DETERMINANTS OF INTERMODAL TRANSPORT
AND
TURKEY'S TRANSPORT INFRASTRUCTURE

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1. Introduction

Intermodalism has been increasing both in the world and Turkey due to the demand and supply side developments in transport industry. Turkey has great potential in terms of intermodal transportation owing to its privileged geographical position amid European, Central Asia and Middle Eastern countries. The trend in development patterns in the Mediterrenean, the Black Sea, The CIS countries and Central Asia implies new intermodal networks leading to rising demand for intermodal transport.

Container throughput which is the core concept of intermodal transport was almost 1.5 million TEU in Turkey in 2001. The Mediterranean share of the world container traffic is increasing very quickly. Industrial activities have been accelerated in CIS countries and new transport corridors in the region have been planned. It is obvious that transport infrastructure of Turkey will gain importance with these developments in the region. Recent political, economic and technical developments have forced Turkey to take further steps towards improving its transport infrastructure to benefit from its geographical position.

This study aims at providing basic understanding on the concepts of intermodal transport based on the literature review and evaluating Turkey's intermodal transport infrastructure.

2. Concepts of Intermodal Transport

There are several terms defining the concept of intermodal transport. The terms "intermodal", "multimodal", "combined" and "through transport" are sometimes assumed to be the same and interchangeable.

The need for more efficient transport systems in developing countries is a concern of the United Nations Conference on Trade and Development (UNCTAD) where the preferred term is multimodal transport. The United Nations Convention on Multimodal Transport defines multimodal transport as (UNCTAD, 1994):

> "The carriage of the goods by **at least two different modes of transport** on the basis of a **multimodal transport contract** from a place in one country at which

goods are taken in charge by a **multimodal transport operator** to a place designated for delivery situated in a different country".

The European Conference of Ministers of Transport (ECMT) has adopted the following definition for intermodal transport (Institute of Logistics, 1994):

> "The movement of goods in one and the same loading unit or vehicle that uses successively several modes of transport without handling of the goods themselves in changing modes."

Many developing countries are unable to provide the full transport and communications infrastructure necessary for a completely intermodal system. In these countries a multimodal system, which can be seen as an interim stage on the way to full intermodalism, is a more realistic target (Gray and Kim, 2001). UNCTAD advocates multimodal transport as a type of service where a multimodal transport operator assumes a contractual responsibility to move goods from a point of origin to a destination under a transport contract, for an agreed price with - possibly - a time limit for the delivery. UNCTAD points out the possible confusion regarding legal liability if there is damage, particularly in a developing country with a relaxed approach to liability. A truly intermodal system requires unitary liability of the intermodal operator. The ECMT definition requires that there is no handling of the goods/items during transport chain. This requirement rules out the possibility of performing any value adding activities such as third party logistics services in the terminals. Furthermore, it rules out the possibility of changing cargo-carrying equipment according to the possibilities and requirements of the different transport modes.

The major objectives of intermodalism are to increase the speed of cargo distribution and reduce the amount of unproductive capital, whether in inflated inventory levels, inactive rail-cars or vessels delays at ports. Since new international trade patterns require quicker, has been cheaper and faster transport of goods than in the past, the main obstacle was found to be at each transport mode interface causing delay and increasing the cost of the whole transport chain rather than a moving part of that chain. Thus, both in developed countries and in developing countries the intermodalism is gaining ground.

2. Merits of Intermodal Transport

Demand for freight transport is a *derived* demand (Kotler, 2002; Cerit and Güler, 1998). It is part of the economic process – and therefore strongly influenced by such trends as global competition, customised production and the concentration of supply centres and distribution depots. Freight transport is closely linked with production and distribution processes and is being driven to meet increasing quality requirements in terms of flexibility, speed and reliability. Taking into account the complex interaction of sourcing, suppliers, manufacturers, retailers and consumers, freight intermodality requires the integration of a broad range of transport services in the supply and distribution chains.

The concept of intermodalism provides rational cargo handling, safe storage, quicker turnarounds of ships, rail wagons, trucks and cargoes and prevention of loss, pilferage and contamination. It also ensures increased productivity in the ports and other nodal points, and an efficient cost effective transport network, thereby promoting the growth of international trade (Chadwin, Pope and Talley, 1994:2).

The rationale for intermodal transport solutions stems, on the one hand, from the merits of the various modes of transport as such and, on the other hand, from relative merits due to problems in other modes.

As for the relative merits of the various transport modes, these are primarily of two kinds (UNCTAD, 2000). One is the obvious ability of certain transport modes to cover geographical areas where there is no other alternative. For example, in most cases, road transport is the only alternative in the "capillaries" of the transport system; whereas, there are other instances where waterborne transport is the only practical transport solution.

