MODES OF TRANSPORTATION AND COORDINATION BENEFITS

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ABSTRACT

Over the years, methods of movement of passengers, goods and services has been an activity that has evolved constantly through innovation and research to meet the ever changing and challenging demands of users of these services especially as it relates to the supply chain process. The use of multi modal system of transportation requires strategic coordination to ensure the desired results are achieved. This article will look into the various modes of transportation and establish the benefits of their coordination as an integral step towards further improving the service. Transportation coordination can reduce transportation program costs and time by clustering passengers and goods, utilizing fewer one-way trips, and sharing the use of transportation personnel, equipment, and facilities. In addition, people in need of transportation often benefit from the greater and higher quality transportation services available when transportation providers coordinate their operations.

Key terms: Modes of transportation, strategic coordination and coordination benefits
1. Introduction

Travel is essential for independence. To shop, maintain health, work, become educated, socialize, worship, and be entertained may depend on traveling from one’s home to somewhere else. The distances between residences and commercial or service destinations can create barriers to accessing the goods and services available in the community (Langen, 2017). Recognizing this, a variety of public and private agencies and organizations provide specialized transportation services to persons who have difficulties providing their own transportation. This human service transportation “system” has resulted in a multiplicity of local services targeted to particular populations for specific (and often limited) purposes. Transportation resources are often not coordinated and frequently duplicate expenditures and service efforts (Givoni, & Banister, 2012). They lack cooperation and communication, provide inadequate levels of service, vary in service quality, provide inadequate and unreliable information about services and costs, and have no comprehensive plan for meeting service needs. The fragmented system confuses consumers and fails to address the needs of many individuals who do not meet specific agency or program eligibility requirements.

Coordination is one management strategy for improving the performance of transportation services and increasing overall mobility by wringing inefficiencies out of disparate operations and service patterns. The potential benefits of coordination among transportation providers include more resources applied to transportation, more cost-effective use of those resources, expanded service, more trips taken, lower costs to customers, cost savings for some participating agencies, more centralized management, and improved service quality. When transportation providers are able to coordinate their operations, older persons—and other special population groups—often benefit from the increased availability of transportation and higher-quality services.

Coordination has its costs. Implementing and maintaining coordination are often more expensive, more difficult, and more time consuming than most agency representatives initially perceive. Coordination may increase overall cost-effectiveness or reduce unit costs, but it does not necessarily free transportation dollars for other activities (Slack et al, 2009).

Transport modes are the means by which passengers and freight achieve mobility. They are mobile transport assets and fall into one of three basic types, depending on over what surface they travel; land (road, rail and pipelines), water (shipping), and air. Each mode is characterized by a set of technical, operational and commercial characteristics.

**Road transportation**

Road infrastructures are large consumers of space with the lowest level of physical constraints among transportation modes. However, physiographical constraints are significant in road construction with substantial additional costs to overcome features such as rivers or rugged terrain. While historically road transportation was developed to support non-motorized forms of transportation (walking, domestication of animals and cycling at the end of the 19th century), it is motorization that has shaped the most its development since the beginning of the 20th century.
Road transportation has an average operational flexibility as vehicles can serve several purposes but are rarely able to move outside roads. Road transport systems have high maintenance costs, both for the vehicles and infrastructures. Pallis et al (2010). They are mainly linked to light industries where rapid movements of freight in small batches are the norm. Yet, with containerization, road transportation has become a crucial link in freight distribution.

Rail transportation and pipelines

Railways are composed of a traced path on which wheeled vehicles are bound. In light of more recent technological developments, rail transportation also include monorails and maglev. They have an average level of physical constrains linked to the types of locomotives and a low gradient is required, particularly for freight. Heavy industries are traditionally linked with rail transport systems, although containerization has improved the flexibility of rail transportation by linking it with road and maritime modes Langen (2015). Rail is by far the land transportation mode offering the highest capacity with a 23,000 tons fully loaded coal unit train being the heaviest load ever carried. Gauges, however, vary around the world, often challenging the integration of rail systems.

