (JNP) and Mundra ports.

These dry ports have facilitated interaction between the shippers/consignees on the one hand and shipping lines/carriers on the other. This chapter attempts to study the functional role of dry ports in global logistics in general, and India in particular, with the objective of analyzing the advantages and disadvantages of such facilities from the customer's perspective.

1.2 Role, Purpose and Definition of Dry Ports

The term "dry port" has been in use for decades now. It has often been used interchangeably with Inland Clearance (or Container) Depot (ICD Beresford et al., 2004. More recently, it has been used in industry as a marketing tool to imply that a facility has reached a particular level of sophistication in terms of services offered, such as customs or the presence of Third Party Logistics (3PL) firms within the site and/or an adjoining freight village.

A new definition was proposed by Roso et al. (2009); "A dry port is an inland intermodal terminal directly connected to seaport(s) with high capacity transport mean(s), where customers can leave/pick up their standardized units as if directly to a seaport." (p.341). The key feature of this definition is the authors' contention that "for a fully developed dry port concept the sea port or shipping companies control the rail operations" (p.341). One of the aims of this paper is to consider to what degree this situation actually is achieved in the industry. In other words, are rail operations to sites which label themselves "dry ports" run by seaport or shipping companies? As a contrast, Rodrigue et al (2010) prefer the term inland port and draw useful distinctions between the functions of different sites into satellite terminal, inter-modal centre and load centre.

As a crucial part of the international transportation systems, ports are not solely independent and natural area for the transfer of physical goods, but also a systematic element of (often multimodal) logistical supply chain. Therefore, the role of a dry port within this system is becoming particularly important. Research on inland terminals or dry ports is often focused on individual sites, while less attention has been given to the port-dry port system. This thesis will add to the literature by considering the system as a whole, with the aim of understanding how dry ports are developed in relation both to ports and to other inland terminals.

This thesis builds on previous works which have dealt with developing inland terminal taxonomies and applies them to the Indian case, with supplementary focus on the "extended gate" concept. Theoretical contributions include both the importance of development direction (land-driven vs sea-driven) and the identification of an emerging disparity in port development strategies between port centric logistics and dry ports.

Another major reason for the rising importance of dry ports is due to their roles in the coordination of materials and information flows; minimization of costs; as well as reliable cargo handling which is becoming crucial as a functional part of the global logistics and supply chain management. The increasingly demanding customers push service providers hard to provide speedy, just-in-time services at low/reasonable prices. This may require shipping lines to carry cargo further inland with a much more flexible schedule and it will need dry ports to cope with it. Thus, the efficiency of the whole logistics supply chain largely depends on dry ports as they act as the integrating and coordinating mechanism between different components, e.g., shipping lines, inland transportation and warehousing (Bichou and Gray, 2004; Miyashita, 2004).

This deficiency has been one of the key factors in the shipping lines deciding not to bring large container ships (10000 TEU and above) to India. Instead smaller feeder vessels carry Indian cargoes to major hub ports such as Singapore, Colombo, Jebel Ali and Salalah which results in increased transport costs.

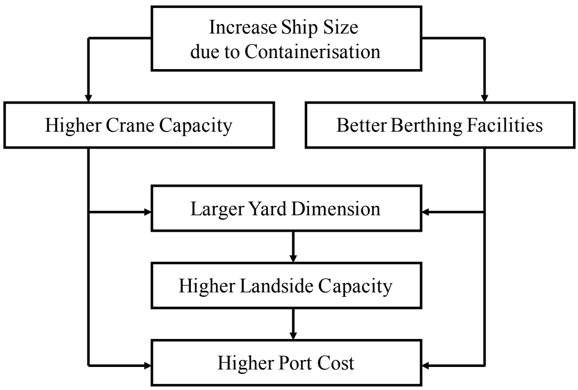

Figure 1. Diagram illustrating the relationship between increasing ship size due to containerization and port cost

Cullinane et al (2000) have pointed out that "while the expansion of reach on the maritime side of a port's operational environment is clearly recognized and relatively widely analyzed, the process of a port's spatial development of its hinterland (other than simply the fact of its expansion) has received considerably less attention" (pp9-10). The aim of this thesis is to contribute towards addressing this research gap. The majority of research on inland terminals or dry ports has focused on individual sites, while less focus has been given to the port-dry port system.

Thus, the demand from ports to achieve the supply chain logistical goals has given rise to the concept of 'port logistics'. Under such system, the port operation process would be integrated with the multimodal supply chain based on efficient physical cargo flows, common strategic goals, as well as innovative organizational relationships. Physical flows consist of the port entry, stevedoring, transit, storage and linkage systems, while information flow relates to all relevant operational information concerning the physical cargo flows. Thus each sub-system is interconnected in accordance to the cargo flow within the port logistics concept. The dry ports are an extension of this port logistics concept into the hinterland.

Essentially the evolution of dry ports is a direct result of development of global transport strategies. The phenomenon of shifting manufacturing basis from coastal areas to further inland locations was a consequence of capacity limitations of gateway ports. The growth of intermodal transport in turn assisted in addressing the capacity issues. The congruence of these factors has created the right conditions for the evolution of dry ports.

Notteboom (2010) has noted that immediate hinterlands remain the primary focus of ports, notwithstanding the increasing attention given to hinterland access. The pros and cons of public vs. private sector development have been examined by Cullinane et al (2010), Notteboom and Rodrigue (2005) and Jarzemskis (2007). The over-optimism about the number of sites developed by local or regional bodies has been noted, with the result of some terminals being under-used. Roll and Hayuth (1993) and Ng and Gujar (2009) have discussed centrality and intermediacy and how it can be affected by government policy.

A particularly relevant concept for this thesis is the concept of extended gate, discussed by Van Link 2000) and more recently by Rodrigue and Notteboom (2009). The potential behind the new concept of "terminal haulage" represents a new stage of integration that forms the basis for a fully realized "dry port" concept. Therefore any discussion of a "dry port' as an active node in the transport chain must relate to the move from push logistics towards pull logistics or even "hold logistics", as outlined by Rodrigue and Notteboom (2009) in their concept of supply chain terminalisation.

The growing focus on inland/dry ports is indicative of transport development strategies gradually shifting inland to address capacity and efficiency issues in the light of global supply chains. The complexity of modern freight distribution in emerging economies like India, the increased focus on intermodal transport solutions and capacity issues appear to be the main impetus. In the light of technological, market and supply chain changes, this thesis looks at the role inland terminals play in the organization of regional freight distribution.

1.3 Dry Port Development in India

Since the advent of containerization in Western Europe and USA, intermodal dry ports have become an integral part of freight transport systems. There were several reasons for the evolution of dry ports. The insatiable focus on trade growth led to exhaustion of port capacities resulting in congestion, diminishing returns and drastic fall in efficiencies. This forced stakeholders to shift gateway ports outside the city limits in the initial phase and available port facilities services, such as customs clearance, to inland dry port locations in the subsequent phase (Haralambides and Gujar, 2011).

According to Haralambides (2007), there are three major types of dry ports: Gateway Terminals, Rail Terminals and Distribution Centers. A seaport terminal provides an interface between the maritime and inland systems of freight distribution, while rail terminals serve as linkages to gateway ports. They could be located very near the gateway ports or could be quite some distance away. However the chief difference between the two different types of dry ports is not a matter of distance but, as stated earlier, the ability to clear sea port with or without customs clearance. The dry port operator transports the container to the dry port without clearing customs at the gateway ports by furnishing a bond for potential liabilities. The third type of dry port is known as a distribution centre in western European countries. They perform an array of value added functions in addition to the transportation and warehousing operations, such as sorting, grading, packing, labeling, de-bulking, inventory control, etc. All the dry ports in India are served by rail or road and conduct little value added activities.

Holtgen (1995) has suggested that intermodal terminals can be classified according to a set of functional criteria, including traffic modes, trans-shipment techniques, network position or geographical location. Konings et al. (1995) has also proposed a typology of hinterland nodes. According to Notteboom et al (2005) and Haralambides et al (2001, 2003) the major factors determining the definition from uni-modal to tri-modal are as follows. Uni-modal nodes are ubiquitous in the road haulage industry, while Bi-modal facilities are equipped to accommodate two transport modes, typically rail and truck or barge and truck. Tri-modal inland nodes are designed to handle cargo between three modes: rail, barge and truck which are conspicuous by their absence in India.

Ironically, containerization was introduced for the first time in the Indian domestic market way back in 1966 by the Indian Railways (IR) to provide door to door service to their customers and attract cargo from roadways. IR used containers with a five ton payload. However the International Marine Container did not become the standard model until the late 1980s which has in turn affected international trade growth. Hence the necessary infrastructure required for multi modal transport was never created until it was almost too late (Raghuram.G., 2002).

It was only in 1987 that the Government of India realized the importance of containerization and started constructing a satellite port at Bombay which commenced operations in 1988 and was christened The Jawaharlal Nehru Port (JNP) after the first Prime Minister of India. Subsequently CONCOR constructed the first dry port at Tughlakabad in New Delhi.

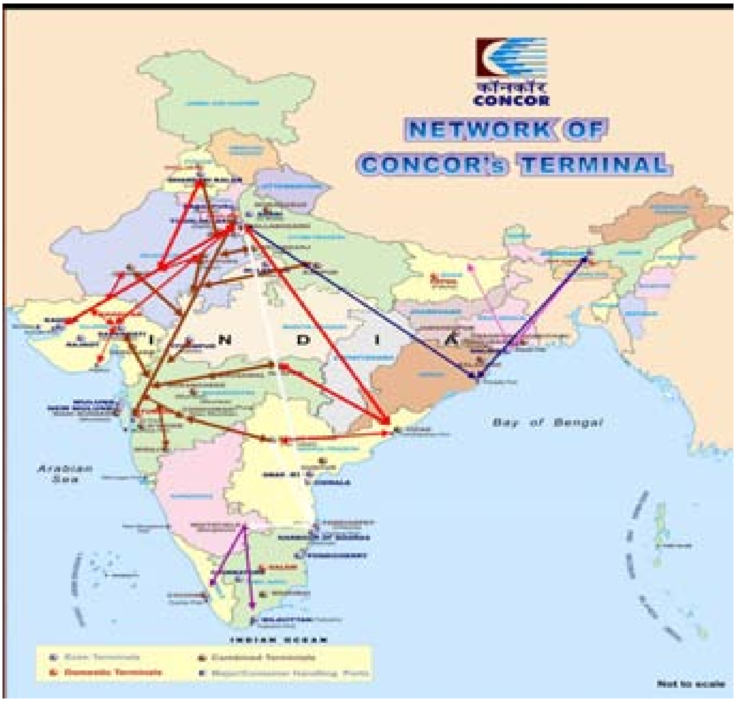

Figure 1.2 Network of CONCOR owned/operated Dry Ports in India

The requirements of exporters/importers at dry ports are varied and demand different kinds of skills and expertise. At the same time, there are commercial formalities and legal requirements which have to be strictly observed. For example, an exporter may require a competent freight broker to negotiate the best rates for ocean voyage, an expert for proper stuffing, another expert to complete their documentation, and so on. It would be ideal for the users to get all the services from a single agency. But the increasing specialization of activities has given rise to specialists in every activity, as they are able to provide greater value for money. As such, it has become necessary for the dry port operator to facilitate the provision of such specialized services to his customers at their premises.

Typically, a dry port will provide a set of core services, such as container handling, to the customers while allowing them full freedom to choose their service provider for, say, forwarding freight and road transportation. For other operations, the options are limited, but the customer is free to negotiate rates with the service provider. The dry ports also facilitate interchangeability through transport modes from rail to road and vice versa. In addition, they provide temporary storage for goods and containers in order to consolidate or de-bulk into smaller or larger loads for onward transit. The goods could be liquid, dry bulk or general in nature.

The government of India also expected that the dry ports would attract several associated services along with manufacturing activities which could subsequently lead to an agglomeration of manufacturing and service industries. Such an expansion would have been particularly beneficial to small and medium sized enterprises in assisting their growth. The dry ports were subsequently expected to progressively expand with addition of value added services such as packaging, labeling, storage, etc, eventually broadening further towards import/export processing or special economic zones ideal for goods assembly, manufacturing and agricultural processing. Thus ultimately dry ports could potentially act as growth poles just as seaports which were once the traditional growth nodes. As such the objective of the dry ports in India was partially socio-economic rather than purely commercial in nature. The development of rail-connected dry ports was also expected to divert traffic from road to railways resulting in significant environmental benefits.

However, the contrast between the objectives of the government in promoting development of dry ports and actual objectives of the dry port operators soon became apparent as none of the dry port operators envisaged a role of regional socioeconomic catalyst. Neither did they consider it their priority to encourage regional growth by attempting to meet local demand for specific specialized logistical services. In reality they provided a standardized set of services irrespective of existence of demand for such services, on a cost plus basis. Hence most of the dry ports continue to be underutilized. This thesis emphasizes this fact and endeavors to analyze the government policies with regard to dry ports and to ascertain a solution for the vexing issues of excess capacity and wasteful competition by suggesting the initiation of suitable Public Private Partnerships (PPPs) between public and private sector dry ports. This thesis further goes on to access the efficiencies of the dry ports by taking into account important outputs such as carbon emissions (undesirable) and container security (desirable) and by using the DEA method.

1.4 Operational Policy of Indian Dry Ports

There are several models for providing services which are almost the same for public as well as private sector dry ports; management by the owner or through other service providers or a mix of both. The popular model which has emerged in India, and adopted by dry port operators, is an improvised landlord model. The dry port operator usually outsources most of its services to several contractors/vendors while giving full freedom of choice to its customers/users of the dry port facility regarding their CHA (Customs House Agent) or Freight Forwarder, Shipping Line, etc. The dry port operator focuses on the following framework activities in addition to setting up and operating dry ports:

- Landlord function such as long-term planning, infrastructure development, asset management.
- Regulatory function such as obtaining permission from Customs, transport safety, environmental protection and fair competition, and
- Co-ordination function such as co-ordination among government agencies, decision making authorities and planners of the city; under the commonly shared long-range policy and
- Facility/promotion function such as strategic marketing

The landlord model with minor variations of departmental and outsourcing mix offers the following advantages to the customers:

- Customers have access to highly specialized service providers
- Customers have more options. This helps them to control their costs
- Less centralized control permits greater flexibility in rating and control of activities
- Dry port owner is not burdened as the direct employer of a large number of workmen who are instead employees of the service providers.
- It generates stable income for the dry port owner from the license fees, lease rent, etc. charged to the service providers.

The disadvantages of this model are as follows**;**

- Dry port owner has little control over the price or quality of the services by the outsourced service providers.
- Poor service by any of the service providers may result in the customer deserting the dry port.
- Service is expensive as there is an additional charge levied on the customer.
- Service provider may not have the inclination to invest in any long term asset as he may not be assured of his tenancy or lease period

1.5 Research Objective

The purpose of this research is to empirically measure the performance of Indian dry ports and their impact on the country's logistics performance. The specific research objectives are as follows:

Main Question: How to measure and analyze the performance and efficiency of dry ports in India?

In order to answer the main research question the research problem has been divided into secondary questions, mentioned hereunder, each of which would be discussed in different chapters of this thesis.

- Analysis of the spatial characteristics of Indian dry ports with specific examples of south Indian dry ports
- Location analysis of Indian dry ports using the GIS technique
- Analysis of the pricing policies of the dry port sector in India and assessment of the opportunities for construction of a suitable Public Private Partnership (PPP) framework which would help in resolving the issue of excess capacities and regulate competition amongst various dry port operators
- To construct a regression model for performance measurement of dry ports.

- To ascertain the efficiency of the dry ports by using DEA method with undesirable carbon emissions as one of the outputs.
- To ascertain efficiency of the dry ports with container security as one of the outputs.
- Erect a solid foundation for dry port performance measurement to enable further academic research.

1.6 Key Aspects of this Research

The importance of dry ports in several areas of the international trade for India and the far reaching implications of this sector have generated a large set of interesting and important research issues. The strategic nature of dry ports in ocean transportation and the exploratory nature of a large part of this study call for a holistic and trans-disciplinary approach to the research questions. For this reason the thesis can be connected to the following research domains:

- Applied (Transport) Economics
- Industrial Organization
- Public Policy
- Supply Chain Management

The current research aims at exploring, without the presumption of being exhaustive, some of these issues. Although throughout our research work and during the writing the thesis a large number of issues emerged, six key aspects can be traced as dominant in the thesis.

- Impact of dry ports on shippers, carriers and allied stakeholders
- Competitive advantage derived by dry port users
- Transaction costs and dry ports
- Strategic policy
- Dry ports and the supply chain;
- Competition issues and regulation.

All the above mentioned aspects are related to the main research questions which is measurement of performance and efficiency of the dry ports in India.

1.7 Research Issues

Dry Ports and Logistics Services in India

The research creates a theoretical framework on the issue of dry port management with an application to logistics and maritime transport. The idea is to visualize ocean transportation as a segment in the chain and identify how dry ports could be integrated with it. The selection of the components to be so integrated depend on different considerations, such as the degree of complementarities among services, transaction cost issues and demand characteristics.

Spatial Characteristics of Dry Ports and Network Economies

The ascertaining of optimal efficiency and performance requires an extension of the theoretical approach used in the literature. This involves the necessity of extending the location paradigm of centrality and intermediacy proposed by Roll and Hayuth (1993) to encompass some of the distinctive characteristics of transport and logistics services, the existing economies of scope, scale and network among others, but primarily the investigation of the nature of the transaction between dry port service providers and shippers.

Pricing of Dry Port Services, Competition and Excess Capacities

The research relies on a market survey of dry port users and allied stakeholders in order to assess their opinions and perceptions about dry ports and their willingness to pay for the services offered. The indirect estimation of elasticities of demand and other conceptual issues are also addressed in the thesis by taking into consideration excess capacities which tend to act as entry barriers which dampen competition and increase the relevance of the research, both from an empirical and a theoretical point of view.

Performance and Efficiency Analysis of Dry Ports

The research will make clear which dry port services are outsourced by the dry port operators and how this impacts their overall performance measured in terms of annual throughput. The problem of the performance and efficiency measurement of dry port services also involves the issue of multiple inputs, outputs and methodology adopted for their quantification. The dry port services, in fact, are found to be strongly integrated and difficult to measure independently. The attractiveness of a favorite dry port though is not only related to its annual throughput but also to the existence of substitutes that are provided by competitors. There are further issues which pertain to government policies and provision of necessary infrastructure. When the success of a dry port is due to a symbiotic relation between the dry port operator and the user or when the degree of asset specificity is high, bilateral dependency develops, leading to higher switching costs and loss of objective performance measurement.

Issues of competition and policy implications

There are several issues related to competition that are relevant for this research. First, it is worth discussing whether a government by way of policies can hold any type of market dominance on the logistics market, either by rising barriers to entry or soothing competition. Second, it is interesting to analyze to what extent dry ports, both public and private, compete in the provision of services. Third, how competition in the shipping and the logistics markets is affected by vertical integration among logistics operators and shipping lines on one the hand and ports, container rail operators and dry ports on the other. It is also obvious that carriers' sources of competitive advantage are to be found at the network or at the chain level more than at the level of the chain component.

1.8 Proposed Approach

The research underlying the thesis consisted of the following phases:

Phase 1 - Literature review. In this phase a comprehensive literature review was performed in the various research sub-areas. The outcome is an overview of the results, hypotheses and problems discussed in the contemporary literature on dry port logistics in India. The information collected is subsequently analyzed and synthesized. The output of this phase is a clearly structured framework of the available theory on location (chapters 2 and 3) and Public Private Partnerships (chapter 4) and methods such as DEA (chapters 5 and 7) and Multiple Regression Analysis (chapter 6), aiming at selecting the conceptual frameworks that best fit the research problem.

Phase 2 - Empirical survey. This phase of the research consisted of a survey of the perceptions of various stakeholders with respect to dry port services. This phase is aimed at gaining insight to the feasibility of improved dry port services in India as well as global logistics industry and at inferring possible future developments.

Phase 3 - Modeling. This phase entailed the selection and the elaboration of theoretical models that encompass the relevance of dry ports in the logistics and transportation sectors. The outcome of phase 3 consists of: a) a theoretical model (chapter 6) of dry port performance and efficiency in an oligopolistic market; b) An optimal dry port performance and efficiency model (chapters 5 and 7) taking into consideration dry port operational outputs such as carbon emissions (undesirable) and container security (desirable).

Phase 4 - Evaluation of the model. Once the models had been selected, their validity is tested against the survey data previously collected. The objective of phase 4 will be to answer the major research question.

1.9 Contribution of this Thesis

This study analyses the synergetic relationship content of efficiency and performance measurement of dry ports in India while attempting to develop a performance criterion for dry port operators. It is conducted by empirically testing a performance measurement model in chapter 6. The empirical evidence and validity tests could make this study applicable to dry port facilities in various developing countries.

Currently dry port research ignores the synergy generating potential of the cooperative relationships between the different stakeholders. This study attempts to cover this gap by compiling necessary data for conducting useful and relevant research.

1.10 Thesis Framework

This thesis is divided into eight chapters;

Chapter 1 titled Dry Ports in India describes the research background, research objectives, academic contribution and the thesis framework.

Chapter 2 is an investigation into the spatial characteristics and competitiveness of dry ports and empirically studies the southern Indian dry ports.

Chapter 3 conducts location analyses of several dry ports using GIS technique.

Chapter 4 discusses the Indian dry ports sector, pricing policies and opportunities for public-private partnerships.

Chapter 5 is about balancing of supply chain efficiency and environmental impacts: an *eco*-DEA model applied to the dry port sector of India.

Chapter 6 is titled A Critical Analysis of Factors influencing Performance of Dry Ports in India: A Case Study of Dry Ports Located in the JNPT Region.

Chapter 7 is about dry port efficiency and container security

Chapter 8 analyzes the role of government in dry port development in India

1.11 Conclusion

This introduction aimed at presenting the research problem, the main and secondary research questions, the research approach adopted in the thesis and its overall structure. It has been argued that although the dry ports play a critical role in global supply chains and there has been extensive research focused on dry ports in the developed countries of the west, limited attention has been given to the growth and development of Indian dry ports.

This has lead to the formulation of the main research question; how to measure the performance and efficiency of the dry ports in India.

The main research question entailed the subdivision of the research problem in seven areas of research: the spatial characteristics of Indian dry ports; location analysis of the dry ports using the GIS technique; shippers perception of dry port performance and efficiency; analysis of pricing policies and assessment of opportunities to develop Public Private Partnerships (PPP); construction of a regression model to measure performance of dry ports in the JNPT region of India; ascertaining the efficiency of the dry ports with undesirable carbon emissions as one of the outputs by using DEA method; measuring the efficiency of the dry ports with container security as one of the outputs.

These areas of research are represented in six themes which emerge from the four major research domains connected to the thesis: Transport Economics, Industrial Organization, Public Policy and Supply Chain Management. The introduction also explains the methodological framework that the thesis utilizes in order to answer the main research question and address the major research issues emerging from the research problem.

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Chapter 2

An Investigation into the Spatial Characteristics and Competitiveness of Dry Ports: The Case of Southern India *

2.1 Abstract

The increase in international trade and globalization had forced the Indian industries to expand its markets rapidly to avail itself of the benefits of economics of scale, while it has also forced itself to focus on its core activities while offloading the majority of logistical functions to experts in the field and thus had exerted substantial pressure for major Indian seaports to improve their connections within further inland regions so as to optimize the multimodal supply chain, often through patronizing, the formation of strategic alliances and the establishment of inland terminals. In this aspect, the location of inland terminals (i.e. inland container depot, or ICD) is becoming one of the most critical components as it has a major bearing on other parameters of the entire supply chain e.g. transport cost, connectivity, transport modes, etc. However, while various studies existed in the analysis of inland terminal location in the western world, the study of this topic on the developing, newly-industrialized countries like India remains scarce. With such understanding, this paper analyzes the importance of landside component with specific emphasis on the location of inland terminals (ICD) in Southern India. Using the transportation links between two major production bases (Tirupur and Coimbatore) and two major seaports (Tuticorin and Cochin) within the region, attention will be paid on whether the current solution, of which all the shippers from the production bases would ship their cargoes to their respective

local ICDs is the optimal solution within the logistical networ[1]k and, if not, why the optimal solution currently cannot be established within the region. Through the case study, this paper also attempts to provide some further insight on the major reasons in explaining the significance of different factors in deciding the location of transport hubs. It is believed that this paper had added significant value in enhancing the understanding on the concepts of transport hub location and the attributes in influencing their degree of importance, as well as how artificial forces had affected the transportation network as a whole.

Keywords: India, inland container depot (ICD), location, transport cost, policy[2]

2.2 Introduction

The increase in international trade and globalization had forced the Indian industries to expand its markets rapidly to avail itself of the benefits of economics of scale, while it has also forced itself to focus on its core activities while offloading the majority of logistical functions to experts in the field and thus had exerted substantial pressure for major Indian seaports to improve their connections within further inland regions so as to optimize the multimodal supply chain, often through patronizing, the formation of strategic alliances and the establishment of inland terminals. Indeed, with the rising of the concept in freight distribution system, which emphasized on the development of supply chain, such inland terminals, often known as Inland Container Depot (ICD)/Container Freight Station (CFS), were often in demand and developed to complement the changing role of ocean carriers and other stakeholders within the entire supply chain (Notteboom and Rodrigue, 2005). In this context, ICD/CFS can be understood as an inland setting with facilities to allow the consolidation and distribution of cargoes, temporary storage of containers and cargoes, custom clearance, connection between different transport modes and group presence of institutions (both private and public), as well as dealing between different

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freight stakeholders. In many ways, ICD/CFS actually conducts many functions similar to modern seaports except that it does not perform stevedoring operation.

The establishment of such inland terminals has allowed shippers to undertake consolidation and distribution activities within inland locations which are often closer to their production bases, resulting in possible reduction of transaction costs and accompanying risks so as to ensure the competitiveness of their products e.g. textile, automotive components, etc. in the global market. Since optimization of logistical supply chains would inevitably require the close cooperation between different supply chain stakeholders e.g. transport service providers, ports, freight forwarders, etc. and the synchronization of their operations (Chopra and Meindl, 2001), logistics hub is likely to play a pivotal role in this process (Heaver, 2002; Sánchez, 2003). To accommodate market consolidation, seamless integration and closer collaboration between different stakeholders along the multimodal supply chain, the contribution of inland terminals would be impossible to ignore, especially in countries with vast land mass like India. Indeed, by the end of 2006, 177 ICD/CFS had already been set up within the country (CONCOR, 2007), with most major ones operated under the public entity of the central government, the Container Corporation of India Ltd. (CONCOR).

In this aspect, the location of inland terminals is becoming one of the most critical components as it has a major bearing on other parameters of the entire supply chain e.g. transport cost, connectivity, transport modes, etc. Quoting Hayuth and Fleming (1994), the location of a transport hub would significantly affect the overall transport network, which in turn also affected its cost, operation and marketing significantly. Nevertheless, unlike other components along the supply chain like transport equipment, information and capacity increase, of which decisions can be altered at relatively short notice based on market demand and availability of land and capital, the decision on where the inland terminal had been established would be relatively inflexible as it would be difficult, if not impossible, to relocate in the short term and inefficient locations would often result in excess costs being borne throughout the lifetime of the facility no matter how well connected the transportation options, capacity enhancement and information sharing decisions are optimized. Given such situation, an understanding on the location of these transport nodes becomes very important as the optimization of location can potentially save a lot of unnecessary waste of resources. Indeed, the fundamental question of logistics and freight distribution does not necessarily reside in the nature, origin and destination of cargoes, but also on how the freight is moving (Hesse and Rodrigue, 2004), as well as the situation of transport hubs, including its quantity and locations. However, while various studies existed in the analysis of inland terminal location in the western world (see Hesse and Rodrigue, 2004; Notteboom and Rodrigue, 2005), the study of this topic on the developing, newly-industrialized countries like India, until now, still remains rather scarce.

With such understanding, this paper analyzes the importance of landside component with specific emphasis on the location of inland terminals (ICD) in Southern India. Using the transportation links between two major production bases (Tirupur and Coimbatore) and two major seaports (Tuticorin and Cochin) within the region (figure 1), attention will be paid on whether the current solution, of which all the shippers from the production bases would ship their cargoes to their respective local ICDs (i.e. Tirupur ICD and Irugur (Coimbatore) ICD), is the optimal solution within the logistical network and, if not, why the optimal solution currently cannot be established within the region. Through the case study, this paper also attempts to provide some further insight on the major reasons in explaining the significance of different factors in deciding the location of transport hubs.

Figure 2.1: The study area of spatial competition of Dry Ports

After this introductory section, the next section will discuss the concept of the locations of transport hubs, followed by a brief introduction of the study area of this paper. After then, the methodology and empirical results will be illustrated, of which attention will be paid on whether the current situation is the optimal solution. In the conclusion, it will analyze the major factors in enabling Southern India to achieve the optimal solution, as well as providing further insight to the establishment of major attributes in affecting the locations of transport hubs.

2.3 The Locations of Transport Hubs

An economic activity can be understood as the process undertaken by human beings in providing the material needs of the society against a backdrop of scarcity of wants (Heilbroner, "The Economic Problem", 1972) and most economic decisions are subject to market laws of supply and demand in a market economy. As noted by Kuhn (1966), five major decisions should be considered when solving an economic problem, namely quantity, availability of resources, relative monetary values, distribution of outcomes amongst the populace and the geographical patterns of organization of the economic activity. In this sense, it implies that economics and geography were actually complementary with each other, of which while economic activities were affected by location constraints the former also affected the spatial patterns of those particular economic activities and such background had actually partially led to the development of location theory as an attempt to investigate the optimal usage of available space which is subject to the major regulators of the market economy, due to the existence of the friction of distance which indicated impediments to the movement since places, objects or people are spatially separate. This also implied that movement involves a cost which could be calculated in different terms (Von Thunen). Such concept acted as a fulcrum along with the costs associated with connecting the two locations for the various location determining models used by the planners. Indeed, when deciding where a transport hub should be established, decision makers should often act as both as an economist and geographer.

Dating back to the mid-20th century, it had been recognized that the physical direction of cargo movements (and sometimes information and services) did not occur in isolation but stimulated by certain interdependent forces (Ullman, 1956). To understand such forces, it is important to review the major works related to the application of location theory in explaining the location of transport hubs. In this aspect, Ullman (1941) served as one of the pioneers. In his work, he argued that a transport hub could be defined as a city having transport facilities and the relationship between the productive land supporting the city and its essential services, notably collection and distribution of its productions, were complementing each other most of the time. His idea was echoed by Christaller (1966) who studied the importance of various parameters in affecting the formation of central places/clusters, suggesting that the relative importance of each central place depended on the numbers of goods and services it provided, thus forming regular central place ‘hierarchy’. Higher hierarchy did not only provide goods and services which are specific to its level but also those of the lower orders. In other words, the highest order centres provided the maximum number of goods and services (or the so-called the highest *K* value). In this context, such high order would, without doubt, stimulate the development of transportation network so as to accumulate further wealth through export while at the same time fulfilling the increasing demands from the local population. Gradually, such development would lead to the development of consolidation of such central places into transport hubs connecting them with the surrounding areas, forming 'gateways' to distant places outside the region and, subsequently, becoming the optimal points of transport activities as well as the consolidation and distribution of in- and outbound cargoes (Losch, 1967). Some typical examples include the European cities of London, Madrid, Moscow and Paris.

Note that, however, the generation of traffic and the development of transportation hub were actually mutually dependent on each other, as induced by the artifice of transport facilities and infrastructures (Dickinson, 1961). As pointed out by Cooley (1894), in many cases, transport was largely a critical component in the establishment and consolidation of a market centre through value-added services like sorting grading, packaging, processing, etc. and, in fact, the existence of transport facilities had contributed largely to the development of industrial and urban agglomeration which emphasized on the connection between economic activities within a particular geographical area, enabling different stakeholders (like manufacturers, suppliers, purchasers, service providers, sub-contractors and, of course, transport companies) to interact with each other and to achieve mutual benefits (Weber, 1909) through better linkages namely transportation, service linkage and marketing. An agglomerate economy with the support of transportation, where some or all of these linkages are present within a relatively small geographical area, could lower a firm's costs or increasing its revenue or both. Indeed, such close connection between city and transportation hub development can be summarized by the concept of 'centrality' introduced by Fleming and Hayuth (1994), who stressed that the market size of a city often has a positive impact on its traffic generating potential. Under the influence of centrality, the transport hub being located at the centre would become part of the industrial clustering which would facilitate the flow of skilled labour pools and the informal transfer of knowledge and information (Marshall, 1919), and proximity of transport hubs to industrial clusters would enhance the competitive advantage of that particular industrial region (Porter, 1990 and 1996; Krugman, 1996). The influence of centrality is clearly not geographical in nature, but by non-geographical attributes like economic development, industrial agglomeration and even human perception (Ng, 2006).

Nevertheless, real world evidence suggested that centrality alone was inadequate in explaining the location of transportation hubs comprehensively. Some regions have nothing but their locations to recommend them as transport hub. For example, as early as the early 20th century, it was observed that Las Palmas and Tenerife assumed importance as bunkering ports merely due to their locations which could straddle the confluence of major trade routes (Sargent, 1912), while Ullman (1941) pointed out that Illinois in the US and Lodz in Poland, which had been bypassed earlier, were subsequently connected to the main network due to their traffic generating potential. More recent examples include a number of container transhipment seaports which hardly possess a hinterland with significant traffic generating potential e.g. Gioia Tauro, Malta, etc. As noted by Ullman (1941), apart from origin-destination traffic (generated by the city itself), extra traffic levels conveyed by the preference of carriers of its location as transportation hub can be generated (the so-called 'flow through traffic') of which, in many cases, the intermediate point (i.e. 'intermediacy') between origin and destination was often selected due to its proximity to both origins and destinations, the so-called 'geographical logic' (Fleming and Hayuth, 1994). In this sense, intermediacy is very much related to the geographical aspect in affecting the location of a transport hub.

Note that, however, intermediacy does not only imply a direct measurement of geographical distance, as impediments, like the existence of physical/natural barriers, which affected the easiness and time required commuting between one place to another, would also affect the 'intermediacy' of a particular location. At such locations local services connect with national and international services and one mode of transport with another. This importance is imparted to the hub by the transport carriers who may also decide to take the importance away due to several reasons like development of new locations or change in technology. Indeed, as pointed out by Appleton (1963), routes with 'natural advantage' would only create opportunities but did not hide the fact that it seldom created a genuine demand. As noted by Hayuth and Fleming (1994), the magnitude of the perspective of carriers, notably their perception, is equally important and is directly proportional to the level of traffic, as in certain cases such routes were not opted for at all due to various reasons, often due to the lack of complementarities like wants and desires of populace living at one place which could not be suitably satisfied by people living at another place, even though the two population centres were well connected by the route.

