THE SPATIAL CHARACTERISTICS OF DRY PORTS IN INDIA

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ABSTRACT

Using the case of India, this paper investigates the spatial characteristics of dry ports. By applying the grid technique, an attempt is made to identify the optimal location of dry ports for three major industrial regions in southern, central and northern India, namely Tirupur, Nagpur and Ahmadabad, respectively. Attention is paid to whether the simulated optimal locations correspond to the real situations, as well as the reasons for and impacts of such similarities and/or differences.

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

INTRODUCTION

Developing economies often rely upon exports of agricultural and non-high value, often labour-intensive, manufactured products in sustaining their economic development. The values and competitiveness of such products within the global market are often influenced by value added activities such as grading, sorting, packaging, labelling, marking, refrigerating, processing, distributing and retailing. Such requirement, together with the development of multimodal supply chains, have gradually triggered the development of dry port, which often plays an important role in suiting the need for market development, seamless integration and closer collaboration between different participants of supply chains.

Generally speaking, a dry port can be understood as an inland location where the consolidation and distribution of cargoes takes place, with functions similar to those of seaports, including the handling of cargoes, the provision of intermodal transport connectivity, information exchange and other ancillary services, such as customs inspections, storage, the

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maintenance and repair of empty containers, and tax payments. The establishment of dry ports allowed 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, and leading their products to become competitive in the global markets. In some cases, the existence of a dry port even acts as a prerequisite for the export of certain products, especially in developing economies where the logistics sector is often not only disorganized and inefficient, but also highly fragmented, thus resulting in high logistics costs. In this case, a dry port can play indispensable role, which can have various positive impacts on export potentials, including: (i) the preservation (and even improvement) of a product's quality, thus sustaining (or even increasing) its value; and (ii) the reduction of transport costs (through consolidation) and damage to cargoes.

By early 2009, about 200 dry ports had also been established throughout India. In view of the proposed establishment of special economic zones throughout the country and the simplification of customs procedures, further development in transport infrastructures and superstructures by way of capacity augmentation and mechanization/automation is imperative to realize the true potential of containerization in India.

With such understanding, the geographical location of dry ports is pivotal for efficient and cost effective freight movements between production bases and gateway seaports. The locational decisions of dry ports have significant bearings on the efficiency and competitiveness of the whole supply chain. Here the fundamental questions concern not only the nature, origins and destinations of cargoes but, more importantly, how they are moving and which particular transport hub(s) should be used. While strategies and decisions relating to capacities and networks are usually short-term by nature and can be altered in the intermediate term in response to market demand and the availability of land and capital, location decisions are fixed and difficult, if not impossible, to reverse in the short or medium term. Simply speaking, making inappropriate location choices can result in massive financial wastage, which can ultimately affect the price, and thus the competitiveness, of the country's merchandise within the global market.

I. SOME THEORIES ON LOCATION

While deciding upon the suitable locations for transport hubs, geographical consideration is essential because economic activities are organized within chosen areas, as well as the underlying processes leading to the creation of spatial patterns. One of the offshoots was the location theory, of which its core concern was not just related to the optimal usage of available spaces, but also the precise locations where particular facilities should be settled.

In this context, two concepts should be highlighted - centrality and intermediacy (Fleming and Hayuth, 1994; Fujita and Krugman, 1999). Centrality could be understood as the ability of the centres concerned (often cities and industrial bases) in generating their own traffic. Subsequently, such centres assumed some of the qualities of intermediacy (of which the concept will be discussed later in this section) and became gateways to distant places outside the region. Apart from being nodal points for cargo consolidation and distribution, these centres also become the foci of economic and transport activities (Chakravorty and Lall, 2005). Thus, centrality, be it local, regional, national or continental, would have significant impacts on the centre’s size, functions and traffic-generating potentials. Indeed, it was not surprising that many central places are also the natural seats of political power, as well as important transport intersection points (Losch, 1967). However, it should be noted that identification of a central place, to a certain extent, also depended upon the perceptions of facility users.

Intermediacy is a spatial quality which could be identified in the context of the transport system, and could generate additional traffic if favoured by users (usually carriers) as connecting hubs. At such locations, services were often connected with national and international services, as well as transfer between different transport modes. As pointed out by Fleming and Hayuth (1994), some locations had nothing else, but simply geographical advantages, to be recommended as transport hubs. A number of container ports nowadays gained their trans-shipment centre status mainly due to the strategies of liner carriers like Gioia Tauro (Ng, 2009).

Similar to centrality, intermediacy does not necessarily only imply direct measurement of geographical distance, of which its criticality is also perceived by users who might decide to take its significance away, e.g. the introduction of alternatives, technological improvements, changing trade patterns, etc. While any favourable sites could often create potentials and opportunities to flourish into transport hubs, they do not necessarily create genuine demands to ensure their survival and/or competitiveness. Thus, similar to centrality, the significance of intermediacy also possesses subjective elements.

The above analysis clearly indicates that centrality and intermediacy serve as major spatial qualities in deciding the optimal locations of transport facilities. These concepts, however, are not always clear-cut and, sometimes, they might overlap with each other (Fleming and Hayuth, 1994). For instance, while many seaports started as gateways due to intermediacy (and favourable physical conditions), they gradually developed into central places as business started to move into surrounding areas so as to exploit the potential competitive advantages, while also mutually assisting each other through agglomeration. In turn, enhanced centrality could trigger further improvements in accessibility, between the seaports and other regions, leading to further increases in cargo flows. As noted by Notteboom and

Rodrigue (2005), this process could be exemplified by the case of the United States, where a number of dry ports started to attract service agglomeration around and gradually developed themselves in local/regional logistics centres. To a certain extent, most transport hubs nowadays possessed certain degrees of both centrality and intermediacy so as to maintain their survival, and the degree of influences of these forces could change overtime.

