An example of a supply chain involving Multi modal containerised transport

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Abstract: This paper describes a stream of physical activities, involving multiple modes of transport and handling, and multiple actors – in the context of supply chain management. Part 1 is a general introduction to the area of multimodal transport and containerised movement of goods. Part 2 provides an analysis of one particular channel through which containerised movements through rail and road move through one of the major ports in India. The main focus is to map the flows of material, information, finance and transactions in this supply chain and see how the management of these flows fit in with supply chain objectives. This has implications on the planning and use of IT for this purpose are and the way the actors involved in this chain organise themselves. This is elaborated for two of the major actors in this: Container Corporation of India (Concor) and Indian Railways (IR).

Introduction: Logistics management is concerned with the effective movement of goods from point of production to point of consumption and managing the associated services. Two aspects of such movement are noteworthy when non-bulk goods are moved over long distances: First, goods are generally containerised, and this is especially true for higher value goods. Second, the movement of goods in such cases usually involves more than one major mode of transport.

Using different modes of transport may be effective for a shipper as it may offer the right mix of cost effectiveness, speed and locational flexibility. It could also be globally effective in the sense that it involves lower environmental, energy and overall social costs. For this reason, government policy also is aimed at facilitating this kind of movement.

Containerisation, when combined with multi-modal transport capability, it has some obvious advantages in terms of supply chain integration, since it provides for a unified flow of material and handling effectiveness across different transport modes. From the shipper's point of view, containerisation is sometimes a forced option while servicing export markets. Shippers then have to decide on the option of providing for container handling facilities at their end or resorting to stuffing of containers at container

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terminals. The former is obviously the prefered (but more expensive) model for door-to-door effectiveness in handling.

From the transporter's perspective, the multimodal nature of movement invariably means that multiple agencies are involved in the activity, one way or another. An additional activity is the provisioning of containers themselves, and providing for facilities at which containers can be stored and handled. Apart from this, multimodal movement implies co-ordination across the various agencies, such as freight forwarders, truckers, container stations, sometimes rail, ports, shipping lines, etc. There is often an infrastructural element in these activities, which have sometimes to be facilitated or provided by government or other agencies with long time horizon plans in place.

Given that this can be quite a challenging task to plan for, we attempt to outline some specifics of such multimodal movements, in a particular case of containerised import and export traffic to and from India. The objectives of this paper are:

(a) to highlight the role of some of the major players in the business of multimodal transport and to discuss the accompanying issues in logistics management

(b) to describe one such supply chain involving multimodal movement of containers and to identify how various initiatives by organisations have resulted in supply chain effectiveness.

Rangaraj and Viswanadham (2001) provides a more detailed discussion of these.

PART 1

1. Multimodal transport: The concept of multimodal transport has been comparatively slow to get started in India. Containerisation is not yet the major mode of transport, and on the roads, open truck movements are quite common. Srivastava and Khanna (2001), Ravi Babu (2001) and [4] provide a quick, comparative study of developments in multimodal transport, with special reference to India.

Another dimension to the management of multimodal transport activity is that it is difficult to set norms and design systems that are easily accepted. This is because there are a number of actors and there are natural conflicts of firm level economic interest that are not easy to resolve. For example, the aggregation efficiency that determines one firm's cost effectiveness could lead to overall delays and inventory costs in another firms performance, all as part of the same supply chain. This is quite typical in an integrated supply chain management environment context, where multi actor co-operation is required. A framework for benchmarking multimodal transport activity has been attempted by Ockwell [3].