The above analysis has indicated that centrality and intermediacy serve as the major spatial qualities that increase traffic levels of transport hubs. While the degree of centrality depends on factors more than just distance, intermediacy is a spatial quality which can only be defined in context of the transportation system and can generate additional traffic if favoured by transport carriers as connecting hubs. However, in many cases, the two concepts are not as clear-cut and, in many cases, even overlapping (Fleming and Hayuth, 1994). For example, while many seaports started as gateways due to its intermediacy between foreland and hinterland and favourable physical conditions e.g. Rotterdam, Hamburg, etc., the hub gradually developed itself as central places as business started to move into the surrounding areas so as to exploit the competitive advantage offered by these ports, while also mutually assisting each other through agglomeration (like better flow of information), and thus forming seaport clusters (De Langen, 2002). In turn, the enhancement of centrality could encourage the improvement of accessibility e.g. more and better connections between the hub and other regions, as the magnitude of change can be characterized by the interaction within a geographical area, leading to an increase in the flow of cargoes (Hesse and Rodrigue, 2004), as exemplified by the US where a number of inland terminals had started to attract agglomeration of services around and gradually developed themselves in local/regional logistics centres (Notteboom and Rodrigue, 2005). While such inland hubs were largely located near the production bases half a century ago (largely due to the influence of centrality), its location had gradually shifted outwards, often towards the intersection of interstate highways and warehouses with roughly equal distance between the inland industrial regions and seaports (Hesse and Rodrigue, 2004). In fact, to a certain extent, most transport hubs possess certain degrees of both centrality and intermediacy, and the degree of influence of these forces on transport hub location could be adjusted overtime with the changes in technological improvements and regional economic patterns.

2.4 An Introduction to the Case Studies

Before proceeding forward, it is necessary to give a brief introduction to the major components of the case study so as to provide readers a firm background in understanding the production bases of the paper i.e. Tirupur and Coimbatore.

Often known as 'Manchester of the South' in India due to its prosperous textile industries, Tirupur is located in central Tamilnadu with a population of 400,000 spreading over a region of 30 km^2. With more than 3,000 knitting, stitching, dyeing, bleaching and printing units manufacturing all kinds of garments and hosiery, the region generated an annual textile export (mainly to Europe and the US) which worth US$ 1.5 billion, equivalent to about 40% of India's total (NIC, 2007). Virtually all export cargoes were carried by sea through the major ports of Tuticorin, Cochin and, to a small extent, Chennai. Tirupur's inland terminal, Tirupur ICD (TICD), commissioned in January 2005, was located about 20 km away from Tirupur's core industrial region, spreading over 0.76 hectares consisting of a covered warehouse admeasuring 300 m^2 and custom clearance facility, had an annual capacity of 40,000 TEUs (CONCOR, 2007). However, due to its small cargo size, until now, TICD is not connected by railroads to any of the gateway seaports, and all cargoes are carried by trucks.

On the other hand, Coimbatore is the second largest city in Tamilnadu situated at the foothills of the Nilgiris mountain range, with a population of 3.2 million spreading over 38 km^2. Its major industries include tea, cotton textiles, engineering goods, iron and steel and automobile components and the city is well-connected by railroads and air transport to the rest of India. Coimbatore's inland terminal, Irugur ICD (IICD), commissioned in April 2005, was located about 15 km away from Coimbatore's core industrial region, spreading over 18.52 hectares consisting of a covered warehouse admeasuring 2,000 m^2 and custom clearance facility (CONCOR, 2007). Also, contrary to its counterpart, IICD is well-connected by railroads between the gateway seaports of Tuticorin and Cochin.

2.5 Research Methodology

As important production bases for exports, this study only investigated cargoes which had been containerized for overseas exports using container liner shipping due to the nature of the production bases which emphasized on the production of containerized manufactured goods like textile. Also, simulation will be from a user perspective i.e. shippers. Given the derived demand nature of freight transportation, it would be sensible to assume that the optimal solution would be the one with minimum annual transport cost along the whole transportation network. Indeed, the minimization of transport cost was confirmed by the central government, of which the degree of reduction in total transport cost was regarded as the prime criterion in defining the success of an ICD in India (NIC, 2007).

Moreover, in the following analysis, several further assumptions had been made, namely: (1) there was no significant difference between ICDs in performance and efficiency; (2) the unit transport cost had a linear relation with distance; (3) unacceptable routes did not exist; (4) only local cargoes (within 100 km surrounding Tirupur and Coimbatore) were considered; (5) not calling an ICD was not an option. As mentioned, ICD was more than just cargo distribution centres which also served additional necessary functions in facilitating the shipment process. Moreover, given that Indian shippers largely consist of medium and small-sized companies, it was also practically impossible for most of them to get around ICD and shipped their cargoes to any of the SPs directly; and (6) train service, instead of trucks, could be introduced, as long as a particular route has reached the cargo size's minimum threshold of 453,600 metric tons (32,400 TEUs) per year[3], as well as the route concerned is connected by railroads.

In the analysis, only the operation cost (thereafter called 'transport cost') would be considered, where the fixed cost like constructing the ICDs (if applicable) would be excluded, although the operation cost of ICD would be included. Finally, it was assumed that ICD users i.e. shippers would be responsible to pay all the expenses aroused from shipping their cargoes between origins and destinations, including the operation costs of ICDs. Transport cost was further sub-divided into two major components, namely shipping cost and ICD operation cost. Shipping cost was defined as the cost aroused from the physical movements of cargoes from the production bases to the gateway seaports (SPs) *via* the ICDs, while ICD operation cost was defined as the cost to ensure that an ICD would remain operation normally which, as mentioned earlier, would eventually be borne by ICD users. According to industrial information, the unit transportation

[3] According to industrial information provided by CONCOR, for every freight train service in India, there must be a minimum of 90 TEUs (1,260 metric tons) to enable such service to become economically viable. Thus, assuming that one train service would be provided per day (360 services per year), there should be at least 32,400 TEUs (453,600 metric tons) of cargoes available for transportation between two different points. In this case, clearly, cargoes from Tirupur and Coimbatore must be agglomerated together at one particular ICD in order to sustain any rail service.

costs of cargoes carried by trucks and rail service (when reaching the minimum threshold) are US$ 0.25 per metric ton per km and US$ 0.15 per metric ton per km respectively (AEPC, 2007).

To calculate the transport cost, the linear programming model of the transhipment problem (LPTP) would be applied. LPTP is a commonly used operational research technique in solving a particular network flow problem with transhipment node(s) (indexed by *t*) lying in between an origin (indexed by *i*) and a destination (indexed by *j*). One of the most important advantages of LPTP lies in its inclusion of both freight volume and distance in affecting optimizing the transport network which complemented very well with the already discussed concepts of centrality and intermediacy in deciding the location of transportation hubs. LPTP can be computed through the following formulation:

$$\sum F_t + \sum_{\text{all arcs}} c_{ij} x_{ij} \qquad \{1\}$$

s.t.

$\sum_{\text{arcs out}} x_{ij} - \sum_{\text{arcs in}} x_{ij} \leq s_i$ }	Origin node (*i*) constraints	{2}
$\sum_{\text{arcs out}} x_{ij} - \sum_{\text{arcs in}} x_{ij} = 0$ }	Transhipment node (*t*) constraints	{3}
$\sum_{\text{arcs out}} x_{ij} - \sum_{\text{arcs in}} x_{ij} = - d_j$ }	Destination node (*j*) constraints	{4}
$x_{ij} \geq 0$ }	Non-negative integers	{5}

Where F_t is operation cost of ICD *t*, x_{ij} is the number of units shipped between *i* and *j*, c_{ij} is the unit transport cost between *i* and *j*, s_i is the supply at *i* and d_j is the demand at *j*. In equation {1}, 'arc in' refers to a linkage between *i* and *t* while 'arc out' refers to a linkage between *t* and *j*. Apart from modelling, analysis was complemented by qualitative information which was obtained from 15 in-depth interviews undertaken by the authors (during spring 2007) with various industrial stakeholders within the region, including major ICD users (shippers), ICD operators, as well as government officials.

2.6 Empirical Results

To investigate whether the current solution is the optimal solution, the transport cost of the following scenarios will be simulated: (1) the current solution; (2) the establishment of a new

ICD at an intermediate location (Scenario I); (2) calling alternative ICD e.g. some cargoes from Tirupur calling IICD instead of TICD, *vice versa* (Scenario II); (3) the 'preferential policy' is relaxed (Scenario III). In all scenarios, it will be further divided into sub-scenarios i.e. what would happen if rail service were (not) used, whenever possible.

The Current Solution

The fact that cargoes would be shipped from the production bases of Tirupur and Coimbatore to SPs *via* ICD(s) implied that a transhipment problem had been established between the origins (production bases) and destinations (gateway seaports, or SP) within the geographic grid. According to industrial information, in 2006, Tirupur had an annual cargo throughput of 20,000 TEUs (280,000 metric tons)[4]. Despite a significantly shorter driving distance between Cochin SP and Tirupur than that of Tuticorin SP, currently, 98% and 2% of the cargoes were forwarded towards Tuticorin SP and Cochin SP respectively, due to the Tamilnadu state government's preferential policy to Tuticorin SP (hereafter called 'preferential policy') which will be discussed further later in this paper.

Figure 2 illustrates the graphs of Tirupur's and Coimbatore's transhipment problems respectively with ICD acting as nodes ({b} and {c}) connecting in-between different O-D pairs, with Tuticorn and Cochin as the SPs[5]. Here is to note that combining figures 2a and 2b into a single transhipment problem (with two *i*, two *t* and two *j*) is not possible as Tirupur and Coimbatore did not belong to the same decision-making unit. Although the re-location of some production from one base to another could possibly provide a better solution in terms of transport cost minimization, such possibility is not considered here as it does not lie within the scope of this paper.

[4] It was assumed that one TEU consists of 14 metric tons of cargoes.
[5] Some cargoes were also destined to the seaport of Chennai. However, due to its negligible tonnages, it was not included in this analysis.

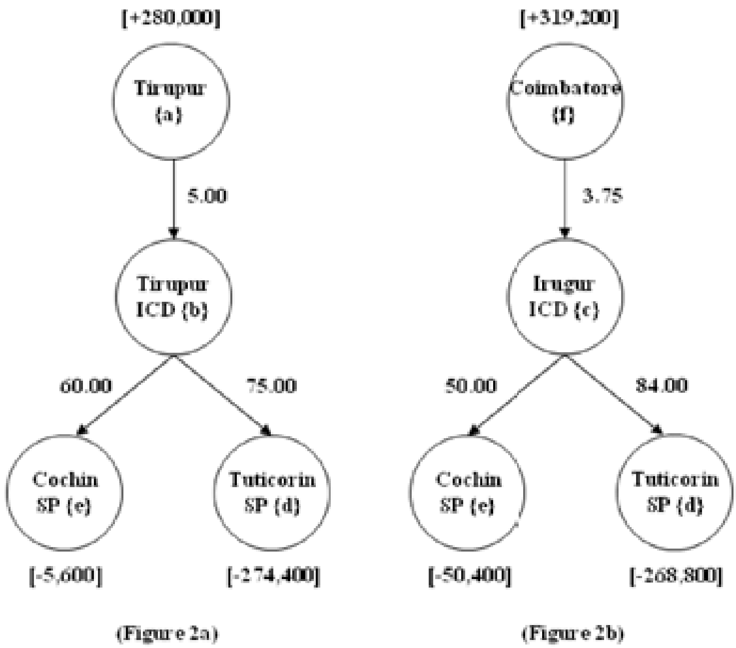

Figure 2.2: The transshipment problem of the current solution (*Remarks*: arcs are not constructed in accordance to actual distances)

In figure 2, different nodes are indexed by alphabets {a} to {e} while the figures along the arcs represent their respective unit shipment costs between respective nodes (unit transport cost x distance), expressed in US$ per metric ton (c_{ij}). Since *i* equals *j*, the tonnages of cargoes leaving the origin ({a} and {f}) would be equivalent to the total tonnages arriving at the gateway seaports ({d} and {e}). The current solution of the transhipment problems is that the all the shippers from different production bases would use their respective local ICD as the transhipment node. In reality, the ICDs could hardly attract any cargoes from other regions, while ICDs were often very proximate from the city's industrial core. Unsurprisingly, all cargoes are carried by trucks since none of the arcs have reached the minimum threshold for the introduction of rail service. From figures 2a and 2b, the O-D pairs between *i* and *j* (x_{ij}) are as follows:

From Tirupur (figure 2a):

{a}→{b}→{d}   {a}→{b}→{e}

From Coimbatore (figure 2b):

{f}→{c}→{d}   {f}→{c}→{e}

The total transport cost for the current solution (with all shippers from Tirupur and Coimbatore calling TICD and IICD respectively) in solving the transhipment problems of Tirupur and Coimbatore is illustrated in table 1.

Table 2.1: The current solution to the transshipment problem of Tirupur and Coimbatore

Shipping Cost					
From (*i*)	To (*j*)	Via (*t*)	Units shipped (*x*) (metric tons)	Unit cost (*c*) (US$ per metric ton)	Agglomerate cost (US$)
Tirupur	Tuticorin SP	TICD	274,400	80.00	21,952,000
Tirupur	Cochin SP	TICD	5,600	65.00	364,000
Coimbatore	Tuticorin SP	IICD	50,400	87.75	23,587,200
Coimbatore	Cochin SP	IICD	268,800	53.75	2,709,000
ICD Operation Cost (F_t) [6]					
TICD					738,000
IICD					1,218,000
Total Transport Cost					**50,568,200**

Scenario I: Introducing a new 'Intermediate' ICD

In this scenario, the hub-and-spoke system would be established and a new ICD would be constructed at an intermediate location between origins and destinations. In other words, instead of using two ICDs, only one 'intermediate' ICD would be used. In searching for such intermediate location, the grid technique would be applied, a heuristic approach attempting to

[6] The annual operation cost of ICD mainly includes land rent paid to the government, salary, interests, maintenance and some other miscellaneous expenses. According to industrial information, the average annual operation costs of TICD and IICD were approximately US$ 61,500 and US$ 101,500 per month.

determine the location of a fixed facility representing the lowest 'centre of gravity' (C) (minimum transport cost) in moving cargoes within a geographic grid, based on existing transport infrastructure. In applying the grid technique, it is assumed that origin and destination are fixed and that the operator (in this case, ICD operator) knows in advance the approximate volume it can handle. The technique then superimposes a grid upon the geographic area containing the origins and destinations. The grid's point 'zero' corresponds to an exact geographic location, as do the grid's other points. Every source and destination can then be determined by its grid coordinates. The technique defines each O-D location in terms of its horizontal and vertical grid coordinates. It is then possible to visualize the technique as a series of strings which are attached weights corresponding to the weights of cargoes which the ICD handles and found the optimal location for the ICD concerned, based on the empirical data available at a particular time period. The grid technique can be expressed in the following formulation:

$$\textbf{Min}\, C_{(i,j)} = \frac{\sum(r \times d \times s) + \sum(R \times D \times S)}{\sum(r \times s) + \sum(R \times S)} \qquad \{6\}$$

Where D and d are the distances between point zero to the grid location of out- and inbound cargoes respectively (if any), S and s are the volume of out- and inbound cargoes (if any), and R and r are the unit transportation rate of out- and inbound cargoes (if any). The major shortcoming of the grid technique, however, is that it does not consider the topographic conditions which exist at the optimal location, nor does it consider other non-geographical factors which can affect the optimal location e.g. land prices, regional economic development, government policy, etc. In other words, the grid technique only considers the 'intermediate' aspect of hub location, while centrality is largely ignored. Moreover, another weakness of the grid technique lies in the fact that it only identifies one optimal location within the identified region and multi-terminals (in this case, ICD) will not be considered. Nevertheless, such weaknesses, ironically, served the objective of this study very well, as it means that the non-geographical aspect can be temporarily removed so as to facilitate the analysis on whether the current locations of Indian ICDs are more affected by centrality or intermediacy, while its identification of a single location also gave us an indication on whether a simple 'hub-and-spoke' or 'multi-hub' systems should be established within the region.

By applying equation {6}, it was found that the 'intermediate' ICD should be located at a road distance of 193 km, 221 km, 142 km and 274 km from Tirupur, Coimbatore, Tutocorin SP and Cochin SP respectively. The location of the identified 'intermediate' ICD based on the grid technique can be found in figure 1, of which the arc which can potentially be served by rail is presented by a dotted arrow.

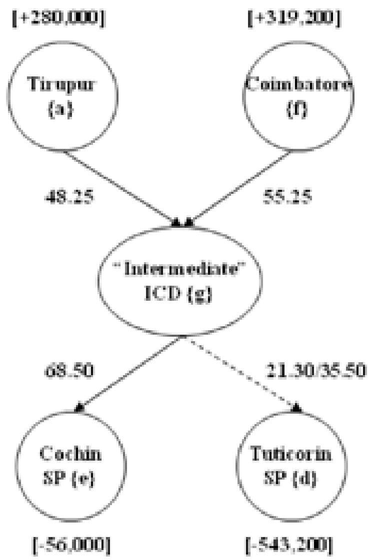

Figure 2.3: The transshipment problem in Scenario I (*Remarks*: arcs are not constructed in accordance to actual distances)

From figure 3, the O-D pairs between *i* and *j* (x_{ij}) are as follows, of which the arcs which can be potentially served by rail are symbolised by "⇨":

From Tirupur:	{a}→{g}⇨{d}	{a}→{g}→{e}
From Coimbatore:	{f}→{g}⇨{d}	{f}→{g}→{e}

The total transport cost for Scenario I can be calculated through applying equation {1}. The solution of Scenario I (no rail service is used) can be found in table 2.

Table 2.2. The solution for Scenario I (no rail service is used)

Shipping Cost				
From (*i* or *t*)	To (*t* or *j*)	Units shipped (*x*) (metric tons)	Unit cost (*c*) (US$ per metric ton)	Agglomerate cost (US$)
Tirupur	'Intermediate' ICD	280,000	48.25	13,510,000
Coimbatore	'Intermediate' ICD	319,200	55.25	17,635,800
'Intermediate' ICD	Tuticorin SP	543,200	35.50	19,283,600
'Intermediate' ICD	Cochin SP	56,000	68.50	3,836,000
ICD Operation Cost (F_t)				
'Intermediate' ICD				1,218,000
Total Transport Cost				**55,483,400**

Given the current setting, table 3 indicates that the 'intermediate ICD' solution is not a better option than the current solution, of which shippers would suffer significant extra costs. However, table 2 has not considered the viable option of using rail service. The solution for Scenario I (with rail service whenever possible) can be found in table 3.

Table 2.3. The solution for Scenario I (rail service is used whenever possible)

Shipping Cost				
From (*i* or *t*)	To (*t* or *j*)	Units shipped (*x*) (metric tons)	Unit cost (*c*) (US$ per metric ton)	Agglomerate cost (US$)
Tirupur	'Intermediate' ICD	280,000	48.25	13,510,000
Coimbatore	'Intermediate' ICD	319,200	55.25	17,635,800
'Intermediate' ICD	Tuticorin SP	543,200	21.30	11,570,160
'Intermediate' ICD	Cochin SP	56,000	68.50	3,836,000
ICD Operation Cost (F_t)				
'Intermediate' ICD				1,218,000

Total Transport Cost	**46,551,960**

With the use of rail service, the solution provided in Scenario II had significantly improved and could result in cost saving from the current solution by US$ 4,016,240 (7.9%) annually[7].

Scenario II: Shifting some cargoes to alternative ICD

Instead of constructing a new 'intermediate' ICD, Scenario II investigates whether users could save transport cost if they shift some cargoes to the alternative ICD instead of their respective local ICD. A graphical representation of the transhipment problem can be found in figure 4, of which the arcs which can potentially be served by rail are presented by dotted arrows.

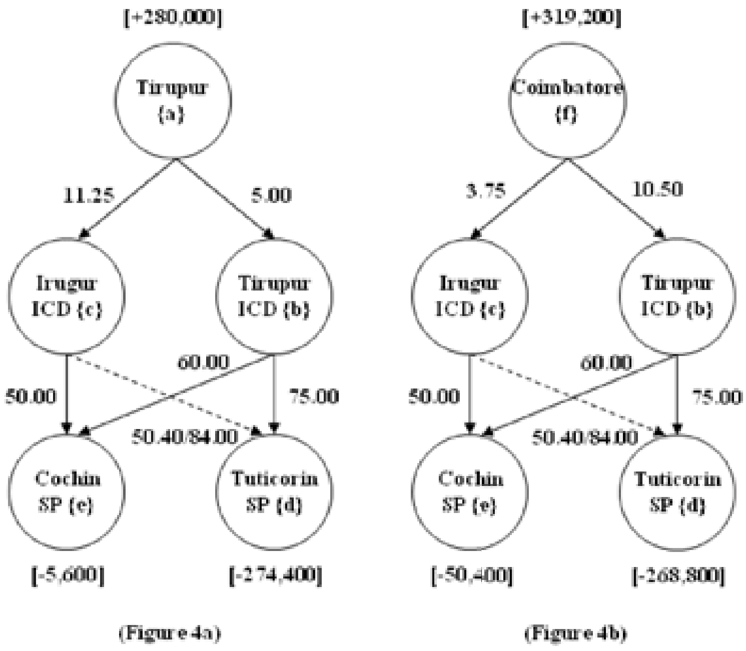

Figure 2.4. The transshipment problems of Tirupur and Coimbatore and the collaboration between existing ICDs solution (*Remarks*: arcs are not constructed in accordance to actual distances)

[7] However, analysis here has not considered the construction cost of a new ICD which would likely to have some impacts on the final transport costs. Thus, the benefits gained from using this solution would likely be less than the simulated figure.

From figures 4a and 4b, the possible O-D pairs between i and j (x_{ij}) are as follows, of which the arcs which can be potentially served by rail are symbolised by "⇨":

From Tirupur (figure 4a):

{a}→{b}⇨{d}   {a}→{b}→{e}   {a}→{c}⇨{d}   {a}→{c}→{e}

From Coimbatore (figure 4b):

{f}→{b}⇨{d}   {f}→{b}→{e}   {f}→{c}⇨{d}   {f}→{c}→{e}

To obtain for the optimal solution, we can extend LPTP which can be expressed in the following formulation:

$$\textbf{Min} \sum F_t + \sum_{\text{all arcs}} c_{ij}x_{ij} \qquad \{7\}$$

s.t.

$\sum_{\text{arcs out}} x_{ij} - \sum_{\text{arcs in}} x_{ij} \leq s_i$	}	Origin node (i) constraints	{8}
$\sum_{\text{arcs out}} x_{ij} - \sum_{\text{arcs in}} x_{ij} = 0$	}	Transhipment node (t) constraints	{9}
$\sum_{\text{arcs out}} x_{ij} - \sum_{\text{arcs in}} x_{ij} = -d_j$	}	Destination node (j) constraints	{10}
$x_{ij} \geq 0$	}	Non-negative integers	{11}

Where F_t is the operation cost of ICD t, x_{ij} is the number of units transported between i and j, c_{ij} is the unit transport cost between i and j, s_i is the supply at i and d_j is the demand at j. In equation {7}, 'arc in' refers to a linkage between i and t while 'arc out' refers to a linkage between t and j.

The transhipment problem above can be solved through applying the transportation simplex method, of which the results can be expressed in a transportation tableau. The transportation tableaux of figures 4a and 4b (no rail services are used in both cases) can be found in tables 4 and 5 respectively. Note that, however, due to the existence of t, only the minimum unit transport costs shipped over particular routes are entered in their corresponding entries (located at the upper right hand corner of their respective cells). Also, given that the minimum threshold for rail service applies, it means that in the direction towards Tuticorin SP, either Tirupur or Coimbatore would be chosen, not both.

Table 2.4: Transportation tableau for figure 4a (no rail service is used)

Origin/Destination	Tuticorin SP {d}	Cochin SP {e}	Origin Supply (s_i)
Tirupur {a}	80.00 274,400	61.25 5,600	280,000
Destination Demand (d_j)	274,400	5,600	280,000

Remarks: the minimum unit cost for [a,d] and [a,e] are {a}→{b}→{d} and {a}→ {c}→{e} respectively

Table 2.5: Transportation tableau for figure 4b (no rail service is used)

Origin/Destination	Tuticorin SP {d}	Cochin SP {e}	Origin Supply (s_i)
Coimbatore {a}	85.50 268,800	53.75 50,400	319,200
Destination Demand (d_j)	268,800	50,400	319,200

Remarks: the minimum unit cost for [f,d] and [f,e] are {f}→{b}→{d} and {f}→ {c}→{e} respectively

The optimal solution for Scenario II (no rail service) can be found in table 6.

Table 2.6: The optimal solution for Scenario II (no rail service is used)

Shipping Cost					
From (i)	To (j)	Via (t)	Units shipped (x) (metric tons)	Unit cost (c) (US$ per metric ton)	Agglomerate cost (US$)
Tirupur	Tuticorin SP	TICD	274,400	80.00	21,952,000
Tirupur	Cochin SP	IICD	5,600	61.25	343,000
Coimbatore	Tuticorin SP	TICD	268,800	85.50	22,982,400
Coimbatore	Cochin SP	IICD	50,400	53.75	2,709,000
ICD Operation Cost (F_t)					

TICD	738,000
IICD	1,218,000
Total Transport Cost	**49,942,400**

Table 6 indicates that the current solution could be improved if shippers shift some cargoes to alternatives other than their respective local ICDs, of which the annual transport cost could be marginally reduced by US$ 0.6 million (or 1.2%). In other words, the current network could be better off if shippers were encouraged to use an ICD located farther away from the production base. This case could be further strengthened if rail service has been introduced whenever a certain arc reaches the minimum threshold of rail service. The transportation tableaux of figures 4a and 4b (no rail services are used in both cases) can be found in tables 7 and 8 respectively. Here is to note that, since the minimum threshold for rail service applies in shipping the cargoes towards Tuticorin SP, either IICD or TICD would be chosen, not both.

Table 2.7: Transportation tableau for figure 4a (rail service is used whenever possible)

Origin/Destination	Tuticorin SP {d}	Cochin SP {e}	Origin Supply (s_i)
Tirupur {a}	61.65 274,400	61.25 5,600	280,000
Destination Demand (d_j)	274,400	5,600	280,000

Remarks: the minimum unit cost for [a,d] and [a,e] are {a}→{b}→{d} and {a}→ {c}→{e} respectively

Table 2.8: Transportation tableau for figure 4b (rail service is used whenever possible)

Origin/Destination	Tuticorin SP {d}	Cochin SP {e}	Origin Supply (s_i)
Coimbatore {a}	54.15 268,800	53.75 50,400	319,200
Destination Demand (d_j)	268,800	50,400	319,200

Remarks: the minimum unit cost for [f,d] and [f,e] are {f}→{b}→{d} and {f}→ {c}→{e} respectively

The optimal solution for Scenario II (with rail service whenever possible) can be found in table 9.

Table 2.9: The optimal solution for Scenario II (rail service is used whenever possible)

Shipping Cost					
From (i)	To (j)	Via (t)	Units shipped (x) (metric tons)	Unit cost (c) (US$ per metric ton)	Agglomerate cost (US$)
Tirupur	Cochin SP	IICD	5,600	61.25	343,000
Coimbatore	Cochin SP	IICD	50,400	53.75	2,709,000
Tirupur	Tuticorin SP	TICD	274,400	61.65	16,916,760
Coimbatore	Tuticorin SP	TICD	268,800	54.15	14,555,520
ICD Operation Cost (F_t)					
TICD					738,000
IICD					1,218,000
Total Transport Cost					**36,480,280**

Table 9 indicates that the current solution could be improved if shippers shift some cargoes to alternatives other than their respective local ICDs, of which the annual transport cost could be substantially reduced by US$ 14.1 million (27.9%).

Nevertheless, in reality, such advantage was unable to compensate the pull factor from using local ICD. As mentioned, in-depth interviews with the major ICD users on the above issue had been conducted and the major findings from such interviews were that, while recognizing that the use of alternative ICD could potentially lead to cost-saving, at the same time, however, they also indicated that such marginal reduction would not divert them away from their current choice (of using local ICD) mainly because: (1) they could obtain better information in their respective local ICDs; (2) by using local ICD, they found it much easier to tackle upcoming challenges which often require immediate responses. For example, if they had sudden, but small tonnage (which could occur frequently, as most of the shippers were small- or medium-sized firms), cargoes for shipment, it was much more convenient for them to travel only 15-20 km to their local ICD to enquire and requesting services, rather than to an ICD which was located more than 40 km away but without any guarantee of service availability; and (3) most of them had established a closer relation with the personnel within their respective local ICD which often saved them a lot of resources and efforts during the shipment process, notably documentary clearance, custom inspections and, most importantly, 'credit facilities' (i.e. preferential treatment). These factors had also ensured that rail service could not be used because shippers from Tirupur refused to use IICD, and thus unable to reach the minimum threshold to carry the cargoes by rail. In this case, shippers clearly prioritised convenience, the establishment of relations and better control over transport cost savings, despite the substantial percentage that they could save, especially if rail service were introduced.

Thus, Scenarios I and II had provided a good example on the pulling force of centrality in affecting the location of a transport hub, of which the forces of agglomeration had prevented cargoes moving away from a 'centrality' to an 'intermediate' point. In many ways, these two scenarios had also illustrated that the power of centrality consisted of various attributes, both monetary and non-monetary, in affecting the location of transport hubs, transport network, as well as the direction of cargoes. Based on the simulated results, it is sensible to argue that, in Southern India, the current locations of ICDs are much more significantly affected by centrality than intermediacy.

Scenario III: Removal of Tamilnadu State Government's Preferential Policy on Tuticorin SP

The above scenarios (and conclusions) were based on the assumption that the 'preferential policy' regarding Tuticorin SP by the Tamilnadu state government would continue. From figure 4, it is not difficult to recognise that, with a complete freedom of choice between Cochin SP and Tuticorin SP without any explicit and/or implicit interference, all cargoes would most likely have gone towards the Kerala port. Apart from better geographical proximity to the production bases (which could cause substantial transport cost savings), Cochin SP also possessed several advantages e.g. geographical proximity to the main trade routes, deep water draught, natural harbour, etc. Tuticorin SP, on the contrary, while not a natural harbour, it had suffered further serious disadvantage due to the existence of the Adam's Bridge (also known as *Rama Setu*) which prevents the passage of large vessels through Gulf of Mannar (figure 5)[8].

Figure 2.5: Location of the Adam's Bridge and Gulf of Mannar

However, at the moment, Cochin SP is not patronized by Tirupur and Coimbatore shippers for two major reasons: (1) long waiting time at the border check post for the collection of Octroi Tax (a state-border tax between different Indian states) as Cochin SP is located within Kerala,

[8] The Adam's Bridge about 48 km long consisting of chains of shoals, between the islands of Mannar, near NW Sri Lanka, and Rameswaram off the SE coast of India, separating Gulf of Mannar from Palk Strait. Some of the sandbanks are dry and nowhere are the shoals deeper than 1 m thus seriously hinder navigation (Britannica, 2007). The existence of the Adam's Bridge has ensured that vessels need to travel another 216 nm (requiring nearly 30 hours) before able to link up with the major trunk routes to East Asia, Western Europe and North America.

whereas Tuticorin SP, Tirupur and Coimbatore are all located within Tamilnadu[9]; and (2) the Tamilnadu state government subsidized the transport cost between Tuticorin SP and Tirupur/Coimbatore to offset the advantages afforded by the Cochin SP so as to prevent the loss of revenues and to promote Tuticorin SP as an gateway seaport for exports[10]. Based on such understanding, if the 'preferential policy' were removed, all exporting cargoes would be destined to Cochin SP. A graphical representation of such transhipment problem can be found in figure 6, of which arcs which can be economically feasibly served by rail services are represented by dotted arrows. Note that, however, since the minimum threshold for rail service applies, it implies that either IICD or TICD would be chosen as the transhipment hub, but not both.

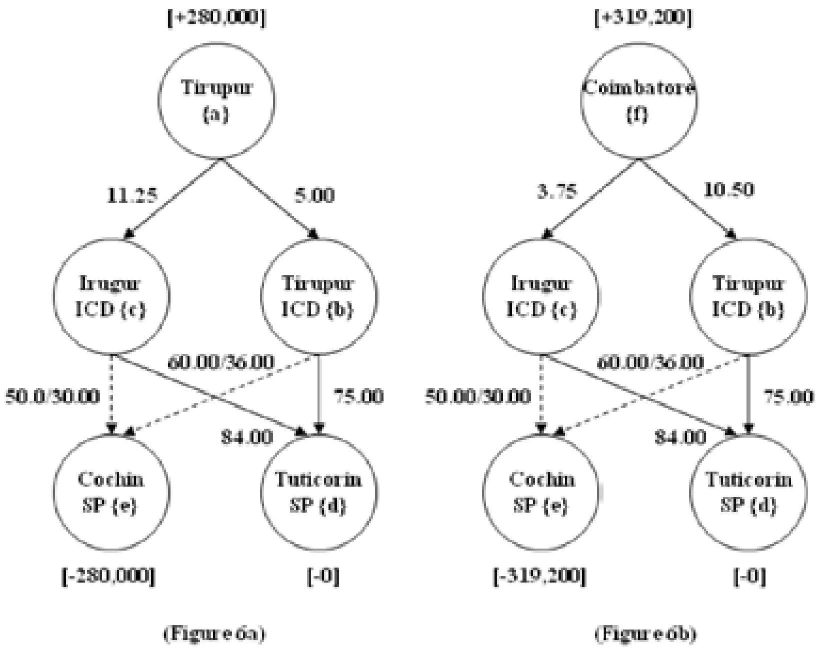

Figure 2.6. The transshipment problem of Scenario III (*Remarks*: arcs are not constructed in accordance to actual distances)

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[9] According to the information provided by shippers (from in-depth interviews), the time required to wait for all documentary clearance in collecting Octroi Tax can be as long as 10-12 hours.

[10] Before the 'preferential policy', Tuticorin SP was mainly a seaport for import cargoes.

The O-D pairs between *i* and *j* (x_{ij}) in this scenario are as follows, of which the arcs which can be potentially served by rail are symbolised by "⇨". Note that, however, since there are no cargoes directed towards Tuticorin SP, the O-D pairs towards {d} are not shown below:

From Tirupur: {a}→{b}⇨{e} {a}→{c}⇨{e}
From Coimbatore: {f}→{b}⇨{e} {f}→{c}⇨{e}

By applying equation {7}, the optimal solution for Scenario III (no rail service is used) can be found in table 10.