II. CASE STUDY

Three major industrial regions located in southern, central and northern India will be investigated. In this section, a brief introduction to these regions will be introduced.

A. Case one: southern India—Tirupur

With a population of 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 $1.5 billion annually, equivalent to nearly 40 per cent 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 United States.

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 seaports 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. Apart from TICD, a small amount of cargoes will also be cleared at Kudalnagar ICD (KICD) located at Madurai.

B. Case two: northern India—Ahmadabad

With a population of 5 million spreading over 50 km^2, Ahmadabad is located in north-western 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 such as 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 per cent, 20 per cent and 13 per cent of the cargoes are shipped out through the ports of JNPT, Mundra and Pipavav respectively. Apart from SICD, a small amount of cargoes will also be cleared at Ankleshwar ICD (AICD) and Gandhidham CFS (GCFS), both located within Gujarat.

C. Case three: central India—Nagpur

Nagpur is an old city located at the Indian state of Maharashtra, with a population of 3 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, aluminium, etc.

Nagpur’s local dry port, Nagpur Inland Container Depot (NICD), is located about 12 km 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 are shipped out through JNPT, of which it is also connected with NICD by road and railroads. 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.

III. RESEARCH METHODOLOGY

One of the foremost concerns of spatial analysis is the “friction of distance” (i.e. impediments to 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 fixed facilities (in this case, dry ports) 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. This technique also integrates both spatial and non-spatial data for solving transport engineering problems, with the shortest path analysis being a precursor to this technique. In other words, the optimal location simulated by the grid technique is the place with the minimum transport cost. A detailed explanation of the grid technique, including the mathematical formulations, can be found in annex 1.

During the analysis, several further assumptions have been made, including the following: (i) there are no significant variations between different dry ports in terms of efficiency; (ii) the unit transport cost has a linear relation with distance; (iii) unacceptable or inaccessible 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, a dry port is more than just a cargo distribution centre, as it also serves additional necessary functions in facilitating the shipment process, and 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 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. Furthermore, it is assumed that freight trains, instead of trucks, would be used, as long as the route concerned can fulfil two criteria: (i) the annual cargo size along this route reaches a minimum threshold volume of 32,400 TEUs; and (ii) this route is supported by railroads to gateway seaports. Given the existence of significant overcapacities in all three cases (see table 1), simulation here is based on a single- (rather than multi-) facility location model.

In order to provide a clear 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 common characteristics, i.e. they are all closely located (≤ 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 (≥ 90 per cent) are exported via their respective local dry ports, i.e. TICD, NICD and SICD.

IV. SIMULATION RESULTS AND DISCUSSIONS

A. Case one: southern India—Tirupur

The current and simulated solutions of Southern India (Tirupur) can be indicated as.

Current Solution: [Tirupur] → [TICD/KICD] → [Cochin/Tuticorin]
Simulated Solution: [Tirupur] → [Optimal dry port] → [Cochin/Tuticorin]

By applying the grid technique, 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).

Table 1. Capacities and container throughput of selected dry ports in India

Dry port	Paved area in 2008 (m^2)	Capacity in 2008 (TEUs)	Throughput (TEUs)	
			2005	2006
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

Source: edited by the authors

B. Case two: northern India—Ahmadabad

The current and simulated solutions of northern India (Ahmadabad) can be summarized as:

Current solution: [Ahmadabad] [SICD/AICD/GCFS] [JNPT/Mundra/Pipavav]

Simulated solution: [Ahmadabad] [Optimal dry port] [JNPT/Mundra/Pipavav]

By applying the grid technique, 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.

C. Case three: central India—Nagpur

By applying the grid technique, 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.

D. Discussion

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 with 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 (see 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 simulated optimal locations have failed to reflect the realistic situations.

Based on empirical analysis, 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). 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 complemented with earlier works by Ng and Gujar (2009) who pointed out that convenience, local relations and better local control often served as equally, if not more, important considerations on shippers’ decisions on which particular dry ports should be used.

CONCLUSION

This paper investigates the spatial characteristics of dry ports in India and reveals that locations of dry ports are, in many ways, 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.

Lessons from India seem to indicate that dry ports in developing, rising economies should locate within the proximity of central places so as to enable them to become commercially viable and become catalyst for regional development. Hence, it is necessary for governments to executive relevant policies so as to provide more centrality to the areas around dry ports and their facilities, and perhaps the establishment of logistics parks dedicated to value addition industries can be a good first step.

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ANNEX 1. INTRODUCTION TO THE GRID TECHNIQUE

The grid technique superimposes a grid upon the geographic area containing the cargo originating sources and final 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 in-/outbound cargoes of which, in this case, dry port operator handles.

It is important 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. The grid technique can be expressed as the following formulations:

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

s.t.

$$C,M,S,r,d \geq 0 \qquad (2)$$

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 transport rate/distance unit for the cargo and r is the inbound cargo transport 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. Last but not least, 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 per metric ton per km, respectively.