The other kind of relative merit is economies of scale. In transport there are often economies of scale, i.e. the unit price decreases with increasing volume, and there is economy in using a large means of transport as long as it can be filled with cargo. On the other hand, there are diseconomies in using oversized means of transport. Big manufacturers have big potential in cost reduction once they learn to concentrate their flows on a few channels. By doing so, the cargo volume allows for a very high frequency for the waterborne transport. This again leads to a flexibility in the transport system approaching the flexibility of road transport. In Table 1 are given expected benefits with increased use of intermodal transport for different stakeholders.

Table 1. Expected Benefits of Intermodal Transport for Different Stakeholders

STAKEHOLDER	EXPECTED BENEFITS
(Inland) shipping companies	Development of a new product and entering of new markets (earnings & employment).
Existing shippers	Lower transport costs, more transport opportunities / alternatives, greater reliability and safety.
Potential (new) shippers	Better access to market, opening up of new markets, more transport opportunities/alternatives, lower transport costs.
Railways	A potential growth market and segments where competition with road transport can succeed.
Road haulage industry	Improved economics, greater flexibility for crew operations (within constraints of prevailing driving and resting regulations).
Forwarding industry	Greater range of transport opportunities/alternatives, lower costs (earnings & employment)
Intermodal transport operators (MTO's)	Improved economics, more transport alternatives, lower costs (earnings & employment).
Authorities, policy makers (The society at large)	Additional transport opportunities/alternatives, enabling limitation/control of traffic congestion and safety, emission of hazardous materials, and energy use.

Infolog, (2000). Public Final Report, Project Funded by the European Commission Under the Transport Rtd. Programme of the 4th Framework Programme, Sept. 2000, pp.23-24.

3. Drivers of Intermodal Transport

Production and customer driven need for an integrated transport chain has led to intermodalism. To offer a competitive intermodal transport solution means making the correct trade-offs between costs and performance and setting the right priorities for the service quality. In order to do this, one must know the market and plan for the future. There are some strong trends at present, supported by various EU and UNCTAD directives and policy statements on intermodality, rail and ports (Gray and Kim, 2001:182-200; Infolog, 2000).

These trends will influence the future transport systems. They will be governed by some major general economic developments such as; globalisation of trade and transport, diversification of production and consumption, growing competition among economic regions in the world, growing congestion in and around main economic centres and growing concern for the environment and the use of energy by the transport sector.

Some major trends in transportation and logistics, imposed by the shippers, are increasing demands for integration of modes along the logistics chain, changing service requirements from node-to-node transport to door-to-door transport services, increasing demand for customised solutions of transport supply (performance, organisation), and increasing co-operation between individual transport modes (operators) and logistics chain organisers (Tuna, 2002; Taylor and Jackson, 2000:6).

The combination of these developments results in a growing demand for fast and flexible transport systems, with increasing attention for the impacts and limits of the existing transport systems. Information technology/telematics has the potential to contribute substantially to these goals by reducing friction and costs in the intermodal transport chain through better control and more efficient use of resources. In addition, for intermodal transport to emerge as a major alternative to road transport, ease of use, transparency, and the possibility of achieving reliable estimates for estimated arrival times are important properties that may be realised by intelligent use of information and communication technologies.

5. Intermodal Transport Infrastructure and Its Functions

Intermodality is a quality indicator of the level of integration between different modes: more intermodality means more integration and interconnectivity between modes, which provides scope for more efficient use of the transport system.

The economic basis for intermodality is that transport modes that display favourable economic and operational characteristics individually can be integrated into a door-to-door transport chain in order to improve the overall efficiency of the transport system. The integration between modes needs to take place at the levels of infrastructure and other hardware (e.g. loading units, vehicles, telecommunications), operations and services, as well as the regulatory conditions (Gray and Kim, 2001).

Efficient information and communication flows are vital for the management of these chains. They allow pre- and on-trip information exchange, including service availability, negotiation procedures, tracking and tracing, information on disruptions and the flow of transport documents.

The system of intermodal transport replaces the conventional fragmented transport system by an integrated system. This system has led to the development of special ships, and the development of relevant ports, rail and road infrastructure to service the needs of the intermodal infrastructure.

Containerisation is the central part of the total intermodal transport concept. Containerisation involves heavy capital investments for the development of an intermodal transport system. Investments are required in cellular container ships, rail flats, truck trailers, container boxes, terminals equipped with container handling cranes such as gantry cranes, transtainers, large container stacking yards, railway terminals for transfer operations, inland container depots, container freight stations and mobile cargo/container handling equipment such as forklift truck and spreaders etc. (Sanders, 1990; Deveci, Cerit and Sigura, 2001; Deveci, 1998).