Table 2.10: The optimal solution for Scenario III (no rail service is used)

Shipping Cost					
From (*i*)	To (*j*)	Via (*t*)	Units shipped (*x*) (metric tons)	Unit cost (*c*) (US$ per metric ton)	Agglomerate cost (US$)
Tirupur	Cochin SP	IICD	280,000	61.25	17,150,000
Coimbatore	Cochin SP	IICD	319,200	53.75	17,157,000
ICD Operation Cost (F_t) [11]					
TICD					738,000
IICD					1,218,000
Total Transport Cost					**36,263,000**

Table 10 indicates that the removal of the 'preferential policy' would create substantial cost-savings from the current solution (table 1), with a reduction of US$ 14.3 million in transport cost (a reduction of US$ 13.7 million compared to Scenario II's solution). Thus, according to the simulated results, the current solution is at least 28% higher than the optimal solution of which the 'preferential policy' has been removed (and such amount is currently subsidized by the Tamilnadu state government). However, table 10 has not considered the fact that the

[11] For the sake of consistency, here is to assume that TICD would not cease operation even without the need to handle any cargoes.

agglomeration of cargoes shipped between IICD and Cochin SP could possibly make the use of railroads becoming economically feasible, of which in such case the shipping cost between *t* and *j* could be further reduced. By applying equation {7}, the optimal solution for Scenario IV can be found in table 11[12].

Table 2.11: The optimal solution for Scenario IV

Shipping Cost					
From (*i*)	To (*j*)	Via (*t*)	Units shipped (*x*) (metric tons)	Unit cost (*c*) (US$ per metric ton)	Agglomerate cost (US$)
Tirupur	Cochin SP	IICD	280,000	41.25	11,550,000
Coimbatore	Cochin SP	IICD	319,200	33.75	10,773,000
ICD Operation Cost (F_t) [13]					
TICD					738,000
IICD					1,218,000
Total Transport Cost					**24,279,000**

Table 11 indicates that the use of rail service would create substantial cost-savings from the current solution (table 1), with a reduction of US$ 26.3 million in transport cost (a reduction of US$ 25.6 million compared to Scenario II's solution) and thus the current solution would be at least 52% higher than the optimal solution for Scenario IV. In other words, with the continuation of the 'preferential policy', the Tamilnadu state government had explicitly subsidized 28% of extra transport costs, while implicitly triggering at least another 24% of hidden transport cost as 'preferential policy' had effectively disabled the economic feasibility of the use of rail services in freight transportation within the region. This scenario had also indicated that, once the 'preferential policy' is removed, TICD would immediately lose its competitiveness and might

[12] The simulation here has not considered the fact that trains could carry heavier containers (more than 20 metric tons per TEU) and that rail distance would usually be shorter than road distance between the same origin and destination, which in turn could further reduce the transport cost.
[13] For the sake of consistency, here is to assume that TICD would not cease operation even without the need to handle any cargoes.

even be forced to close down, indicating that TICD is currently surviving through political rather than economic means. Indeed, by removing the 'preferential policy', it is perceived that the hub-and-spoke system would likely to bear fruit with IICD being the 'intermediate' ICD in serving the region. The case here had illustrated an excellent example on how government policy had affected the quantity and location of transport hubs, as well as the direction of freight movement and the transportation network.

The transport costs of different scenarios simulated above are summarised in table 12.

Table 2.12: The simulated transport costs under different scenarios

Scenario	With rail service	Annual transport cost (US$)	Cost change (%)
Current	X	50,568,200	--
I	X	55,483,400	↑ 9.7%
	√	46,551,960	↓ 7.9%
II	X	49,942,400	↓ 1.2%
	√	36,480,280	↓ 27.9%
III	X	36,263,000	↓ 28.3%
	√	24,279,000	↓ 52.0%

From table 12, it is clear that the current solution is not the optimal solution in solving the transhipment problem in Southern India. Nevertheless, due to the pull factors from agglomeration (which enhanced the significance of centrality), shippers clearly preferred sacrificing the opportunity in saving transport costs in return for the benefits from agglomeration like convenience, relation and better control, while the existence of artificial barriers and governmental policies also ensured that cargoes cannot be allocated towards the best solution within the system, namely the use of better seaport and the use of rail services. As a consequence, currently, the locations of ICDs remain close to their respective cities mainly serving local cargoes, of which intermediacy clearly doesn't apply in this region at all. The case in Southern India had illustrated that transport hub location is actually the result of interaction and compromises from different competing forces, and that reliance of natural and/or geographical and/or economic force(s) in explaining transport hub location is clearly inadequate, as illustrated in figure 8.

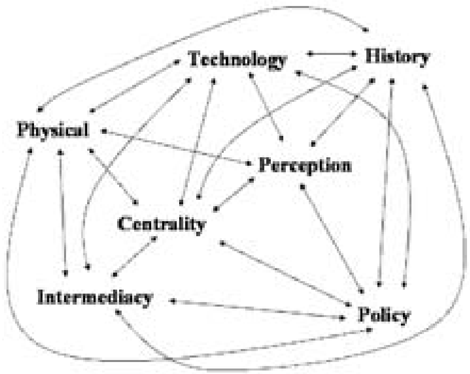

Figure 2.7. Attributes influencing transport hub location

2.7 Conclusions

From the above analysis, it can be concluded that due to the lack of efficient connectivity and policy restrictions, apart from the nature of the business process, centrality has assumed critical importance in the location of ICDs in Southern India. Indeed, such scenario was quite different from western developed regions like Western Europe and North America, as it was noticed that most ICDs (or similar) were located at intermediate places and not at central locations (Hesse and Rodrigue, 2004; Notteboom and Rodrigue, 2005) and preferential policy and political borders were usually less significant than that of India. Indeed, as indicated by the simulated results, with policy reforms, there could be a sea change in the business process with increasing outsourcing and specialization leading to development of ICDs at intermediate locations. As exhibited in the above case study, once the 'preferential policy' had been removed, it could result in significant cost-savings for ICD users due to economics of scale resulting from enhanced usage of intermediate ICDs and would also permit the logistics service providers to introduce innovative value-added services, resulting in gaining of competitive advantages by the shippers. Indeed, in the case of Southern India, the influence of 'centrality' in ICD's location was very much artificially created by political rather than by economic process.

Thus, the above analysis has illustrated that, while centrality and intermediacy are largely useful in explaining the location of transport hubs, an important assumption behind was that location choice fully lied within the hands of users which were not necessarily true. Even within a market economy, location decisions were often restricted by exogenous factors and as a result of other players who could indirectly affect the location of a transport hub, which in turn had seriously restricted the choices of decision maker. In many cases, the degree of centrality and intermediacy a transport hub possesses was sometimes even more 'artificial' than natural. As illustrated in Southern India, while physical barriers (e.g. the Adam's Bridge) had effectively driven Tuticorin SP into a disadvantageous position, the existence of political boundaries and preferential policy had acted as artificial barriers which significantly increased the transport cost of cargo exports from Tirupur and Coimbatore and affecting the number of transport hubs existing within a particular network (i.e. TICD), as well as their final locations. Indeed, the location of transport hubs often reflected a balanced, as well as compromising, solution which at least partially satisfied the influence and competition between different forces, both explicit and implicit. Indeed, as noted by Powell (2001), in attempting to explain transport network and hub location, it should be analysed in terms of 'generalised transport cost' rather than just transport cost.

Through investigating the case of Southern India, this paper has offered some insight on the forces in affecting the existence and location of transport hubs. The authors were confident that this paper had added significant value in enhancing our understandings on the concepts of centrality and intermediacy and the attributes in influencing their degree of importance in explaining transport hub location, as well as how artificial forces had affected the transportation network as a whole.

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Chapter 3

Location Analysis of Dry Ports: a case of India*

3.1 Abstract

This study investigates the spatial characteristics of dry ports using the case of India with reference to providing competitive advantage to export trade. The establishment of dry ports was the most advantageous for exporters who experienc[14]ed quadrupled turnovers within just 15 years. Specifically this paper focuses upon the pre-conditions, including the optimal locations of dry ports and the factors determining such locations that are necessary for the synergies between the logistics and manufacturing industries to be released leading to the gain of competitive advantages. By applying the grid technique, attempts will be subsequently made to identify the optimal dry port's location to three industrial regions in Southern, Central and Northern India, i.e., Tirupur, Nagpur, and Ahmadabad respectively. Focus will be paid on whether the simulated optimal locations are in accordance to the realistic situations, as well as the reasons and impacts behind such similarities/differences. It is believed that this study can contribute significantly to our understanding not just to the attributes in affecting the spatial characteristics of dry ports, but also providing invaluable insight to dry port's appropriate functions, as well as the rationality of government policies on dry ports.

Keywords: dry port, spatial characteristics, location, proximity, grid technique, India

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3.2 Introduction

With the development of global multimodal supply chains, dry ports have assumed increasing importance to suit the need for market development, seamless integration and closer collaboration between the different participants of the supply chain. Thus, it is a natural corollary for the ports to extend the services to locations situated further hinterland by either patronizing, forming strategic alliances or buying out existing dry ports so as to optimize the supply chain. Generally speaking, a dry port can be understood as an inland location where consolidation and distribution of cargoes takes place with functions similar to those of seaports (including cargo-handling facilities, providing intermodal transport connectivity, information exchange, as well as other ancillary services like customs inspections, storage, maintenance and repair of empty containers and tax payments). The establishment of dry ports allowed the shippers to undertake consolidation and distribution activities at inland locations relatively closer to their production facilities, resulting in the reduction of transaction costs and accompanying risks leading to their products becoming competitive in the global markets for example, textiles and automotive components. There are approximately 200 dry ports in Europe and 400 in USA of varying capacities, where governments have enthusiastically promoted the development of dry ports, in some cases, partnering with private enterprises (see Dayal, 2006 and Rahimi *et al.*, 2008).

Towards the end of 2008, about 200 dry ports have been established throughout India. Apart from the conventional functions as described above, dry ports in India are being perceived as the catalyst in promoting regional economic development (Dayal, 2006). As a consequence, the number of dry ports in India has accelerated recently, especially in view of the proposed implementation of establishing Special Economic Zones throughout the country and the simplification of customs procedures, notably digital documentation which would enhance transparency and simplify documentary processing (Raghuram, 2005)[15]. In spite of this, however, further development in road, rail and port infrastructure by way of capacity augmentation and mechanization/automation is imperative to realize the true potential of containerization in India which is expected to treble in the next decade, where hinterland

[15] Here is to note that, however, so far, different from their western counterparts, Indian dry ports are only providing warehousing, custom clearance and cargo-handling functions, rather than any value-addition functions like packaging, re-processing, etc.

potential for container traffic is estimated to increase more than 70% (from currently 35%). The reason for this predicament is because of the absence of a dedicated freight corridor and high density of rail traffic in the north-western rail network. This leads to congestion and unreliability in the performance of rail operators and higher transaction costs for users.

With such understanding, locating dry ports properly is pivotal for efficient and cost effective freight movements between production bases and gateway seaports. Whilst focusing on the importance of the location of the dry ports, one should not overlook recent development of intensified inter-port competition which had contributed to the blurring of boundary lines demarcating port specific hinterlands and forelands (Heaver, 2002). In other words, the locational decisions of dry ports have significant bearings on the efficiency and competitiveness of the whole supply chain, notably connectivity, transport modes and costs, where transport and equipment decisions can be altered at short notice in response to market fluctuations. Indeed, according to certain viewpoints, one can even expect that, after the establishment of the initial dry ports at well chosen locations across the Indian continent, the development of these dry ports into important logistical knots in the overall network will gradually evolve, according to similar patterns as can be observed in Europe (for example, see Ecorys, 2009)[16]. As noted by Krugman (1996), choosing an inappropriate location can result in excessive costs throughout the supply chain, no matter how well different transport modes can be connected, or how efficient facilities and capacities can be achieved, thus affecting the competitive advantages of locally-produced merchandises in the global market (Porter, 1996). Here the fundamental question does not only reside in the nature, origins nor the destinations of cargoes but, more importantly, on how they are moving (Hesse and Rodrigue, 2004), i.e., which particular transportation hub(s) should be called, or the so-called location-allocation problem (Sherali *et al.*, 2002). Furthermore, while strategies and decisions relating to capacities and networks are usually of short-term by nature

[16] According to Ecorys (2009), from relatively simple warehousing functions in the start, and most other business activities situated elsewhere, many distributions centres (dry ports) in Europe have developed themselves during their existence towards multifunctional establishments of their respective companies, providing more and more specialized services, e.g., pick & pack, consolidation, bundling, strapping, and wrapping, customer system order processing, returns processing, quality inspection, UL-certified assembly, damaged returns management, exporting packing and order processing, climate control, bar code processing, labeling and ticketing, pooled distribution, cross docking, lot and serial control, EDI services, cycle counts, kit assembly, sub-assembly, build to order, facility management, recall services, literature fulfilment, inventory management, transportation management, repacking, custom, etc.

and can be altered in the intermediate term in response to the market demand and availability of land and capital, location decisions are fixed and difficult, if not impossible, to reverse in short- or medium-term. To sum up, making inappropriate locational choices, deliberately or not, can result in massive financial costs being wasted, which can ultimately affect the price and thus competitiveness of the country's merchandises in the global market.

Nevertheless, while various studies investigating the locations of dry ports in the western developed world exist (for instance, Rutten, 1998; Macharis and Verbeke, 1999; Hesse and Rodrigue, 2004; Rahimi *et al.*, 2008), the study of this topic in developing, newly-industrialized economies remain relatively untouched. Hence, using India as the focus, this paper aims to investigate the characteristics of dry port locations in developing economies. After this introductory section, Section 2 will provide a comprehensive review on the concept of location, which special emphasis on the major attributes in affecting locational decisions, as well as the major previous studies in this aspect. Sections 3 and 4 will describe the case studies and research methodology respectively, while Section 5 will illustrate and discuss the major findings. Finally, in Section 6, conclusions, including lessons drawn from this paper's analysis, will be made. It is believed that this paper can add significant values to the development of dry ports, especially in developing economies.

3.3 The Concept of Location

Whilst deciding upon a suitable location for a transportation hub, the decision maker is wearing several hats, that of an economist, transport geographer, financial analyst and many more. The essence of geographical approach is that it is spatial and is fundamentally concerned with the ways in which economic activities are organized in the chosen area and the underlying processes which lead to creation of spatial patterns. Once the solutions for the above mentioned parameters are determined it becomes relatively simple to make a location decision. In some instances such decisions were taken by the state directly, in order to provide a catalytic element to promote growth of the local economy where as in rest of the cases the decision was guided by purely commercial motives. Difficult as the market process is to describe, it is one on which the advanced industrial nations of the west rose to economic prosperity and has also been partially adopted by India with spectacular results to show. One of the offshoots of the market process is the location theory which was devised in the context of a market economy system, hence relevant from the Indian standpoint. The central concern of location theory relates not to the optimal usage of available space, but also to the precise site where a particular facility should be situated. In this context, the concept of spatial distance assumes critical importance (Guruswamy, 2000). It is between the dry port locations and shippers/consignees on the one hand and the gateway ports on the other which act as fulcrums along with the costs associated with connecting the two locations for the various location determining models used by the planners.

In this context, two major concepts should be highlighted, namely centrality and intermediacy, which are pivotal in deciding the spatial qualities of transportation hubs (Fleming and Hayuth, 1994 and Fujita and Krugman, 1999). A city's centrality, be it local, regional, national or continental, has a positive impact on its size, functions and traffic-generating potentials. On the other hand, intermediacy is a spatial quality which can be identified in context of the transportation system and can generate additional traffic if favored by transport carriers as connecting hubs. All transport hubs possess both attributes of centrality and intermediacy to certain extent. According to Ullman (1941), the traffic generated by a city is partly due to its location. In this context a transport hub could be defined as a city having transport facilities. Furthermore traffic could broadly be divided into origin-destination and connecting or flow through traffic. The origin-destination traffic is generated by the city itself whereas the connecting traffic is a reflection of extra activity levels conveyed by the transport carrier's preference of its location as transport hub. Thus intermediate locations are basically points between origins and destinations. On the other hand, through analyzing the structure of Southern German urban centres, Christaller (1966) developed the concepts of centrality and illustrated the idea by constructing geometrically symmetrical patterns of circles and hexagons. The underlying economic/geographic logic led to a search for examples on all scales. In these studies, the relative importance of the location of market centre was emphasized like Ullman (1941), who stressed upon the relationship between the productive land supporting the market centre and the essential services like collection and distribution provided by the market centre for the surrounding land. These centres became by virtue of their location transport nodes and also assumed some of the qualities of intermediacy. Such market centers or central places became gateways to distant places outside the region. Subsequently these central places, apart from being nodes for cargo consolidation and distribution, also became the foci of economic and transportation activities (Chakravorty and Lall, 2005). It is not surprising that many central places also became natural seats of political power. Furthermore such centrally located places often became optimum transport points (Losch, 1967). Centrality can also be induced by the artifice of transport infrastructure such as railways, roadways and inland waterways (Dickinson, 1961). It should also be noted that identification of a central place, to a great extent, also depends upon the land surface under consideration as well as the perceptions of the facility user; for example London's Heathrow Airport can be attributed not only to the centrality of its location but also to the perception of the user.

On the other hand, a hub acquires through its transport function the spatial quality of intermediacy. It could be central as well as intermediate. At such locations local services connect with national and international services and one mode of transport with another. This importance is imparted to the hub by the transport carriers who may also decide to take the importance away by shifting his business to another dry port due to several reasons like development of new locations or change in technology. The magnitude of the carrier's perspective is equally important and is directly proportional to the level of traffic. As noted by Cooley (1894) who commented upon the channeling influence of the transport routes upon the development of market centers, he underlined the importance of transport as 'city builder' and recognized the importance of value-added services provided by transportation, e.g., sorting, grading, packaging, processing, etc. As all these activities took place at major seaports, they should be considered as central places, for instance, see Bird (1973) and Weigend (1958). Another reason for considering seaports as central places was due to the fact that the seaports acted as gateways leading on the sea side to overseas foreland and on the land side to the hinterlands. Thus intermediacy is also one of the most important characteristic of seaports where such centres can serve as gateways between contrasting regions with contrasting needs.

Some locations have nothing but their location to recommend them as transportation hubs. For example, Sargent (1939) observed that Las Palmas and Tenerife assumed importance as bunkering ports merely due to their location which straddled the confluence of major trade routes. Accessibility is another important factor in the transportation network. But this factor is normally a *post facto* attribute because a location with traffic generating potential is made accessible by the route builders. Typical examples included Illinois in the US and Lodz in Poland where they were earlier bypassed and subsequently connected to the main network due to their traffic generating potential Ullman (1954). However, here is to note that intermediacy does not only imply a direct measurement of geographical distance and impediments, where such importance is also imparted by users who may decide to take its significance away due to several reasons, e.g., the rise of alternatives, technological improvements, changing trade pattern, etc. While any favourable locations can always create potential/opportunities to flourish into transportation hubs, they do not necessarily create genuine demands to ensure their survival/competitiveness (Losch, 1967). Similar to centrality, apart from objective measurement, the degree of intermediacy also possesses a subjective element.

The above analysis clearly indicates that centrality and intermediacy serve as major spatial qualities in deciding facility locations. The two concepts, however, are not always clear-cut and, in many cases, even overlapping (Fleming and Hayuth, 1994). For instance, while many seaports started as gateways due to its intermediacy and favourable physical conditions, they have gradually developed itself into central places as business started to move into the surrounding areas so as to exploit the competitive advantage offered by these ports, while also mutually assisting each other through agglomeration (like better flow of information). In turn, the enhancement of centrality can encourage the improvements of accessibility, for instance, more and better connections between the hub and other regions, as the magnitude of change can be characterized by the interaction within a geographical area, leading to an increase in the flow of cargoes (Hesse and Rodrigue, 2004), as exemplified by the US where a number of dry ports had started to attract agglomeration of services around and gradually developed themselves in local/regional logistics centres (Notteboom and Rodrigue, 2005). To a certain extent, most transportation hubs possess certain degrees of both centrality and intermediacy so as to maintain its survival, and the degree of influence of these forces can change overtime.

3.4 The Case Studies

Three regions, located in Southern, Central and Northern India, will be studied. In this section, a brief introduction to these regions will be introduced. See figure 1.

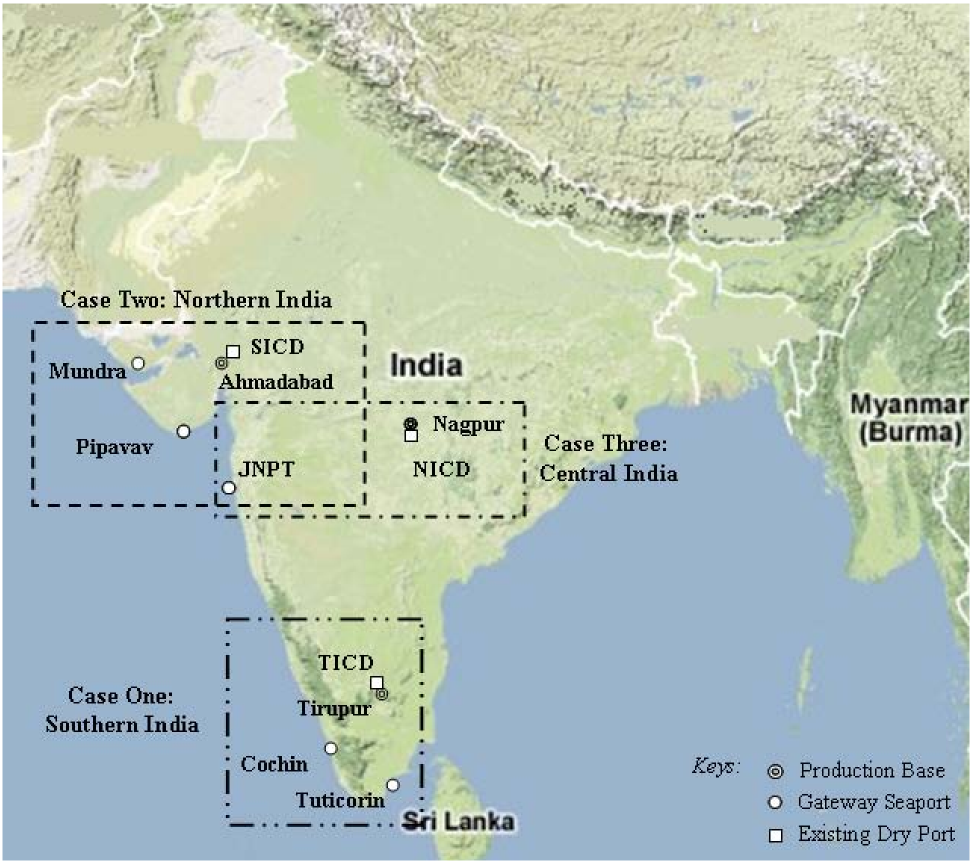

Figure 3.1: The case studies

3.1. Case One: Southern India – Tirupur

With a population of about 400,000 spreading over 30 km^2, Tirupur is located in central part of the southern state of Tamilnadu and is a suburb of Coimbatore. Known as the 'Manchester of the South' due to its prosperous textile industries, Tirupur is connected by road and rail and generates apparel exports worth USD 1.5 billion annually, which is equivalent to nearly 40% of India's total garment export values. There are about 3,000 knitting, stitching, dyeing, bleaching, printing units in the region manufacturing all kinds of garments and hosiery which is exported mainly to Western Europe and the US.

Almost all the cargo is exported by sea, mainly through the gateway seaports of Tuticorin and Cochin. Tirupur's local dry port, Tirupur Inland Container Depot (TICD), commissioned in January 2005 and operated by CONCOR, spreading over 0.7 hectares, is located about 7 km away from the core production bases. TICD has a covered warehouse admeasuring 300 m^2 with custom clearance facility. Until now, however, TICD is not connected by railroads to any of the SPs and all cargoes have to be carried by trucks, and it is understood that neither the national nor the Tamilnadu state government has any concrete plans in constructing any railway lines connecting between TICD and the gateway seaports in the foreseeable future. The location of TICD can be found in figure 2. Apart from TICD, a small amount of cargoes will also be cleared at Kudalnagar ICD (KICD) located at Madurai.

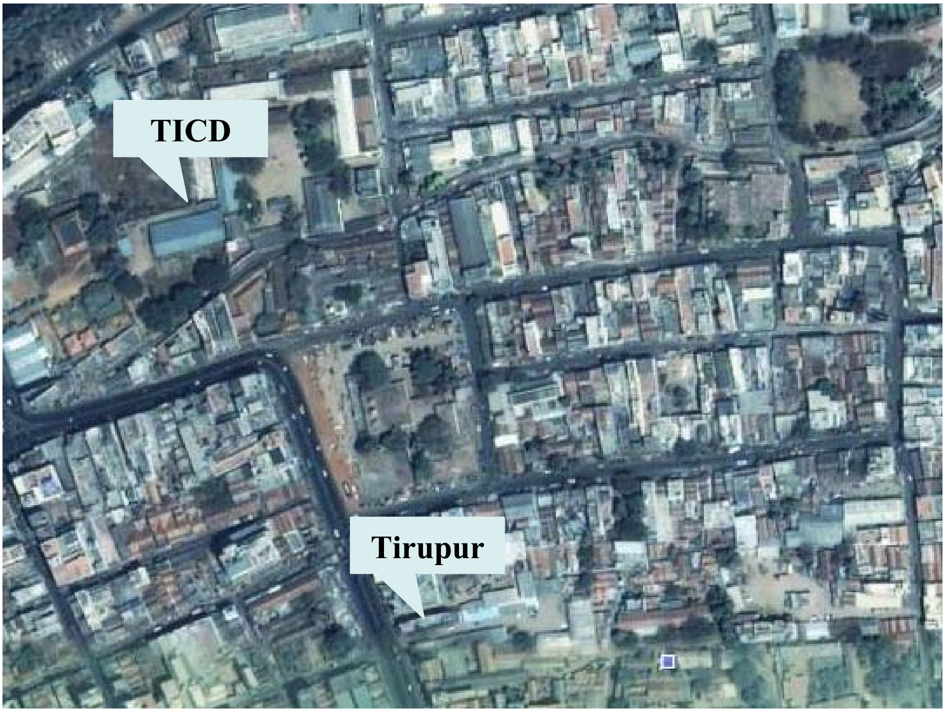

Figure 3.2: Tirupur and TICD
(Source: Google Earth, 2009)

3.2. Case Two: Northern India – Ahmadabad

With a population of five million spreading over 50 km^2, Ahmadabad is located in Northwestern India and is the capital of the Indian state of Gujarat. The city is famous for its textile mills dated back to the last century. Also, apart from textiles, there are several other industries, notably pharmaceuticals, paper, sheet glass, chemicals, as well as agricultural products like oilcake and edible oil.

Its local dry port, Sabarmati Inland Container Depot (SICD), located about 4 km from its core production bases, spreads over ten hectares and is well connected by road and rail to the gateway ports of JNPT, Mundra and Pipavav. According to industrial information, 67%, 20% and 13% of the cargoes are shipped out through the ports of JNPT, Mundra and Pipavav respectively. The location of SICD can be found in figure 3. Apart from SICD, a small amount of cargoes will also be cleared at Ankleshwar ICD (AICD) and Gandhidham CFS (GCFS), both located within Gujarat.

Figure 3.3: Ahmadabad and SICD

(Source: Google Earth, 2009)

3.3. Case Three: Central India – Nagpur

Nagpur is an old city located at the Indian state of Maharashtra, with a population of three million spreading over 40 km^2. It is a market centre located in a region which is rich in mineral and forest resources. Hence, the major industries located in this region are mainly agricultural and mineral (or directly-related) products, e.g., cotton, soya, rayon, paper, iron/steel, aluminum, etc.

Nagpur’s local dry port, Nagpur Inland Container Depot (NICD), located about 12 km away from the core production bases. Despite the fact that the gateway port of Vishakhapatnam is equidistant from Nagpur (and also connected by railroads), nearly all cargoes from Nagpur (according to industrial information, about 98%) are shipped out through JNPT, of which it is also connected with NICD by road and railroads. The location of NICD can be found in figure 4. Apart from NICD, a small amount of cargoes will also be cleared at Bhusawal ICD (BICD) and Daulatabad ICD (DICD), both located within Maharashtra, approximately midway between Nagpur and JNPT.

Figure 3.4: Nagpur and NICD

(Source: Google Earth, 2009)

3.5 Research Methodology

One of the foremost concerns of spatial analysis is the 'friction of distance', i.e., impediments to the movement, occurring due to spatial separation, which often involves an economic and/or financial cost. In this study, analysis has been undertaken with the application of the grid technique, a heuristic approach in determining the optimal location of a fixed facility (in this case, a dry port) based on the least-cost centre in moving in- and outbound cargoes within the geographical grid concerned. The grid technique assumes that the originating sources and outbound destinations for in- and outbound cargoes respectively are fixed, and that the operator (in this case, dry port operator) has concrete ideas on the approximate volumes of cargoes that it is likely to handle[17]. This technique also integrates both spatial and non-spatial data for solving transportation engineering problems, with the shortest path analysis being a precursor to this technique (for instance, see Advani *et al.*, 2005). In other words, the optimal location simulated by the technique is the place with minimum transportation cost. The grid technique can be expressed as the following formulation:

$$C_{(x,y)} = \frac{\sum(r*d*S)+\sum(R*D*M)}{\sum(r*S)+\sum(R*M)} \quad \textbf{(1)}$$

s.t.

$$C,M,S,r,d \geq 0 \quad \textbf{(2)}$$

[17] The grid technique superimposes a grid upon the geographic area containing the cargo originating sources and final dry port destinations. The grid's zero point corresponds to an exact geographic location, as do the grid's other points. Every source and destination can then be determined by its grid coordinates. The technique defines each source and destination location in terms of its horizontal and vertical grid coordinates. It is possible to visualize this technique's underlying concept as a series of strings to which are attached weights corresponding to the weights of inbound/outbound cargoes which the dry port operator handles. Also, here is to note that the application of the grid technique is based on the normative view of location, where: (i) land is isotropic and uniform in resource ability without any significant barriers to movements; and (ii) population is uniform in all respects. Finally, it is assumed that perfectly competitive markets exist and both producers and consumers possess perfect knowledge of the market.

where *C* is the centre of mass, i.e., the optimal location, *D* is distance from 0 point on grid to the grid location of outbound cargoes, *d* is the distance from 0 point on grid to the grid location of inbound cargoes, *M* is the weight (volume) of outbound cargoes, *S* is the volume of inbound cargoes, *R* is the outbound cargo transportation rate/distance unit for the cargo and *r* is the inbound cargo transportation rate/distance unit for the cargoes. *R* and *r* are the transport rates per distance unit. In order to determine the least- cost centre on the grid, it is necessary to compute two grid coordinates, one for moving the commodities along the horizontal axis and one for moving them along the vertical axis. Both coordinates are computed by using the grid technique formula for each direction.

During the analysis, several further assumptions have been made, including: (i) there are no significant differences between different dry ports in terms of performance and efficiency; (ii) the unit transport cost has a linear relation with distance; (iii) unacceptable routes do not exist; (iv) only local cargoes (within 100 km from the production bases) are considered; (v) not calling a dry port is not an option. As mentioned earlier, dry port is more than just cargo distribution centres which also served additional necessary functions in facilitating the shipment process. Moreover, given that Indian shippers largely consist of medium and small-sized firms, it is practically impossible for most of them to get around dry ports and ship their cargoes to any of the gateway seaports directly; (vi) analysis is based on existing transport infrastructure and facilities; and (vii) only one dry port will be called each time.

It is assumed that freight trains, instead of trucks, would be used, as long as the route concerned can fulfill two criteria: (i) the annual cargo size along this route reaches a minimum threshold of 32,400 TEUs[18]; and (ii) this route is supported by railroads to gateway seaports. Based on industrial information, the unit shipment costs of cargoes carried by trucks and rail service (provided that the minimum threshold is reached) are assumed to be 0.25 and 0.15 USD per metric tonne per km respectively. Last but not least, given the existence of significant

[18] It is assumed that one TEU will carry 14 metric tonnes of cargoes. According to industrial information, each freight train must carry at least 90 TEUs (1,260 metric tonnes) to enable such service to become economically viable. Thus, assuming that one freight train is running per day (360 days per year), there should be at least 32,400 TEUs (453,600 metric tonnes) available for shipment between any two transport nodes.

overcapacities in all three cases (table 1), simulation in this paper is based on a single- (rather than multi-) facility location model.

Table 3.1: Capacities and container throughputs of selected Indian dry ports

Dry Port	Paved Area in 2008 (m^2)	Capacity in 2008 (TEUs)	Throughputs (TEUs)	
			2005-06	2006-07
Southern India – Tirupur				
Tirupur ICD (TICD)	7,000	64,600	5,005	3,795
Kudalnagar ICD, Madurai (KICD)	8,580	79,200	1,438	438
Central India – Nagpur				
Nagpur ICD (NICD)	53,250	327,700	58,914	75,452
Bhusawal ICD (BICD)	20,230	186,700	3,204	2,534
Daulatabad ICD (DICD)	12,576	116,100	5,236	5,774
Northern India – Ahmadabad				
Sabarmati ICD (SICD)	128,428	1,185,500	96,113	112,616
Ankleshwar ICD (AICD)	6,650	61,400	341	1,568
Gandhidham CFS (GCFS)	121,406	1,120,700	917	4,032

Notes: Dry port’s capacity is calculated by applying the following formula: (paved area)*(3 layers stacked containers)*(50 weeks of operations)÷(area of one TEU container). Source for paved areas and throughputs: CONCOR’s website (last accessed on January 2009)

For the sake of providing a clearer picture on the choice of dry ports by shippers, a number of existing dry ports have also been included in table 1, including Kudalnagar, Bhusawal, Daulatabad, Ankleshwar and Gandhidham ICDs/CFS. All these dry ports share one common character, i.e., they are all closely located ($\leq$20 km) from the simulated optimal dry port locations of respective case studies. With such understanding, it means that under the current situation, nearly all the cargoes generated from the production bases ($\geq$ 90%) are exported via their respective local dry ports, i.e., TICD, NICD and SICD.

3.6 Simulated Results and Discussions

5.1. Case One: Southern India – Tirupur

The current and simulated solutions of Southern India (Tirupur) can be graphically represented in figure 5.

