Multi modal containerised transport for export and import through Western India – a supply chain perspective

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Abstract

This report 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. It outlines some elements of an integrated logistics strategy and the various agencies involved in this. 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 manaegment 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.

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*Acknowledgements: Thanks to Dr M.Ravi Babu and Prof A.K.Srivastava for discussion support and to Mr Roshan Gaonkar, Mr Naveen Kumar and Mr R.Venkatesh for their help.

In this document, we do not discuss the pros and cons, for shippers, of containerisation as part of the mode of handling and transport. 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 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 in detail one such supply chain involving multimodal movement of containers and to identify how various initiatives by organisations have resulted in supply chain effectiveness.

As a consequence, we also point to the need for an integrated logistics strategy for shippers as well as transporters, third party logistics service providers and government, for the eventual outcome of such activities to be successful

PART 1

1. Planning in the context of multimodal transport

The concept of multimodal transport has been comparitively 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 (2001a) and [6] provide a quick, comparative study of developments in multimodal transport, with special reference to India.

As of 2001, the Multimodal Transport of Goods Act in India is not yet in a shape that meets the professional expectations of industry. The difficulties of implementing

regional initiatives in this regard are nothing new. The European Union, for example, has also found it difficult to find the right mix of incentives and legislation to facilitate multimodal operations to the "appropriate" extent.

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 [4].

1.1 Logistics strategy for a region

There are two starting points for thinking about the logistics strategy regarding a particular region. One starting point is the role of infrastructure and regional planning for economic development (usually growth). While analysing various sectors of the economy such as agriculture and manufacturing, this process would identify logistics and the effective movement of goods as an important objective of the planning process. In the Indian context, the India Infrastructure Report (2001) gives a concise picture of the various developments in transportation and related sectors and points to the need for integrated planning in this sector.

Another starting point could be to look at the logistical strategies and requirements of individual firms or networks of firms and derive the regional logistics strategy as an outcome of that. These are often conditioned by and in response to the logistics infrastructure that is available at the time. For example, Raghuram and Rangaraj (2000) emphasise this connection generally, and also with specific reference to the Indian context, in their chapter on infrastructural constraints on logistics.

In India, there is an attempt at convergence of these two approaches. For example, the role played by apex level industry organisations such as the CII (Confederation of Indian Industry) and others, is to bridge the gap between various actors involved in the activities of Logistics and more broadly, Supply Chain Management. This has resulted in sharper inputs to the debate between planners and the business sector and also some joint planning.

However, it is clear that state level and regional plans for economic growth need to be planned with logistics infrastructure firmly in place and not following in an ad-hoc manner, often too late to be effective, from the outcomes of industrial activity. Issues like proper evacuation facilities from ports, interchange points between road and rail, and multimodal terminals, which need the co-ordination of several different agencies (under the existing set up) are particularly important to pay attention to.

Planning for a regional scope of operations across nations is a still bigger exercise for similar reasons.

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. 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:

a) an assessment of flows in the chain (material, information, money and transactions) – in Section 3;
b) the way these flows fit with the customer focused business needs of the organisations involved – in Section 4;
c) the role of IT and management control in the management of these flows – in Section 5; and
d) the organisational structures that have facilitated these flows – in Section 6.

Although there are several actors in this supply chain, 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.

The major part of our discussion revolves around how this major 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. See Figure 1 in the Appendix for an outline

of this flow. A brief description is also given about similar flows in the major alternative to this chain, viz., truck movement from end to end.

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 [3].

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.

[There are multiple ways in which aggregation could happen.

a) Road movement from manufacturing location directly by containers to the Concor terminal at Tughlakabad.
b) Road movement by trucks to Concor depot at Tughlakabad and container stuffing there
c) Road movement to nearby depots (eg. Moradabad, Panipat) and then rail movement to Tughlakabad. In future, there is the possibility of occasional direct rail movements from these depots to JNPT or other ports, if the traffic warrants it.]

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 (onward 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 [2]. The containers in a typical train load may be bound for a variety of destinations on carriers. The further movement of containers from JNPT to locations in Asia, Eurore 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. The movements are controlled by worldwide shipping interests and is outside the scope of discussion here.