According to Givoni, & Banister (2012), Pipeline routes are practically unlimited as they can be laid on land or under water. The longest gas pipeline links Alberta to Sarnia (Canada), which is 2,911 km in length. The longest oil pipeline is the Transiberian, extending over 9,344 km from the Russian arctic oilfields in eastern Siberia to Western Europe. Physical constraints are low and include the landscape and pergelisol in arctic or subarctic environments. Pipeline construction costs vary according to the diameter and increase proportionally with the distance and with the viscosity of fluids (from gas, low viscosity, to oil, high viscosity). The Trans Alaskan pipeline, which is 1,300 km long, was built under difficult conditions and has to be above ground for most of its path. Pipeline terminals are very important since they correspond to refineries and harbors.

Maritime transportation

Because of the physical properties of water conferring buoyancy and limited friction, maritime transportation is the most effective mode to move large quantities of cargo over long distances. Main maritime routes are composed of oceans, coasts, seas, lakes, rivers and channels. However, due to the location of economic activities maritime circulation takes place on specific parts of the maritime space, particularly over the North Atlantic and the North Pacific. The construction of channels, locks and dredging are attempts to facilitate maritime circulation by reducing discontinuity. Comprehensive inland waterway systems include Western Europe, the Volga / Don system, St. Lawrence / Great Lakes system, the Mississippi and its tributaries, the Amazon, the Panama / Paraguay and the interior of China. Maritime transportation has high terminal costs, since port infrastructures are among the most expensive to build, maintain and improve. High inventory costs also characterize maritime transportation. More than any other mode, maritime transportation is linked to heavy industries, such as steel and petrochemical facilities adjacent to port sites (Gogola, 2014).
Air transportation

Langen, (2017) argues that Air routes are practically unlimited, but they are denser over the North Atlantic, inside North America and Europe and over the North Pacific. Air transport constraints are multidimensional and include the site (a commercial plane needs about 3,300 meters of runway for landing and takeoff), the climate, fog and aerial currents. Air activities are linked to the tertiary and quaternary sectors, notably finance and tourism, which lean on the long distance mobility of people. More recently, air transportation has been accommodating growing quantities of high value freight and is playing a growing role in global logistics.

Intermodal transportation

Concerns a variety of modes used in combination so that the respective advantages of each mode are better exploited. Although intermodal transportation applies for passenger movements, such as the usage of the different, but interconnected modes of a public transit system, it is over freight transportation that the most significant impacts have been observed. Containerization has been a powerful vector of intermodal integration, enabling maritime and land transportation modes to more effectively interconnect. Nazarenko (2010).

Telecommunications

Cover a grey area in terms of if they can be considered as a transport mode since unlike true transportation, telecommunications often do not have a physicality. Yet, they are structured as networks with a practically unlimited capacity and very low constraints, which may include the physiography and oceanic masses that may impair the setting of cables. They provide for the “instantaneous” movement of information (speed of light). Wave transmissions, because of their limited coverage, often require substations, such as for cellular phone networks. Satellites are often using a geostationary orbit which is getting crowded Gogola (2014). High network costs and low distribution costs characterize many telecommunication networks, which are linked to the tertiary and quaternary sectors (stock markets, business to business information networks, etc.). Telecommunications can provide a substitution for personal movements in some economic sectors.

The Supply and Demand for Transportation

Each transport mode shares the common goal of fulfilling a derived transport demand, and each transport mode thus fills the purpose of supporting mobility. Transportation is a service that must be utilized immediately since unlike the resources it often carries, the transport service itself cannot be stored. Mobility must occur over transport infrastructures having a fixed capacity, providing a transport supply. Ballou, (2016). In several instances, transport demand is answered in the simplest means possible, notably by walking. However, in some cases elaborate and expensive infrastructures and modes are required to provide mobility, such as for international air transportation.

Transportation is a market composed of suppliers of transport services and users of these services. Well-functioning transport markets should allow transport supply to meet transport demand so that transport needs for mobility are satisfied. An economic system including numerous activities located in different areas generates movements that must be supported by the transport system.
Without movements infrastructures would be useless and without infrastructures movements could not occur, or would not occur in a cost efficient manner. This interdependency can be considered according to two concepts, which are transport supply and demand:

- **Transport supply.** The capacity of transportation infrastructures and modes, generally over a geographically defined transport system and for a specific period of time. Supply is expressed in terms of infrastructures (capacity), services (frequency) and networks (coverage). Capacity is often assessed in static and dynamic terms where static capacity represents the amount of space available for transport (e.g. terminal surface) and dynamic capacity are the improvement that can be made through better technology and management. The number of passengers, volume (for liquids or containerized traffic), or mass (for freight) that can be transported per unit of time and space is commonly used to quantify transport supply.