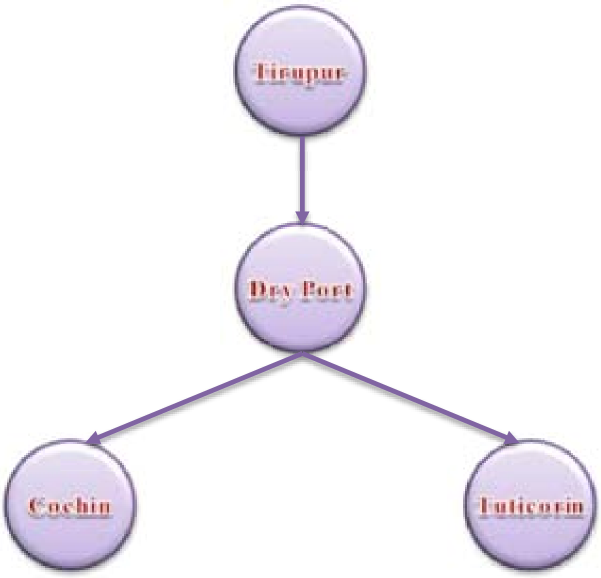

Figure 3.5: Graphical representation of the situation in Southern India (Tirupur)

Remark: arcs are not constructed in accordance to actual distances

Current Solution: [Tirupur] → [TICD/KICD] → [Cochin/Tuticorin]

Simulated Solution: [Tirupur] → [Optimal Dry Port] → [Cochin/Tuticorin]

As indicated in table 1, in 2006-07, the production base of Tirupur had produced cargoes which worth 4,233 TEUs. By applying equation (1), the optimal location for Southern India (Tirupur) can be visualized in figure 6[19].

[19] Data reveals that over 98% of the total cargo moves by road to the gateway seaport of Tuticorin, in spite of the fact that the port of Cochin is relatively closer as compared to Tuticorin. This is due to the Tamilnadu government's policy of promoting the gateway port of Tuticorin which is located in the state of Tamilnadu itself while the port of

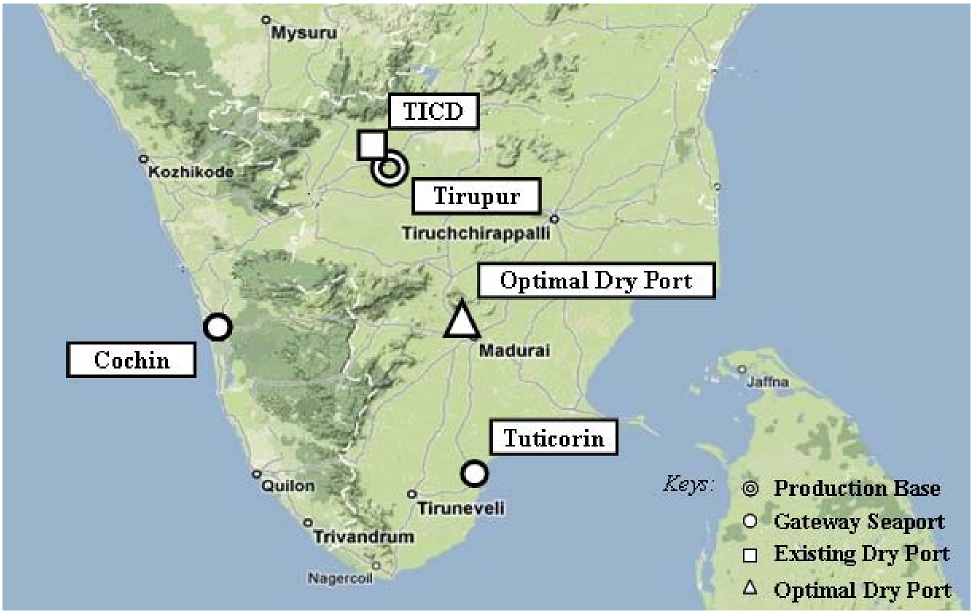

Figure 3.6: The optimal dry port's location for Southern India (Tirupur)

According to the simulated results, the optimal location of dry port in serving Southern India (Tirupur) should be near Madurai which is approximately midway between the production base and the gateway seaports. This location is about 105 km away south from TICD (which is located only 20 km from Tirupur's major production base).

5.2. Case Two: Northern India – Ahmadabad

The current and simulated solutions of Northern India (Ahmadabad) can be graphically represented in figure 7. The route which can potentially be served by rail is symbolized by a dotted-line arrow.

Cochin is located in the neighboring state of Kerala. This is done by offering transport subsidy to the road transporters. This is done by the Tamilnadu state government to prevent the loss of revenues. The port of Chennai though located in the same state does not get much cargo from Tirupur due to longer distance.

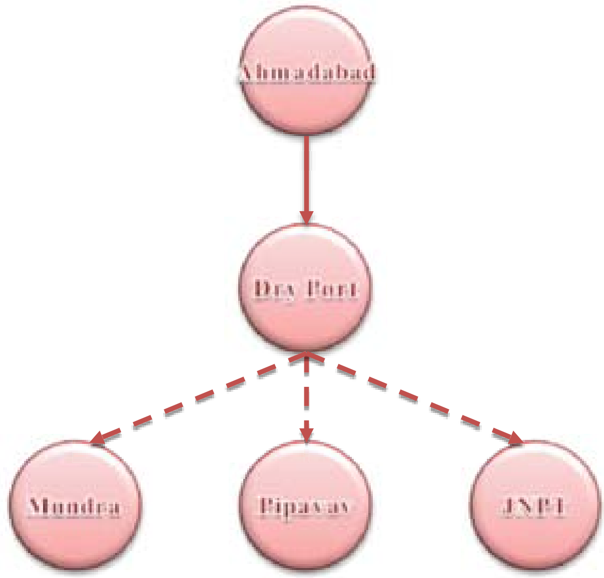

Figure 3.7: Graphical representation of the situation in Northern India (Ahmadabad)
Remark: arcs are not constructed in accordance to actual distances

Current solution: [Ahmadabad] → [SICD/AICD/GCFS] → [JNPT/Mundra/Pipavav]
Simulated solution: [Ahmadabad] → [Optimal Dry Port] → [JNPT/Mundra/Pipavav]

As indicated in table 1, in 2006-07, the production base of Ahmadabad had produced cargoes which worth 118,216 TEUs. By applying equation (1), the optimal location for Northern India (Ahmadabad) can be visualized in figure 8.

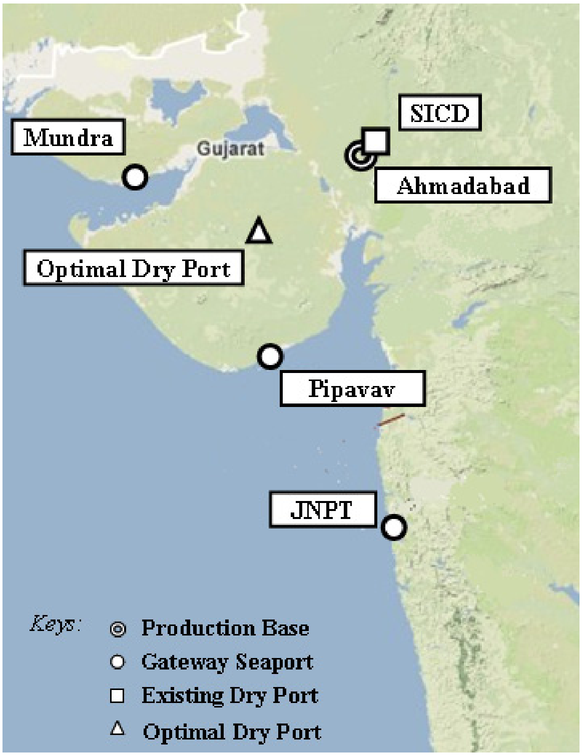

Figure 3.8: The optimal dry port's location for Northern India (Ahmadabad)

According to the simulated results, the optimal location of dry port in serving Northern India (Ahmadabad) should be approximately 170 km to the south west of Ahmadabad's production base, which are significantly more proximate to the major gateway seaports of JNPT, Mundra and Pipavav.

5.3. Case Three: Central India – Nagpur

The current and simulated solutions of Central India (Nagpur) can be graphically represented in figure 9. The route which can potentially be served by rail is symbolized by a dotted-line arrow.

Figure 3.9: Graphical representation of the situation in Central India (Nagpur)
Remark: arcs are not constructed in accordance to actual distances

Current solution: [Nagpur] → [NICD/BICD/DICD] → [JNPT]
Simulated solution: [Nagpur] → [Optimal Dry Port] → [JNPT]

As indicated in table 1, in 2006-07, the production base of Nagpur had produced cargoes which worth 83,760 TEUs. By applying equation (1), the optimal location for Central India (Nagpur) can be visualized in figure 10.

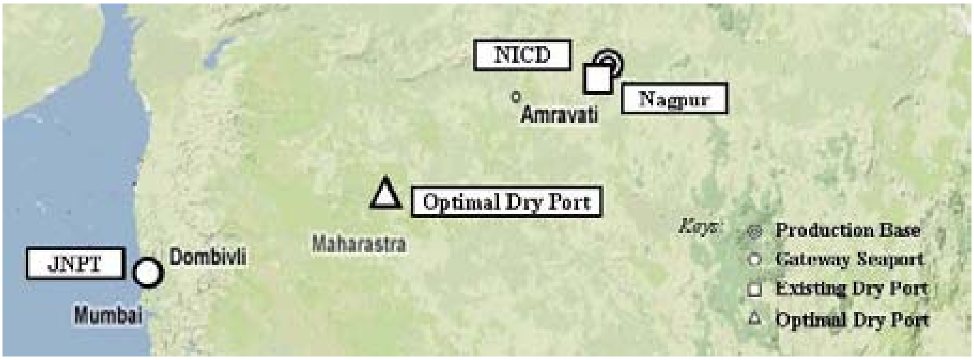

Figure 3.10: The optimal dry port's location for Central India (Nagpur)

According to the simulated results, the optimal location of dry port in serving Central India (Nagpur) should be approximately 150 km to the southwest of Nagpur's production base, towards the direction of JNPT.

5.4. Discussions

All the simulated optimal dry ports share common locational characteristics, of which all of them are situated in locations with significant distances away from both the production bases and gateway seaports. In other words, in accordance to the simulated results, existing dry ports which are located proximate to the optimal dry ports, i.e., Kudalnagar, Bhusawal, Daulatabad, Ankleshwar and Gandhidham ICDs/CFS for Tirupur, Nagpur and Ahmadabad respectively, should possess the best potential in attracting most cargoes from the production bases. Nevertheless, as indicated by the distribution of cargoes between different dry ports is considered (table 1), the simulated phenomenon is significantly different from the realistic situation, where local dry ports, i.e., TICD, NICD and SICD respectively, have significantly higher throughputs than their counterparts. It is clear that all the optimal locations simulated by equation (1) have failed to reflect the realistic situations.

Based on empirical figures, it is clear that only dry ports of which their locations are proximate to the production bases can attract cargoes of any significance (TICD, NICD and SICD are only located 7, 12 and 4 km away from their respective production bases respectively). The existence of significant variations between the simulated optimal and realistic locations (which the latter is often proximate to their respective local production bases) has highlighted the importance of 'centrality' in the decision of shippers in using dry ports, where the pulling force of intermediacy is virtually non-existent. In other words, in India, shippers have clearly chosen to sacrifice transport cost-savings in return for other benefits, for example, convenience, relation, better control, etc. Such results are complementary with earlier works by Ng and Gujar (2008), who pointed out that convenience, local relations and better local control often served as more important considerations on shippers' decisions on which particular dry ports should be used.

3.7 Conclusions

Through the case of India, this study has undertaken a detailed investigation on how dry ports are located in developing countries, as well as their spatial characteristics. Analytical results indicate that geographical location bears significant importance in the competitiveness of dry ports. An inappropriate location can adversely affect all the parameters leading to loss of competitive advantages of locally-produced merchandizes in the global market.

Also, this study found that, currently in India, only dry ports which locate close to the production bases are self-sustainable, despite the fact that the optimal locations of dry ports, simulated through applying the grid technique, are not always proximate to the production bases, as illustrated in the cases of Tirupur, Nagpur and Ahmadabad. According to anecdotal information based on interviews with relevant industrial stakeholders, the major reason is the need for flexibility and better control. Although the number of shippers within the study regions is fairly large, the average quantity of cargoes exported by each of them (in terms of volumes) are actually quite small which require consolidation so as to fill up the containers. In this case, it implies that shippers psychologically feel more comfortable if they can retain control over their consignment until the last moment and thus enabling them to negotiate better freight rates. The pulling force of flexibility is also enhanced by the potential convenience which can be gained by using local dry ports, notably preferential treatments by local authorities (through established local networks) and avoiding paying state-border tax, in case the dry port concerned is located within the jurisdiction of another state (where tax affairs largely lie within the state governments in India). Such scenario is in stark contrast with various developed regions (notably Western Europe and North America), where it is noticed that most dry ports are located at intermediate (rather than centrality) places and, in many cases, along transport corridors (Rahimi *et al.*, 2008). The main reasons behind this include cargo costs, high quality connectivity, the provision of value-added services provided by the dry port operator (like procurement, assembly, production, reparation and reverse logistics, which are lacking in Indian dry ports), as well as the fact that dry ports are largely constructed to relieve seaport congestions (Slack, 1999; Roso, 2008). This is also not helped by the prohibitively expensive land prices within the urban centres and the existence of local and national regulations in restricting the use of such lands for industrial purpose (notably environmental and social issues).

As a consequence, the case studies here have thus illustrated that the locations of dry ports are, in many ways, actually the outcomes of interaction and compromises between competing forces, and that reliance of natural and/or geographical and/or economic forces in explaining how a dry port should be located is inadequate. Even within a market economy, the choice of dry ports is often restricted by exogenous factors and as a result of other players, which in turn seriously restrict the options of decision makers. As illustrated in the Indian context, the degree of centrality and intermediacy a dry port possesses is often more 'artificial' than simply by natural economic forces. Locating a dry port at a particular place often reflects a balanced, as well as compromising, solution which at least partially satisfies the influence and competition between different forces, explicit and implicit, subject to a number of economic, social and even political constraints. Based on this understanding, an important policy implication can be observed, where it is inadequate for any governments (as typified by the current policies promulgated by the Indian government, see Section 1) just to establish various dry ports (and facilities) around the country and expect them to automatically become the catalyst in promoting regional economic development. Indeed, it is not only the mergence of dry port itself and its physical handling of cargoes which can eventually bring the expected economic benefits, but the extent of which the dry ports concerned can become integrated service providers and inscribe into the multimodal logistical supply chains is the decisive factor in fulfilling the objective of benefiting surrounding areas in term of regional development due to their presence. After all, transportation and supply chain, including dry port, is still very much a derived demand and the establishment of facilities does not necessarily generate demands automatically, as illustrated in India where 'intermediate' dry ports found themselves very difficult in attracting cargoes (table 1). Hence, it is necessary for governments to executive relevant policies so as to provide more 'centrality' to the areas around the dry ports and their facilities, and perhaps the establishment of logistics parks dedicated for value-addition industries can be a good first step.

Conclusively speaking, this paper has provided some valuable insight on the forces in affecting the spatial characteristics of dry ports. The authors are confident that this study has added significant values in enhancing our understandings on the concepts of and attributes in affecting the location of transportation hubs, including dry ports, as well as how the interaction between natural and artificial forces can influence the spatial characteristics of transportation hubs, their competitiveness, as well as the transport system as a whole.

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Chapter 4

The Indian Dry Ports Sector, Pricing Policies and Opportunities for Public-Private Partnerships *

4.1 Abstract

At the time of writing (2010), the world is witnessing the aftermath of the most severe financial sector meltdown in modern economic history caused by the real estate bubble in the United States. Its consequences on the real economy, especially in Europe, are yet to be fathomed, and this of course includes the longer-term impacts on international ocean transportation, ports and the distribution of global production.

The economic recession has left the international shipping and port sectors with substantial overcapacity. This has resulted in drastic cost cutting measures on the one hand, and voluntary, often consensual, and coordinated reduction of supply on the other. These measures, together with a noticeable recovery in demand, are gradually leading again to improvement in prices charged by carriers and other transport service providers.

In view of the country's expanse; size of population; and regional inequalities, India's dry ports (inland cargo consolidation and distribution centers) are seen by the government as a pivot of export-led growth and economic development (Haralambides and Gujar, 2011). Moreover, public and private sectors alike see the coordinated development of dry ports as the only way forward in terms of easing pressures at congested coastal ports, thus improving supply chain efficiency. In spite of this, dry port development and operations are still dominated by the public sector, under prices, capacity, land acquisition policies and other conditions that make private sector participation risky and comparatively unattractive. In order to rationalize dry port capacity and prices, this paper argues in favor of greater devolution through competition-enhancing Public-Private Partnerships (PPPs). To effect this, the pap[20]er puts forward recommendations for

* The Indian Dry Ports Sector, Pricing Policies and Opportunities for Public-Private Partnerships by Hercules Haralambides, 1, Girish Gujara, 2 Research in Transportation Economics (2011), doi:10.1016/j.retrec.2011.08.006

the necessary legal, regulatory and general economic policy interventions based on international best practice, while keeping Indian specificities in the right perspective.

4.2 Introduction

Historically, economic growth and trade of countries has revolved around seaports. In India, especially following the advent of British rule, industry and commerce grew largely near and around the old port cities of Mumbai, Chennai and Kolkata. Spatial concentration of economic activity in these port cities has been a key feature of India's rapid economic development. It has been mainly the coastal regions of India that have benefited from the current phase of globalization, thus becoming important nodes in regional production-transport-distribution networks.

To relieve increasing seaport bottlenecks and facilitate the economic development of inland regions, Inland Container Depots (ICD) and Container Freight Stations (CFS) have been developed and linked to coastal *outlets* and, through these, to global supply chains. *Dry ports* constitute one of several important instruments employed by the government for the purpose of consolidation and distribution of goods. Their functions are analogous to those of a seaport, thus also including customs procedures and other steps necessary to relieve congestion and delays at state border crossings and ports, reducing in this way supply chain costs for exporters and importers.

A dry port is the inland equivalent of a marine container terminal. The difference in the case of an inland *intermodal* terminal is that the transfer between transport modes does not require sea access. Roso (2008) define a dry port as *an inland terminal directly connected to seaport(s) with high capacity transport mean(s), where customers can leave/pick up their standardized units as if directly to a seaport.*

In Europe and North America, dry ports function as modal interchange and freight storage facilities, often located at close proximity to strategic rail and road hubs. They are termed differently in different countries, e.g. *Strategic Rail Freight Interchanges* in the United Kingdom; *Freight Villages* in some countries of Western Europe; and *Inland Ports* or

Multimodal Transport and Distribution Hubs in the United States. The European freight villages were established in 1991, when the national freight village associations of France, Italy and Spain joined forces to form a Europe-wide association. *Euro Platform* currently represents 60 freight villages in 10 European countries (Denmark, France, Germany, Greece, Hungary, Italy, Luxembourg, Portugal, Spain and Ukraine), serving 2,400 transport operators. A recent assessment of the European *freight village* concept (UNESCAP, 2006) discusses its essential functional characteristics as follows:

'*The main societal benefit claimed for European freight villages is that they have reduced urban traffic congestion by moving warehousing, distribution and some processing activities outside the cities, to locations that make maximum use of more cost-effective transport modes, such as rail. Best practice examples of freight villages operating at inland locations and involving a high degree of modal integration are to be found in the Bologna Freight Village, or Interporto Bologna (Italy), and at the Cargo Centre Graz, a strategic multimodal facility located in Graz, Austria. The wider economic benefits and multiplier effects of inland freight modal interchange facilities are eloquently presented in UNCTAD's enterprise cluster concept. A well thought out application of this concept to India, in view of the country's size and degree of economic development, could render user benefits much more profound and measurable than those of Europe's freight villages and logistics parks.*'

Dry ports can potentially nurture manufacturing and service clusters, for example, special economic- and export processing zones. Increasingly, dry ports are located close to existing or potential production or consumption centers. If properly planned, the number of dry ports should depend on geography, as well as on diversity and extent of economic activity. Indicatively, UNESCAP (2009) suggests one dry port per one million TEU handled at the country's seaports. The size of dry ports would likewise vary according to the industrial production and commercial transactions in the area served by the facility. The size of dry ports in the European Union is seen to vary from a yearly throughput of 40,000 TEU up to 2 million TEU; their land area similarly ranges between 30 and 200 hectares; the number of associated user enterprises varies between 25 and 100; and the number of employees varies between 7,000 and 37,000 persons.

4.3 Dry Ports and Indian Specificities

One of the main constraints in the expansion of Indian dry port capacity is the saturation of the Delhi-Mumbai road/rail link. In order to further improve connectivity between the gateway seaports of JNPT and Mundra on the west coast, and inland dry ports located in the heartland of North India, the government of India has embarked on an ambitious project. This concerns the USD 90 billion Delhi-Mumbai Industrial Corridor (DMIC) project, stretching over 436,500 sq. km, in six States. The project encompasses some 20 potential high-growth economic zones, to serve as manufacturing, services and export-oriented hubs. DMIC shall, *inter alia*, create a chain of free-trade warehousing zones, and freight logistics parks with rail and road network connectivity.

According to Haralambides and Gujar (2011), the hinterland containerization potential of major Indian seaports is estimated to be at least 70%, whereas the actual container penetration from and to hinterland locations is currently less than 35%. Furthermore, the rail-borne container movements between the dry- and gateway ports is currently around 35%, while an ideal ratio has been established to be around 50% (Raghuram and Gangwar, 2007).

With growing incidence of outsourcing and offshore manufacturing, the market for containerizable cargo, in intermodal transport, has changed radically in recent years. Major manufacturers now go farther offshore in search of low labor costs, low taxes, better market accessibility, and other advantages. This has resulted not only in a large increase in containerized intermodal cargo but also in a significant increase in origin-destination distances (Notteboom and Rodrigue, 2005).

The advent of containerization has been rather late in India and the development of hinterland dry ports took place even later. The share of containers in Indian Railways (IR) freight traffic in 1988-89 was less than 0.2% by weight: of a total freight volume of 302 million tons, containerized traffic accounted for less than 0.5 million tons. At the same time, international trade required more transit-time sensitivity and 'small-volume customer' care than what IR, with its focus on large volumes of bulk commodities, could provide.

On realizing the importance and potential of containerization and intermodal business, the government of India decided to set up a separate government-owned corporate body for the facilitation and promotion of multimodal transport. Container Corporation of India Ltd (CONCOR) was consequently incorporated in March 1988, with the objective to manage change in India's logistics architecture; spearhead the container revolution in the country; build and operate infrastructure linkages for rapid and accelerated inland penetration of containerized international trade; develop and promote the use of ISO containers for intra-country domestic general cargo; aggregate cargo for unit-train operations on specified routes; and encompass the flexibility of road transport, along with robust and economical unit train advantages of a countrywide rail network (UNESCAP, 2006).

CONCOR has joined hands with a number of private, as well as other public sector entities in order to develop synergies and strengths, cost reduction, and efficiency enhancements. *Ab initio*, there has been a strong participation of the private sector in the development of dry ports (ICD and CFS) in India. Of a total of 223 ICDs and CFSs approved by the Inter-Ministerial Committee (IMC), as many as 139 (more than 62%) are in the private sector; of a total of 131 functional ICDs and CFSs, CONCOR facilities account for only 20%. To set up satellite dry ports, the participation of agencies like the state and central warehousing corporations, and those of the private sector, was sought at locations where appropriate warehousing facilities were available. In the interim phase of development, stripping of import containers; customs inspection; and delivery were envisaged at some of the bonded warehouses, e.g., at Ludhiana, Jalandhar, Amritsar, Ahmedabad, Pune and Hyderabad. Private entrepreneurs were invited and encouraged to join hands with CONCOR in providing capital and trained manpower for the handling equipment (cranes, trucks, forklifts, etc.), at its dry ports.

Furthermore, CONCOR proposed to let private operators handle, on contract or under franchise, all transport of containers and cargo by road between the satellite CFSs and the rail-fed ICDs, and between ICDs/CFSs and shippers' premises. It also adopted a strategy of expanding business scope, by diversifying in allied areas by way of alliances and joint ventures with major shipping lines at strategic locations such as Dadri, in the vicinity of Delhi. CONCOR has thus entered into joint ventures with four shipping lines: Maersk Line, APL, CMA-CGM, and Transworld - with 49% equity participation - to develop CFSs. It has also entered into the development and operation of the third container terminal at JNPT, through a joint venture with Maersk, with 26% equity contribution. The terminal, with a capacity of 1.3 million TEU, became operational in March 2006. Another joint venture has been formed with DP World, with 15% equity contribution, to develop a container transhipment port at Vallarpadam, in Kochi (UNESCAP, 2006).

Until recently, the public sector had a near monopoly in the rail transport of containers. At the same time, the government has been quite keen to achieve a modal shift from road- to rail traffic (Raghuram, 2005). The main reason for this thinking was the greater carbon emissions caused by road transport, as well as congestion caused by inadequate road infrastructure. However, due to the absence of specific policy guidelines, this objective has not yet been realized.

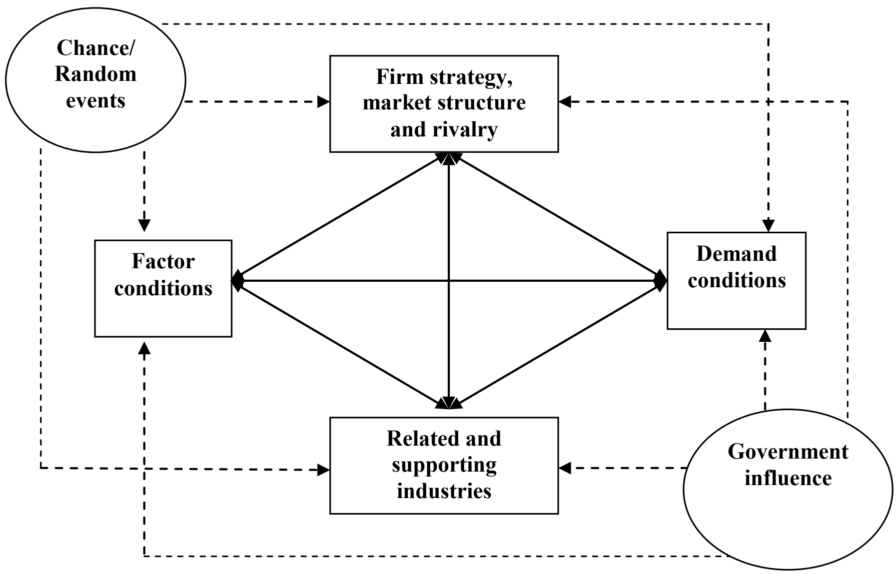
Several private sector logistics service providers were granted licenses to operate block container trains on a nationwide basis in 2006. Expecting a sustained economic growth, a few license holders commenced operations in 2007-2008. However, they were handicapped by the lack of adequate infrastructure, such as railhead terminals and container rail wagons. As a consequence, they entered into agreements with the public sector dry port operators, having had to pay a fee for the use of their terminals. In addition to these factors, higher capital costs ensured that the new entrants could not be competitive either. The subsequent collapse in demand as a result of the 2009 financial meltdown resulted in the creation of substantial overcapacity. In what follows, this paper argues that, in such circumstances, and in order to ensure optimal utilization of dry ports, the government should actively encourage partnerships between the public and the private sector by way of PPPs.

4.4 Theoretical Background

Michael Porter (1998) in his seminal work on *competitive advantage* has argued that, rather than a static focus on cost minimization, competition is dynamic and rests on innovation and the search for differentiation. This is due to the increase in countries open to the global economy, greater efficiency of international factor markets, and diminishing factor intensity of competition. Accordingly, a firm's competitive position depends on two major aspects: *Operational effectiveness* as well as *strategy*. To remain competitive, a firm must maintain operational effectiveness while at the same time create strategies which can distinguish it from existing and potential competitors.

The major factors affecting a firm's competitive advantage, as emphasized by Porter, are the firm's management structure and its resource limitations. In an earlier work (Porter, 1990), he also argues that there is no single common strategy or management theory that can explain the behavior of all firms, because different management philosophies exist, including personal beliefs and company culture. Rather than static, a firm is actually an evolutionary creature, where past experiences and personnel have a direct impact on future strategies and development. Admittedly, market forces alone are not necessarily the only attributes which can influence the direction of the famous Porter *diamond* (Figure 1). As Porter correctly argues, even within a typical market economy, competitive structure is often influenced by random and unexpected events such as the recent financial turmoil and, perhaps more importantly, government policies (or absence thereof). Rather than being a core player, however, Porter insists that the government should only play a catalytic role by creating a favorable economic climate for firms to compete on a level playing field, e.g., by enforcing standards in service quality, encouraging competition, introducing and enforcing non-monopolistic policies, providing necessary aid, etc., but it should not interfere in ways that influence corporate management, as this could result in an ineffective and bureaucratic culture (Porter, 1990).

Figure 4.1: The Porter "Competitive Diamond", authors based on Porter (1990)



In the port sector in particular, the government should aim to achieve three missions, namely the catalyst mission (e.g. financing transport assets which are unlikely to get access to private or alternative sources of finance); the statutory mission (e.g. ensuring navigation safety, coastal management, etc.) and the facilitation mission (e.g. public governance, trade facilitation processes, trade integration, etc.) (Heaver, 2002).

Porter's theories have gone a long way towards explaining competitive structure, clearly defining the distinct roles of firm and government. However, his demotion of the role of government is certainly an issue which is highly debatable especially in the current economic circumstances. As discussed below, in the case of Indian dry ports, the government not only does not restrict itself to the regulatory backseat, but is playing a pivotal role in deciding the 'balancing point' within the Porter *diamond*.

4.5 Research Methodology

Given the exploratory nature of this study, and apart from desk research, the authors have also conducted on-site in-depth interviews with various stakeholders. These interviews were conducted by phone or in person. For each question, the interviewer has summarized, when necessary, the answer and transcribed the results of the interview. More than 50 interviews were conducted, with interviewees in India and abroad, including dry port operators, government officials, and consultants involved in Indian dry port construction and development. Core questions asked comprised:

1. The impacts of government policies on the dry port sector;
2. The competitive structure of the industry;
3. The overt and covert objectives of entering the industry (land acquisition; availability of subsidies; cheap capital; improving supply chain reliability; and, occasionally, profit);
4. Major recommendations for improvements in dry port policies;
5. The precise benefits derived by dry port users;
6. Effects on the regional economy;
7. Competitive advantage pursued by the dry port operator.

(For the sake of simplicity and illustration, the information and opinions of interviewees are referred to below as *anecdotal information*).

4.6 The Core Issues

Due to lack of uniform demand for dry port services, the distribution of dry ports within India is uneven, with about 40%, 30% and 30% being located within the southern, western and northern regions respectively (the central and eastern regions are conspicuous in the comparatively smaller presence of dry ports). This factor, in addition to several others, has led to congestion in a few dry ports, breakdown of infrastructure and under-utilization of capacity.

Unlike European dry ports, and due to scarcity of financial resources and technological and management skills, Indian dry ports have not been innovative nor have they invested in long term efficiency-enhancing technologies such as RFID and GPS systems. To address this issue, the Indian government has decided to further encourage private sector participation in the dry port sector by granting licenses to run container trains on a nationwide basis. Along the same lines, the government has recently encouraged the private sector, including foreign companies, to set up and operate dry ports at numerous locations within the country, often through the sale or lease of land and facilities on attractive terms. It has also entered into several joint ventures with the private sector, through its public sector companies, to manage facilities on a BOT basis. As a result, several multinational logistics service providers like Schenker, Kuehne & Nagel and Prologis, along with shipping companies like APL, MSC and Maersk Line, have entered the sector. Referring to Porter's *competitive diamond*, the objective of inviting foreign company participation was to enhance the quality of the *diamond*, so as to boost the quality of the supply chain within the country, and thus the competitiveness of Indian manufacturing in the global market.

Considering the relatively low value of cargo handled by Indian dry port operators, premium tariffs are not common, certainly not over extended periods: Almost 50% of imports consist of waste paper, scrap iron and cotton waste. Exports too consist of low value-added cargo such as handicrafts, brassware, raw cotton, tea and other agricultural products (Raghuram, 2005).

International trade in such products is highly competitive and even a slight addition to transportation and logistics costs can render such goods uncompetitive.

Thus, the core issue of current concern for the Indian government is how to balance the dry port *diamond* by enhancing its efficiency on the one hand, while simultaneously maintaining the growth of public sector dry ports on the other hand. Indeed, the competitive structure of the dry port industry does not have only economic ramifications, but political and social aspects also pose equally significant challenges. Given the problems discussed in this section, it seems that, in some cases, within the Indian dry port *diamond,* it was the government which brought in foreign dry port operators, in an attempt to imbalance the *diamond*, while at the same time, as discussed below, it is also the government which plays a pivotal role in 'rebalancing' the Indian dry port *diamond*, so as not to *neutralize* the early startup advantages derived by public sector ports operated by state-owned, public sector corporations.

4.7 Land pricing and distribution

In terms of land policy, state-owned corporations were often given preferential treatment so as to ensure that new dry ports could develop with maximum ease. The major component of the capital cost involved in the construction of a dry port is the cost of land. Technical industry information suggests that a typical dry port with an annual throughput of 120,000 TEUs requires, ideally, a land area of about 121,400 m^2 (i.e., about 30 acres) (Ecorys, 2009). The cost of land varies according to several factors, such as location; availability of usable land (for example, marshy land is not suitable for dry port construction, or would require substantial expenditures to make it suitable through filling and/or leveling); economic environment; competition with other potential land users; proximity to markets and gateway ports; affinity to road/rail networks; etc. In 2009, land prices varied between USD 100,000 to 500,000 per acre. Thus, a dry port with an annual throughput of 120,000 TEUs would typically need USD 6-9 million just for land acquisition.

Apart from land prices, acquiring land for the construction of a dry port, especially in green-field projects, is subject to governmental permission for changing the land use purpose (in the majority of cases, land is primarily earmarked for agricultural use). The government, through local agencies such as the City Industrial Development Corporation (CIDCO), appropriates the land, develops it, and then sells or leases it to interested parties.

It should be noted that the Indian government is actually the biggest landlord, thus possessing considerable power in the distribution and use of land. In addition to this, the government, through its corporate limbs, is also the biggest dry port service provider and warehouse owner. Thus, public sector dry port owners who are also partially listed government companies have land available for use at token cost, well under market values. In several instances, land has been leased out to public sector corporations for long periods at very low, subsidized rates. The government thus becomes a price setter for dry port services. In contrast, the private sector is not accorded the same preferential treatment and has to acquire land at market values.

4.8 Subsidies in operational costs

Government influence also exists as regards coverage of operating costs of which transportation costs are also partially subsidized, usually in terms of fuel subsidies. Such assistance has helped in enhancing the competitive position of dry ports operated by state-owned corporations. Given such assistance in both capital and operating costs, state-owned dry ports are able to offer significant volume discounts. Moreover, in certain cases where the cargo involved is time sensitive or prone to pilferage (like perishable products, ready-made garments and accessories, household goods, leather goods, pharmaceuticals), the operator can demand a premium. Indeed, it is not uncommon for the operator to rent out, partially or sometimes entirely, the storage space to a single customer for certain time periods against payment in advance.