[A representative sample of some container trains indicates that 90 TEUs is the full length train, but trains are sometimes run with fewer containers – upto about 75-80 TEUs on this corridor. In other corridors, container trains could be run with fewer wagons, as the operating and traffic conditions warrant. For example, trains between JNPT and Hyderabad are run with fewer containers (about 35 TEUs, although operating conditions may permit trains with up to 60 TEUs).

In the Tughlakabad to JNPT stream, a analysis of destination locations on 692 containers (TEU) over 7 container trains (on a given day) reveals a very large number of global destinations (over a hundred). A pareto analysis suggests that about 12 destination locations account for only about a half of the traffic. This indicates that there is probably not much benefit in any destination wise aggregation at this point in the supply chain. The port provides a staging point for multiple such streams and is a natural point for the destination-wise aggregation activity.

Some of the movement on this sector is of empty containers, for at least two reasons. One is that the flow of empty containers is not balanced and Concor or some other agency would like to position empty containers at appropriate locations. The other is that containers may be owned by companies who intend to use them in specific circuits and are willing to incur the costs of empty returns. The balanced flow of containers is actually a significant problem, worldwide, and at least in aggregate terms, the situation here is not as bad as some other places. There are reasonable flows of containers in both directions, since there is both import and export.]

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 discussed in greater detail in section 5 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.

[The commercial details related to import and export transactions are quite complex, and are not described here. Agents who handle end to end charges will charge rates based on freight, some amount of empty haulage, customs clearance and documentation. Rates are available for container load and less than container load shipments and for various destinations. The exact model for pricing of such end to end services is not well specified in the academic or business literature. With more predictability coming into various subsegments, such as land transport segments and port operations, and with transport exchanges being developed in the country, one can expect to see more transparency in this segment in the future.]

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.

In addition to these general principles, there are commodity and customer specific transactions that must be considered for more detailed supply chain mapping.

[For example, in container movements, the containers themselves have to be procured leased from some agency. Though containers are meant to be interchangeable in design, they are often owned by specific companies or leasing companies and are intended for use in specific routes. These movements have to be managed as well.]

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 (i.e. not specific to a particular commodity), we turn similarly to a general description of customer requirements from such supply chains.

The supply chain process above is now discussed along various dimensions of the customer processes that it must fit into. While we do not discuss the transportation mode choice issue in detail in this note, it is clear that all customers who use this mode for part of their supply chain requirement would do so with an assessment of the following factors, which form the major requirements of customers;

a) Delivery requirement of shipments – both speed of transit and the reliability of delivery schedules
b) Handling and quality concerns
c) End to end cost

d) Ease of transactions.

Where possible, these factors are compared with other supply chain alternatives, such as road haul for the entire stretch.

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.

For end to end road movements, for a single container, there is no consolidation time, and the only constraining factor is the availability of the vehicle and container. Transit time by road is about 4-5 days. Service gurantees are harder to achieve in this segment because of congestion on roads, more vulnerability to weather conditions and detentions en route. For high value items, apart from a 2-3 day saving in lead time, the reliability of the Concor service is likely to be higher. The implications on inventory and of course, the timing commitment satisfaction in export shipments, are significant.

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. We assume that shippers under consideration are anyway 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.

Truck rates can be obtained from individual operators from factory directly to JNPT. These are approximately Rs 15,000 for a 9 Ton shipment from the New Delhi region to the Mumbai region. Commercial truck rates in the open market are available, valid from New Delhi to Mumbai (these fluctuate even on a daily basis) and one would have to add some amounts for local movements and entry to the port.

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 Information Technology and Management Control Systems

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.

[The planned use of IT in IR is more complex and difficult to achieve, because, among other things

- IR is a huge enterprise in human involvement (some 16,000,00 employees),
- IR carries on with a legacy of many fragmented, geographically and culturally dispersed systems
- IR operates in an environment of uncertainty, where even right of way is not unquestioned
- IR handles a very wide mix of activities ranging from carrying commercially viable, high value goods, to bulk goods of national, strategic importance; from business class passengers to socially subsidised travel of various kinds.]

We start by outlining the informational requirements from a supply chain, from the customer's view point, and then look at how Concor and IR have tried to align their IT and management control systems in this regard.