2. Flows of containerised traffic: The movements of goods by the containerised mode has increased in India over the last few years. This has happened both in the import/export as well as the internal movement sector. For example, the movement of goods through major ports has shown the following indicative trend. The most important port that handles containerised traffic in India is Jawaharlal Nehru Port Trust (JNPT) and the associated Nhava Sheva Inland Container Terminal (NSICT). Traffic handled here has grown from 11.723 million tonnes in 1998-1999, to 18.573 million tonnes in 2000-

2001. Container traffic over these two years has grown from 669108 TEU containers to 1189780 TEUs.

While these numbers are small compared to some of the largest ports and shippers in the world, it is showing a stable growth trend and is likely to be an increasingly important mode of transport in India and the South Asian region in the coming years. Also, the size of the country and the hinterland region from the ports makes for a variety of choices for land movement. The issue of mode choice for internal movement of sea bound export cargo has been studied in detail by Ravi Babu (2001). One of the major modes of transport for this stream, as well as that of imported goods has been through trains carrying containers on flat wagons. Container Corporation of India (Concor) has been the agency that has bridged the sea movement with inland movement, wherever rail is involved. Movement of containers through JNPT and by Concor has some of the broad characteristics described below.

The movement is to hinterland areas in the western, central and northern parts of India. Major streams are to container depots in the Delhi region, to depots in Central India and to Gujarat. For example, between JNPT and Tughlakabad (near Delhi) in the 6 monthly period from April to September 2000, 52609 TEUs were moved in the export segment and 53938 TEUs in the import segment. The export and import figures a year (April to September 1999) earlier were 36869 TEUs and 39886 TEUs respectively. The overall fraction of containers moved by the rail mode is now coming close to 40%.

2.1 Commodity flows and aggregation points: Container movement by train offers economy of scale in transport costs. But this is achievable provided the movements are in sufficient volumes. The container trains to and from Tughlakabad to JNPT are based on aggregation of traffic from a regional base covering parts of Northern India consisting of the states of Delhi, Uttar Pradesh, Haryana, Punjab and northern Rajasthan. Tughlakabad is situated in the Delhi area (17 km south east of New Delhi) which is the main industrial area in Northern India.

The inland container depot (ICD) at Tughlakabad is one of Asia's largest ICDs. The throughput of Tughlakabad ICD has increased from 71,386 TEUs in 1993-94 to 2,21,068 TEUs in 1999-2000. The throughput is projected to touch 2,56,508 TEUs by 2000-01. Apart from the ICD at Tughlakabad which has container storage, handling and stuffing facilities, there are nearby ICDs at Moradabad and Agra in Uttar Pradesh and Panipat in Haryana, which provide as additional feeder depots to this flow. Moradabad is 150 km from Tughlakabad, and is a known centre for brass and glass artware. Agra is a centre for leather based exports, and the major product categories through Agra are shoes, garments, artware and hand-woven carpets. Panipat (about 100 km from Tughlakabad) provides exports of cotton garments and furnishings and processed rice.

PART 2

The next few sections attempt to describe and analyse the various dimensions of a specific physical supply chain process. This detailed look at a real life process is examined in the context of some principles and frameworks of supply chain management, drawn from the literature and from benchmarks of good practice in the business world.

The core process that we look at is the physical movement of goods between the container terminal of Container Corporation of India (Concor) at Tughlakabad, near New

Delhi, and the Jawaharlal Nehru Port (JNPT) near Mumbai. These goods are exported or imported at JNPT, and are linked to container carrying sea vessels at the port.

The goods that are carried in this manner are, of course, part of the overall supply chain of various manufacturers who use this service. The fit of this process in their supply chain is one area of interest. At the next level, since Concor acts as a consolidator and uses Indian Railways (IR) for the major part of the physical movement, the way in which Concor's supply chain objectives are achieved through IR is another matter of interest. At the next level of transaction, since IR is a large organisation, both physically and functionally, we examine how this service is operationalised effectively through the internal divisional (geographical) and functional mechanisms.

We highlight various dimensions of supply chain management: an assessment of flows in the chain (material, information, money and transactions) – in Section 3; the way these flows fit with the customer focused business needs of the organisations involved – in Section 4; and the role of IT, management control and organizational structures in the management of these flows – in Section 5.