4.9 "Growth Protection" Umbrella

The government has also introduced policies which have restrained free competition in order to allow its own newly created dry ports gain market share. For example, new public sector dry port operators have often been allowed to charge fees which do not cover the capital cost during their start up periods. Such pricing policies have largely benefitted state-owned corporations, allowing them to develop a dominant market position.

4.10 Optimum Size and the Conundrum of Dry Port Pricing

A dry port is essentially a land-intensive industry, especially in cases where the land is located close to a central market place and is well connected to rail and road networks. This is the first issue where a pricing policy encounters a major hurdle: what is the value and the opportunity cost of land? Under what terms and conditions is land made available to dry port operators? A piece of land located close to a residential or commercial area is a scarce commodity having a fairly high opportunity cost and several potential claimants. Such a land can be alternatively used for residential or commercial purposes in addition to tourism, recreation etc. In India, the land issue becomes more complicated in old cities like Delhi, Mumbai and Kolkata where land availability is far more restricted due to old tenants, archaic laws, labor issues etc.

As dry port related infrastructure is considered to be a public good serving the collective interest of the entire nation, dry port development has been considered to be within the sole purview of the state. This was arguably true in the past, when India followed a central planning economic development model. Among others, this allowed for mass production, low marginal costs and the achievement of international competitive advantage. With some exceptions, dry port capacity was developed ahead of existing demand from industry, agriculture or commerce, in the hope that industry and trade activities would pick up subsequently in the wake of the dry ports (Haralambides *et al.*, 1997). As large capital requirements and long gestation periods were expected, the development of dry port infrastructure was generally considered to be the prerogative of the public sector.

However, as international trade picked up, followed by demand for dry port services, the government realized that public monopolies could result in inefficiencies, leading to the withering of gains and, adversely affecting export-led trade ambitions. As a result, the government eventually permitted the private sector to invest and operate in this industry, albeit in a restricted manner. Several private operators thus entered the sector expecting to reap handsome benefits. Most of them were shipping companies such as APL, MSC and Maersk, or Terminal operators like DPW and APM terminals, who ventured into this sector with the added advantage of their own captive cargo which they aimed to handle at their own dry ports, and transport it by their own rail wagons. However, with new operators joining the competition, the equation was altered: Supply increased significantly, leading to under-utilization of resources. Moreover, supply did manage to cater to the increasing demand, albeit with a slight lag due to the time required to construct the required infrastructure such as access roads and rail sidings.

Finally, competition between the public and the private sector has not been taking place on a level playing field: Massive amounts of public monies were funnelled into dry port development in the past, either directly or indirectly by way of overt and covert subsidies, enabling public sector operators to consolidate a strong market position. This has allowed them to adopt pricing policies which have often deterred new entry. At the same time, and reinforcing this effect, a large and well-spread system of public dry ports has been developed, strategically occupying prime land close to important market places.

The creation of excess capacity has obviously had a direct impact on pricing policies, which are examined next in connection with the parameters considered important in the planning of a dry port.

4.11 Pricing Policy

In India, about 70% of containers handled by gateway ports are transported to hinterland dry ports, with the balance of 30% handled locally. It should also be noted that the level of container penetration in India is only about 35%, against a global average of over 70%. Furthermore, it is more profitable for the dry port operator, as well as the user, to transport containers by train rather than by road. It costs less than USD 0.05 per ton-km to transport a container by railway, as against USD 0.15 by road. As such, with rising demand, low costs and good returns on capital, it is not surprising that public sector dry ports with their own railheads enjoy a distinct comparative advantage. In order to maintain its dominance in the market, CONCOR has constructed 57 dry ports with a total combined area of 5 million square meters. According to the *Watanabe* formula discussed below (Watanabe, 2001), the combined dry port capacity of CONCOR is over 10 million TEUs. However, at present, CONCOR utilizes only one fifth of this capacity. This substantial excess capacity allows CONCOR to dominate the market quite effectively, thus driving out competition. CONCOR's market position is further strengthened by rolling stock ownership of over 5,000 rail wagons.

A convenient starting point for all calculations regarding terminal capacity; number of ground slots; etc., is the theoretical approach to planning. An important factor to consider when planning stacking area requirements is the "peak-factor". The following formula developed by Watanabe (2001), is usually adopted for computing the size of a proposed (dry) port.

$$C = (L*H*W*K) / (D*F) \quad (1)$$

Where:

C: annual capacity (TEU/year)

L: number of container ground slots (in TEU)

H: mean stacking height of containers

W: percentage of working slots ($0<W\leq 1$)

K: total number of working days in the period (365 days per year)

D: mean container dwell time in the container yard

F: peaking factor ($1< F < 1.5$)

Establishing the optimum size of a dry port is an iterative decision which has to satisfy a number of technical, commercial, and legal requirements. The optimum size of a dry port is derived from projections of existing and future demand for dry port services. The aspect of optimum size becomes important in view of required investments; competing residential and commercial demands for land; pattern of traffic flows between dry- and gateway ports; type of commodities transported; directional-split (imports/exports); proportions of less-than-container load (LCL) and full-container-load (FCL); forecast of future growth; modes of transport available; and overall minimization of hinterland transport distances.

In addition to economic viability, the attractiveness of a dry port to users also needs to be taken into account. Dry ports with their own railheads are preferred by customers. However, the minimum size of such a rail-connected dry port is 10 hectares, as additional space is required for the stabling and turnaround of the rail rakes. The availability of such a large piece of prime land, at a competitive price, is difficult, to say the least. Furthermore, rail transport pricing depends on the haulage rates charged by Indian Railways. The movement of empty containers, as well as empty (naked) wagons is also charged for by the railways. Dry port operators also have to pay stabling charges, if the rakes are detained outside the dry port for want of space inside the facility. The wagons are required to be inspected periodically. Indian Railways has become more liberal with its inspection frequency, as the modern BLC (Container Flat Wagon) wagons (pioneered by CONCOR) have been found to be more reliable. Whereas in the 1990s each wagon was inspected by Train Examiner before each journey, wagons can now move freely for 6,000 kilometres without intermittent inspection. This improves wagon turnaround, and productivity gains are often shared with the customer.

CONCOR began operations from dry ports which were built on land leased from railways at attractive terms. In its early years, CONCOR had to pay lease charges based on the number of containers handled, with no regard to the area it had leased from the railways. This resulted in CONCOR acquiring terminals as large as possible, which it could then develop in phases in the future. This not only provided CONCOR with adequate room for expansion, but it generated huge surpluses for fuelling its future growth. In several instances, the ground rent received by CONCOR for the stacking of containers was more than the total operating expenditure of the terminal, which also included the land lease charges paid to the government.
While determining its tariffs, CONCOR takes the following factors into consideration:

- Freight payable to railways (as IR also acts as a rail transport sub-contractor)
- Historical average of load factors (due to limited and unequal availability of two way traffic)
- Historical average of terminal detentions (average turnaround time required by rakes)
- Transit times in the sector – competitors' strength (traffic demand by other users such as passengers, grains and defence cargo, having higher priorities)
- Earnings from other operations of the terminal

To recover initial capital costs such as land acquisition, levelling, paving, access roads etc., a *private* dry port operator needs to charge a price equal to his long-run average cost (LRAC). This automatically puts him at a competitive disadvantage *vis à vis* a public operator whose investment costs need not be recovered, being the 'ownership' of the populace by and large. The, consequently, higher price does not compensate the private operator for his loss of custom, particularly as his (public) competitors are unlikely to follow suit in a price increase. The demand for dry port services is thus *kinked* (Haralambides, 2002; Haralambides, 2004), as the one depicted in Figure 2.

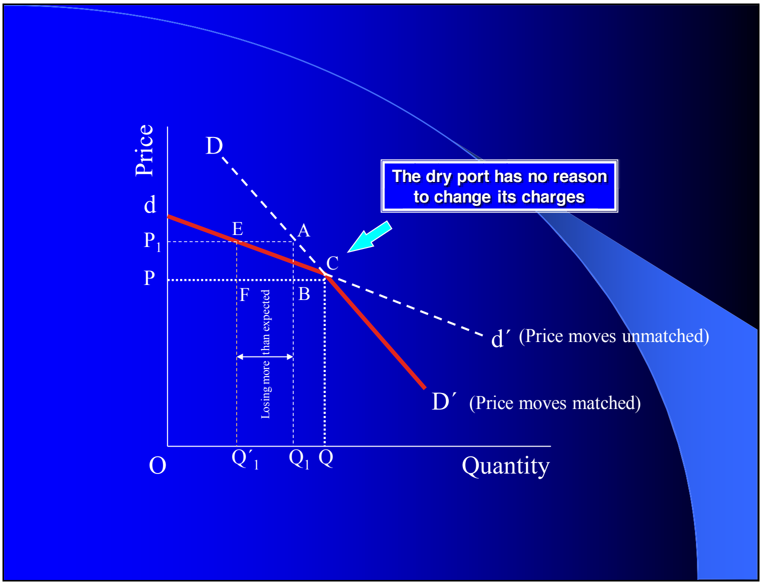


Figure 4.2: Dry port competition: kinked demand

In such circumstances a new entrant has two alternatives (in the absence of subsidies):

1. Provide the service at below costs and incur losses,
2. Lose market share and eventually exit the market altogether.

Either way, this will most probably lead to concentration which is inimical to the interests of the consumer.

It has already been mentioned above that the creation of excess capacity by CONCOR and its adoption of certain *limit pricing* policies act as entry barriers to competition. This is illustrated in the example of Figure 3 (Haralambides, 2004).

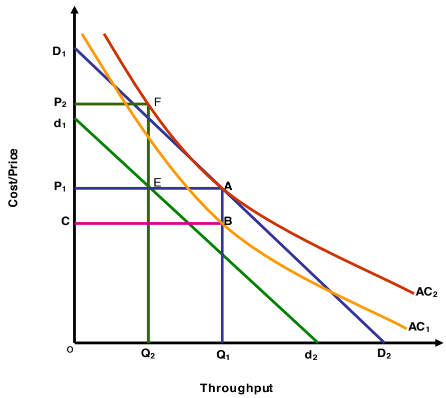


Figure 4.3: Limit pricing strategies of public dry ports

Assume dry port A – with average cost curve AC_1 and demand D_1D_2 – is a government owned (incumbent) facility with a dominant position in the market it serves. The port has been established over several years with the help of public investments, both in the dry port itself, as well as in the related infrastructure (access roads, rail lines and links, etc.). As a result, port A has 'strategically' developed capacities well in excess of existing demand, enabling it to meet a substantial part of the trade. Having been financed predominantly through public money, the port does not have to depreciate past investments nor to fully recover its costs. For a given level of demand, Q_1, port A can thus set prices at P_1, having a unit cost equal to OC. The port enjoys *economic rent* of a magnitude equal to the area $CBAP_1$.

Now consider a privately owned dry port B (new entrant) that needs to recover its costs in full (no government subsidies or preferential terms). Port B's average cost curve is represented by AC_2 and, following entry, it expects the demand for its services to be given by d_1d_2. Upon entry, B's throughput is OQ_2 and at current prices it incurs a loss equal to P_1P_2FE. This is caused by its higher fixed costs as a result of the need for full cost recovery.

4.12 Public Private Partnerships

A PPP involves the private sector in aspects of infrastructure development, or provision of new or existing infrastructure services that have traditionally been provided by the government.

PPPs are usually long-term projects based on a contract or *concession* agreement between the government (or a statutory entity) on one side, and a private sector company on the other, aimed at delivering an infrastructure service at a fee. Typically, a special company, often termed a *special purpose vehicle* (SPV), is accorded the task to build and maintain the infrastructure. It is often the SPV that signs the contract with the government and sub-contractors, to build the facility. The PPP contract also incorporates a risk mitigation framework which apportions risks amongst the parties.

While many governments have actually reformed their infrastructure and utilities without private participation, some seek finance and expertise from private companies, often foreign ones to ease fiscal constraints and increase efficiency. By engaging the private sector and giving it well-defined responsibilities, governments broaden their options in terms of delivering better services.

The range of options for PPPs has expanded enormously over the past 30 years. Agreements between public and private entities take many forms and sizes, for both new and existing services. At one end of the spectrum there is a management or service contract whereby the public sector pays a fee for a service. At the other end there is full privatization or divestiture (outright sale), where the government sells assets to a private company. Outsourcing has recently become another popular option. Here, a private company would handle an aspect of a service, such as billing, metering, transport or even cleaning of facilities.

Hybrid models of PPPs have seen explosive growth in recent years, especially with the development of a more diversified pool of emerging market investors and operators with local expertise. These models often rely on simpler contractual agreements and blend public and private money to diversify risks.

Often, there are certain misconceptions about the meaning of the word *partnership* in PPPs. Rather than the common meaning of the word in terms of 'joint work towards a common objective', *partnership* in a PPP context involves some rather distinct objectives: The challenges for the public sector are to provide modern, efficient, and high quality public services; promote competition; curtail public expenditure; reduce general government budget deficit; increase foreign direct investment (FDI); introduce advanced foreign technology; and, often, reduce public sector employment. In pursuing the above, the government needs to ensure that abusive monopolies are not created as a result of devolution; adequate monitoring and price controls are in place; benefits from the PPP are shared with the general populace; and finally the economic outcome of the partnership furthers the economic and developmental plans and objectives of the country.

The private sector on the other hand needs to ensure that its long term investments receive an adequate return on capital, at least equal to its opportunity cost; mitigate investment risks, at least during the gestation period of the investments; transparency, consistency and stability prevails in contractual arrangements and terms; a stable and trustworthy political and public administration system is in place; and, finally, generally accepted accounting principles (GAAP) are adopted to assess costs, revenues, profits and dividends to investors.

The IR is *prima facie* encouraging public private partnership (PPP) in its capacity enhancing and modernizing efforts. Projects through the PPP model have started in a few sectors and are envisaged in others. The functions of IR can broadly be divided into core activities, such as transportation of passengers and freight, and non-core involvements such as operating catering units, hospitals, and education facilities. However, the *Indian Railways Act* stipulates that no private sector participation is permitted in the operation of trains. Thus, PPP contracts are specified in a document called the *Model Concession Agreement* (MCA). This document plays a pivotal role in the implementation of a project. It also spells out the formula for revenue sharing, among other important details.

In 2006, IR awarded licenses for container operations to 14 private sector companies, thus ending the monopoly of CONCOR. Most of the new licensees are likely to use the concessions for developing their own commercial operations, but third party container operators have also started to emerge. These companies are involved in every step of the container business, from booking of traffic to aggregating and distributing goods to their final destination. In addition, these companies have invested over USD 200 million to overhaul old terminals and purchase rail wagons. Finally, the Ministry of Railways also intends to partner with state governments and private infrastructure providers to establish multimodal logistics parks equipped with rail sidings, storage warehouses and highway connectivity.

4.13 Government Policy on PPP in dry ports

PPP projects still form a miniscule part of IR though the scope is immense. In spite of a dire need of funds and technical and managerial knowhow, the approach of IR has been overcautious. One of the reasons for this state of affairs is the absence of a clear articulation of policy with respect to PPPs. Hence, private participation has been invited only in areas requiring immediate attention, by way of funding, or improvements in service quality, or whenever a government agency has consistently failed to make adequate use of assets. The legal machinery of the government has also not gained adequate experience for the enforcement of contractual discipline by way of legal precedents in this field.

The government also fears the emergence of private monopolies in case suitable regulations and safeguards are not instituted. Having said this, the government does not appear to be overly concerned with state monopolies, whereas, often, there appears to be a degree of prejudice against private sector participation and this would require a change in the mindset of government officials. Arguably, however, historical evidence could not immediately rebuke such prejudices, for private sector participation in public monopolies has not always been successful and in some cases it has also resulted in the feared private monopolies.

It is equally important to develop clear and unambiguous criteria for monitoring and evaluating PPP projects. Ideally, it would be wise to build in a suitable periodical audit system, for the purpose of such evaluations. Such criteria could broadly be divided in two headings viz; assured revenue stream generation; and a clear legal framework for the enforcement of contractual stipulations. The private sector is usually unwilling to invest in such projects, not because the return on capital is inadequate but because of the uncertainty that shrouds the interpretation of contractual terms, combined with an inexperienced legal system that might eventually be called upon to enforce the contract. In other words, private investors do not always trust the willingness or ability of the government to adhere to the contractual terms.

4.14 Conclusions

The role of dry ports in facilitating and developing the international trade of large countries of bottlenecked seaports is unquestionable (Haralambides et al., 1997; Haralambides and Londoño-Kent, 2004). Moreover, by increasingly becoming *basic infrastructure* – albeit with considerable private sector financial interests - dry ports contribute to economic development; easing of public funding requirements; introduction of FDI and related technologies; and the enhancement of competition.

Indian dry ports in particular are characterized by a dominant public presence – often not without good cause - which, in spite of the government's determination to increase private sector involvement, makes the latter rather difficult; substantial excess capacity and related limit pricing policies by incumbent dry ports contribute to this, coupled with a fairly weak legal framework to ensure mitigation of risk and uncertainty for the private investor.

Successful PPPs and greater involvement of the private sector in dry port operations would require pricing policies based on *long-run average cost pricing* aimed at full cost recovery by public and private dry port operators alike. This would eventually eliminate wasteful subsidies and cartelization, and establish a level playing field among the public and the private sectors. To achieve this, land should be made available to interested parties indiscriminately, at prices reflecting its opportunity cost. Moreover, possible government guidelines on pricing policies based on full cost recovery will necessitate the compilation and equitable dissemination of relevant statistics, as well as greater transparency and the adoption of a standardized accounting system (Haralambides *et al.*, 2001).

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On Balancing Supply Chain Efficiency and Environmental Impacts: an *eco*-DEA Model Applied to the Dry Port Sector of India*

5.1 Abstract

Indian dry ports (inland cargo-consolidation and distribution centers) are expected to play a pivotal role in connecting the north Indian heartland with the gat[21]eway seaports of Mundra, JNPT and Chennai. However, in this process, dry ports contribute considerably to the vexing problem of atmospheric pollution due to the ensuing road and rail transportation.

There is a considerable body of research on the socially undesirable side effects of production, for instance in sectors such as manufacturing and transport. In spite of this, the standard methods so far employed in the analysis of port efficiency and productivity, notably Data Envelopment Analysis (DEA), have failed to address and internalize the economic ramifications of transport externalities.

In this paper, a comparative study of the typical DEA models is undertaken, in an effort to illustrate the problem at hand. A new *eco*-DEA model is proposed that simultaneously evaluates both the undesirable and the desirable outputs of port service production. The model is applied to evaluate dry port efficiency, while taking into account the CO_2 emissions caused by the transport of containers from dry ports, located in the North Capital Region (NCR) of India, to the various gateway (coastal) ports. The results reveal that efficiency evaluations are significantly altered once environmental aspects are factored in to the model. The methodology proposed here can be easily transferred to any other industrial sector where environmental concerns are becoming an issue.

Keywords: Dry Ports, Data Envelopment Analysis, Transport Externalities, India.

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5.2 Introduction

As a result of significant policy changes by the government of India, whereby the private sector is now allowed to invest in the dry port and rail transport industry, the dry port sector is currently suffering from the consequences of massive overcapacity, resulting in unsustainable pressure on prices and profitability. Several private sector companies have for some time now been active in this industry, with many more expected to follow suit in the near future (Reinhard *et al*., 2000). In this environment, the only possible way to carry on is by cutting costs and increasing operational efficiency. It is therefore not only important but also critical to improve understanding of the concept of efficiency in the context of this specific sector. Definitions of efficiency measures, however, vary widely across industries due to the broad array of factors involved. The concept of efficiency should therefore be studied cautiously by considering the particular features and operational purposes of production units. Efficiency assessments of dry ports need to take into consideration both the intangible factors involved in the production process, such as brand equity and customer satisfaction, as well as, of course, the tangible aspects such as container transportation and handling equipment; manpower deployed; and container throughput. In this vein, Data Envelopment Analysis (DEA) is utilized here, to analyze productivity and performance of the dry ports located in the North Capital Region (NCR) of India during the period 2006-2009. In addition to the commonly considered outputs, such as container throughput, this paper, for the fist time in the port economics literature, also takes into consideration the ‘negative’ output of carbon emissions caused by port and transport activities.

A substantial body of research has been reported in the past decade on port productivity and efficiency assessments and benchmarking (for a good review, see Haralambides *et al*., 2010). Amongst them, Tongzon (2001); Hidekazu (2002) and Cullinane and Wang (2006) have applied DEA models to assess the efficiency of container terminals. Roy and Yvrande-Billon (2007) have investigated the impact of ownership structures on technical efficiency in the urban public transport sector. The results corroborate the frequently propounded assumption that *technical efficiency* depends on the ownership regime of the inputs deployed in the production process. In the case of ports in particular, such inputs concern the provision of infrastructure; cargo-handling equipment; nautical services; and port labor in general. Growitsch and Wetzel (2009) have conducted a pan-European efficiency analysis to investigate the performance of European railways. They conclude that undesirable outputs, such as environmental impacts, do affect adversely operational efficiency.

Terminal productivity studies, especially those concerned with the measurement of *technical efficiency* in container handling operations, mainly adopt *container throughput* as the single output variable. In this way, higher levels of container throughput will indicate greater levels of efficiency, with the same amount of inputs. Nowadays, however, this approach may be questioned, in view of the adverse environmental impacts of port operations and related transport systems. The efficiency scores computed in the current paper explore what might be called the *socially efficient* operational performance of dry ports, by considering both outputs; i.e., container throughput along with its conjoined and incidental twin, i.e. carbon-dioxide (CO_2) emitted by the decision making unit (DMU), either directly (due to its own operations) or indirectly (as a result of the operations of inputs used –in this case rail transport to/from dry ports). Furthermore, the paper takes into consideration the fundamental characteristics of the dry port industry, looking at it essentially as an integrated transport industry using multiple modes of transport to carry containers between gateway ports and the country's hinterland. The CO_2 emissions of dry ports are quantified, based on established global norms such as emissions per ton-mile of rail transport (Agarwal, V.K. & Gupta, A.K., 2009).

The NCR dry ports play a key role in the supply chain of the country's international trade by acting as nodal points of cargo consolidation and distribution, and by providing connectivity to gateway seaports. However, before addressing the efficiency of dry ports, it is essential to first define the pertinent inputs and outputs of the dry port service. It is also necessary to understand and explore, in the proper perspective, the fluctuations in efficiency estimates of dry ports, vis à vis variations in output and in the constituent input factors. Adding to existing literature, this paper endeavors to ascertain the relevance of conventional efficiency estimates, when one incorporates negative environmental externalities. The methodology proposed here can be easily transferred to any other industrial sector where environmental concerns are becoming an issue.

Recent studies on *environmental impact assessment* and the ensuing policy changes are urging logistics service providers and port operators to re-evaluate and re-calliberate their roles and responsibilities in protecting the natural environment. Various management systems have at the same time been developed to evaluate the environmental impact of container transportation processes. In spite of this, CO_2 emissions during the transportation process have not been considered to be of particular importance until very recently. However under the present circumstances this state of affairs is unlikely to continue for long. One way to gain insights to the environmental impacts of a production process is to analyse its *eco-efficiency*. In this paper, we attempt to define eco-efficiency as a measure which also takes into consideration the *undesirable* outputs of the decision making unit (DMU), in this case CO_2 emissions.

Data Envelopment Analysis (DEA) is a well established methodology of assessing the efficiency of organizations with the same set of inputs and outputs. In recent years, conventional DEA methods have been extended to also measure *eco-efficiency* by including undesirable outputs. Such models are often called eco-DEA or environmental DEA models. As pointed out by Dyckhoff and Allen (2001), it is no longer appropriate to solely embrace the assumptions of the traditional DEA model: i.e. maximizing the quantity of outputs while minimizing the amount of inputs to achieve higher efficiency. Thus, new approaches have been proposed, incorporating undesirable outputs in the DEA framework.

For the purpose of this study we collect data by conducting personal interviews with 16 dry port managers located in the North Central Region of India. Nine of the 16 dry ports are managed by private operators, while the remaining seven dry ports are under public administration. The container handling equipment deployed at each dry port; the number of employees; and the terminal area are considered as inputs here, while the annual throughput and the total CO_2 emissions are considered as outputs. All seven public dry ports enjoy a comparative advantage over their private counterparts, in that they possess their own rail heads located on their own premises; only three of the privately operated dry ports have this facility. The rest have to transport their containers by truck to the nearest rail head, resulting in additional generalized costs. Thus, the size of the dry port becomes an important input, as a dedicated rail head necessisates a larger area.

Section 2 below provides the research background of this paper, through a review of the major relevant literature. It is followed by Section 3, which is a conceptual buildup and explanation of *desirable* and *undesirable* outputs, and the validation of the model for the quantification of the dry port production output. Section 4 is an exposition of the DEA methodology employed in this paper. Section 5 specifies input and output indexes utilized in the model, developed specifically for the achievement of the paper's stated objective. This section also explains the nature and sources of the data collected for this study. The results of the data analysis are presented in Section 6. The results of the analytical exercise, along with conclusions and implications, are presented in Section 7.

5.3 Research Background

With the development of global multimodal supply chains, dry ports have assumed increasing importance in facilitating market development, seamless integration and closer collaboration between the different stakeholders of the supply chain and of transport networks. It was thus a logical step, by many gateway ports, to integrate upstream and extend their services to locations situated further hinterland. This was done by either forming strategic alliances or buying out existing dry ports so as to increase the reliability of their supply chains. The establishment of the NCR dry ports allowed shippers to undertake consolidation and distribution activities at inland locations closer to their production facilities, resulting in the reduction of transportation costs and accompanying risks, as well as in their products becoming competitive in global markets.

Towards the end of 2008, over 200 dry ports, both private and public, had been established throughout India, with over 30 in the NCR region alone. Apart from the conventional functions described earlier, dry ports in India are also perceived as catalysts in promoting regional economic development (van den Bossche and Gujar, 2010). As a consequence, the government has been promoting the establishment of dry ports, especially by the private sector. Another reason for the rapid growth of this sector has been the creation of Special Economic Zones (SEZs) throughout the country and the simplification of customs procedures, notably digital documentation. Further developments in road, rail and port infrastructure, by way of capacity augmentation and automation, is expected to assist in the realization of the true potential of containerization in India, expected to treble in the next decade. The hinterland of gateway ports for container traffic is estimated to increase to 70% from its current 35% level (Dayal, R., 2007).

The contemporary global economy is characterized by increasing consumption of goods and services that can be produced at distant locations. This has also facilitated the opening up of global consumer markets to India. As such, being the inland logistics nodes of supply chains, the efficiency of dry ports becomes pivotal in complementing the changing role of ocean carriers and other stakeholders along the supply chain (Heaver, 2002; Sánchez *et al.*, 2003; Notteboom & Rodrigue, 2005).

Next to, and as a result of, the intense competition that characterizes the Indian dry port industry today, the interests of the Indian policy makers have also been drawn to questions regarding the efficiency with which resources are utilized and their impact on the environment. Thus, the analysis of the performance of individual dry ports assumes greater significance for the success of the supply chain as a whole (Haralambides, 2006). It is obvious however that a dichotomous dilemma exists between increasing dry port throughput on the one hand, and containing carbon emissions on the other. In other words, the greater the number of TEUs handled and transported over longer distances within shorter time periods, the greater the environmental impact and the higher the transaction costs.

The paper also illustrates a common finding, encountered in many existing approaches to dealing with undesirable outputs in DEA (Tongzon J 2001): When an undesirable output, such as polution, is simply incorporated into a DEA model, the eco-DEA model gives higher, instead of lower, efficiency scores. This is a problem that needs to be corrected, and the undesirable output properly isolated, so that its impact can be quantified in the overall effciency score. The existing literature fails to address undesirable outputs in this light.

We summarize below the five alternatives available to the dry port operator, prior to conducting DEA efficiency analysis.

1. Ignoring undesirable outputs:

This refers to the traditional DEA model which neglects undesirable outputs. (Lu and Lo, 2007a and 2007b; Nakashima et al., 2006). However, nowadays it is not only inappropriate to ignore the presence of CO_2 emissions during transportation, but this could result in erroneous decisions, since undesirable and desirable outputs are produced at the same time. As the undesirable output is of a different, i.e. 'negative', nature, it should be clearly distinguished in modelling the problem.

2. Treating undesirable effects as inputs (costs):

Dyckhoff and Allen (2001) consider DEA as a multicriteria approach, modelling the undesirable output as input. The model is applied to measure the environmental efficiency of the Dutch dairy farms (Reinhard et al., 2000) and compare it against the permissible quota of CO_2 emissions stipulated in the Kyoto Protocol (Paul, J. 2005). However, as regards Indian dry ports, treating undesirable outputs as inputs fails to reflect true production. Also, the present regulations do not impose a *penalty* to encourage the minimisation of carbon emissions by way of a carbon tax or usage of better fuels. In general, there is a lack of political will to implement suitable policies to reduce carbon emissions. Hence, it is difficult to consider carbon emissions as an input which the dry port operator would naturally try to minimize in an effort to improve operational efficiency. On the contrary, when a dry port tries to improve efficiency by increasing throughput, it is also increasing the quantity of emitted CO_2.

3. Non-linear monotonic decreasing transformation approach:

This data transformation approach is suggested by Golany and Roll (1989). It converts an "undesirable" output into a "normal" or "desirable" output by a monotonically decreasing function f of the form: $f(u_i^k) = 1/u_i^k$, where u_i^k is the i^{th} element of the vector u of undesirable outputs of decision-making unit (DMU) k. In such a manner, performance would be inversely related to the undesirable output. Lovell et al. (1995) compare the macroeconomic performance of 19 OECD countries using the same approach: The reciprocals of undesirable outputs (carbon and nitrogen emissions) are treated as normal outputs.

4. Linear monotonic decreasing transformation:

This approach has been suggested by Seiford and Zhu (2002). Here, the data transformation is given by $f(u_i^k) = -u_i^k + \beta_i$, where β_i is a sufficiently large positive scalar. Lu and Lo (2007b) utilized this model to examine the overall performance of different regions in China, based on economic and environmental factors. In their analysis, the desirable output under consideration was GDP and the undesirable outputs were emissions such as soot, dust and sulphur dioxide. This model has been criticized for its invariance to data transformation within the DEA model (Lu and Lo, 2007a and 2007b).

5. Treating undesirable factors in non-linear DEA models:

This approach is based on the non-linear DEA model suggested by Färe et al. (2004). The model builds on the *weak disposability* of undesirable outputs theory of Zhou et al., (2007a). Weak disposibility assumes that it might be too costly to reduce undesirable outputs because, at the same time, this increases inputs (costs) or decreases desirable outputs (Yang et al., 2008). Therefore, this approach models the undesirable output as a “normal” output and then adjusts by optimizing the distance measurement of the undesirable output (Liu, Z. 1995). The model tends to increase the desirable and undesirable outputs at the same time. The weak disposable reference technology is also referred to as the *environmental DEA technology* (Färe et al., 2004; Zhou et al., 2007a; Zhou et al., 2008). This model has been applied by Färe et al. (Färe et al., 1996) to compare the environmental performance of US fossil-fuel-fired electric utilities, incorporating an aggregate undesirable output of global annual emissions of SO_2, NO_2 and CO_2. Yörük and Zaim (2008) employed the above framework to construct a performance index to evaluate the environmental performance of 28 OECD countries.

5.4 Research Design

In recent years, the issue of climate change has grabbed the attention of policy makers at an astonishing rate. Widespread acceptance of the basic science of climate change and recognition of the potential threat that it poses to our ecosystems and way of life has made the pursuit of CO_2 reductions a major priority for all concerned.

This paper takes into consideration the results of a macro-level analysis of CO_2 emissions, undertaken by the Indian Government, with regard to domestic freight transport. In the absence of a robust methodology and reliable data for computing the quantity of CO_2 emitted per ton-kilometer of cargo transported and handled by dry ports, crude estimates had to be considered, often involving extrapolation from research done in foreign countries, especially western

European. However, necessary diligence has been exercised while making computations. The following factors have been taken into consideration:

1. Fuel consumption is assumed to be proportional to load factors. A 90% load factor has been considered for rail wagon utilization and 70% in terms of weight utilization (UNESCAP, 2008). We have also taken into account the demand imbalance that exists to and from the dry ports. This results in a 10% empty wagon movement. The imbalance problem has been further aggravated in the recent past due to the additional wagons introduced by private operators and the almost simultaneous fall in traffic (UNCTAD: *Review of Maritime Transport*, 2009).
2. We have assumed each loaded TEU to have an average weight of 12 metric tons (70% of maximum gross weight). According to our data, 10% of the containers transported to and from the NCR dry ports are empty. The average gross weight of a container is 18 metric tons (the maximum permissible weight is 24 metric tons).
3. Considering the fact that containers from NCR dry ports are destined for JNPT (80%), Mundra (15%) and Chennai (5%), we have assumed an average distance to gateway port of 1000 kms, which corresponds to 12,000 ton-kms per TEU.
4. Analyses of the carbon intensity of freight transport invariably express CO_2 emissions in terms of ton-kms, i.e. average weight of container transported multiplied by the average distance travelled.

Calculations of CO_2 emissions are derived from estimates of the actual amount of cargo transported and the energy consumed per unit of output. The "output" of freight transport operations is generally measured by ton-kms and energy consumption by liters of fuel or kilowatt-hours of electricity used per ton-km. The latter is based on extensive surveys conducted on freight transport operators. Such a "bottom-up" system of measurement is generally acknowledged to provide accurate estimates of CO_2 emissions. Based on generally accepted international estimates (Seiford and Zhu, 2002) we have assumed an average carbon emission estimate of 40 gms /ton-km for container rail transportation (Lan and Lin, 2006).

Containers moved on the rail network of India are hauled by diesel locomotives. Previous studies have indicated that CO_2 emissions per ton-km are significantly lower for electric traction

(Anand, S., Vrat, P., Dahiya, R.P., 2005). However, due to capacity and cost constraints in the electrified tracks, electric traction is exclusively used for passenger traffic.

Fuel consumption data was obtained from CONCOR, a large rail freight operator. Ton-kms were multiplied by estimates of fuel consumption per ton-km, and a CO_2 conversion ratio for gas oil (Table 1). The calculation took also into account differences in fuel consumption between loaded and empty container haul operations (UNESCAP, 2008).