Intermodal transport requires efficient transport systems supported by efficient infrastructural and institutional facilities so that goods move smoothly, safely and rapidly from door to door. The major infrastructural facilities include railroads, roads, airports, seaports, inland container depots and container freight stations.

Road vehicles capable of transporting containers not only provide local distribution but also long haul services where rail links do not exist. Road transport has the inherent advantage of flexibility, door-to door service capability, speed, etc.

Rail transport is used between ports and inland distribution centres separated by long distances since it is less expensive for carrying large volumes of cargo over long distances. Rail traffic has been adapted to carry container traffic, through special designed wagons and container yards. Specialized container trains, such as, double stack trains offer regular schedules with guaranteed departure and delivery time.

Air transportation began to take part in more advanced intermodal movements of cargo on international routes. The construction of special air-surface containers produces a common denominator for air-sea and air-surface intermodal movements.

Shipping services are regular, scheduled container carrying services. Ideally, they guarantee departure times, delivery times, regularity and frequency of service, direct service without transshipment or warehousing en route. The movement of containerised cargo by inland waterways is not very popular as component leg of the intermodal system. However,, it has been taking place in Europe with the concept of short sea shipping.

Container Ports are fully equipped to handle container ships so as to cause minimum detention to ships. In particular, the ports are equipped with container terminals, container handling equipment (including gantry cranes, transtainers, sttradle carriers, reach stackers and forklifts) and container yards. The productivity of the port in this respect is generally reckoned in terms of containers handled per crane per hour. Success of a hub port depends on various factors: Economic and political stability, strategic location, high level of operational efficiency, high port connectivity and inland transport facilities, adequate infrastructure, cheaper terminal costs, simplified customs procedures, adequate info structure (such as EDI etc.) and a wide range of port services (Tongzon, 2001)

Inland Container Depots (ICD) are established to relieve the congestion at the ports and its adjacent areas, and to extend the continuous movement of container traffic beyond ports, thus bringing containers closer to the cargo generating hinterland areas. ICDs serve a significant role of changing the mode of transportation, usually from rail to road and vice versa. ICDs provide the following services: Handling of containers from road, rail and barges to a temporary storage yard (CY), intermediate storage between various transport modes, receipt and delivery of containers and general cargo, cargo consolidation and distribution, depot functions, maintenance and repair services for container handling equipment, refrigeration equipment, road chassis etc. Custom's clearance activities at inland terminals could help to decrease the dwell time of containers in deep sea ports. Physical distribution services can be provided economically at or close to the ICDs (Sanders, 1990; Chadwin, Pope, and Talley, 1994)

Container Freight Stations (CFS) main function is to provide stuffing and stripping service for a container, along with necessary custom formalities. Another important function of a CFS is to consolidate smaller shipments of LCL (Less Container Load) cargo into full FCL (Full Container Load) shipments. The CFS is normally connected to the nearest ICD by road. From the ICD, the containers are transported to the gateway ports, for direct transportation from and to ports. A CFS thus serves as a cargo aggregation center (Deveci, 1998).

4. Determinants of Intermodal Transport and Critical Success Factors

Definitions of intermodalism usually concentrate on operational aspects and transport infrastructure. However, successful intermodal transport also requires a conducive administrative and legal environment, an efficient interchange of information. Lloyd's of London (1992) has proposed a framework that describes the intermodal system in terms of five layers representing five different functions vital to the efficient intermodal system. The top layers are first; the physical base of transport operators and transport movements and second, the associated commercial services and their costs. The third layer refers to management control of the system and is measured in terms of management time and effort. The forth layer is an adjunct to the management system and concerns the flow of information required to coordinate the intermodal trip and process the required documentation. Finally, the fifth layer refers to the liability for damage and delay and is measured in terms of relative risk. Sanders (1990) added one more layer to this model, called logistical approach, and is measured in terms of saving made.

D'Este has pointed out the intermodalism as a technical, legal, commercial and management framework for moving goods from door to door using more than one mode of transport. This definition emphasizes that intermodalism is an "service" rather than a "technology" (D'Este, 1996:5).

Tablo 2. Components of Six Facets of Intermodal transport

CFS CY	Road Rail	Terminal	Sea/tuck leg	Terminal	Road Rail	CFS CY
Container Positioning	Inland Movement	Terminal Operation	Ship Stowage Route Scheduling			
C& D	LCL Packing	Inland Move	Port to Port	Inland Move	C& D	
Booking	BL or WBL	Invoice	Manifest	Delivery Instruction	Release of Cargo	
CFS	Road	Rail	Terminal	Sea	Concealed	
Production	Stock	Intermodal Distribution	Stock	Further Transform. & Sale		

Source: Sanders, G. (1990). Concept of Multimodal Transport, Brugge, p.47; Lloyd's of London Press, 1992.