We analyse the supply chain from the point of view of Concor as a supply chain driver, since it has defined the service, takes the responsibility of consolidation of goods, contracts with IR and provides performance guarantees to final customers.

This study may serve eventually to benchmark this intermodal service against international standards of supply chain effectiveness. The supply chain described here and the emerging role of Concor may set the stage for Third Party Logisitics providers in the industry. Manufacturers are moving towards such service providers as part of their overall move towards logistical effectiveness. For example, see Boyson et al (1999) for survey data in this regard. This is possible only with a level of professionalization and integrated control over activities like transportation, warehousing and storage, and also the capability to integrate into manufacturing activity at the level of scheduling and inventory management.

Emergence of this supply chain: Even from an integrated supply chain point of view, one has to make a choice as to the set of activities that can be reasonably managed, and analysed. It makes sense to consider this segment of movement (Tughlakabad to JNPT) as a supply chain, since one end - the port - is a natural point of separation of activities, as of now. Although there are agencies which would attempt to provide door to door shipments across the world, those processes would also be segregated for operational control at the port interface. This is because of factors such as customs regulations, uncertainty in port operations and lack of fully integrated information systems across ports and other modes.

Another major reason is that movements of ships carrying containers would be determined by factors larger than that of a single shipper's schedule, since the economies of scale are of a different level. For example, a truck may carry one or two TEU (twenty foot equivalent unit) containers or one FEU (forty foot equivalent unit) container, a container train may carry 70 to 100 TEUS, whereas a shipping vessel may carry in the range of 2000 TEUs. So as of now, it makes sense to plan for this supply chain as an entity and then attempt to interface with the onward supply chain from the port. Ship schedules can be viewed as determining some constraints on the timing of shipments that manufacturers place and perhaps their manufacturing activities.

The design of this supply chain relies on the fact that there is a viable stream of traffic between the two areas, achieved by aggregation of a number of different goods provided by different customers. We use the term customer to refer to the shipper of goods who would use directly or indirectly, Concor, IR and other agencies for the purpose of movement of goods. Our discussion revolves around how this stream of goods movement and its associated flows, are planned and managed effectively.

3. Flows in the supply chain: As identified earlier, the main activities involved in supply chain management can be analysed in terms of flows. The various flows are to do with physical flow of materials, the information flow, the flow of money or finance, and the transaction flow, identified, for example, in Tilanus (1997). These flows are described in general, and are valid for all commodities that are handled in this chain.

3.1 Physical flow: The supply chain in question deals with three major flows that have to be managed: the aggregation of goods at Tughlakabad, the movement of goods from Tughlakabad to JNPT and the disaggregation of goods at JNPT. The end points of the physical supply chain under question are from factories or warehouses of individual shippers to the container handling area at JNPT. An important intermediate location is the ICD (Inland Container Depot) at Tughlakabad, where containers are aggregated and trainloads are formed [2].

3.1.1 Consolidation (aggregation): There are two levels of consolidation. One is the formation of container loads by Concor or by freight forwarders or consolidators and the other is the formation of container train loads by Concor.

Since the rail movement from Tughlakabad to JNPT is over a congested section of IR, principles of capacity utilisation dictate that traffic is moved in rake (full length train) loads only. The normal load carried on a container train is nine or ten composite units of 5 container flat wagons. Each container flat can carry one FEU container or two TEU containers. A typical load combination could be of eleven FEUs and sixty seven 20 TEUs, which therefore forms a train load of 45 container flats. A typical load could contain shipments from a variety of customers and a variety of destinations (from JNPT).

3.1.2 Bulk movement: The movement of containers happens through train load movements on IR, as described above. The design of the integrated container flats and the associated braking system permits train movements at high speeds (up to 100 kmph, which is considered high in Indian operating conditions, given the condition of track, rolling stock and safe operating practices).