5.5 Comparison of DEA models

DEA is a non parametric linear programming technique for assessing the efficiency of a facility, or a profit centre, usually called a *decision making unit* (DMU) (in this case a dry port). From a given set of DMUs, the DEA technique constructs an empirical production frontier representing the most efficient production technology, given factor endowments. The relative performance of an individual DMU is evaluated (benchmarked) by comparing it to the most efficient unit, located on the frontier. The performance measurement is expressed in the form of an efficiency score. This comparison reveals the changes in inputs and outputs, necessary for the individual DMU in order to reach the production frontier (Banker, Charnes, Cooper, 1984)

On comparing with other techniques of efficiency evaluation, the DEA methodology has significant advantages as it can handle multiple inputs and outputs without the need to postulate a certain production function specification. The model selected for the current paper is essentially a multiple output-oriented one, attempting to simultaneously maximize throughput and minimize carbon emissions, while retaining the same tangible inputs, i.e. number of container handling equipment, manpower deployed, and surface area.

Table 5.1: Data of 16 DMUs

Dry Port	Equipment	Employees	Area ('000 m^2)	Throughput '000 TEU (T)	Weight (M) = (Tx12) '000 MT	Distance (C) = (M) x1000 Million MT-km	Emissions- (E)= (C) x.00004 '000 MT
1	4	22	50	21.34	277.4	277485	11.09
2	4	26	50	26.75	347.8	347802	13.91
3	4	30	50	28.73	373.5	373503	14.94
4	4	24	50	24.89	323.5	323583	12.94
5	4	25	50	31.25	406.3	406302	16.25
6	4	28	50	31.98	415.8	415818	16.63
7	1	19	50	31.27	406.5	406588	16.26
8	1	28	50	48.96	636.5	636545	25.46
9	8	32	50	156.71	2037.2	2037000	81.48
10	7	36	150	145.76	1894.9	1895000	75.79
11	4	14	160	168.54	2191.0	2191000	87.64
12	5	27	68	82.34	1070.4	1070000	42.81
13	2	17	80	74.39	967.1	967174	38.68
14	1	12	24	16.76	217.9	217932	8.71
15	2	14	53	13.23	172.0	172029	6.88
16	32	84	36	432.98	5628.8	5629000	225.15

Assuming there are n DMU_j (j=1,…,n) and they use k inputs x_{ij} $(i=1,...,k)$ to produce s outputs y_{rj} $(r=1,...,s)$, the DEA-CCR model computes the relative efficiency score of DMU_j by maximizing:

$$\text{Max } \sum_{r=1}^{s} u_r y_{rm} = \theta_m$$

Subject to:

$$\sum_{i=1}^{k} v_i x_{im} = 1$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{k} v_i x_{ij} \leq 0 \quad j = 1,..., n,$$

$$u_r \geq 0 \qquad r = 1,..., s,$$

$v_i \geq 0 \qquad i = 1,...,k,$

Where v_i and u_r are the unknown input and output weights, and x_{im} and y_{rm} are the observed input and output values of DMU_m (the DMU to be evaluated). The target is to obtain those weights u_r and v_i that maximize the efficiency score of DMU_j. The values of θ_m are the scores of DMU_m, relative to all DMU, and range between 0 and 1. A DMU is technically efficient if $\theta_m = 1$, otherwise it is technically inefficient.

Consider now the dual problem to this, and let φ and λ_j (*j=1,..., n*) be the dual variables. The above model can be reformulated as:

Min φ

Subject to:

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \varphi \; x_{im} \quad i=1,...,k$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{rm} \quad r=1,..., s$$

$$\lambda_j \geq 0 \qquad j=1,..., n$$

The addition of the convexity constraint $\sum_{j=1}^{n} \lambda_j = 1$ to the above formulation constitutes what is known as the DEA-BCC model (constant returns to scale).

The output-oriented measure of technical efficiency of DMU_m is given by: $TE = \dfrac{1}{\varphi}$

The efficiency score of DMU_m is given by: $SE = \dfrac{TE_{\_CCR}}{TE_{\_BCC}}$

By using data collected from the NCR depots (www.concorindia.com), we review the eco-DEA models discussed in the previous section.

Table 1 gives the data of the 16 DMUs, with three inputs and two outputs, one of which is undesirable (emissions). DEAP 2.1 is used to run the models. The study assumes variable returns to scale.

Table 5.2: Results of DMU efficiency scores for methods 1 to 4

DMU	Method 1	Method 2	Method 3	Method 4
1	0.224	1.000	0.481	0.554
2	0.281	1.000	0.411	0.522
3	0.302	1.000	0.399	0.530
4	0.262	1.000	0.438	0.539
5	0.329	1.000	0.424	0.556
6	0.336	1.000	0.414	0.542
7	0.673	1.000	0.903	1.000
8	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000
10	0.638	0.864	0.638	0.638
11	1.000	1.000	1.000	1.000
12	0.672	1.000	0.684	0.732
13	0.882	1.000	0.896	0.986
14	0.529	1.000	1.000	1.000
15	0.198	1.000	1.000	0.864
16	0.229	0.307	0.229	0.229
Mean	0.539	0.957		0.735
No. of efficient DMU	3	14	5	5

Finding 1: The existing approaches tend to increase efficiency scores

According to Table 2, when method 1 is compared with other approaches, the efficiency scores are fairly similar. In general, the number of efficient DMUs and the mean efficiency score under methods 2, 3 and 4 are similar. However there is a small increase in the efficiency ratios.

Finding 2: The undesirable output can either have a positive or negative effect on the efficiency score

From Table 2, it can be seen that after incorporating the undesirable output, the results are altered. However, this change fails to explain the presence of undesirable output. In fact, the efficiency score should change in a manner which unambiguously reflects the presence of the undesirable output. For example, the desirable output of dry port A is greater than dry port B. However, when accommodating the carbon emissions generated by both dry ports, dry port B generates less CO_2 than dry port A. Taking into consideration both these aspects for comparison, dry port B behaves better in the environmental aspect because it produces less CO_2 per unit of desirable output. Therefore, dry port B can be regarded as more environmentally efficient compared with dry port A. (Nakashima et al; 2004).

5.6 The *Eco*-DEA Model

As explained in the previous section, existing methods fail to accommodate the adverse effects of the eco-variables viz; CO_2 emissions, in the DEA model. In this section we propose a new approach to deal with undesirable outputs.

This method takes into account the impact rate of the undesirable output on the efficiency score. Accordingly, the intensity of the impact, or the influence of the undesirable output, is considered as a negative output that leads to a decrease in efficiency scores. The whole idea can be expressed as follows:

$$\mathbf{C= (B\text{-}A)}$$
$$\mathbf{A^{*}= A\ (1\text{-}C)}$$

A represents the efficiency score obtained by the conventional DEA model without considering the undesirable output. *B* refers to the efficiency score obtained by the conventional DEA model with the incorporation of undesirable output. The undesirable output is treated in the same way as the desirable output. *C* denotes the environmental impact brought by the undesirable output where $0 \leq C \leq 1$. The value of (1-C) implies the proportion of reduction in *A* when undesirable output is included. Following this logic, A^* represents the efficiency score which accounts for the impact of the undesirable output brought to the original efficiency score *A*.

As seen in Table 3, the values of *C* are equivalent to the impact brought about by the undesirable output. For example, under the impact rate method, (Tongzon, 2001) the efficiency scores of the DMUs drop significantly. The present approach of solving DEA models with undesirable outputs is more advanced than the previous methods seen in the literature. The effect of the undesirable output is considered as negative and the efficiency score takes this factor into account. Thus, the impact rate method 'transforms' the undesirable output from a new perspective.

Table 5.3: Results of efficiency scores under the impact rate method

DMUs	A	B	C	A*
1	0.224	0.224	0.000	0.224
2	0.281	0.281	0.000	0.281
3	0.302	0.302	0.000	0.302
4	0.262	0.262	0.000	0.262
5	0.329	0.329	0.000	0.329
6	0.336	0.336	0.000	0.336
7	0.673	0.673	0.000	0.673
8	1.000	1.000	0.000	1.000
9	1.000	1.000	0.000	1.000
10	0.638	0.864	0.226	0.493
11	1.000	1.000	0.000	1.000
12	0.672	0.672	0.000	0.672
13	0.882	0.882	0.000	0.882
14	0.529	0.529	0.000	0.529
15	0.198	0.198	0.000	0.198
16	0.229	0.747	0.518	0.110
No. of efficient DMU	3	3	0	3

The undesirable output could also be converted into a ratio form, by comparing it with the desirable output. In this manner the undesirable aspects of the outputs can be eliminated altogether.

5.7 Empirical Analysis and Discussions

Table 5.4: Comparative Efficiency scores of 16 DMUs derived by different methods

DMU	Method 1	Method 2	Method 3	Method 4	Method 5
1	0.224	1.000	0.481	0.554	0.224
2	0.281	1.000	0.411	0.522	0.281
3	0.302	1.000	0.399	0.530	0.302
4	0.262	1.000	0.438	0.539	0.262
5	0.329	1.000	0.424	0.556	0.329
6	0.336	1.000	0.414	0.542	0.336
7	0.673	1.000	0.903	1.000	0.673
8	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000
10	0.638	0.864	0.638	0.638	0.668
11	1.000	1.000	1.000	1.000	1.000
12	0.672	1.000	0.684	0.732	0.672
13	0.882	1.000	0.896	0.986	0.882
14	0.529	1.000	1.000	1.000	0.529
15	0.198	1.000	1.000	0.864	0.198
16	0.229	0.307	0.229	0.229	0.110
Mean	0.539	0.957	0.686	0.735	0.531
No. of efficient DMU	3	14	5	5	3

As can be seen from table 4, the efficiency of all except three dry ports varies under different methods. Dry port 16 is the largest in the region with the highest throughput. It has also the highest labour force and equipment deployed. Furthermore, the number of efficient dry ports is the highest according to the second method. This is an anomaly due to the fact that carbon emissions are not taxed and as such do not constitute a cost for the operator.

Every dry port has its own strengths and weaknesses, on the basis of which they develop their own strategic business plans. In the current environmental situation, however, the pursuance of strategic objectives –i.e. cost minimisation and/or product differentiation- cannot be unconstrained: they ought to be pursued with an eye to minimizing environmental impact. This is particularly the case of privately owned and managed dry ports which are completely focused on maximizing profits while simultaneously minimizing transaction costs (UNESCAP, 2006). It is however the public sector that should set the example. Public sector operated dry ports have an altogether different focus which is rather broad. The focus in this case is more aligned with the government's macroeconomic policies where financial results have a comparatively lower priority, compared to the provision of services to trade as a whole. Furthermore, environmental issues are accorded a lower priority vis à vis the growth of international trade. At present, public sector dry ports completely ignore CO_2 emission impacts.

5.8 Conclusions

Different methods to incorporate the undesirable aspects of port service production into DEA models are discussed and compared in this paper. However, these methodologies tend to give the port a better efficiency score after taking undesirable factors into consideration and this does not allow operators and policy makers to single out environmental effects and act upon them.

To address this issue, the model presented here, in addition to simultaneously dealing with both desirable and undesirable outputs, adjusts port efficiency scores and the number of efficient DMUs. In this way, a better balance can be achieved between production and its negative externalities.

Finally, although the model is applied to the dry port sector of India, its generality allows its straightforward application to any other industrial or service sector of the economy where environmental impacts and other externalities are issues of concern.

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A Critical Analysis of Factors influencing Performance of Dry Ports in India [*]

6.1 Abstract

Intermodal logistics includes a stream of activities involving more than one mode of transport operated by multiple actors. It results in efficient movement of goods from the point of production to the point of consumption. During this process the dry ports play an important role as logistical nodes in transport networks and have absorbed lots of investments from both public and private sectors for the past several decades. Dry ports are thought of as critical nodes in global supply chains. However, from 2008 massive investments in dry ports have apparently induced fierce competition among dry ports. Current stakeholders and potential investors are now pondering how the performance of a dry port, which is usually measured by its throughput, can be improved and what are key factors to successes. Using the data collected from a sample of customers patronizing dry ports located in the Jawaharlal Nehru Port (JNPT) region of India, this paper constructs a measurement model to evaluate the performance of the dry ports and the factors affecting it. Our findings suggest that key elements affecting the performance of dry ports measured in number of TEUs handled annually are tariff, number of employees and container handling equipment while the other factors such as size of the dry port, service quality etc do not have a significant impact on the performance.

Keywords: dry port, organizational performance, India.

6.2 Introduction

Containerization and global trade are conjoined twins indicating that one cannot live without the other. The ease with which containerization facilitates door to door delivery of cargo has facilitated the growth of global trade. The actual process of container transport is affected by simultaneous use of multimodal carriers combining sea/river going ships/barges and land based services such as trucks and trains (Bichou, 2004; Schoenherr, 2009). In view of consistently rising expectations of shippers/consignees for faster, efficient and low cost services, the logistics

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services providers had no alternative but innovate new concepts to improve their services while simultaneously endeavoring to lower costs. One of the objectives of this behavior of the service providers is to increase reliability of commitment towards the shipper/consignees. With the development of global multimodal supply chains, dry ports have been assumed increasing importance to suit the need for market development, seamless integration and closer collaboration between the different participants of the supply chain and transport network. Thus, it is a natural corollary for the ports to extend the services to locations situated further hinterland by either patronizing, forming strategic alliances or buying out existing dry ports so as to optimize the supply chain.

A dry port is an inland location where consolidation and distribution of cargoes takes place with functions similar to those of seaports (including cargo-handling facilities, providing intermodal transport connectivity, information exchange, as well as other ancillary services like customs inspections, storage, maintenance and repair of empty containers and tax payments). The latest definition of a dry port according to UNCTAD (Beresford and Dubey, 1990) is: "A common user facility with public authority status, equipped with fixed installations and offering services for handling and temporary storage of any kind of goods (including containers) carried under customs transit by any applicable mode of transport, placed under customs control and with customs and other agencies competent to clear goods for home use, warehousing, temporary admissions, re-export, temporary storage for onward transit and outright export." This definition demonstrates a shift of emphasis from merely highlighting the role of shipping lines to the dry port itself as a specific facility to which goods could be consigned for inspection of customs and determining and collection of revenue accompanied by special documentation like a through bill of lading.

The essential aspect of the dry port is provision of scheduled transportation services to and from the gateway seaport. In addition, closeness of a dry port to the seaport also results in increase of the terminal capacity and productivity of the seaport. On the other hand, dry ports situated further away have to necessarily depend upon the modes of transportation to derive similar advantages (Beresford and Dubey, 1990). Essentially, four functions take place at a dry port: transfer of cargo, mostly unitized, between two modes; the assembly of freight in preparation for its transfer; the storage of freight awaiting pickup; and delivery and the logistical control of flows (Slack, 1999). We define a dry port as an inland intermodal terminal directly connected to seaports, with high capacity transport means, preferably rail, where customers can leave/pickup their units as if directly to/from a seaport.

Since the advent of containerization in Western Europe and USA intermodal dry ports became an integral part of the freight transport systems. There were several reasons for this evolution of dry ports. The insatiable focus on trade growth led to exhaustion of port capacities resulting in congestion, diminishing returns and drastic fall in efficiencies. This forced the stakeholders to shift the gateway ports outside the city limits in the initial phase and making available the port facilities such as custom clearance to in inland dry port locations in the subsequent phase. Thus the evolution of dry ports could be seen as cycle in the ongoing development of containerization and intermodal transport (Notteboom and Rodrigues, 2009).

India was a relatively late starter in respect of containerization. It was only in the late eighties due to the persisting demand of international commerce; the government was perforce compelled to adopt some aspects of containerization. The pace of containerization in India really picked up in the late nineties as the economy grew and the export-import trade witnessed a sustained growth. In order to facilitate door to door intermodal transportation of containers the need for setting up dry ports was severely felt. Initially the government improvised some rudimentary dry port infrastructure at railway goods sheds before proper intermodal facilities could be constructed. The government set up an autonomous corporation under the auspices of ministry of railways, not only to transport the containers to and from the gateway ports but also to establish and operate dry ports at various locations in the hinterland. Moreover, to stimulate local economy, many inland regional governments in India are advocating investments in dry ports. Towards the end of 2009, about 250 dry ports have been established throughout India. From the year 2000 Indian dry ports, in their endeavor to avail the benefits of economies of scale and to cater to the future demand, invested massively in dry port infrastructure. Until the summer of 2008 they appeared to have been on the right track. But since the financial meltdown and the drastic fall in global trade the dry ports are stuck with excess capacity. This has led to a significant drop in financial performance, traditionally measured in terms of throughput. In such an event every dry port operator is attempting to rig up performance either by further expansion by buying out competing dry port facilities and eliminating competition or by indulging in cost cutting exercise drastically. It is this intense competition that characterizes the Indian dry port industry today which has stimulated interest in the performance with which resources are utilized.

At this juncture it becomes imperative to ponder upon the indicators of performance as well as the factors which influence such indicators. Dry port operation is a commercial activity as such there can be no better indicator than the measure of real profit. But reliable and accurate figures indicating profit derived from dry port operations itself are usually business secret and publicly unavailable. As such the only other indicator of performance is annual throughput. The data regarding throughput is clearly accessible as it is public information and hence it is considered as a performance indicator. Factors that can affect the performance of dry ports can be classified into two categories: tangible and intangible parameters. The tangible parameters of a dry port are size, container handling equipment, number of employees, rail connectivity to port, tariff etc. whereas the intangible parameters are organizational effectiveness, service quality and synergetic/strategic relationships with other stake holders. The tangible parameters can be quantified easily on the other hand a methodology needs to be developed and tested to use the intangible parameters. It should also be noted that the influence of the different parameters on the performance indicator will vary from side to side. As such benchmarking dry port performance and comparing one with another may lead to erroneous inferences. However benchmarking would be acceptable to compare performance of similar dry ports.

Although dry ports are important to the whole supply chain, related research is scarce. The purpose of this paper is to develop a measurement model to evaluate the performance of the dry ports and affecting factors for dry ports located in the Jawaharlal Nehru Port (JNPT) region of India. India has 12 major ports, yet over 80% of its international containerized trade moves only through the three major ports of JNPT, Chennai and Mundra. The JNPT port located on the west coast of India as shown in Figure 1[22] is by far the most frequented port by main line deep sea services commanding approximately 40 calls per week across the three main trade routes.

[22] The map is from Indian Ports Association.

Currently the port handles about 3 million TEUs annually which constitute about 60% of the country's container traffic. The port is linked by road and rail with a wide network of dry ports located all over the country. In this research, we investigated 33 dry ports in the JNPT region of India. All of them serve the JNPT port. The 33 dry ports in the JNPT region of India differ by way of size, ownership, number of employees, number of equipment, rail connectivity, tariffs etc. The only thing common amongst them is the fact that they all serve the JNPT port. Some of the dry ports were built over 15 years back while some are less than 5 years old. The analysis of performance of individual dry ports assumes competitiveness of the dry ports service providers and significance for survival of the supply chain as a whole. Thus such an analysis will provide a powerful management tool for the dry port stake holders. In addition it will also constitute an important input for informing regional and national logistic planning and operations. To our knowledge, this work is the first research to address the performance of dry ports and affecting factors.

Figure 6.1: JNPT in India

6.3 Theory and Hypotheses Development

The main objective of this paper is to specify a performance measurement model and explore the relationships amongst themselves and jointly with the performance indicator. We have collected data for three consecutive years for 33 dry ports located in the JNPT region. Considering the fact that available literature on dry ports is scarce we had to construct models for the performance and affecting factors of dry ports, by reviewing related research on seaports, which can provide useful insight to our model due to the similarity of dry ports and seaports on some aspects.

6.4 Performance measurement

Performance is one of the most widespread dependent variable used by academics to assess the impact of an organization. At the same time it remains one of the most ambiguous variables (Rogers and Wright, 1998). In order to minimize the quantum of ambiguity it is essential to have a proper perspective of organization theory (Venkataraman and Ramanujam, 1986). In the opinion of some scholars performance is nothing but a reflection of strategic management. Performance could be defined as nature and quality of action that an organization takes to accomplish its principal mission and functions for generation of profit (Sink, 1991). From a quantitative perspective performance is related to a generalized scale and can be quantified in different manners. For example, it can be expressed as an absolute number, which managers can understand. In commercial organization performance measures usually have financial connotation such as costs and profits.

Although monetary indicators may be the best to measure the performance, dry ports usually take the figures as the business secret which is not available to public. In the literature of seaports, throughput is usually used as the performance measure. Tongzo (1995) uses the number of containers moved through a port (throughput) on the assumption that ports are throughput maximizes. Park and De (2004) employ cargo throughput as one of the indicators to evaluate the performance of seaports. Hung, Lu and Wang (2010) also take the container throughput as the output of their empirical model. Marlow and Casaca (2003) also indicate that the performance of ports has been measured in terms of TEUs. They have also classified the performance indicators of seaports into two groups, i.e. financial and operational. Tongzon and Heng (2005) investigate the relationship between port ownership structure and port efficiency.

Operational indicators for seaports are typically not applicable to dry ports for most of them are about berths and ships, which do not exist in dry ports. Pallis and Syriopoulos (2007) employ revenue and net earnings as indicators to measure the performance of Greek ports. Roso (2008) recently conducted research on factors influencing implementation of a dry port. In her study, TEUs are used to measure the performance of dry pots when she compares two dry ports serving Sydney's Port Botany. In sum, throughput is widely used as the performance measure for seaports as well as dry ports in literature.

As the seaport and the dry port have the same products to handle, i.e. containers, and the latter one serves as the inland access of the form one, we employ the throughput, which is total number of containers loaded and unloaded in 20 foot equivalent units (TEUs) and is publicly accessible, as the indictor to evaluate the performance of dry ports in this research. For we study dry ports in JNPT region, they provide similar services to the same target customers. The marginal profit of each dry port is close and in effect the throughput is in proportion to the profit. It guarantees the throughput is a suitable indicator to measure the performance of a dry port.

6.5 Factors affecting the performance of dry ports

Conventionally labor and capital are seen as factors affecting the performance of seaports and dry ports. Except those, one must dig deeper to exploit other internal and external factors that can influence the performance. To identify these affecting factors for dry ports, we first analyze the ones that influence the performance of seaports since the literature on seaports is relatively rich. Then we can examine which factors are applicable to dry ports. Besides that, we also consider the special features of dry ports to probe particular factors affecting the performance of dry ports. Crane productivity and berth utilization are usually considered as factors affecting the throughput of sea ports, for many research articles are concerned with the comparison of sea ports in different countries or regions (Dowd and Leschine, 1990; Tongzon, 2001; Song, et al., 2001; Song and Han, 2004). Berth utilization is not applicable to dry ports since there are no berths in dry ports. Similar to seaports, container handling equipments are used in dry ports, which include rubber-tired gantry cranes, mobile cranes, top handlers, side handlers, reach stackers, forklifts and so forth.

Usually container handling equipments are viewed as the main machines for dry ports as well as seaports, and they can greatly influence both the container handling capacities and, in turn, the performance of the dry port. Thus in this research we use the number of container handling equipments in each dry port to represent the level of equipments. In addition, a number of research articles consider the size of the seaports as another factor that influences their performance (Notteboom, 2000; Tongzon, 2001; Song, *et al.*, 2001; Wiegmans *et al.* 2004), since the land size determines the total storage capacity of a seaport. It is especially important in the peak season. Accordingly, the size of a dry port is taken as one of the factors when we consider its performance. Both equipments and the land of each dry port are capital intensive items, and are major expenditures of the total investment.

Except hardware, the efficiency of dry port also logically depends on the productivity, which is largely determined by the crane efficiency. Tongzon (1995) considers the crane efficiency as a determinant of seaports' efficiency. Park and De (2004) also indicate that efficient crane operations can greatly influence the competitiveness of the port. Hence in our study machine efficiency is considered together with the number of container handling equipments. That is we take their product as one determinant of the performance of the dry port.

Expect for above mentioned factors, the numbers of staff or the labor costs are also considered as a potential factor that may influence the performance of sea port, and has been examined in several works (Hayuth and Roll, 1993; Martinez-Budria et al., 1999; Tongzon, 2001). Labor cost is useful when we study seaports in different countries or regions. In this study, we focus on dry ports in JNPT region and their labor costs are fairly similiar. In contrast, the number of employees is usually taken as a critical factor influencing businesses of dry ports as more staffs can handle the inbound and outbound containers or bulk cargos more efficiently especially in peak hours. In interviews with senior management of the dry ports indicated that dry ports should have sufficient middle-level and front line managers as well as workers to handle the businesses.

Thus in our model the number of employees in each dry port is studied as an independent variable.

The tariff level is usually viewed as the critical point on the throughput of the seaports. Customers are generally sensitive to it. For example, in recent years, the throughput of the seaport in Hong Kong has largely dropped attributed to the competition of the seaport in Shenzhen, which is very close to Hong Kong. Customers can go through either of the two ports to transport goods into China, while the former can provide better service with a higher charge and the later competes using acceptable service and lower tariff level. In our study, we use dry ports in JNPT region as the objects to analyze, which are in a close region and compete against each other. Providing similar services to customers, dry ports in JNPT region employ the tariff as a main competition tool..

Geographical location is another factor that may influence businesses of dry ports. It has been seen as an important factor to seaports in previous research (see Cullinane et al 2002; Marlow and Casca, 2003; Park and De, 2004). In two recent research papers on dry ports (see Roso, 2008; Roso et al, 2009), location was identified as a critical factor as well. Customers usually consider the convenience of the dry port's location, for it is directly related to the transportation time to the destination, i.e. the seaport. In JNPT region, dry ports cluster in a very close region and the difference in distance to the seaport is not noticeable. However some of the dry ports are connected to the seaport by railway, which can influence the efficiency of transportation and, in turn, patronage of customers. We have considered the convenience of location as another potential factor affecting the performance in this paper.

In addition to these tangible factors, intangible determinants may also have an effect on throughputs of dry ports. Service quality has been viewed as the critical factor in many industries, and unexceptionally it is advocated by many managers and investors of dry ports in India. They believe that the higher quality of service can attract more business. However, in our interviews with different levels of managers of dry ports we have heard contradicting opinions. A fair number of interviewees indicated that though higher quality of service was good for dry ports, it was not essential to attract more customers. They suggested that dry ports should maintain an acceptable service quality, but it would not be a good idea to improve service quality into a higher level with much more costs. That is higher level of service usually requires more cost, and, in turn, leads to higher tariff level. They believe that customers would be more sensitive to tariff than service quality in India because currently most goods are not high value goods and it is not necessary to provide much high quality and value-added services. On the other hand, in our interviews, many managers still insisted that high quality services should be critical to dry ports and they advocated much more investment to it. Evidently there is a divergence on whether dry ports should improve high service quality into a higher level with more cost or just maintain an acceptable level. It is especially important for existing and potential investors for they are confused by different opinions on service quality. In this research, we investigate this issue. To our knowledge, perhaps it is the first time this intangible factor, i.e. service quality is considered in research of dry ports. Service quality has been conventionally seen as a powerful way to attract new customers and attain patrons in many industries. We analyze whether it has significant impact on the performance of dry ports when other factors are also considered together. The data for measuring service quality was collected by conducting over 150 personnel interviews with different dry port stake holders and service users. A questionnaire was constructed for the purpose of conducting the personnel interviews. In addition to exploratory factor analysis a modified version of Delphi technique was employed to construct the said questionnaire with the assistance of industry experts. The data so collected was also tested for reliability and co linearity prior to being deployed in the specially developed model. The model was operationalized with the help of AMOS 3.1 version software.

With the above analysis, we have developed five hypotheses to address the performance and affecting factors:

H1: The performance of the dry port will be negatively related to the tariff level of the dry port in India.

H2: The performance of the dry port will be positively related to the number of employees of the dry port in India.

H3: The performance of the dry port will be positively related to the service quality of the dry port in India.

H4: The performance of the dry port will be positively related to the product of the machine efficiency and the number of container handling equipments of the dry port in India.

H5: The performance of the dry port will be positively related to the size of the dry port in India.

H6: The performance of the dry port will be positively related to convenience level of location.

6.6 Research Methodology and Design

To test our hypotheses, we have collected the data of the throughput and tangible factors, including the tariff level, the number of employees, the number of container handling equipments, the efficiency of machines, the size, and convenience of location, for each dry port. However, all the values may change year by year. To enhance the robustness of this research, we have collected data for three consecutive years and conducted the cross-sectional regression for each yearly data set. If the results from three regression analyses are consistent, it can strengthen the reliability of conclusions of this research.

6.7 Sample and data collection

The data of 33 dry ports in JNPT region were collected for three years (2007-2009). The data was collected by the authors by conducting personal interviews with the respective dry port management, dry port customers/users and from the gateway port officials of JNPT. The data so collected was cross tallied and verified with published data by the Indian Ports Association (http://www.ipa.nic.in), The Jawaharlal Nehru Port Trust (http://www.jnport.com), The Reserve Bank of India, (www.RBI.com), and The Ministry of Commerce, Government of India (http://commerce.nic.in).

To measure the service quality which is relatively difficult to quantify, the survey questionnaire consisted of 21 items were designed and distributed to customers as well as operators in patronizing and operating the dry port to reap the information. An extended and modified version of the gap model developed by Parasuraman et al (1994) is used for service quality measurement. From exploratory factor analysis, it has five factors/dimensions as follows;

- **Tangibles** – Physical facilities, equipment, personnel, etc.
- **Reliability** – Ability to perform the promised service dependably and accurately.
- **Responsiveness** – Willingness to help customers and provide prompt service.
- **Assurance** – It covers aspects like competence, courtesy, credibility, security, etc. In short, it measures the Dry Port Operators ability to inspire trust and confidence.
- **Empathy** – This aspect accounts for the access ability, communication and understanding which the customer receives from the operator.

The survey instrument is divided into two main sections.

1) **Expectations (E)** – It measures what is anticipated in an ideal service.
2) **Perceptions (P)** – It measures those aspects of service actually delivered or experienced. Thus **Service Quality (S)** can be defined as the gap between Expectations and Perceptions **S = E – P**

All the measurement items are anchored on a 7-point Likert type scale (i.e. 7= strongly agree and 1= strongly disagree). In Appendix, we describe the detailed information on the survey to measure the service quality.

6.8 Variable measures

6.8.1 Dependent and Independent Variables

The dependent variable is the performance of the dry port. We employ the annual throughput in TEUs as the indicator. Although the profit of the dry port is a better indicator, reliable and accurate figures indicating profit derived from dry port operations itself are publicly unavailable. Dependent variables include the tariff level, the service quality, the number of employees, the product of the machine efficiency and the number of container handling equipments, the size of the dry port, and the convenience level of location. For the tariff level of dry ports, we employ the 3-point scale, i.e. high=3, medium=2, low=1, as the range of tariff offered by dry ports are not lengthy enough to require more levels. To quantify the service quality, we employ the SERVQUAL model developed by Parasuraman et al. (1985) to evaluate the service quality of the dry port, with which the perceived quality of a given service is an outcome of the comparison between the customer's expectations about the service and the perception about the actual service received by him.

The service quality is measured by *S*. In another work, we study the quantification of the service quality of dry ports in detail. The number of equipments is measured by the number of container handling equipments, and the efficiency of machines is quantified by the average number of TEUs processed per hour per machine for each dry port. The number of employees refers to number of management and supervisors, which are critical for the efficient management of the dry port. The size of the dry port is measured the area of the dry port. Finally, we set "1 = having train connection" and "0 = having no train connection", to measure the convenience level of the location of each dry port.

6.8.2 Control Variables

Because the dependent variable in this study may be influenced by other factors outside this model, two additional variables of less interest were incorporated. They include special conditions and the ownership for the dry port. Special conditions involves whether the owner of the dry port also holds some upstream or downstream companies along the transportation chain. For example, if a seaport and a dry port are held by the same company, the efficiency of the dry port could be higher than a dry port without close partners along the chain. Set "1 = having special conditions" and "0 = having no special conditions". The ownership of the dry port refers to whether the dry port is privately owned or state-owned, which will influence the patronage of customers. State-owned dry port has good relationship with state-owned companies, but usually its service quality is lower than privately owned dry ports. In contrast, privately owned dry ports usually can provide better service but have fewer connections with stat-owned companies. We set "1 = state-owned dry port" and "0 = privately owned dry port".

Table 1, 2 and 3 show the descriptive statistics for the dependent variable, independent variables and control variables in year 2007, 2008 and 2009 respectively.

Table 6.1: Descriptive Statistics for Variables in 2007 used in study

Items	N	Mean	Std. Deviation
Throughput	33	$5.979 * 10^4$	43621.343
Equipment*Productivity	33	16.395	8.976
Number of employees	33	24.879	7.592
Size of the dry port	33	$7.139 * 10^4$	45013.299
Service quality	33	-.8019	.389
Convenience level of Location	33	.091	.292
Special conditions	33	.091	.292
Tariff	33	2.364	.820
Ownership	33	.300	.467

Table 6.2: Descriptive Statistics for Variables in 2008 used in study

Items	N	Mean	Std. Deviation
Throughput	33	$5.821 * 10^4$	47968.727
Equipment*Productivity	33	15.715	10.583
Number of employees	33	21.000	7.802
Size of the dry port	33	$6.571 * 10^4$	38429.164
Service quality	33	-.9219	.418
Convenience level of Location	33	.091	.292
Special conditions	33	.091	.292
Tariff	33	2.152	.834
Ownership	33	.300	.467

Table 6.3: Descriptive Statistics for Variables in 2009 used in study

Items	N	Mean	Std. Deviation
Throughput	33	$5.670 * 10^4$	38429.164
Equipment*Productivity	33	15.152	10.159
Number of employees	33	22.576	8.574
Size of the dry port	33	$6.447 * 10^4$	40346.592
Service quality	33	-.8321	.264
Convenience level of Location	33	.091	.292

Special conditions	33	.091	.292
Tariff	33	2.109	.798
Ownership	33	.300	.467

6.9 Model Specification

Our hypotheses are tested using standard multiple regression models employing ordinary least squares (OLS) estimation. The estimation model is given as follows

$$\begin{aligned}\text{Performance} = \alpha + \beta_1\text{Tariff} + \beta_2\text{Service Quality} + \beta_3\text{Size} + \beta_4\text{Number of Employees} \\ + \beta_5(\text{Equipment*Productivity}) + \beta_6\text{Convenience level of Location} \\ + \beta_7\text{Special Conditions} + \beta_8\text{Ownership} + \text{error}\end{aligned}$$

6.10 Hypotheses Testing and Results

To test our hypotheses, we conduct the multiple linear regressions for three years respectively. The collinearity diagnostics for the data in 2007, 2008 and 2009 are displayed in Table 4, 5 and 6 respectively. Too small or large eigenvalues would indicate multicollinearity problems, and ideally all eigenvalues would be 1 indicating no collinearity. In our results, no eigenvalues can be regarded as the extreme cases. The condition index for each factor, which is the ratio between a specific eigenvalue and the maximum of all eigenvalues, confirms it. If the value of the index is greater than 15 (30), it indicates a possible (serious) problem with collinearity. In Table 4-6, no condition index is greater than 15.