The model of intermodal transport system which is presented here is a descriptive rather than a mathematical one. **Table 2** show the layers of the intermodal model and required infrastructure. It is designed to assist an understanding of the various elements of intermodal transport and show how they are related to each other and to the whole. All the components of the intermodal infrastructure need to be connected via “infostructure”.

Gray and Kim consider the five determinants to successful intermodalism. These are standardisation, expenditure, interchange points, types of carrier, organisational coordination and role of government-deregulation and other encouragement. Figure 1 shows the main features associated with successful intermodal transport.

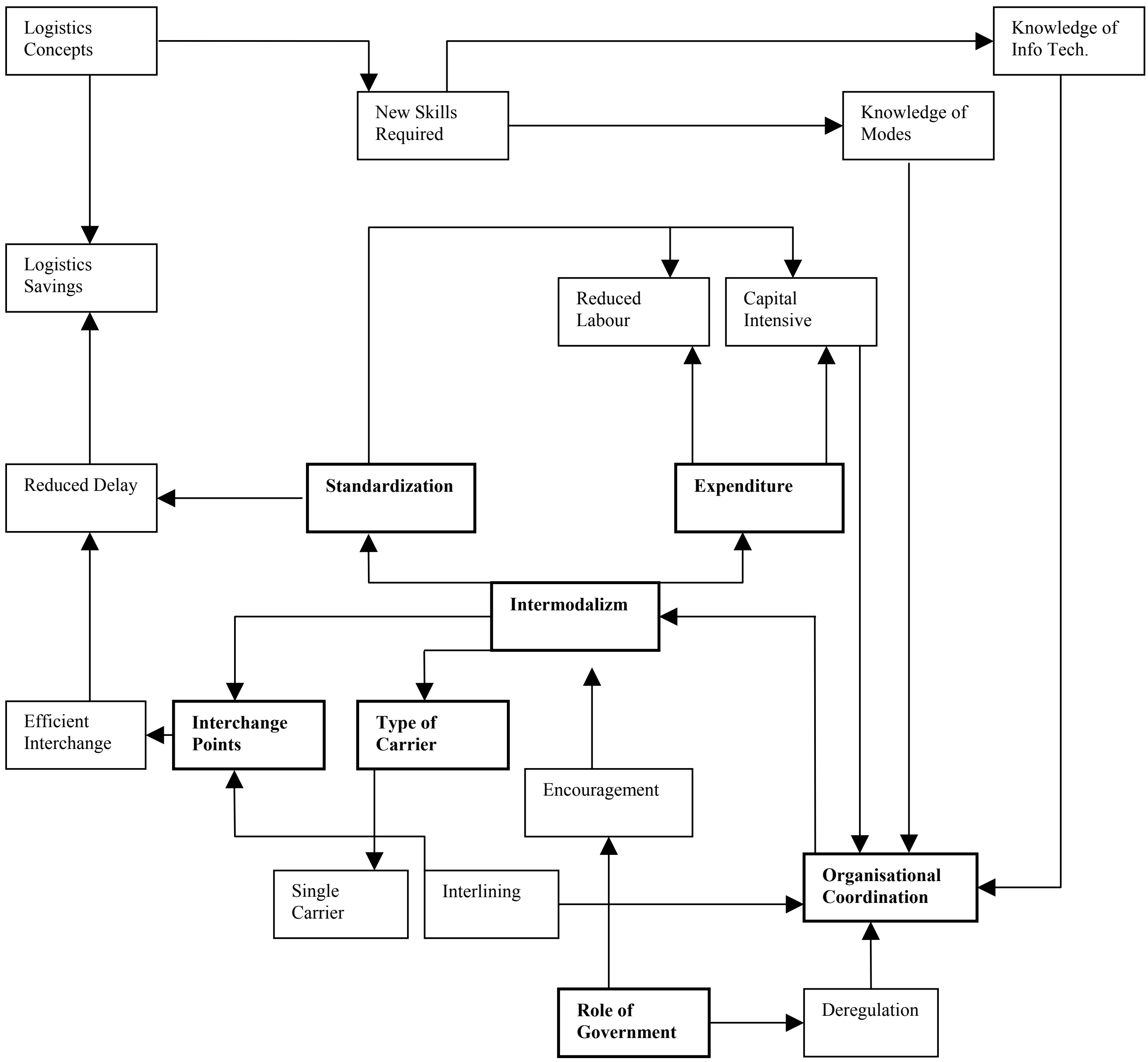

Figure 1. Keys to Successful Intermodalism (Gray and Kim, 2001:188)

Intermodal movements usually include both international and national transport. Containers have been subject to ISO (International Standards Organisation) for many years, although sometimes shipping lines have attempted to move away from ISO standards. Sometimes there are non standard applications in domestic transport. In fact, it is more difficult to standardise intermodal transport than to standardise containers. In some ports of the world, national interests may predominate and be a reason for standardisation necessary for intermodal transport. There have been standardisation efforts in the USA and EU in railways and road transport. Double stack trains are heavily used in the USA but it is not so dominant in EU because of electrification and height restrictions (Gray and Kim, 2001:190). Europe has developed its own standards under the European Committee for Standardisation (CEN).