The movement over about 1500 km between Tughlakabad and JNPT is via the following major nodes on the IR network: Mathura, Kota, Ratlam, Vadodara and Vasai Road. The fastest train on this section of IR (the Rajdhani Express) takes about 16 hours on the stretch between Tughlakabad and Vasai Road.

3.1.3 Disaggregation and further movement: The disaggregation activities are then handled by the port, JNPT [1]. The containers in a typical train load may be bound for a variety of destinations on carriers. The movement of containers from JNPT to locations in Asia, Europe, and other parts of the world is done by shipping companies and consortiums. This activity is outside the direct influence of the supply chain drivers in our case. These movements are controlled by worldwide shipping interests and is outside the scope of discussion here.

The physical flow consists of containers carrying a number of different commodities. For example, major commodities exported to European countries through this route using containers include textiles, garments, steel coils, rice food products, plastic materials, marble, cotton/wool yarn and dyes.

3.2 Information flow: The major integrator of information flow in this supply chain is Concor, since it acts as the interface with shippers and transporters (IR and perhaps truckers and freight forwarders). Concor would provide information regarding the stuffing of containers, if done at their ICDs, their location, their loading onto trains, the progress enroute and the unloading of containers at JNPT.

For Concor, the visibility of movement between Tughlakabad to JNPT is provided through the Freight Operations Information System (FOIS) of IR. This system tracks the progress of trains - currently at a rake level, but soon to be provided at the wagon or container level. Concor allows customers to track this information through their system. Since trains are not marshalled en route, the train level information provided by the FOIS is enough to allow Concor and thereby its customers to locate individual shipments. Concor provides the train number which is carrying a particular shipment and updates the progress of this train, which the user can track. The IT infrastructure of the various organisations and their impact on the management of the supply chain is briefly discussed below.

In case of truck movements, some of the larger trucking companies are attempting to provide professional services to do with commercial and operating practices. The trucking market is highly competitive and rates fluctuate on a daily basis. Trucking companies need to offer the best rates. In terms of monitoring and tracking, technologies are being tested to provide geographical accuracy of movements. Such technologies have to be quite robust to operate in Indian conditions of road infrastructure, weather and operating practices.

3.3 Finance flow: The individual contract of movement is between customers and Concor. Concor in turn contracts with IR on a long term basis and is able to offer individual rakes with guaranteed times of transit. We explore a few basic financial transactions in greater detail.

- Shippers are charged a basic rate per container load but shippers can negotiate bulk rates for larger volume offerings. This is negotiated through agents.
- In the case of trucks, the rate that is charged for the pure transport will have to include the cost of loading at origin, unloading at destination (which may be governed by port labour utilisation rules), and charges (both official and unofficial) to be paid en route. Although there are moves to streamline the road movement of goods and eliminating hurdles such as checkpoints and entry restrictions, there are still a few significant ones remaining that have to be included while costing road transport in India.
- Concor negotiates contracts (yearly or more frequently) with IR for carriage of train loads. Concor would get some benefits of a long term customer of IR and would have some flexibility of rates. On the other hand, Concor is one of the first customers of IR with whom there is a negotiated guarantee of service (transit time) for some routes, with penalties for non-fulfilment. This is in addition to the usual service guarantee mechanism of handling and losses, which are addressed by the mechanisms

of claims and redressals. This area is one of the concern areas in IR's relationship with its customers but is much less of an issue in containerised traffic, which by its physical nature is relatively secure.

- There are two ways in which the rates offered by Concor to its customers are delinked from the rates offered by IR to Concor.
  - On IR, by and large, rates are for classes of commodities. Containers would fall under a certain classification, irrespective of what is carried in the containers. Concor on the other hand, in principle, can charge differently for different commodities, although it appears that the only distinction they seem to make now is the loaded weight on to containers (e.g. different rates for 20 TEU containers loaded upto 9 Tons and greater than 9 Tons).
  - On IR, for a given commodity class, rates are based on distance only, except for some well defined special cases. Even for a given commodity, Concor rates may depend on distance *and* other considerations. Concor can, in principle, charge origin-destination specific rates or time varying rates, depending on market conditions.