The OLS regression results are displayed in Table 7, 8 and 9. We observe that the model *F* value is significant, indicating overall model significance, and the adjusted R-square is 0.821, 0.833 and 0.813 for year 2007-2009 respectively. From the results of our model, significant negative relationships were found between the performance of the dry port measured by the throughput and the tariff level ($\beta_1 = -0.287, p < 0.05$ in year 2007; $\beta_1 = -0.233$, $p < 0.05$ in year 2008; $\beta_1 = -0.297, p < 0.05$ in year 2009). The number of employees of the dry port exerts a significant and positive effect on the throughput ($\beta_4 = 0.372, p < 0.05$ in year 2007; $\beta_4 = 0.341, p < 0.05$ in year 2008; $\beta_4 = 0.293, p < 0.05$ in year 2009). These findings strongly support hypotheses H1 and H2. Moreover, the product of the number of equipments and their productivity is not significant at 0.05 level, however it is significant at 0.1 level. It indicates that both the number of container handling equipments and their productivity are important to the performance of dry ports, and H4 is supported at 0.1 level of significance.

From the results, we have also found that hypotheses H3, H5 and H6 are not supported. More specifically, the service quality, the size of dry ports and the location have no significant impacts on the performance.

Table 6.4: Collinearity Diagnostics for factors in 2007 used in study

Dimension	Eigenvalue	Condition Index
1	5.904	1.000
2	1.131	2.285
3	.785	2.742
4	.509	3.405
5	.434	3.686
6	.128	6.793
7	.062	9.779
8	.050	11.013
9	.035	12.986

Table 6.5: Collinearity Diagnostics for factors in 2008 used in study

Dimension	Eigenvalue	Condition Index
1	5.809	1.000
2	1.141	2.256
3	.786	2.719
4	.552	3.244
5	.459	3.557
6	.139	6.475
7	.068	9.211

8	.049	10.889
9	.035	12.958

Table 6.6: Collinearity Diagnostics for factors in 2009 used in study

Dimension	Eigenvalue	Condition Index
1	5.920	1.000
2	1.128	2.291
3	.786	2.744
4	.513	3.399
5	.435	3.688
6	.118	7.073
7	.054	10.435
8	.043	11.769
9	.030	14.072

Table 6.7: Hypotheses testing -- Multivariate regression for 2007 (N=33)

Variables	Standardized coefficient
Equipments*Productivity	.332***
Number of employees	.372**
Size of the dry port	.069
Convenience level of Location	.031
Special conditions	.046
Tariff	-.287**
Service quality	-.088
Ownership	.052

* *p*<0.01
** *p*<0.05
*** *p*<0.1

Table 6.8: Hypotheses testing: Multivariate regression for 2008 (N=33)

Variables	Standardized coefficient
Equipments*Productivity	.359***
Number of employees	.341**
Size of the dry port	.125
Convenience level of Location	.074
Special conditions	.024
Tariff	-.233**
Service quality	-.055
Ownership	.080

* $p<0.01$
** $p<0.05$
*** $p<0.1$

Table 6.9: Hypotheses testing: Multivariate regression for year 2009 (N=33)

Variables	Standardized coefficient
Equipments*Productivity	.325***
Number of employees	.293**
Size of the dry port	.123
Convenience level of Location	.086
Special conditions	.058
Tariff	-.297**
Service quality	-.073
Ownership	.052

* $p<0.01$
** $p<0.05$
*** $p<0.1$

6.11 Implications and Discussions

The 33 dry ports in the JNPT region of India differ by way of size, ownership, number of employees, number of equipment, rail connectivity, tariffs etc. It is but natural that the different factors numerated above will influence to different extent the annual throughput performance of the dry port. However it is noticed from the performance model developed for this purpose that the throughput is significantly impacted by only two factors viz; tariff and number of employees at 0.05 level and another factor, i.e. the product of the number of equipments and their productivity at 0.1 level, while all the rest have very low significance. In order to understand this phenomenon it is necessary to understand the profile of the dry port customer, the characteristics of the cargo being handled by the dry port, the value addition or lack thereof in the services offered by the dry port.

It should be understood ab-initio that the role of International trade in India's GDP is less than 10 %. Furthermore most of the International trade compromises of crude oil imports and export of services rather than manufactured goods. This is quite in contrast to other Asian countries such as China, Japan or Singapore. In addition the level of containers penetration in the counting is less than 40 %. A study of the cargo profile of the goods containerized will reveal that they are of low value such as handicrafts garments, simple machinery, leather goods, metal scrap, waste paper etc. which demand very little value added services. Neither are they able to bear high transportation/logistics costs. The global trade of such goods is extremely competitive and profit margins are very thin. As such the prime factor influencing the decision making process of the dry port users is the cost. When customers consider options among dry ports, usually the first-priority goal is to select the one with low tariff charge. It is also verified in our interviews to patrons of dry ports. Thus it is not surprising that tariff level stands out as one of the significant factors affecting the performance of dry ports in this study. It should also be noticed that most of the services in the dry ports are outsourced yet the residual liability of the dry port operator is not diluted. This is so because of the Indian legal system is not structured to render speedy justice. As such even in the presence of legally binding contracts between the dry port operator and its sub contractors the dry port management relies on its own employees to supervise the work of the sub contractors and their employees. As such the number of employees deployed by the dry port assumes critical importance considering the fact the all the dry port selected for the study handle a minimum of 10,000 containers annually. After taking into consideration the above mentioned facts it is not surprising to note that the number of employees and the tariff levels are quite significant at 5 % level. In addition, the product of the number of equipments and their productivity is significant at 10% level. It indicates that equipments with high productivity, as the component of capital factor, can largely influence the performance of dry ports. In this research, we consider the product of equipments and productivity as the factor instead of the number of equipments itself. It can better reflect the fact that the utilization of equipments plays the key role in the efficiency of the dry port. Actually, the general handling capacity of a dry port is mainly determined by efficient equipments and the number of employees, and our research suggests that they are important factors to the performance of dry ports.

Among insignificant factors, the size of dry port may be unexpected, for conventionally the area is viewed as a critical factor. Although in our interviews to the top managements most of them take the size as the strategic and critical factor to further expansion, they admit that it is not a binding constraint at the current stage. Many dry ports in India have not taken the full use of land, and it rarely happens that a dry port is full and there is no space to receive more goods. In fact, the capacity of dry port is mainly constrained by the number of employees and equipments, which can influence the performance. This point is also supported in our research. The search of scale economies and availability of cheap land and capital permitted the dry port operators to develop large capacities. Such capacities loose significance when under utilized due to its indirect impact on costs and tariffs. This fact is also borne out by our performance measurement model. Besides that, for the collinearity among the size, the number of employees and the product of equipments and productivity in the multi-linear regression, the relationship between the size and the performance has been largely adjusted by the latter two factors that are significant at 5% and 10% level respectively. It can technically explain why the size is insignificant when we consider the three factors together.

Next we analyze why service quality is not effective to dry ports in India. Cargo profile of the goods containerized in JNPT are of low value, which demands very little value added services. Most of the containerized goods are not time sensitive either hence there is no particular emphasis on service quality. The revenue of a dry port mostly depends upon the quantum of containers handled and not the value of the cargo stuffed in the containers. It should also be noted that the dry port tariff is identical for all kinds of cargoes and thus the dry port revenues and profits are solely a derivative of the number of containers handled. As such service quality is not an effective factor while measuring the performance of the dry port. One of the underlying factors influencing service quality was reliability and assurance of quick delivery to gateway ports. This enabled the shipping lines a faster turn around. But again due to the global financial meltdown, contraction in international trade and excess supply of container ships, the needs and requirements of the dry port customer has undergone a sea change. In order to economize on fuel and optimize on usage the ships have reduced their speeds by almost 40%. The customer/user is no longer willing to pay a premium for faster service nor does he need it. As such the customer no longer values service quality. This aspect also gets highlighted in one model where service quality has not only low but negative significant relationship with performance. The cost /price characteristics of the Indian cargo also influence the relationship between service quality and performance. The inherent demand for value added service simply does not exist.

It has also been observed that the convenience level of dry ports, which is measured by whether they have train connectivity, also does not have much significance. Due to the low-value goods containerized in JNPT, the prime factor influencing the decision making process of the dry port users is the cost, and most of the containerized goods are not time sensitive. It is not efficient transportation but lowering cost that is critical to dry port customers especially when the marginal profit is thin. That is why the efficient train connection of dry ports to the seaport does not play a significant role on performance.

Among developed economies trade logistics costs account for less than 10% of the GDP whereas in India it is in excess of 13%. All possible endeavors are being made to reduce this cost which could result in annual savings of 20 billion USD. In order to achieve this objective the government not only offered various incentives by way of soft loans and cheap land to the dry port industry but also became a major player through state owned corporations such as CONCOR and CWC. It also relaxed the norms for entry of private sector in 2003 by granting licenses for setting up dry ports and operating container freight trains. Thus we witnessed a spate of private sector companies such as Boxtrans, SICAL, DPW, Adani Logistics, APL etc. entering the field enthusiastically and getting bankrupted or shutting down as soon as the trade contracted due to global financial meltdown. This fact supports the strong relationship established by the performance model developed by us. According to one model the only parameters having a significant relationship with performance are tariff, number of employees and the equipments as well as their productivities.

6.12 Conclusions

Since 2008 due to fall in global trade the dry ports are faced with the consequences of excess capacity. This has led to a significant drop in efficiency, traditionally measured in terms of throughput.The findings of this research suggest that only tariffs, employee strength and productivity of container handling equipments influence the overall dry port performance measured in terms of throughput. Our investigations also reveal that other factors such as service quality, size, special relationships or convenience level have no significant impact on the dry port performance.

The strong impact of tariff on performance indicator viz throughput is well understood by all operators. As such they try to compensate lowering of tariffs with increasing of volumes to avail benefits of scale. It was in pursuit of scale economies that all the dry port operators, invested in construction of large capacities. However due to the trade downturn these capacities are to a large extent underutilized.

The higher levels of service quality, special relationships with container sea terminals or container rail operators too, have no significant impact on the performance indicators. This is due to the characteristics of the cargo handled at the dry ports. Such cargoes require very little value addition and are unable to bear higher tariffs. Such cargoes are not time sensitive either.

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Dry Port Efficiency and Container Security [#]

Abstract

This paper measures the efficiency of 26 dry ports located in the Jawaharlal Nehru Port Trust (JNPT) region of India using the Data Envelopment Analysis (DEA) approach while taking into consideration the important issue of *container security*. Dry ports, while playing an important role in increasing the container throughput of gateway seaports, also constitute the weak link in global supply chains, often due to nonexistent or inappropriate legal and enforcement frameworks. The standards of container security in the dry ports were measured with help of a specially developed *CONSEC* model. The measurement of dry port operational efficiency, from the perspective of container security, and drawing proper inferences, is thus necessary for the overall success of the supply chain, while simultaneously reducing the risks involved. Our research reveals that ownership structures and competition policies favoring public sector dry ports (vis-à-vis private sector) play an important role in the formulation of container security strategies and consequently dry port operational efficiency.

Key words: Dry ports, Container Security, India, DEA, Competition policy, Public Sector.

Introduction

The reliability, safety, time and cost of transportation, both on land as well as over sea have morphed the global trade and have almost uniformly enhanced the standard of living. Furthermore technological advances particularly in information and communication have resulted in lower transportation costs and shrinking of *economic* distances and consequently more trade. Dry ports have been playing an increasingly important role in the trading system. Economic reforms, trade liberalization and the development of land infrastructure have abolished captive hinterlands, thus obliging different dry ports to compete for custom. Greater choice in routing cargo and parallel advances in supply chain management has altered the nature of

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competition from ports and dry ports to one between supply chains. This is precisely what makes *container security* a most critical, relevant and timely issue for the present era.

Before the advent of the containerization era in the late 1990's the dry port competition was regarded as a negligible issue that was relevant in only in a two geographical locations in the country at New Delhi and Mumbai (JNPT). Dry port markets were widely perceived as either monopolistic or oligopolistic due to their exclusive and immovable geographical location and the unavoidable concentration of cargo traffic that this engendered. However, the rapid development of international container and intermodal transportation has dramatically changed this situation. Presently dry ports no longer enjoy the freedom yielded by a monopoly or oligopoly over the handling of cargoes from within their hinterland. Thus, dry port operators are not only concerned about whether they have the capacity or technology to physically handle cargo, but also whether they could compete for cargo on the basis of price and quality of service offered. However, since the past few years especially after the Mumbai attacks in 2008, container security has started to demand attention and from the current trends it appears that it would be the most critical issue in near future. Thus dry ports will be judged not only on the quality of their security equipment but also their safety, security and managerial culture and allied policies.

The operational efficiency of the Indian logistics sector in general, and dry ports in particular, has been suffering from the consequences of massive over capacity. This results in unsustainable pressure on prices and profitability. In such an environment the only possible way of logistics firms to survive is to cut costs and increase efficiency. This has far reaching implications for container security and, in the opposite, security measures and related costs and benefits have their own impact on dry port efficiency. This relationship is investigated here through DEA analysis. Efficiency measures, however, vary depending on the definition of efficiency employed, and the identification of the factors involved in its measurement. In the present paper, the efficiency measurements of a dry port take simultaneously into consideration such aspects as container security, along with annual container throughput. In this vein the data envelopment analysis (DEA) technique is utilized to analyze efficiency of the dry ports located in the JNPT region of India.

Usually located near or along gateway seaports, industrial regions and/or transportation axes, dry ports perform several important functions. (Nozick & Turnquist, 2000; Woxenius *et al.*, 2004). These include: (i) cargo aggregation and unitization; (ii) in-transit storage; (iii) customs clearance; (iv) issuance of bills of lading; (v) relieving congestion in gateway seaports; (vi) assistance in inventory management; and (vii) deference of duty payment for imports stored in bonded warehouse (Paul, 2005). Dry ports also play a key role in the supply chain of a country's international trade and inland cargo transportation, acting as nodal points of cargo consolidation and distribution, while providing connectivity to the gateway seaports. In India in particular, over 70 per cent of container throughput originates in the dry ports (Ng and Gujar, 2008).

In the past decade, various scholars have carried out studies on the efficiency aspects of the maritime transport industry from different perspectives. Tongzon (1995) specified and empirically tested the various factors which influence the efficiency and performance of a container port using empirical data from 23 international ports. Tongzon (2001) and Hidekazu (2002) applied DEA models to ascertain the factors influencing the efficiency of container ports. Farsi *et al*. (2006) computed the impact of cost and scale efficiencies on container ports operating within regional networks. Roy and Yvrande-Billon (2007) investigated the impact of ownership structures and contractual choices on performance efficiency in the French port sector. The main focus of such studies was to ascertain the ability of DEA models to distinguish inefficiency from the unobserved firm-specific heterogeneity in a port related industry. (For a thorough review of the DEA technique as applied to the port sector sees Haralambides et al., 2010).

Frontier models allow the estimation of productive inefficiency in an organization, such as a dry port, relative to a point of reference representing best practices for a given policy and technology. This offers scholar, academics and policy makers a benchmarking criterion for drawing and implementing organizational reform and appropriate policies.

Most of the productivity studies relating to container dry port research have mainly adopted the container throughput as one of the outputs. This perspective implies that higher levels of throughput would indicate greater levels of efficiency. This argument is not only anomalous but also occasionally untenable in certain industries such as transport which also generate pollution as an undesired output. The efficiency scores attained under this perspective do not always explore the real reasons behind operational performance of the individual ports as the container throughput is highly influenced by some factors beyond control of the decision making unit (DMU). In order to improve the focus of the dry port service providers, the output combination in this paper includes *Container Security*. The standards of container security established at a dry port are a result of policies adopted by the operator, as such it is considered as an output.

Post 9/11, governments all over the world have upgraded their security systems and have also implemented new laws. In many cases, this development has often had unintended side effects I the form of disrupting the free flow of trade. In the case of container inspections in particular, scanning and other inspection equipments are not only expensive but often difficult to maintain, requiring specialized training.

Through personal interviews with a number of relevant Indian stakeholders, it has become apparent that there is a lack of clarity with regard to liability and responsibility regarding security issues. This often necessitates the actual examination of all containers, something naturally rather impractical.

As per the manning guidelines of the Central Board of Excise & Customs, dry ports would normally operate with a staff of 10-12 officers. For dry ports having an annual throughput of 10000 TEUs or more it appears they are insufficiently equipped to undertake a detailed inspection of cargoes and containers (as compared to random sampling checks, which is the current practice followed at the dry ports) and are perforced to outsource security related activities. This is one of the reasons why explosive materials and live ammunition has escaped the eyes of dry port officials at the Tughlakabad dry port near New Delhi in October 2010. Ironically, none of the Indian dry ports have explosives detection equipment nor X-ray scanning facilities.

Presently, the ownership and operations of the dry ports in India can broadly be divided under two heads; private and public. The permission for construction of dry ports is granted by the ministry of finance of the government of India. While granting the permission, the government implicitly permits individual dry ports to develop their own security plans without explicitly expounding on the liability and responsibility issues in cases of security breaches. The government has allowed only public sector dry port operators to issue railway receipts (RR) on its behalf for containers transported to and from the gateway seaports to its dry ports. By doing so the government is implicitly accepting responsibility for container security and allows the dry port to absolve itself of any liabilities for security lapses. On the other hand, private sector dry port operators issue lorry receipts (LR) for the containers transported by them to the seaports. The latter dry ports are thus fully responsible and liable for container security failures. This dual policy of the government towards public and private dry ports is an interesting case of moral hazard, with private sector dry ports being more diligent about their security arrangements (Ng and Gujar 2009).

Containerized cargo is customs cleared at dry ports. However, inspections are random and largely based on documents such as shipping bills and forwarding notes prepared by the shippers themselves. Furthermore only a small percentage of randomly selected packages are actually opened for physical inspection and verification of actual contents. Due to time, manpower and equipment constraints, the reliability of such examinations is not satisfactory. As yet, no attempt has been made to empirically investigate the impact of such security procedures on the operational efficiency of the dry ports. This is the purpose of the present paper.

The International Ship and Port Facility Security (ISPS) Code was adopted by IMO in December 2002 and was fully effectuated in July 2004 (IMO, 2002b). The objective of the code is to afford better protection against terrorism to ships and port facilities. In essence, the (ISPS) code takes the approach that the security of ships and port facilities is a risk management activity and in order to determine appropriate security measures, an assessment of the risks needs to be made in each individual case separately.

The code also mandates installation of surveillance equipment. The code proposes to achieve its stated objectives by (i) detecting and identifying potential security risks; (ii) implementing security measures, e.g. protection terms, procedures, communications etc; (iii) collating and promulgating information related to maritime security; (iv) providing a reliable method in assessing maritime security risks; (v) developing detailed security plan procedures in reacting to changing security levels; and (vi) establishing security related roles and responsibilities for contracting governments, port administrations and ship owning and operating companies at national and international levels, including the provision of professional training. The code could be made applicable to dry ports with some necessary modifications (Hariharan. K.V., 2007).

Research Design and Data Collection

For data departing from normality, DEA often emerges as the preferred method, in addition to its other perhaps more significant advantages mentioned above. Roll and Hayuth (1993) are the first to apply DEA- CCR to the port sector. The authors presented a hypothetical case of 20 ports, and they use capital and labor as inputs and cargo throughput; service level; consumer satisfaction and ship calls as output. Martinez – Budria et al. (1999) analyzed the efficiency of 26 Spanish ports using labor expenditure; depreciation allowances; and other expenditures as inputs, and cargo movement; and lease revenue as outputs. Tongzon (2001) studies the efficiency of four Australian and 12 international ports. The study used cross section data and applied both the DEA- CCR and the DEA additive model. Number of cranes; terminal area; tugs; and container berths are used as inputs, and cargo throughput and ship working rate as outputs.

Barros (2003a) studied the technical and allocative efficiency of five Portuguese seaports using the number of employees and the book value of assets as inputs. Outputs consist of the movement of freight; market share; break bulk-, containerized-, dry bulk-, and liquid cargoes; and the price of capital. Barros (2003b) uses *total productivity* to analyze the technical efficiency and technological change of 10 Portuguese seaports from 1990 to 2000. The number of employees and the book value of assets are used as inputs, and the movement freight; market share; break bulk-, containerized-, dry bulk-, and liquid bulk cargoes, together with the price of capital, as outputs. Barros and Athanassiou (2004) applied the DEA- CCR and BCC to estimate the relative efficiency of two Greek and four Portuguese ports in the period 1998- 2000. They used labor and capital as inputs, and the movement of freight; cargo handled; containers handled; and the number of ships as outputs.

Cullinane et al. (2004) applied the DEA *windows* analysis to a sample of major international container ports. Their approach overcame the problem of biased results in earlier models due to a missing time variable. Container throughput was used as output, and quay length; terminal area; quay and gantry cranes and straddle carriers as inputs.

The methodology adopted here for measuring dry port efficiency with container security as one of the outputs, is equally important because it allows for comparisons of dry ports from the perspective of *container security*; this also helps in the establishment of *container security* standards. The measurement and analysis of security standards become the starting point of furthering quality in security. While there have been multitudinous efforts undertaken to study container security, to date there has been no consensus on the adoption of the necessary measurement tools. The *CONSEC* model developed in this paper is an endeavor to introduce such a tool. Our model identifies the gaps (actual or perceived) between stakeholder expectations and their perceptions on security, and in this way it highlights policy directions aiming at bridging disparities associated with dry port security.

With the use of the Delphi technique, we constructed a questionnaire covering 5 dimensions and 25 measurement items, taking into account the opinions of the various stakeholders. We broadly divide the dry port customers into three major groups depending on the kind of services rendered to them. The questionnaire was further validated with the help of Exploratory Factor Analysis (EFA) and, following this, the service items were reduced to 24. The groupings of the measurement items, under their respective dimensions, are summarized below.

Equipment

1. The quantity of equipment is adequate.
2. Achievement of objectives/targets
3. The maintenance program is appropriate.
4. The equipment is upgraded regularly.
5. Investments are justified.
6. IT and surveillance systems function satisfactorily.

Personnel

1. The number of personnel is adequate.

2. The personnel incompetent to implement security programs.
3. Organization structure is unambiguous.
4. Average Salaries paid to security personnel is appropriate.

Policy and Planning

1. Security plans are adequate.
2. Approval by an independent authority is necessary.
3. Appointment of a security officer should by mandatory.
4. Responsibilities and liabilities of the dry port are understood by employees.
5. Guidelines for rewards and punishment for security awareness of employees.
6. Benchmarking dry port security is essential.

Drill and Training

1. Security plans are accessible to all.
2. Training of personnel in security matters should be conducted by professional trainers.
3. Certification of such programs is a must.
4. Periodic review of security policy should be conducted.

Security Audit

1. The audit period is appropriate.
2. Security audit is carried out objectively by independent auditors.
3. Audit findings are accepted without prejudice.
4. Mandatory action is necessary for implementing security audit guidelines.
5. Procedures for the appointment of auditors are necessary.

The data was collected through personal interviews with the use of structured questionnaires. The first questionnaire was administered to 177 selected interviewees who patronize the dry ports. The only criterion used for the selection of the respondent company was a throughput of a minimum of 100 containers per annum. The criterion used for the selection of the respondent employee was a minimum service time in the dry port of 12 months. Customer respondents were classified in the categories shown in Table 1.

Table 1: Details of Respondents

Categories of Respondents	**No. of Respondents**
Shipping lines /NVOCC operators	28
Surveyors	32
Consignees/clearing agents/freight forwarders	24
Dry port management personnel	21

Dry port employees	27
Customs officers	25
Dry port security personnel	20
Total	**177**

To evaluate the constructs of security quality -i.e. the individual dimensions and items which influence dry port security- we performed an Exploratory Factor Analysis to confirm the underlying factors embedded in the survey data, constituting the different drivers for the customers who patronize the dry ports. The factors are extracted using the maximum likelihood method. To purify the original list of 25 items, those with factor loadings of 0.10 and above, on more than one factor, were eliminated. Table 2 below includes the purified list of 24 items representing the aspects which affect dry port security. These items explain 90% of the variance. The survey questionnaire consisted of these 24 items and all the measurement items were anchored on a 7-point Likert scale (i.e. 7= strongly agree and 1= strongly disagree).

Table 2: Results of Exploratory Factor Analysis

	Items	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**
1	Number of equipment	0.888	0.441	0.324	0.462	0.322
2	Purpose being served	0.892	0.325	0.421	0.410	0.523
3	Maintenance program	0.736	0.532	0.232	0.423	0.541
4	Equipment upgrading	0.891	0.145	0.216	0.436	0.563
5	IT and surveillance systems	0.462	0.857	0.254	0.425	0.413
6	Number of personnel	0.542	0.809	0.366	0.236	0.236
7	Competency of personnel	0.314	0.792	0.256	0.315	0.436

8	Staff qualifications.	0.231	0.881	0.214	0.341	0.355
9	Organizational Structure	0.462	0.576	0.851	0.301	0.430
10	Staff salary	0.451	0.264	0.872	0.236	0.520
11	Security plans	0.321	0.356	0.749	0.532	0.531
12	Approval of plans	0.134	0.452	0.802	0.420	0.234
13	Security officer	0.212	0.536	0.200	0.855	0.244
14	Procedural guidelines	0.112	0.301	0.106	0.814	0.361
15	Benchmarking security	0.342	0.533	0.201	0.756	0.540
16	Accessibility of plans	0.314	0.361	0.321	0.933	0.610
17	Training	0.241	0.245	.0322	0.189	0.800
18	Program certification	0.9624	0.261	0.253	0.456	0.714
19	Periodic review	0.309	0.323	.0.421	0.411	0.966
20	Audit period	0.322	0.543	0.329	0.165	0.899
21	Independent auditors.	0.345	0.436	0.132	0.222	0.752
22	Acceptance of audit	0.624	0.542	0.712	0.221	0.102
23	Mandatory action	0.722	0.314	0.115	0.221	0.423
24	Appointment of auditors	0.511	0.523	0.245	0.519	0.104

The above 24 items covering the five dimensions, reveal the differences between expectations and perceptions of the customers. The average dimension scores of expectations and perceptions are tabulated, with the difference between the two scores revealing the gaps. The total of the products of weights (allotted by the respondents according to their significance) and average dimension scores divided by five gives the weighted *CONSEC* score which is shown in Table 3. The *CONSEC* score of each dry port is taken into consideration while evaluating the efficiency of the dry ports.

Data Envelopment Analysis and Indicators

Data Envelopment Analysis (DEA) can be generally defined as a non parametric linear programming-based method for assessing the efficiency of a facility (in our case a dry port), called, in DEA jargon, a decision making unit (DMU). The performance of an individual DMU is evaluated by comparing it to the best performing units within the system, constituting the 'frontier'. The benchmarking of the performance of a single DMU, and thus its relative inefficiency, is determined by its 'distance' from the production frontier. The model selected here is an output oriented one which attempts to maximize dry port output (including service quality) while retaining constant the tangible production inputs such as equipment and manpower.

Assume there are n DMU_j ($j=1,\ldots,n$), which use k inputs x_{ij} ($i=1,\ldots,k$) to produce s outputs y_{rj} ($r=1,\ldots,s$) and let φ and λ_j ($j=1,\ldots,n$) be the dual output variables i.e. throughput and *CONSEC* scores. The dual output-oriented DEA-CCR model can be written as:

$$\text{Min } \varphi$$

$$\text{Subject to } \sum_{j=1}^{n} \lambda_j x_{ij} \le \varphi \; x_{im} \quad i=1,\ldots,k$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \ge y_{rm} \quad r=1,\ldots, s$$

$$\lambda_j \ge 0 \quad j=1,\ldots, n$$

The following equations, further restricting λ_j ($j=1,\ldots,n$) are known as DEA-BCC model,

$$\text{Min } \varphi$$

$$\text{Subject to } \sum_{j=1}^{n} \lambda_j x_{ij} \le \varphi \; x_{im} \quad i=1,\ldots, k$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \ge y_{rm} \quad r=1,\ldots, s$$

$$\lambda_j \ge 0 \quad j=1,\ldots, n$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

The output-oriented measure of scale efficiency of DMU_m is thus defined as:

$$TE = \frac{1}{\varphi}$$

The DEA-BCC model differs from the DEA-CCR model in that it includes the so-called convexity constraint $\sum_{j=1}^{n} \lambda_j = 1$. Then, the CCR model can be modified to assess efficiency under variable- rather than constant returns to scale. The technical efficiency of a DMU is derived from CCR and BCC models as follows:

$$SE = \frac{TE_{\_CCR}}{TE_{\_BCC}}$$

If $SE = 1$ the DMU is efficient, otherwise not ($SE < 1$).

The accurate definition of input and output indexes is critical for the application of DEA models. As regards output, container throughput has been widely used in several previous studies (Haralambides and Gujar (2011), Cullinane et al., (2004). However, this paper takes *container security* as an additional output into consideration. In view of the Container Security Initiative (CSI) and similar legal developments initiated by the United States and other countries, it is important to understand that container security might become the fulcrum on which the competitive advantage of an Indian dry port is judged. Thus, both 'throughput' and 'security' are employed here as the primary basis upon which the dry ports are compared.

Among others, dry port (and as a matter of fact port) security depends on the number of employees (including security personnel); security equipment and related facilities (e.g. fences); total terminal area; and container handling equipment. These are also the input variables used in the present model. Their summary statistics are presented in Table 3 below.

It has been argued by different researchers (cf. De Neufville & Tsunokawa, 1981; and Notteboom *et al.*, 2000) that there exists a fairly close relationship between the size of a terminal and the number of its employees. Mostly, this argument is put forward to justify the fact that either 'terminal area' *or* 'labor' is used as an input but no both (usually due to the lack of data). To our view this constitutes a drawback, for capital-labor and land-labor relationships vary significantly among countries. Thus, both variables are used here. The final sample included in the analysis compared 26 dry ports, located in the JNPT region, with a minimum annual throughput of 10,000 TEUs.

Table 3: Summary of Dry Port Statistics

	Number of Equipment	Number of Employees	Terminal Area (sq.m)	TEU Throughput	Container Security *CONSEC* Score
Mean	2.961538	20.73077	77801.96	54356.98	-0.87662
Std Dev	1.825329	7.973277	70759.38	46871.02	0.368201
Median	2.5	21.5	50000	37447.5	-0.81
Minimum	1	9	20000	10426	-1.63
Maximum	7	39	364000	184561	-0.023

Empirical Analysis and Discussion

The relationships between inputs and outputs are analyzed in three different ways, for two different periods. In the first case, *throughput*, measured in terms of TEUs, is considered as the single output. In the second case, dry port security, measured in terms of absolute *CONSEC* scores, is considered as an output along with throughput together. The results are shown in Table 4.

Table 4: Results for the Year 2008-2009

Dry Port	CCR		BCC		Scale Efficiency		Returns to Scale (Increasing - IRS and Decreasing - DRS)	
	TEU	TEU + CONSEC	TEU	TEU + CONSEC	TEU	TEU + CONSEC	TEU	TEU + CONSEC
1	0.141	0.15	0.145	0.153	0.969	0.986	DRS	DRS
2	0.508	0.549	1	1	0.508	0.549	IRS	IRS
3	0.282	1	0.394	1	0.716	1	DRS	-
4	0.073	0.101	0.078	0.101	0.929	0.997	DRS	-
5	0.358	0.362	0.426	0.429	0.84	0.844	DRS	DRS
6	0.346	0.35	0.397	0.4	0.872	0.876	DRS	DRS
7	0.233	0.248	0.256	0.325	0.912	0.762	IRS	IRS
8	0.268	0.614	0.268	1	1	0.614	-	IRS

9	1	1	1	1	1	1	-	-
10	0.839	0.84	1	1	0.839	0.84	DRS	DRS
11	0.383	0.444	0.563	0.588	0.681	0.755	IRS	IRS
12	0.393	0.413	0.466	0.482	0.843	0.857	DRS	DRS
13	1	1	1	1	1	1	-	-
14	0.488	0.514	1	1	0.488	0.514	IRS	IRS
15	0.147	0.166	0.197	0.222	0.747	0.75	IRS	IRS
16	0.333	0.539	1	1	0.333	0.539	IRS	IRS
17	0.201	0.298	0.201	0.438	1	0.679	-	IRS
18	0.806	0.806	1	1	0.806	0.806	DRS	DRS
19	0.383	0.444	0.563	0.588	0.681	0.755	IRS	IRS
20	0.393	0.413	0.466	0.482	0.843	0.857	DRS	DRS
21	0.68	0.732	0.999	0.999	0.681	0.733	IRS	IRS
22	0.326	0.376	0.478	0.497	0.681	0.756	IRS	IRS
23	0.454	0.463	0.466	0.473	0.973	0.978	IRS	IRS
24	0.277	0.316	0.375	0.396	0.74	0.798	IRS	IRS
25	0.22	0.255	0.497	0.497	0.442	0.514	IRS	IRS
26	0.149	0.188	1	0.769	0.194	0.244	IRS	IRS
Mean	0.411	0.484	0.577	0.648	0.758	0.769		

One of the reasons for the different efficiency estimates in the two periods is the drastic changes in the value of the two outputs, the foremost reason being comparatively sharp rise in throughput of the dry ports. The results also suggest that there exists a fair level of wastage in the production of dry port services, signifying the potential for substantial improvement, especially in those ports facing increasing returns to scale. On the other hand for decreasing returns, the dry ports face two choices, of either increasing/upgrading the inputs by way of equipment and manpower or reducing their throughput. The returns to scale properties, when considering both outputs together (last column of Table 4), indicate that, of the 26 dry ports, 9 dry ports exhibit constant returns to scale while 5 exhibit increasing returns. The remaining 12 display decreasing returns to scale. However when we also consider the container security as the other output the results undergo a drastic change. They exhibit that 17 dry ports have decreasing returns while only 4 dry ports have increasing returns with the balance 5 dry ports displaying constant returns.

Conclusions

In seeking to interpret the results and findings of this study, especially while attempting to draw some general inferences, caution needs to be exercised. This is because extrapolation is neither correct nor possible as it is practically impossible to replicate all the inputs. Furthermore certain results are the outcome of several inputs combined together in different ratios of permutations and combinations.

Some broad inferences can certainly be drawn from the paper though. The first is that of capital investment is essential for implementing container security. This might adversely impact operational efficiency when *throughput* is considered as the sole output. There is also an unintended consequence of such capital investments, which is the creation of excess capacity to cater for future demand and growth. This, in turn, may further affect dry port efficiency, at least in the short run.