5.1 Customer view of information requirements: Customers view the supply chain under discussion as part of their order fulfilment process. In that regard, they need information from the supply chain regarding the following basic levels:

- Strategic information exchange; regarding the fit of the process under consideration with their own process, the investments required for the purpose, the selection of long term partners, etc. We do not discuss this in detail here.
- Tactical information exchange; regarding the contractual details of rates over the medium term (up to a year), service norms and guarantees, new destinations and collection points.
- Operational information exchange; regarding individual shipments, requisition of containers, order placements, tracking of shipments, payments and claims.

In all this, customers would like a single point contact within Concor or whichever player is positioning itself as the logistics service provider.

5.2 IT and management control system at Concor: Rather than discuss the spectrum of IT applications at Concor, we focus on those IT applications that have the most direct bearing on the supply chain management that Concor seeks to be a part of. From information available through its webpages, Concor has now implemented a number of information technology applications which allow it to offer (among others), the following:

- Service information to customers (scope and schedules of services offered, physical dimensions of shipments, carriage restrictions,e tc.)
- Initial rate information for individual shipments between various origin destination pairs
- Capability for customers to track and monitor the progress of the rail movement part of the supply chain movement by train number and shipment date.

Regional offices of Concor have developed some of these systems independently and have their own way of providing the information that is listed above. As of now, it does not seem that full commercial capability of automated booking of consignments and transfer of document is possible.

5.3 IT and management control systems on Indian Railways: The informational basis for planning and opeational control on IR is a complex one. The system is a human intensive one, which is designed to respond to the human intensive nature of the operations, sometimes under conditions of high usage and uncertainties. On the IT front, at present, IR is in the midst of an elaborate and fast developing phase of partial automation and computerisation in various areas of planning and control. We consider three aspects of the IT system on IR here (for a more general discussion in the context of supply chain management, see Rangaraj and Srivastava (2001)).

5.3.1 Demand Forecasting and Customer Interface: The assessment of demand on IR is a multi-level exercise in forecasting and marketing. There is a formal system of collecting past data and projecting targets based on market conditions and services, but this is not a very watertight system as of now. The export oriented manufacturing segment of the economy is quite uncertain and the freight transport market is highly competitive. So forecasts leading to service design and service offerings are indicative, at best.

The commercial interface of IR with the freight customer is one of the least developed and IT-enabled aspects of the system of working. In many areas such as automated order enquiry, order placement, tracking, settlement of payments, settlement of claims, etc, there is scope for improvement. For the present supply chain, IR essentially deals with a single customer (Concor), and is able to manage this single interface.

5.3.2 Freight Operating Information System (FOIS): This is an integrated management information system which is now in place in most of IR. It is installed and operating on the circuit under consideration (see the section below on organisation, for some more details). It is a system designed and developed through CRIS (Centre for Railway Information Systems) and outside vendors. It provides for information reporting from the divisional level upwards for a variety of requirements.

[As of November 2001, the FOIS has a rake management system which is functional almost across the entire IR organisation, and a terminal management system which is being implemented. Both of these systems have a large number of modules and functionalities. They are designed primarily for efficient management of railway activities and resources, since a large part of railway acitivities consists of

managing large, known flows of goods and passengers and all the resource allocation activities associated with that.]

Of interest here is the tracking of trains, which is now being done in a batch mode - every half hour or so. Train information will eventually be updated continuously, when semi-automated control charting or equivalent systems are installed. This allows reliable and detailed information to be made available both for the operational planning of services and associated commercial activities.

Without elaborating further, the current capabilities of FOIS go some way in addressing the IT requirements of efficient supply chain management at the Concor-IR interface. They allow precise information to be passed on to the commercial front of IR and thereby Concor about placement of rakes, likely transit times and any en-route detentions. Large customers such as Concor will eventually have (limited) access to the FOIS system directly.

5.3.3 Management and control of trains on sections of IR: The real time control of trains on sections of IR is a complex task. Skilled section controllers, who are trained over a period of time, much of it on the job, form the backbone of this system. This is an area where IR is trying to introduce an appropriate level of automation.

[The range of tasks done by this branch of IR is too large to discuss fully here, but includes acceptance of trains in sections, co-ordinating with crew and loco allocation teams, communication with station masters and cabin personnel, arranging precedences (overtakes) and crossings, deciding on sequence of station operations, providing advance information for train inspection, acceptance, placement on sidings, and a variety of informal tasks in a highly human intensive system.