3.4 Transaction flow: This subsection illustrates the transaction flow, especially where there is a written contract of transfer of responsibility between two parties, in managing the other flows (of material, information and finance).

For road-rail-port shipments via Concor and IR, the individual shipper who needs to move one or more container loads of material from a location in Northern India to the port at JNPT would usually book traffic either through an agent with Concor or with a trucking company, which in turn would arrange to move the consignment either by own or hired trucks. In the case of end to end road movement, the trucker takes the responsibility of managing the entire flow. This includes movement over various state boundaries (in this case via Uttar Pradesh, Rajasthan, Gujarat and Maharashtra) which have entry regulations and entering the customs area at JNPT. In the case of movement through Concor, the responsibility is passed on either to Concor or to a freight forwarder. If the latter, there is a further level of transaction between the freight forwarder and Concor. In either case, Concor then forms train loads of containers and passes on the combined responsibility of shipment to IR.

4. Customer requirements and fit into customer processes: The supply chain of containerized goods that has been described is one of many such flows of freight in India. It is one of the identified streams of traffic that can offer both economies of scale to the service provider and an acceptable degree of effectiveness to the customer. Having described the flows in a general sense (across commodities), we turn similarly to a general description of customer requirements from such supply chains. Rangaraj and Viswanadham (2001) also provide some comparisons with competing modes.

The supply chain process above is now discussed along various dimensions of the customer processes that it must fit into. Customers who use this mode for part of their supply chain requirement would do so with an assessment of the following factors:

4.1 Delivery requirement: Goods meant for export and import, especially the former, are usually time constrained, by the needs of foreign markets (over which the

manufacturer may have little control), liner schedules and international norms of delivery reliability. This therefore forms a major part of the customer concern. The schedules of these ship carriers would typically act as constraints on the delivery requirements of this supply chain. Manufacturing activities and shipment schedules from factories would be governed by these schedules. This is why predictable and reliable movement from manufacturing locations to ports becomes a crucial issue.

Concor has advertised daily services between Tughlakabad and JNPT. In practice, there are 5-6 container trains which run per day and it appears that more services can be offered as per requirement – with flat wagons and containers not being constrained in the current scenario. This means that consolidation times may not be too high and are on an average, can be expected to be less than a day.

There do not seem to be explicit guarantees for consolidation time, but for the transit between Tughlakabad and JNPT, the service guarantee that is provided is for 48 hour movement. This compares favourably with road transport, which would take at least 72-96 hours for the corresponding segment. Overall, it appears that the delivery requirement of customers would be met by this supply chain, since it is best possible under the current infrastructure in India. Air is an option, but is in a different segment of cost and value altogether.

4.2 Handling and quality considerations during shipment: When there is containerised movement of goods, a number of handling and quality considerations are much less significant as compared to open truck movements. Shippers are committed to the containerised mode of operation and therefore have capabilities to handle containers either at their end or at consolidation locations such as the ICD at Tughlakabad. Container handling requirements at the manufacturing site include space for locating container trucks, or cranes for handling them. When comparing containerised road movement versus the supply chain being considered here, there is not much to choose between the services offered by the two choices. Container movement by rail is as safe and pilfer resistant, if not safer than similar movement by road. Both the end points of operation (the Concor facility at Tughlakabad and JNPT) have adequate handling facilities.

Increasingly, customers at the higher end of the value chain are willing to invest in container handling facilities at their end and do not want intermediate handling of goods and insist on door to door container movement. Especially for the return stream (from JNPT), this means that the final point of train movement must have container handling facilities to load containers on to trucks. Many smaller freight handling facilities on IR just have a goods rail line and provide access for trucks. If container handling facilities are not there, then the cost of road bridging by truck from the nearest container depot may make it unviable for the port-rail-road stream.