Intermodal transport users incur friction costs because of the lack of interconnectivity at three levels: Infrastructure and transport means, operations and the use of the infrastructure, especially terminals, and modal based services and regulations. Although economies of scale are achieved in container ships, it is not achievable on the land-side where investment has been relatively low and costs are high. High cost land side activities include terminal handling, empty running on inland movements, empty container storage, maintenance and repair etc. One writer estimates that the sea leg for intermodal movements provides 70-80 % of total revenue, whereas the land activity, including sales and control, creates at least 2/3 of total intermodal costs for land and sea combined (Graham, 1998).

In intermodal system, ports are interchange points and very important to contribute seamless or continuous flow of goods. At interchange points there is often a transfer among different carriers. Thus, there is a need to coordinate different types of carriers. The relationship between shipping lines and ports has led to greater concentration of cargo moving through fewer and larger ports. Such ports form hubs serviced by feeder ports. In intermodal systems inland terminals are as important as seaports.

There is collaboration between different types of carrier in different forms ranging from conference agreements to strategic alliances and vertical to horizontal (Panayides, 2001). The main objectives of these collaborations are to control intermodal transport chain, to reduce overall transport cost and to increase service quality.

In many countries, private sector companies have taken the initiative with many intermodal developments, although government legislation has often assisted their efforts, generally through laws associated with the deregulation of transport. An important feature of deregulation was the separation of government business into discrete units. This structural separation occurred in three main areas: The separation of regulatory and commercial functions, the separation of natural monopoly and potential competitive activities, and the separation of potential competitive activities. Deregulation has made the market contestable and has led to competitive outcomes. A major impact of deregulation has been that transport operators have been forced to restructure and refocus and, in the face of growing competition, have been forced to reinvent themselves (Everett, 2001).

6. Strategic Position of Turkey in Terms of Intermodal Transport

When Turkey's land bridge position both, in East-West and South-North axes, economic developments in CIS, Central Asia and Caucasian, traffic increase in east Mediterranean and acceleration in the relations with EU are considered, Turkey has great potential within the logistics activities and intermodal transportation. It is estimated that the volume of the market will have reached 7 million USD by 2005 (Dünya, 2001).

Turkey is at the cross-roads of existing and planned multimodal intercontinental transportation links. It is at the epicentre of road, railway, maritime, inland waterways and air transportation interconnecting Europe, Caucasus, Central Asia, Northern Africa and the Middle East. Creating an efficient and cost effective outlet to major markets, Turkey is a key transportation terminal at a point of regional and international convergence.

In EU system: Besides corridor 4 (Berlin / Nurnberg - Prag - Budapest - Constanta / Thessaloniki / Istanbul), several other priority road and railway corridors within the *Pan-European Transportation System* involves Turkey through corridor 4 to Istanbul. This system aims to develop a Europe-wide transport policy based on co-ordinated infrastructure development, harmonisation of national transport regulations, border crossing facilitation and an expanded research effort. Turkey is also the eastern gateway of *Trans-European Networks (TENs)* particularly designed for European Union members and included in one of the four *Pan-European Transportation Areas (PETRAs) (www.mfa.gov.tr).*

In Europe - Turkey - Caucasus - Asia connection: *TRACECA (Transport Corridor Europe - Caucasus - Asia)* project, launched in 1993 with a view to developing a transport corridor on the West -East axis from Europe, across the Black Sea, through the Caucasus and Caspian Sea to Central Asia, shall bring out the importance of the East Black sea Highway as the practical over-land connection of the project. This highway is also an integral part of the *Black Sea Ring Corridor Concept* which follows the Black Sea coastline, enhanced with railway and maritime links. Invariably, Turkey is on the path natural prolongation of the ECO (Economic Co-operation Organisation) transportation network as well as of Mediterranean, North Africa and the Middle East. Moreover two of the three corridors envisaged within the framework of ESCAP (Economic and Social Commission for Asia and Pacific) to link Central Asia to Europe pass through Turkey (UN, 2001).

Europe - Turkey - Middle East motorway: *Trans-European Motorway (TEM)* shall, in the south of Turkey, continue on to Iraq and other Middle Eastern countries. Completion of the south-eastern section of the motorway shall provide better access to the Middle East (OCDI, 2000).