Currently, a variety of automation options are being tried and are being tested on different sections of IR. Eventually, a common model for the whole of IR may emerge, although there may be customized ways of handling particular types of sections. The different options being tried encompass a range of options (fully automated to manual) in various dimensions, inlcuding;

a) capture of train information
b) recording of information (charting or other means)
c) decision making and prospective scheduling.]

For the supply chain in question, the issue of interest is the extent of interface the section control provides with the FOIS. This is not resolved as of now, but is moving in the direction of integration of the control charting procedure (with an appropriate level of automation) with the updating of the information on the rake management system on FOIS.

Another concern area for IR is the detention of trains at terminals due to various reasons such as rake formation, availability of locomotives, crew availability and train examination. For the stream being discussed, these do not seem to be serious constraints, as more modern, standardised rolling stock is being used. As of now, the faster speeds of these trains and the inherent prioritisation of activities (see Section 6.3 and 6.4 below) associated with these container trains has ensured satisfactory performance in this.

6. Organisational structures vis a vis the Supply Chain

We briefly highlight the structure of a few major actors in the supply chain under consideration and see how they contribute to or create hurdles to effective supply chain management. We begin with a summary of the two major organisations that are part of the supply chain; Concor and Indian Railways.

6.1 Organisation of Concor: Concor started operations in 1989 and is a public sector enterprise under the Ministry of Railways in India [3]. It was set up with the prime objective of developing modern multimodal transport logistics and infrastructure to support the country's growing international trade as well as to encourage containerized cargo movement within the country. Concor has a regional structure as well as a structure oriented towards major business lines (Export-Import, Domestic, Piecemeal etc.).

Concor has emerged as a strong player in the integrated logistics industry in India, for two reasons: Rail is still one of the important modes of transport over long distances in India and Concor has natural linkages and synergies with rail operations and secondly, the container as a carrier is a natural integrator across modes and is in keeping with the requirements of modern movement of high value commodities. So far, Concor has not fully taken on (directly or indirectly) the responsibility of consolidation and aggregation and relies on the market to provide viable loads for efficient operation. In future, though, Concor could position itself as a third party logistics provider.

Concor is well suited to provide a good interface and integrated services in conjunction with IR. Apart from information integration through technology, this is facilitated by the overlap of professional interests in the two organisations, since Concor also is under the Ministry of Railways and many officers of Concor are either on deputation from IR or have prior experience in working in IR. Concor is now also willing to operate beyond the Indian Railways umbrella and has purely road based operations as well, where necessary.

6.2 Organisation of Indian Railways: IR has a complex organisational structure, involving many technical and functional cadres and a hierarchy of control and decision making. Referring to the section on ease of transactions from the customer's point of view, there is a move within the railways to offer more customer focused service and provide windows of interaction to meet the supply chain goals of customers who may be making the key decisions in the flow of materials. This calls for a role beyond that of a pure transporter, and is one that IR may be planning to move into, subject to its constraints of organisational flexibility.

Here, we discuss the implications of the current structures of IR, and some innovations in those, which have an impact on supply chain management. These are discussed in two dimensions, and in a simplified manner. One is the definition of an service class by Concor and IR and the other is the operational control of the service, with customer effectiveness in mind.

6.3 Service definition by Concor and IR: A major step in establishing the supply chain under discussion is the definition of a separate category of service for the long distance transit by rail. This service has been christened Contrack by Concor, and is known (informally) as Conraj – or Container Rajdhani in various operating parts of IR. The major innovations in this service definition are as follows:

- The Contrack trains are run at certain specified frequencies so that customers can do backward scheduling with respect to due dates, especially for exports. For example, the Tughlakabad-JNPT services are announced as daily services and other locations served by Concor are also advertised with a service frequency. The implication is that these services will be run at least at those frequencies, if not more frequently, irrespective of consolidation volumes. This provides a sort of service reliability to the small volume customer. This type of customer is generally unsure about moving shipments using modes of transport that are inherently scale economic and therefore likely to wait for "economic" load quantities before moving. In earlier days, Concor had run these container trains with less than train loads, in order to establish the regularity and reliability of the service.
- The Contrack trains are composed of air-braked rolling stock, which are capable of speeds up to 100 kmph.
- The Contrack trains are counted separately in freight planning and statistics of commercial and operational planning in IR, which allow the provisioning of some paths for these trains specifically.
- The Contrack trains are monitored at a higher co-ordinating level (the railway board), partly because they are run with service guarantees of transit times and partly as an experiment in system wide definition of new service categories. Whether the current levels of performance will continue without this level of monitoring, is an issue, but it is believed that the system will be set in place, with a higher level of technology (rolling stock) and higher standard of expected performance.
- A further plan of Concor and IR is to consider running these trains as timetabled trains, with pre-specified departure and arrival times.

[For a discussion on costs and service definition of such operations in a general setting, see Rangaraj and Sohoni (2001) and [5], where the costs of services subject to loaded and empty running, and waiting are considered. The model is also extendable to situations where scheduled services are run, even where there are uncertain demands. Concor runs such services in other sectors, such as Kolkata-Chennai.

Subject to wagon and container availability, Concor and IR will run trains whenever there is sufficient load, so there is not much uncertainty for large volume consignments. Scheduled services are clearly beneficial to smaller volume shippers, who can book slots and plan their shipments without too much of transit time uncertainty. Surprisingly, scheduled services are not necessarily viewed as beneficial for the supplier of services, for example, IR. See below.]

6.4 Operational Control on IR and at Concor

On IR, we focus on the physical operating infrastructure and its geographical control. The physical movement is over seven divisions of Indian Railways over three zones: Delhi division of Nothern Railway, Jhansi Division of Central Railway, Kota, Ratlam,

Vadodara and Mumbai divisions of Western Railway and finally Mumbai division of Central Railway. Freight trains are handled by each division through a system of interchanges at the interfaces between divisions. The system allows operational targets to be set and monitored. These targets refer to aggregate quantities of traffic handled over a period, and also to balances of traffic measured at certain points in time. They do not by themselves allow prioritisation of different freight trains and the tighter control of more time sensitive services (like the container trains under discussion) is achieved through direct monitoring by operating officers.

[Along the route from Tughlakabad to JNPT, the bulk of it is electrified double line main line territory and only the section between Vasai Road and JNPT (about 100 km) is single line – this involves some delays because of crossings with oncoming traffic and sharing of line resources. The only significant source of delays is the interchange between Western Railway and Central Railway at Vasai Road, because of the beginning of a congested single line section and some co-ordination difficulties between the two railway zones.

Resources such as crew and locomotives are allocated quite systematically, and across zones and divisions. Again, the faster speed and reliable operation of the container services means that these resources can be planned to meet the requirements. It is observed that delays in these resources are very minor.

As of now, there is no system of timetabled end to end paths for freight trains, although there have been occasional attempts to achieve this. As mentioned earlier, the Concor container specials are one of the freight traffic segments where there is an attempt to plan timetabled services.

The normal mode of operation is to push trains into the system at the first available "reasonable" time slot and then schedule the train section by section as and when time paths are available. This works reasonably well, since IR schedulers are highly experienced and make flexbile use of resources as and when they become available. This is considered preferable by some, given the levels of uncertainty in the operation even of the timetabled passenger trains. There are others who argue that a tighter control of all operations is ultimately required and therefore that planned freight services are a step in the right direction, even if it means initial difficulties.]

Organisationally, the tighter operational control of these services is obtained by the following means:

- The Contrack trains are scheduled at high levels of priority – among freight carrying trains – and are monitored with the service guarantee in mind. This is possible because of the speeds mentioned above, which means that the train can follow paths in the shadow of, or just before the fast moving mail express trains and thereby avoid delay-causing overtakes and loop line movements, which normal freight trains are subject to.
- Even in the high density suburban areas near Mumbai, these trains have a slightly larger window of operation, due to their faster speeds. Therefore, on average, detentions just short of the Mumbai area are avoided to some extent.