4.3 End to end cost: The end to end cost of shipments between Tughlakabad and JNPT by truck are in favour of rail movement especially for heavy shipments, since a shipment of more than 9 tons would require either two trucks or special multiaxle trucks for road movement.

For example, between the Inland Container Depot at Tughlakabad to JNPT, the rates as quoted on the Concor website are as follows.

Stream	Loaded TEU (upto 9 T)	Loaded TEU (upto 21 T)	Empty TEU	Loaded FEU	Empty FEU
ICD Delhi - JNPT	9400	13700	14500	28000	?
JNPT – ICD Delhi	9500	13800	14800	28400	19000

This would not include the cost of the shipment to the ICD at Tughlakabad, which would be the responsibility of the shipper or the freight forwarder. This would be in the region of Rs 2000 per 9 tons, depending on the distance from Tughlakabad.

4.4 Ease of transactions: The ease of order placement, documentation, monitoring and control of the shipper over the supply chain under discussion is inherently in favour of the single vehicle service provider such as the individual trucker. However, with proper use of IT and a more pro-active role by Concor, which might play the role of a third party logistics provider, this may not be a hard barrier in today's business environment. To some extent, some recent concerns about railways as a mode in India (poor wagon availability, low service guarantees, difficulties with claims, lack of supply chain visibility, difficulties in terminal management and price flexibility) may be addressed by Concor stepping in between the shipper and the pure transport function provided by the railways.

5. Role of IT and organisational structure in Concor and IR: In the supply chain under discussion, the role of IT in the supply chain is important for a number of reasons. Firstly, the value of containerised goods is relatively high and the requirement of speed, timeliness and reliability is perhaps greater than that of bulk goods or lower value goods carried in open vehicles. Therefore the value of information visibility to final customers is high. Secondly, multi-modal transport in the form of containers involves a number of agencies. This requires effective transfer of information between multiple players.

In most large modern organisations, information technology is so pervasive in management control that these two facets of the functioning of an organisation can be discussed concurrently. This is true of Concor to a large extent and of IR to a smaller extent. A customer view of IT requirements and some details of the management control systems in place at Concor and IR are provided in Rangaraj and Viswanadham (2001). This paper also contains some insights into the organizational structures and policies in these two organisations, which have led to an efficient delivery mechanism for the supply chain activities in question. This discusses the way in which the service has been defined and operationalised.

6. Some Conclusions: We have attempted to map the various elements of a collection of activities with supply chain implications for shippers, transporters and other service providers. This can be analysed using the language of value delivery processes and its implications for information system design and service design as elaborated in Viswanadham (2000) or from a decision making context, as in Raghuram and Rangaraj (2000) and Chopra and Meindl (2001) or from the point of view of benchmarking international multimodal operations as in [3]. The analysis will have to be complemented with a detailed study of the commodities moved in the chain, the specific concerns of

shippers and the overall infrastructure required to deliver effective services in the medium run.

Forward integration of this supply chain with port activities and backward integration with manufacturing or transport activities of shippers are other directions to extend the analysis. The operational interface at JNPT, which is a fast developing port, could be of practical interest.

This study has identified a coherent stream of activities and traced some systemic decisions on service design and effectiveness to the the supply chain concerns of the end customer. It has given a detailed example of how a service has been planned, within the organisational constraints of multiple agencies involved in the activity. It may also provide the elements of a more strategic positioning of the business activities of Concor and Indian Railways (two of the key players) by highlighting the interrelated nature of certain decisions and plans. It illustrates how the corporate goal of achieving customer focused and operationally effective services can be planned and operated.

There are also a number of operational optimisation issues involved in the management of this supply chain. Some of these would result in problem formulations where analytical techniques could be useful. The management of flows and the supply of containers (including empty containers) at multiple locations is an area with significant cost implications. Terminal management, aggregation strategies, scheduling of services over a network and in the presence of random demands are other challenging problem areas in the analysis of supply chains.

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