Silk route for the 21st century: The building of deep seaports and receiving terminals in the Mediterranean and the Black Sea, construction of a rail tube tunnel crossing through the Straits of Istanbul, building of a transcontinental bridge over the Dardanelles, completion of the Kars-Tbilisi railway (as a complementary part of TRACECA), and extension of TEM motorways in the eastern and south eastern direction as well as the production and trade centres in Anatolia, will position Turkey in 2010 and 2020 at the regional and intercontinental control panel of multimodal transportation (www.mfa.org).

Consequently Turkey, envisaged as an energy bridge and terminal of the future, also forms the transportations backbone of three major continents in a fashion reminiscent of the historical silk route for the 21st century.

Turkey has 4 main development axes (OCDI, 2000, Tuna, 2002; Yetgin, 2002):

(1) Europe-Asia Corridor axis (Marmara-Ankara-Mersin Axis): it is considered as driving force for the Turkish economy and Port of Marmara and Port of Mersin are the main nodal points in terms of international access. The Bosporus Railway Railway Tunnel Passage, which will provide uninterrupted railway transport between Europe and Central Asia, the project on improving the Gebze-Halkali Suburban Track, Port of Derince and Marmara Port Project are underway in order to increase the efficiency of this axis. Port of Mersin will benefit from the outputs of GAP Regional Development Program in terms of export container in the near future. In addition to that, Port's Free Trade Zone, rail link and easy access to International networks make it an ideal transshipment port for trade to the Middle East.

(2) Agean-Black Sea Corridor Axis (Izmir-Ankara-Samsun Axis):The axis has a great potential due to its proximity to the large cities. Port of Izmir is the main nodal point in terms of international access. Port of Black Sea can give the access to Europe through Danube Canal.

(3) Aegean Sea Axis and (4) These two axes are expected to play a leading role in stimulating the national economy. Due to their strategic locations, these two axes to Europe and Asia should be developed. Port of Mersin and Port of Izmir are the main nodal points in terms of intermodal access.

6. Evaluation of Turkey's Transport Infrastructure in Terms of Intermodal Transport

As mentioned earlier, Turkey has great potential in terms of intermodal transportation. However, if Turkey does not improve existing transport infrastructure and invest on new facilities, it will not be able to benefit from its strategic advantages. For improved performance, well-connected services between modes of transport can be developed. Current situation of Turkey's transport industry is analyzed below.

6.1. Road Transportation

In 1999, the total length of roads in Turkey was 385.672 kms consisting of 1.749 kms of motorways, 31,388 kms of state roads, 29535 kms of provincial and 323,000 kms of village roads. The average annual growth of motorway development was 13.41 % in the period of 1992-1999. Road transportation is used heavily in Turkey compared with the other transportation modes. Share of domestic road transportation in terms of ton x km was 89. 1 % in 1999 (SPO, 2000).

6.2. Railway transportation

Railway transportation mode plays a minor role within both the international and domestic transportation of Turkey. Share of domestic railway cargo transportation in terms of ton x km was only 4.36 % in 1999 (OCDI, 2000, Tuna, 2002).

Total container traffic by railway was 439.000 tons consisting of 227.000 tons of international and 212.000 tons of domestic cargo in 1998 (TCDD, 2000). However, container transport by railway represents only 3 % of total container traffic which was handled at Turkish State Railway (TCDD) ports. The main reasons behind this fact are lack of wagons and low frequency of service for container transportation.

6.3. Air Transport

The number of airports operated by General Directorate of State Airports Enterprise, which was by the end of the year 1995, reached 38. Of these 38 airports, 20 airports have international status at the end of the year 1999. The share of domestic airway cargo transportation in terms of ton x km was only 1.72 % in 1999 (OCDI, 2000)

6.4. Maritime Transport

Maritime transport in Turkey has an international nature. 91.4 % of the foreign trade of Turkey in terms of volume is realized via maritime transport. The amount of the cargo handled within the international maritime trade was 118.248 million tons in 2000. Of this, 32.291 million tons (%27) were in exports and 85.956 million tons (% 73) in imports. Turkish flag has undertaken only 30.5 % of the international maritime transport.

The tonnage of the Turkish merchant fleet was 9.183 million dwt for the vessels suitable for the international transport (over 1500 dwt) in 2000. The share of the container ships within the fleet were minor (Turkish Chamber of Shipping, 2001)

6.4.1. Container Transportation in Turkey

The evolution of container trade indicates the increase in international intermodal shipments and the connection between maritime and the land-based transport systems, whether rail or road. Majority of the container transportation to/from Turkey depends on the feeder services mainly from Giotauro, Damietta an Port Said. Main container routes within Turkey can be stated as follows: (1) Northern Europe: Containerized cargo is carried by the vessels operating on the North Europe-the Mediterranean-Asia route, transshipped at Port Said and transferred to Mersin, Izmir and Istanbul by feeder services. (2) North America: Containerized cargo is carried by ships operating on the North America-the Mediterranean - Asia route, transshipped at Gioiatauro and transferred to Mersin, Izmir and Istanbul by feeder services. (3) Mediterranean Region: Containerized cargo is carried by vessels operating on the West Mediterranean-Asia route, transshipped at Damietta and transferred to Mersin, Izmir and Istanbul by feeder services. (4) Asia Route: Containerized cargo is carried by vessels connecting Europe and Asia on the West Mediterranean-Asia route (OCDI, 2000).