7. 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 [4]. 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. For example, pricing of intermodal services has been studied in Yan et al (1995) using network flow models and other techniques. The management of flows and the supply of containers (including empty containers) at multiple locations is an area with significant cost implications. For example, the Mack Blackwell Center for Transportation Center at the University of Arkansas has initiated a series of studies in this area [1]. 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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[1] http://www.mackblackwell.org/research/inprogress/2003Cole.html

[2] http://www.jnport.com

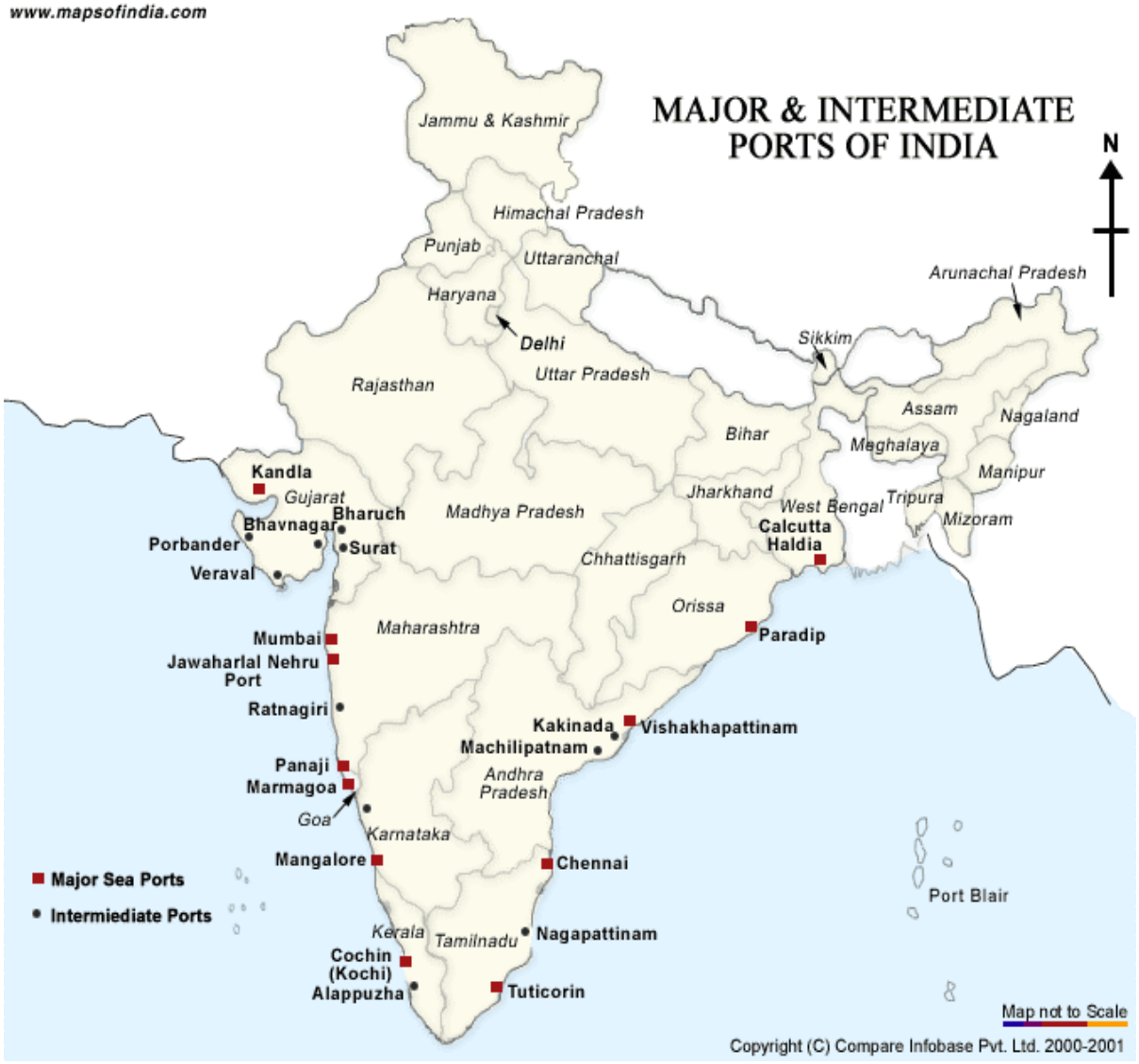
[3] http://concorindia.com

[4] http://www.bestransport.org/conference02/Ockwell2a.pdf

[5] http://www.cse.iitb.ac.in/~sohoni/public.html/traffic.ps

[6] http://www.rscbrc.ac.in/abh-arch/jul96/art4.html

Appendices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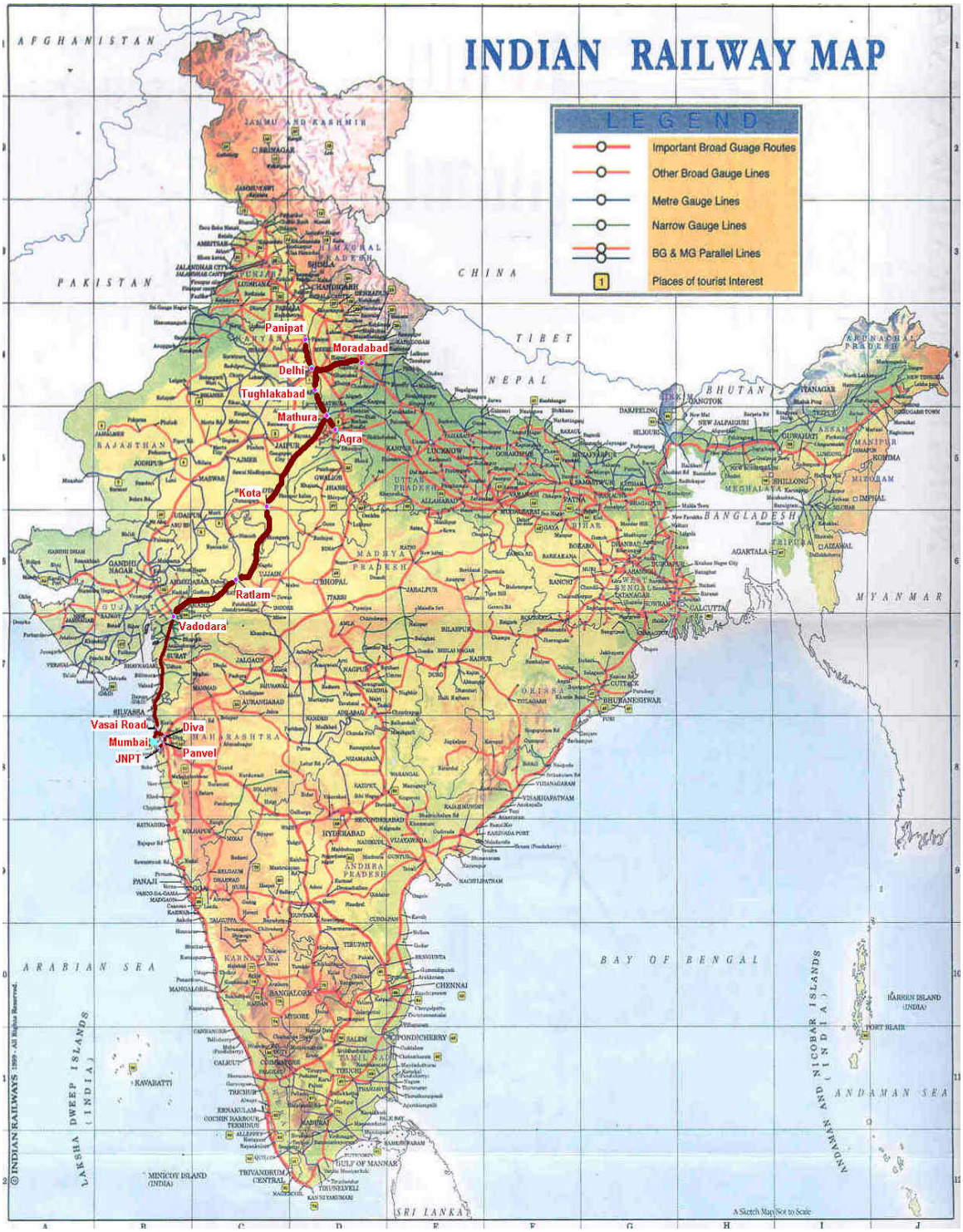

Route of interest from Tughlakabad to JNPT
Source: Adapted from railway map of Trains at a Glance (Indian Railways)