Caution about reforms (Haralambides et al., 1997) structural and bureaucratic rigidities; institutional and deeply entrenched interests; management culture and practices and finally education and training are some of the factors which have not allowed the optimum combination of factors of production that would allow Indian dry ports to move closer to their technological frontier. Dry ports in this premier region of India need to deeply reflect on the vexing issue of *container security* and undertake to develop and implement appropriate measures in the very near future. Generically speaking the security at public sector dry ports is perceived to be less than satisfactory. The management of these dry ports is perceived to be complacent on security issues as compared to the managers of private dry ports, even though all the dry ports operate according to a common set of guidelines issued by the customs. It's easy to understand the reasons for their complacency- government managers are true to the letter but not the spirit of the regulations. An in depth analysis of the various Acts related to transport of containers in India by different means leaves an impression that there are several gray areas in the legislative regime. There are areas where there are contradictions, such as the extent of liability, and there are areas, such as 'due diligence' in checking the cargo, for which there are no clearly defined roles and liabilities

Efficiency measurements of dry ports are found to differ, as expected. It can be noticed that the privately organized dry ports have managed to fare better than those operated by the government.

This finding is interesting because such a difference indicates that more complicated factors, such as customer service, commitment, competence of management etc (Cullinane et. al., 2004) apart from those considered in this paper, come into play, which may exert a significant influence over the efficiency of dry port operators.

For a variety of reasons it can also be inferred that, if each unit under study is observed once only (as in a cross-sectional data analysis), the efficiency results that are derived may be rather misleading or even completely erroneous. For instance, random shocks (such as poor machine performance, bad weather, input supply breakdowns, and so on) might contribute (positively or negatively) to variation in derived efficiency estimates. From this point of view we recommend, the units under study should be observed at more than a single point of time. The authors also realize that when panel data are utilized, it is inappropriate to attribute all efficiency improvement over time to a single factor (in this case, privatization), considering that technological development always provides impetus for efficiency gains within firms from both the public and private sectors. In other words, it would seem that privatization may not necessarily provide the panacea for salving the variety of ills, particularly inefficiency, in the emerging economies of the world.

As such, further investigation into the complex and often unquantifiable factors behind the relative inefficiency of dry ports is not only relevant but has nowadays becomes imperative in order to achieve further improvements in an increasingly competitive environment. This paper should be seen as a fist step in this direction and the derivation of our efficiency estimates just constitute the proverbial tip of the iceberg.

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Government policies, efficiency and competitiveness: The case of dry ports in India*

8.1 Abstract

India's rapid economic growth has not given due credit to the significant contribution of the logistics sector which has also grown phenomenally in the past 15 years. The pace of economic growth in future will demand a rapid development of logistics service providers with specific focus upon costs and skills development, which implies that the efficiency of dry ports is likely to play pivotal role in this process in complementing the changing role of ocean carriers and other stakeholders within the entire supply chain. However, dry ports in India were often characterized by poor performance and under-utilization, which in turn affecting international competitiveness of Indian products. While the Indian government was fast to address this problem through the introduction of foreign participation within the sector, at the same time, the sector had fallen i[23]nto the dilemma that the competitiveness of existing local dry port operators would be in jeopardy, of which the consequence was not something that the government would be ready to bear. It is the endeavor of this paper in addressing how the government is trying to balance these conflicting issues initiated by globalization. Through exploratory study on governmental policies on dry port development in India, it is hoped that it will be provide some insight not only on the development of dry ports in India, but also shedding some light on the how the forces of globalization had its impacts on the development of newly developing countries.

Keywords: India, dry ports, government, competitiveness, policies

8.2 Introduction

It is a general knowledge that contemporary global economy is characterized by globalization which can be interpreted as the increasing universality and of consumption (Levitt, 1983), production in separate locations (Brooks, 2000) and services, of which simultaneous

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technological progress like ICT has allowed services to be provided at a distant location, e.g., invoices, salary administration, marketing and promotion development, call centres, etc. Nevertheless, globalization would not be possible without the support of an efficient supply chain, as it implies unimpeded free flow of goods and people which when translated in colloquial terms means integrated intermodal transport systems as the market driven economies do not recognize borders nor respect nationalities. Indeed, the logistics revolution had allowed a better management of cargo flows with low inventory costs, reliable delivery time and distribution (the so-called 'just-in-time', or JIT). With the exception of those activities that require the physical presence of cargoes, various logistics services, such as tracking, invoicing, custom procedures, etc, could be easily (and are increasingly) performed at a distance. Adding to the fact that, in the case of container transportation, very often, the same locations are used for manufacturing or transshipping for the final consumers, it would be expected that if the costs of providing these services at a distance remain low it will make it advantageous to logistics operators in the manufacturing countries to start providing these services.

Such development has opened the global consumer market to industries in India. To ensure that notable Indian products, for example, textile, automotive components, etc., can sustain their competitiveness in the global market, efficient supply chains (in some cases, multimodal) need to be established so that the shipment process of shippers' cargoes is smooth and, perhaps more importantly, cost-saving, and this has exerted substantial pressure to the country's export supply chain. However, it was clear that Indian manufactured goods would become competitive only if supported by an efficient transportation supply chain. Geographically, the northern states (like Delhi, Punjab and Uttar Pradesh) were the home of which major agricultural and the manufacturing activities took place (where the majority of the consumer population also exists, and it was also historically the seat of the national government since the British colonial period) while international trade, including exports, was largely conducted through the gateway ports along the southern coast. With the advent of containerization, this pattern had become even more emphatic. For example, in 2006, the two coastal ports of Mumbai (Jawaharlal Nehru Port Trust, or JNPT) and Kandla (Mundra) handled almost 80% of the country's containerized trade which almost entirely originated from the north. Under such situation, it implies that dry ports, often known as Inland Container Depot (ICD) or Central Freight Station (CFS) in India, is likely to play pivotal role in this process (Heaver, 2002; Sánchez *et al.*, 2003) in complementing the changing role of ocean carriers and other stakeholders within the entire supply chain (Notteboom and Rodrigue, 2005). Generally speaking, dry port can be understood as an inland setting with cargo-handling facilities to allow several functions to carry out, for example, cargo consolidation and distribution, temporary storage of containers, custom clearance, connection between different transport modes, allowing agglomeration of institutions (both private and public) which facilitates the interactions between different stakeholders along the supply chain, etc.

As inland logistic nodes with comprehensive consolidation and distribution facilities, dry port plays significant roles in optimizing all activities to ensure the delivery of cargoes from one end to another in an efficient manner (Juhel *et al.*, 1999). To enable dry ports to perform their designated role effectively, they need to be located at strategic places (Stopford, 2002), usually near major ports, industrial areas, and/or along major transportation axes (like railway terminals and highways). In India, a dry port basically attempts to meet various needs along the supply chain, including: (i) aggregation and unitization of cargoes; (ii) in transit storage; (iii) localized custom clearance; (iv) the issuance of bill of lading in advance; (v) allowing less congestion in ports; (vi) assisting in inventory management; and (vii) deferred duty payment for imports stored in bonded warehouse (CONCOR, 2007). In many ways, dry port actually conducts many functions which are very similar to modern seaports, with the only exception that it does not perform stevedoring operations from vessels. In many cases, many dry ports in India were established within the hinterland regions which subsequently became catalysts of economic growth for their respective regions.

The problem was that, however, dry ports in India, of which many were operated by state-owned corporations like CONCOR, were characterized by poor performance and under-utilization, which in turn affecting international competitiveness of Indian products. While the Indian government was fast to address this problem through the introduction of foreign participation within the sector, at the same time, the sector had fallen into the dilemma that the competitiveness of existing local dry port operators would be in jeopardy, of which the consequence was not something that the government would be ready to bear. Indeed, it is the endeavor of this paper in addressing how the government is trying to play the game in balancing these conflicting issues initiated by globalization.

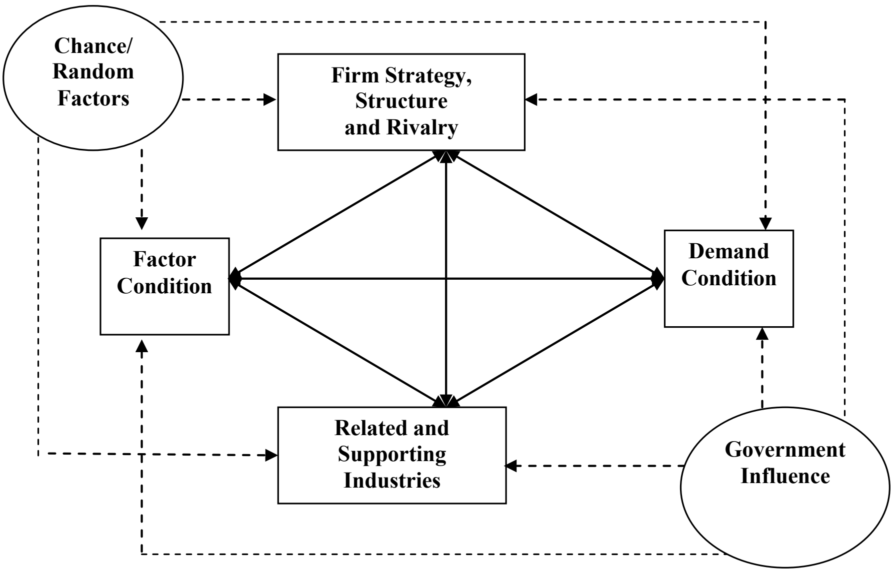
This paper is structured as follows. After this introductory chapter, the next section will discuss the major theoretical framework, the Porter's Competitive Diamond, followed by an introduction to the issues and dilemmas of the current development of Indian dry ports. The remaining of the paper will then analyze the Indian government policies on dry port development, with special emphasis on how such policies would impact on the competitive platform, followed by discussions and conclusions. It is hoped that this paper can provide some insight not only on the development of dry ports in India, as well as shedding some light on the how the forces of globalization had its impacts on economic development, especially in newly developing countries like India.

Before getting on, it is necessary to note that, given the exploratory nature of the study, apart from desk research and documental review, the authors had also conducted on-site in-depth interviews with various relevant personnel. The interviews have been done either telephonically or in person. For each question, the interviewer has summarized, when necessary, the answer and transcribed the results of the interview. More than 15 interviews had been conducted, with interviewees including dry port operators, government officials, and consultants who were involved in Indian dry port construction and development.

8.3 Theoretical framework: Porter's Competitive Demand

In this paper, we use the concept of firm's competitiveness as the conceptual background of the theoretical framework to examine the competitiveness of Indian dry ports. In this aspect, we can start with examining Porter's Competitive Diamond (hereafter called CD) in explaining how a firm can enhance its competitiveness through the creation of competitive advantage (Porter, 1990), as well as capturing the key elements of a company's situation that influence its potential international strengths (Bowman and Faulker, 1997). Porter's CD can be found in figure 1.

Porter's CD argued that, rather than static focus on cost minimisation in relatively closed economies as suggested by Porter's former Five Forces Model (Porter, 1985), competition is dynamic and rests on innovation and the search for strategic difference because of the increase in countries open to the global economy, greater efficiency of national and international factor markets and diminishing factor intensity of competition (Porter, 2000). According to CD, a firm's competitive position depends on two major aspects, including *operational effectiveness* (sought for the best operation practice) and *strategies* (sought to answer 'how to compete') (Porter, 2000). In order to remain competitive (or, at least, sustain its survival), a firm must maintain operational effectiveness while at the same time creating strategies which can distinguish itself from existing/potential competitors (Porter, 2000).



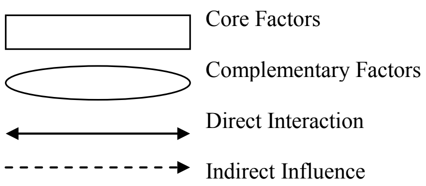


Figure 8.1: Porter's Competitive Diamond
Source: Porter (1990)

Porter's CD can be summarized as follows:

*Factor Conditions***:** Although basic economic factors (i.e., labour, land natural resources and capital) can provide initial advantages, with the existence of competition and it can exert pressure to advanced factors, and thus CD emphasizes on creating advanced (like IT and professional personnel) and specialised (like container-handling cranes in container port industry) factors of production, as they are not only more critical in a globalize economy, but also more difficult to create and retain. However, what is special about factor condition is that selective disadvantages in more basic factors can enable firms to create competitive edges because they may be forced to innovate in order to compensate the disadvantages, provided that they are offered the chance and favourable circumstances to do so. Following this line of argument, for example, the geographical disadvantage of a port can possibly be compensated through better efficiency and management strategies.

Demand conditions: Demand conditions can be multi-folded in terms of local, regional, national foreign and global. When the market for a particular product is larger locally than in foreign markets, the local firm devotes more attention to that product than do foreign firms, leading to a competitive advantage when the local firm begins exporting the product (Porter, 1990). Character of demand also plays an important role as highly sophisticated buyers might force the firm to meet higher standards, while special local circumstances may also make demand character more complicated. This point is especially significant for ports since ports are virtually immobile. Also, a strong and growing local market offers a strong base for a company when going global and in the case of maturity local demand may also be an incentive for firms to move to foreign markets.

Related and Supporting Industries: The role of related and supporting industries is critical to ensure that goods and services can be produced and offered effectively. It comprises of complementary products of which an organisation can use and can coordinate particular activities in the value chain together. In port, for example, related and supporting industries can be situated in the port like ship repairers, bunkers, warehousing, feeder providers, etc. The closer the relationship between service providers and related industries, the more effective coordination between different parties, the better the effectiveness of the port cluster, which leads to the possession of competitive advantage of that particular port.

Firm strategy, structure and rivalry: The major factor which distinguishes Porter's CD previous competitive theories (like Five Forces Model) is the emphasis on management structure and resource limitations in affecting a firm's competitive strategy. Porter (1990) argued that there is no one common strategy or management theory which can explain all the behaviours of firms because different management ideologies exist like personal beliefs and company culture. Rather than static, a firm is actually an evolutionary creature where past experiences and personnel have direct implications on future strategies and development. In tackling competition, strategic decisions can be multi-faceted, e.g., revolutionary or conservative, expansionary or maintenance of *status quo*, market consolidation or specialisation, etc. Porter later strengthened this point by arguing that a firm should develop 'creative but effective' strategies (Porter, 2000), and such philosophy had witnessed various new port development initiatives towards the end of the last century, e.g., cross-border investments by port/terminal operators, cooperation between competing ports to achieve win-win results (Song, 2002), intensive marketing [24], etc. Nevertheless, it is important to note that strategy in attracting customers is often characterized by a combination between monetary cost and service quality. Market environment is not the only decisive element in deciding strategies and competitiveness of a company. Also, the competitive position of a firm depends on whether it can exploit the surrounding environments towards its favour, whether the management hierarchy prefers stability or adventures and whether it accepts that change is necessary. In other words, how a firm perceives itself can play a role in deciding its own competitiveness.

Based on the above analysis, it is clear that CD has included elements originated from Resource-Based Theory where a firm has the opportunities to decide on its own fate[25]. When facing competitive threats (or, in other words, any 'imbalance' within the Diamond), existing firms can either drop out, or undergoing the process of restructuring in tackling upcoming challenges, of

[24] For example, according to Barba *et al.* (1998), by the end of the 20th century, resources allocated to port promotion and marketing by Rotterdam amounts to more than 30% of its annual budget, compared to just about 20% for Antwerp and Hamburg.

[25] Resource-Based Theory believes that the best performing firm can make use of its best available resources into producing high quality products/services. The selection of competitive strategies should be based on sensible evaluation of available resources and strategic decisions which are constrained by past resource deployments which result in further reinforcement of the company's profile. While Five Forces Model emphasises on industrial environment, Resource-Based Theory focuses on individual characteristics and believes that the fate of a firm in the competitive market mainly lies within its own hands. See Conner (1991) and Grant (1991).

which such strategic decisions would be affected by the firm's culture, characteristics of decisions makers, the market environment, as well as the business objectives, e.g., profit maximization, target return on investments, target sales figure, target market share, etc. For example, a firm needs to decide how the four 'P's of the marketing mix, i.e., price, product, promotion and place, should be implemented so that the industry's 'Diamond' can lean towards its advantages, which implies that 'market strategies' would be the key in deciding how the 'Diamond' of that industry would result in.

Nevertheless, empirical evidence suggested market factors are not necessarily the only attributes which can manipulate the direction of the Diamond fully. As suggested by CD, even within a typical market economy, its competitive structure is often influenced by chances (i.e. random/unexpected factors) and, perhaps more importantly, the government. Rather than a core player, however, Porter insisted that government is only taking a catalytic role through creating a favourable economic environment for firms to compete at a fair platform, e.g., enforcing standards in service quality, encouraging competition, introducing and enforcing antitrust policies, providing necessary aid, etc. and should not participate in company's management and competitive strategies because direct participation of government will lead to ineffectiveness and bureaucratic culture (Porter, 1990). According to Juhel (2001), in the port industry, government should achieve three missions, namely catalyst mission (e.g. finances transport assets which are unlikely to get access to private or alternative financing sources, creates regulatory enabling environment, etc.), statutory mission (e.g. ensures navigation safety, coastal management, etc.) and facilitation mission (e.g. public governance, helps trade facilitation process, initiates trade integration, etc.). He further argues that all these require an established public sector (usually port authority) with well-defined roles in achieving this. His view was supported by Ng (2002) who notes that public presence still matters in affecting the efficiency of port operations. Indeed, governmental influence within the industry can still be found worldwide, either in regional or national scales (World Bank, 2000). For example, state aids can still be found in many European ports (EC, 2005) while the public sector is also often involved in port projects like dredging and widening river channels[26]. In Western Europe, for example, the role of government in ports

[26] According to EC (2005), limited amount of state aids to the maritime transport is necessary and thus should be justified.

differs considerably between countries, where the Benelux countries, France, Germany and the UK all have port policies.

As a summary, without doubt, Porter's CD has largely explained the competitive structure of an industry, with the roles of firms and market environment being clearly defined. Nevertheless, its emphasis on whether government is only playing a complementary role within the market is certainly an issue which is highly debatable. As will be discussed in the case of Indian dry ports in this paper, the role of government is not only being restricted to the backseat, but a pivotal role in deciding the 'balancing point' within the 'Diamond'.

8.4 Dry Port Development in India: Issue and Dilemma

In India, in order to assist export growth several free trade (FTZ) and special economic zones (SEZ), by 2007, 184 dry ports were set up at several locations within the country, of which 40 of them were located close to the gateway ports. According to consulting information, by 2004, 58% of the container traffic between these dry ports and the gateway ports was handled by the roadways with the balance being handled by the railways (Hariharan K.V., 2004). To accommodate market consolidation, seamless integration and closer collaboration between different stakeholders along the multimodal supply chain, the contribution of dry ports is impossible to ignore. The most important dry ports are under the public entity of the central government, the Container Corporation of India Ltd. (CONCOR) (CONCOR, 2007).

However, given the uneven distribution of dry ports within the country, with about 40%, 30% and 20% being located within the southern, western and northern regions respectively (the central and eastern regions are conspicuous by the almost negligible presence of dry ports) (CONCOR, 2007), it has led to congestion of facilities and breakdown of infrastructure on one hand, but under utilization of the capacity on the other. Moreover, given the extreme scarcity in financial resources, technological and management know-how, dry ports in India had never been innovative and long term efficiency-enhancing investments and R&D like RFID and GPS systems were often not considered. This was not helped by the government's policies on labour protection which had bred inefficiency, sloth and indiscipline and the cost of such inefficiency was often borne by the manufacturing and service sector.

Indeed, the almost complete monopoly of state owned companies like CONCOR and CWC in the sector had also contributed to the problems as mentioned above, especially since, as government-approved monopolies, different dry ports often provided generic solutions in solving non-standardized demands along different regions, hence raising the question on whether dry port services were really customer-oriented (Dayal and UNESCAP, 2006). The price of such problems had resulted in poor performance and under-utilization, which in turn affecting international competitiveness of Indian products, especially since such inefficiency had often resulted in the reluctance of dry port operators to offer time bound commitment to cargo owners and shipping lines, resulting in the inability of the latter in planning connection of the hinterland containers to specific vessels. Finally, inefficiency had also led to poor perception of dry ports (and indeed logistics industry) by the general public. According to anecdotal industrial information, working in the logistics industry, including dry port operation, is perceived as a 'backward' and 'bleak' career in India, and thus the sector often found it very difficult to attract the necessary talent nor has it been able to impart the necessary skills and vision, which partly led to sloth and inefficiency.

To resolve this problem the Indian government has embarked upon a massive capacity enhancement program, as well as loosening the grip of its control on dry port operation through private sector participation (Department of Shipping, 2006). In addition to this two special freight corridors are being constructed on the eastern and western flanks of the country from Delhi to Mumbai and Kolkatta. Furthermore, an eight lane golden quadrilateral roadway is being constructed connecting the four metropolitan areas of Mumbai, Delhi, Chennai and Kolkatta. An inter ministerial committee for approval of applications for dry ports has been set up to facilitate single window mandatory clearances, payments, incentives, certifications, customs presence etc. the legal and liability framework too has been improved by implementing the Multimodal Transportation of Goods Act and refining the Motor Vehicles Act. Having recognized the importance of private sector participation the Government has accepted the World Bank proposed concept of landlord ports and have handed over the ports of JNPT, Chennai, Tuticorin, Vishakhapatnam and Kochi. Based on similar principles, the Indian government had recently encouraged the private sector, often foreign, to operate dry ports at numerous locations within the country, often through the sale/lease of facilities to the private sector under attractive terms. It has also through its commercial organization like Central warehousing Corporation entered into several joint ventures with private sector companies to manage facilities on BOT basis. Indeed, apart from enhancing the efficiency of the supply chain, the government also anticipates the participation of foreign firms in the operation and management of dry ports as a means of increased foreign incomes (through various means like land rents and taxes) and the transfer of technology and know-how. As a response to this initiative, in the past few years, several multinational logistic service providers like Schenkers, Kuhne & Nagel and Prologis, along with the shipping companies like APL, MSC and Maersk, had entered this sector[27].

Referred back to Porter's CD, the participation of foreign investments was to enhance the quality of the 'Diamond', so as to boost the quality of the supply chain within the country, and thus the competitiveness of Indian manufactured products in the global market. On the other hand, however, foreign participation, often with superior technology, marketing strategies, management know-how and, more importantly, willingness to provide time-bounded guarantee to cargo owners and shipping lines, would pose significant threats to the survival of local, CONCOR-operated, dry ports, especially if they had lost the advantages of government protection umbrella. Moreover, the foreign companies which have entered this field usually have captive cargoes, e.g., shipping lines, freight forwarders/NVOCC companies, etc. The main objective for the construction of a dry port is not only to make profits from operations but also to reduce the risk of non reliable performance in the supply chain. By controlling the dry ports and the inland transportation of cargoes they are able to generate synergetic benefits which lead to competitive advantage, of which most local dry port operators (like CONCOR) find it difficult to match.

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[27] The common practice in this trade is most of the dry ports operators charge their fees in advance from the users comprising of mostly shipping lines and NVOCC operators. It is not uncommon for the users to keep certain amounts of money with the operator and replenish the deposits at regular intervals. On the other hand the dry port operator employs vendors for transportation and handling of cargoes and containers and pays him at a later date. The surplus cash is used by the operator as seed capital for expansion and servicing of debts. This serves as another reason why many shipping would like to enter into the business of inland logistics, as the profit margins are thin but the cash flow is steady and comparatively low risk.

Indeed, given the massive number of such dry ports established within the country (and the number of employees being employed) as mentioned earlier, it would potentially pose a political tragedy to the Indian government if these dry ports were forced to close down due to the competitive advantages of these newly established foreign-operated dry ports, not helped by the fact that the government has, so far, failed to establish a properly-implemented legal and regulatory framework in facilitating the adoption of efficient supply chain (including dry port) management practices, including the adoption of procedures which could lead to higher safety and security levels of products being transported[28].

Before going on, however, it is important to note that the pivotal role of governmental influence does not imply that the dry port operators did nothing to enhance its competitiveness, as witnessed by such dry ports operated by state-owned corporations in providing value added services like packaging, marking, de-bulking, sorting palletizing, fumigation, container repairs, storage, etc. In India, most of the dry ports operators have plans on the anvil for constructing of tank farms and cold storages within the dry ports premises. Indeed, in this case, most Indian dry ports have a separate custom bonded warehouse, where importers usually store their entire consignments there without payment of custom duties. Some dry ports operated by state-owned corporations even availed themselves additional revenues by acting as a third party logistics service provider and physically handled and held cargo charges on behalf of the actual owner and delivered it to the eventual consumer on the instructions of the shippers. CONCOR, for example, had developed its own gateway terminals in its dry port near JNPT in offering a single vendor service to meet the logistics requirements of customers. Currently, they are also exploring the possibilities of entering into freight contracts with cargo interests directly to meet all the logistics needs of their customers.

However considering the nature and value of the cargo handled by the operator tariff premium is not common and certainly not for long periods as increased competition will appropriate the

[28] The difficulty in establishing a healthy and transparent legal and regulatory framework is not helped by the fact that, being a democratic socialist country, the executive branch of the government, i.e. the cabinet, is often fragile/short-lived and often been coalitions of several political parties. Apart from political structure, the establishment of such framework is also hindered by the common practice of corruption (often through so-called 'credit-facilities' within the dry ports) of which political reforms would often conflict the interests of various, sometimes authoritative, players. Given such problems, it is difficult to see how a healthy and transparent framework can be established in the foreseeable future.

consumer surplus. One had to bear in mind about the low value of most of the cargoes handled by dry port operators, where almost 50% of the imports comprise of waste paper, iron scrap and cotton waste, while there was hardly any significant value addition to exports such as handicrafts, brassware, raw cotton, tea and other agricultural products (CONCOR, 2007). International trade of such products is highly competitive and slightest addition to costs can render the goods uncompetitive especially where goods are price sensitive. It should also be taken into consideration the fact that moist of the goods handled by the operator are seasonal in nature especially the agricultural products. The volume also fluctuates with the festive seasons, fluctuations in the currency markets, increase in cost of credit and other inputs.

The remaining of this paper is going to review and analyze how the Indian government had attempted to resolve the dilemma as indicated above. Indeed, the core dilemma of the Indian government lies about how it can balance the dry port 'Diamond', enhancing its efficiency on the one hand, while at the same time maintaining the survival of local non-foreign-invested dry ports before any fundamental but long term solutions, i.e., significant structural reforms, can take place. Indeed, the competitive structure of the dry port industry does not only have an economic aspect, but political and social aspects would also pose equally (if not more) significant implications. Given the problems as discussed in this section, it seemed to indicate that, in some cases, within the Indian dry port 'Diamond', it was the government which brought in foreign players as an attempt to 'imbalance' the Diamond, while at the same time, as will be discussed below, it is also the government which plays a pivotal role in 'rebalancing' the Indian dry port 'Diamond' but without causing the phasing out of dry ports operated by state-owned corporations, notably CONCOR.

The major initiatives, both monetary and non-monetary, that the Indian government had taken in helping state-owned companies in resisting the challenges posed from foreign dry port operators can be categorized as: (i) land pricing and distribution; (ii) subsidies on operational costs; and (iii) growth protection umbrella. In the following sections, these policies will be analyzed one by one.

8.5 Land pricing and distribution

In term of land policy, state-owned corporations were often given preferential treatment so as to ensure that such new dry ports could develop with maximum ease. The major component of the capital costs involved in the construction of a dry port is the cost of land and technical information from the industry suggested that a typical dry port with an annual throughput of 120 000 TEUs requires a land area of about 121 400 m^2 (i.e., about 30 acres) (Ecorys, 2007). Although land cost varies based on several factors, e.g., location, availability of usable land (for example, marshy land is not suitable for dry port construction, or would require substantial expenditures to make it suitable through filling and/or leveling), economic environment, competition with other potential land users, proximity to market place or gateway ports, close affinity to road/rail network, etc., Taking the above factors into consideration, by 2007, the land price would vary between US$ 25 000 to 100 000 per acre, and thus a dry port with an annual throughput of 120 000 TEUs of throughout would typically need to spend US$ 1-3 m just for acquiring the necessary land required.

Apart from land price as mentioned above, acquiring land for the construction of dry port, especially green-field projects, is subject to governmental permission in changing the land use purpose (as almost in all cases, the land was initially used for for agricultural purposes). Last but not least, in India, the acquiring of land is complicated the non-availability of proper land records, which often led to wastage of time and litigation. To resolve such problems, the government, through local bodies like City Industrial Development Corporation (CIDCO) or other similar bodies, acquires land from the user and develops it after which it is sold or leased to the interested parties. However this process is often riddled with corruption and sloth. As noted by various interviewees (including developers who were involved in dry port projects), it was all too common to find that the promised road electricity, telecom infrastructure was never delivered or delayed due to the fact that government officials were often waiting for ‘credits’ before taking the initiative in acquiring the required land.

In this aspect, it is interesting to note that, in India, the government itself is actually the largest landlord within the country, and thus possessing considerable strength in manipulating the distribution and use of its land, with the Ministries of Railways and Defense and port trusts, owning huge tracts of land across the country. In addition to this the government, through its corporate limbs like CONCOR and the Central Warehousing Corporation, is the biggest service provider and warehouse owner. As such these dry port owners have land available for use at nominal cost or well under market value. In most of the cases land has been leased out to them for long periods at very low, subsidized rates. Furthermore, being the biggest landlord in India and is also a major presence in the field of logistics, it is not surprising to find that the government itself is also an important price setter, rather than dictated by the market forces, thus enabling the implementation of 'dual' pricing on the sale/lease of land. While charging market prices to foreign investors, the government often ensures that the land available for setting up of dry ports by CONCOR is either on long term lease or sale at highly subsidized rates. According to the information provided by interviewees, the US$ 1-3 m investments on land could even be waived in certain circumstances, as long as government officials were compromise 'alternative' arrangements to ensure that their interests could be maintained.

Being the largest landowner, the government's land distribution policy was also highly protective to state-owned corporations, of which the latter (like CONCOR) often enjoyed the privilege of obtaining cheap required land *vis-à-vis* other private operators. A typical example can be found in Mumbai. While most of the 17 dry ports surrounding JNPT are privately owned and operated, until now, the government has, so far, only granted land to the CONCOR-operated dry port in the construction of railhead (which was also constructed through public funding), whereas leaving all others transporting their containers by trucks. Given that the typical cargo transportation rate between dry and gateway ports cost about US$0.15 per km US$ 0.25 per km by trains and trucks respectively (Ng and Gujar, 2007), it was clear that the government had imposed preferential policy so as to trigger the attractiveness of state-owned corporation against its competitors.

8.6 Subsidies on operational cost

Government influence also existed with regards to the coverage of revenue costs[29], of which transportation costs were also highly subsidized, usually in terms of fuel subsidies, as well as rail and road haulage between dry ports operated by state-owned corporations and the gateway ports/production plants. According to anecdotal information provided by industrial players (through interviewees), users would often enjoy nearly 50% discount in fuel costs in using dry ports operated by state-owned corporations like CONCOR. Such assistance had significantly enhanced the competitive positions of dry ports operated by state-owned corporations, especially given the current rapid increase in oil price[30] and the policy simply implies that rail can possibly be employed in such dry ports even if the minimum threshold has not been fulfilled[31].

Given such substantial assistance in both capital and operational costs, dry ports operated by state-owned corporations were often able to make extensive use of discounts and preferential pricing in attracting customers. Although the company has a published tariff, based on in-depth interviews as conducted by the authors, even CONCOR made no secret that published information is merely for window dressing purpose, and the actual service price was significantly lower than what had been stated, especially towards the major customers, where bulk discounts, extended credit periods and storage offered at subsidized rates were common, unless during congestion seasons/periods. Moreover, apart from discounts, in certain cases where the cargo involved was time sensitive or prone to pilferage (like perishable products, ready-made garments and accessories, household goods, leather goods, pharmaceuticals), the operator often demanded a premium above the published tariff simply for being extra diligent whilst handling such goods. Indeed, it was also not uncommon for the operator to rent out partially or sometimes entirely the storage space to a single customer for certain time periods against payment in advance which relieved its cash flow burden.

8.7 Growth protection umbrella

[29] The revenue component mainly comprises of costs of transportation from the dry port to the gateway port and back.

[30] For example, between Jan 07 and Jan 08, oil prices have been doubled, while such figure had increased more than quadrupled since 2002 (BBC, 2008).

[31] In India, it is generally agreed that a minimum of 90 TEUs of containers is required for rail service to become economically feasible at the indicated rate of US$0.15 per km. For more information, see Ng and Gujar (2007).

The government also carried out policies which restricted competition and to allow its own new dry ports to grow. For new dry ports established by state-owned corporations, the operator was often allowed to suffer a financial loss in the initial period of two years. During this period, the operator was expected to make every effort to keep his overheads low on the one hand while canvassing for more business on the other. Such scenario had largely benefitted such state-owned corporations like CONCOR, as it implied that a guarantee was offered by the government in absorbing any losses which had incurred during this period. In fact, even if the objective of balancing the books failed after the initial two years, the dry port operator was able to cut its loss, through selling off its equity holding at that time, either partially or fully.

8.8 Conclusions

The case study in this paper serves as a typical example illustrating the dilemmas of many developing countries in tackling the forces of globalization. On the one hand, the government would like to take advantages of globalization in assisting the country's economic and thus enhancing its global status and competitiveness (Dickens, 1998), while at the same time need to minimize the shocks and potential negative consequences as imposed by globalization. Indeed, as witnessed by the case of Indian dry ports, the Porter's CD does not only have an economic perspective, but social and political perspectives are equally important, if not more.

Another lesson learned from this paper has posed a big question mark on the 'complementary' nature of governmental influence on the competitive structure of an industry. Porter (1990) argued that the role of government was limited other than providing a favourable competitive platform for firms to compete. Indeed, in the case of Indian dry ports, such a platform had been created, but rather than favouring all players, it was clear that the platform was favouring those operated by state-owned corporations, of which the government also had significant interests in, as the market was severely influenced by factors like overt and covert subsidies, as well as restricted competition. Rather than the market 'referee', it seemed that the Indian government was taking both the roles of referee and player, and imposing policies which favoured their interests most, not helped by the continuing presence of relations and corruption, which further increased the government's rather conflicting policies in attracting foreign investments on the one hand, while continuing reluctance in allowing the industry to work freely based on economic principles. Clearly, the case of dry port had illustrated that, rather than purely a business, dry port was very much a tool used by the Indian government in achieving various political purposes and national objectives.

Through this paper, it is hoped that it will be provide some insight not only on the development of dry ports in India, but also shedding some light on the how the forces of globalization had its impacts on the development of newly developing countries.

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