As far as the developments in the world, in the East Mediterranean and Black sea Region, and also Turkey are considered container demand which is subject to intermodalism is expected to increase in Turkey. Majority of the container trade will be achieved within Marmara Region, Aegean Region, and the Mediterranean Region in the future (See **Table 3**).

Table 3. Future Container Demand in Turkey (1,000 TEU)

	2010			2020		
Region	**High Case**	**Middle Case**	**Lowe Case**	**High Case**	**Middle Case**	**Lowe Case**
Marmara Sea	**1.550**	**1.460**	**1.370**	**2.680**	**2.400**	**2.160**
Aegean Sea	**1.020**	**960**	**890**	**1.840**	**1.650**	**1.480**
Black Sea	**170**	**160**	**140**	**500**	**460**	**410**
West Black Sea	120	110	100	340	310	280
East Black Sea	50	50	40	160	150	130
Mediterranean	**840**	**800**	**740**	**1.660**	**1.490**	**1.350**
İskenderun	140	130	120	280	250	230
Mersin	640	610	560	1.250	1.120	1.010
Antalya	60	60	60	130	120	110
TOTAL	**3.580**	**3.380**	**3.140**	**6.680**	**6.000**	**5.400**

Source: OCDI, 2000.

Turkey must be prepared to facilitate this traffic in the future and must invest on new intermodal infrastructures. These infrastructures include both land based and shore based infrastructures.

6.4.2. Container Ports in Turkey

There are approximately 290 shore facilities including ports and piers in Turkey. Majority of the container ports are operated by Turkish State Railways (TCDD). **Table 4** analyzes the container throughput in both public and private ports. Although Port of İzmir is the leading port in Turkey, Ports in Marmara Sea achieved significant amount of throughput in 2000 due to the contribution of private ports. As far as the Mediterranean Sea is concerned, Port of Mersin is the leading port in the region. Container throughput is negligible in the ports of Black Sea.

Routes of the container vessel moving in the Mediterranean Sea are classified as Europe-Far East. Mediterranean-Far East, Europe-East Asia/East Africa, Mediterrenean-North America, and Inter European. Large capacity vessels are deployed for Europe-Far East Transportation. Due to this fact, feedering service plays an important role for the delivery of containers to the ports. Turkish container ports are considered as feeder ports in the Eastern Mediterranean (Yetgin, 2002, OCDI, 2000, Tuna, 2002).

Table 4. Container Throughput in Major Turkish Container Ports

Region	1996	1997	1998	1999	2000
Marmara Sea	**436.813**	**437.040**	**420.171**	**636.934**	**700.716**
Haydarpasa	*329.569*	*330.151*	*322.596*	*277.233*	*298.230*
Derince	*13.979*	*10.209*	*5.087*	*5.501*	*1.194*
Bandırma	*493*	*297*	*447*	*0*	*1.417*
Private Ports	*43.386*	*96.383*	*92.041*	*354.200*	*399.845*
Aegean Sea	**345.924**	**388.172**	**398.619**	**435.962**	**470.576**
İzmir	*345.924*	*388.172*	*398.619*	*435.962*	*470.576*
Black Sea	**2.915**	**4.229**	**3.259**	**1.904**	**1.824**
Samsun	*2.915*	*4.229*	*3.259*	*1.904*	*1.824*
Mediterranean	**181.650**	**268.634**	**242.309**	**251.567**	**300.090**
İskenderun	*123*	*193*	*444*	*379*	*714*
Mersin	*181.527*	*268.441*	*241.865*	*251.188*	*299.376*
TOTAL	**967.302**	**1.098.075**	**1.064.358**	**1.326.367**	**1.473.206**

Source: Turkish Chamber of Shipping, 2001.

The most important transshipment ports (Gioiatauro, Marsaxllook, Algerias, Damietta) had a rate of utilization of 78.9 % in 1998. The most important o/d ports (Geneo, La Spezia, Livorno, Naples, Marseille, Lisbon, Barcelona, Valencia, Haydarpaşa, Izmir, Ashdod, Haifa, Beirut, Alexandria, Port Said) had a utilization of 68.2 %. The less important ports (those of the Southern Mediterranean and Black Sea Ports) had much lower utilization, roughly 44.8 % (Francesetti and Foschi, 2001).

6.5. Infrastructural Problems Related to Intermodal Transportation in Turkey

Transport Infrastructure problems of Turkey in terms of intermodal transportation can be classified in terms of facilities and their operations.

In terms of intermodal facilities, ports and terminals, railroads and cargo handling equipment lack to facilitate intermodal traffic in Turkey. The length and draft of the Turkish Ports is not enough to handle the container vessels in Turkish Ports. If some Turkish container ports aim at becoming hub ports in the future, a berth length over 300 m and depth of over –

15 m would be required. Road traffic is congested at Turkish ports due to the lack of railroad connections. Cargo handling equipment is quite old and often requires maintenance, which leads to reduced productivity. Inland container depots need to be developed in Turkey.

In terms of operation, productivity and efficiency of intermodal facilities of Turkey is lower compared with many ports in the world. The reasons for low performance can be stated as follows (OCDI, 2000): The lack of capacity causes traffic congestion in the port and reduces the efficiency of container handling. The containers unloaded from the ship must wait for the arrival of tractors. Infrastructure of the port is in poor condition, and this has a negative impact on the vehicle and equipment. In some ports, pavement of terminal is deteriorated and this has negative effect on the vehicle and equipment. Cargo handling equipment need to be repaired which leads to reduced productivity. Since tugs and pilots services are operated by TCDD and TDI respectively, insufficient linkage in the works of these services causes delay in the vessel schedule. Heavy bureaucracy of custom clearance causes delays in the operation.

6.6. Solutions of Infrastructural Problems in Turkey

New terminals must be constructed and existing terminals must be developed in Turkey in order to facilitate intermodal traffic through Turkey since it is certain that the container volume will exceed the existing capacity within several years In the Mediterranean Sea, Port of Iskenderun and Port of Mersin , In the Aegean Sea, Port of Izmir need new terminals. Even if the new terminal completed in Port of İzmir, the shortage of capacity of 30-40 thousand TEUs in 2010 and of 0.9-1.2 million TEUs will be expected in Aegean Sea Region (OCDI, 2000). Thus another new port with sufficient capacity should be constructed in the Aegean Sea, In the Marmara Sea, it should be taken into account that too many small scale container terminals would prevent a port in this region from becoming a calling port. In this context, large scale container terminals should be given high priority. Since the container traffic via Mediterranean to Black Sea port is increasing, new facilities for containers should be constructed in a timely manner, watching the future progress of container volume of each port.

Since the rail and road network is also important for container land transport, road and railway connection of the ports must be developed and new railways must be constructed to connect the industrial zones in the region and Turkish ports. Fast train and combined transportation, which reinvigorate the railroads, must be supported in parallel with the policies adopted in the international arena. The fast train lines and international connections like Kars-Tbilisi, Istanbul Tube Railroad must be given priority (OCDI, 2000).

In order to improve cargo handling efficiency, it is necessary for Turkish Ports to consider carefully the following basic concepts: effective use of existing facilities, improvement of container handling operation, introduction of advanced technology, introduction of advanced computer technology, proper use and maintenance of cargo handling equipment and introduction of EDI (Electronic Data Interchange).

CONCLUSION

Turkey should develop a framework for an optimal integration of different modes so as to enable an efficient and cost-effective use of the transport system through seamless, customer-oriented door-to-door services whilst favouring competition between transport operators.

A number of obstacles have been identified which prevent the extensive use of intermodal transport in Turkey. These include the lack of a coherent network of modes and interconnections, the lack of technical interoperability between and within modes, lack of data-interchange systems etc. There are uneven levels of performance and service quality between modes, different levels of liability and a lack of information about intermodal services.

New intermodal transport infrastructures of Turkey must be planned and constructed considering the increasing intermodal traffic both in domestic and regional market. While planning new transport infrastructure, special attention must be paid to meet the requirement of international intermodal standards. EU transport and shipping policy will play an important role in determining the standardization of the equipment. Existing railroads must be improved and the planned railroads must be constructed as soon as possible. This will avoid the congestion at roads and ports. Railroads must also be connected to the ports. Government must take actions to shift the cargo traffic from roads to railways and sea.

Existing infrastructure must be improved considering the determinants of successful intermodalism. One of the most important infrastructures in effective intermodality is the interchange points where different modes of transport intersect. Existing port infrastructure and equipment must be replaced with the modern technology suitable for intermodal transport. Productivity and efficiency of port operations must be improved by proper measures. Advanced information technology, such as EDI must be introduced to the ports and transport industry within country.

From the institutional point of view, Turkey must first develop a transportation and shipping policies to meet the requirement of international trade and transport industry considering the international, regional and national industrial developments. All the partners of the intermodal transport must take part in the formulation of policies.

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