- **Transport demand.** Transport needs, even if those needs are satisfied, fully, partially or not at all. Similar to transport supply, it is expressed in terms of number of people, volume, or tons per unit of time and space.

2. **Problem Statement**

There is a complementarity between passenger and freight transport systems. With some exceptions, such as busses and pipelines, most transport modes have developed to handle both freight and passenger traffic. In some cases both are carried in the same vehicle, as for instance in air transport where about 80% of the freight is transported in the cargo holds of passenger aircraft. In others, different types of vehicle have been developed for freight and passenger traffic, but they both share the same road infrastructure, as for example in rail and road traffic. In shipping, passengers and freight used to share the same vessels and often the same terminals. Since the 1950s specialization has occurred, and the two are now quite distinct, except for ferries and some other services.

The sharing by freight and passengers of a mode is not without difficulties, and indeed some of the major problems confronting transportation occur where the two compete for the use of scarce transport infrastructure. For example, trucks in urban areas are seen as a nuisance and a cause of congestion by passenger transport users. Daytime deliveries and double-parked trucks are a particular nuisance. The poor performance of some modes, such as rail, is seen as the outcome of freight and passengers having to share routes. There are also growing interests expressed at using segments of transit systems to move freight, particularly in central areas. This raises the question as to what extent and under which circumstances freight and passengers are compatible.

3. **Problems That Coordination Addresses**

As the numbers of providers of special transportation services multiplied in the 1970s, the amount of service increased, the total outlay for such services rose, and the resources needed to provide them became more constrained. The multiplicity of special transportation providers resulted in a number of problems in communities without coordination efforts, including these:
Multiple individual providers, each with its own mission, equipment, eligibility requirements, funding sources, and institutional objectives, often resulting in significant duplication of expenditures and service efforts;

The absence of a formal mechanism for cooperation or communication among these operators;

A total level of service well below the total level of need — often including substantial unmet transportation needs among populations with growing numbers and proportions of older persons;

Significant variations in services during particular times of day or days of the week and for specific groups of persons, with duplicative services in some neighborhoods but substantial service gaps in other areas;

Substantial variations in service quality, including safety standards, from provider to provider;

A lack of reliable information describing the services being provided and their costs;

The absence of an overall compendium of services available or of the funds being used to provide them; and

The absence of a comprehensive plan to address these problems.

Coordination has been one of the most discussed mechanisms to resolve such problems and improve specialized transportation services. Still, it is important to realize that coordination is only one of a number of management strategies for improving both the performance of various individual transportation services and overall mobility within a community.

4. Modal Competition

Each transportation mode has key operational and commercial advantages and properties. However, contemporary demand is influenced by integrated transportation systems that require maximum flexibility in the respective use of each mode. As a result, modal competition exists at various degrees and takes several dimensions. Modes can compete or complement one another in terms of cost, speed, accessibility, frequency, safety, comfort, etc. There are three main conditions that ensure that some modes are complementing one another:

- **Different geographical markets.** It is clear that if different markets are involved, modes will permit a continuity within the transport system, particularly if different scales are concerned, such as between national and international transportation. This requires an interconnection, commonly known as a gateway, where it is possible to transfer from one mode to the other. Intermodal transportation has been particularly relevant to improve the complementarity of different geographical markets.

- **Different transport markets.** The nature of what is being transported, such as passengers or freight, often indicates a level of complementarity. Even if the same market area is serviced, it may not be equally accessible depending of the mode used. Thus, in some markets rail and road transportation can be complementary as one may be focusing on passengers and the other on freight.
• **Different levels of service.** For a similar market and accessibility, two modes that offer a different level of service will tend to complement another. The most prevailing complementarity concerns costs versus time.

Thus, there is modal competition when there is an overlap in geography, transport and level of service. Cost is one of the most important considerations in modal choice. Because each mode has its own price/performance profile, the actual competition between the modes depends primarily upon the distance traveled, the quantities that have to be shipped and the value of the goods. While maritime transport might offer the lowest variable costs, over short distances and for small bundles of goods, road transport tends to be most competitive. A critical factor is the terminal cost structure for each mode, where the costs (and delays) of loading and unloading the unit impose fixed costs that are incurred independent of the distance traveled.

With increasing income levels, the propensity for people to travel rises. At the same time, international trade in manufactured goods and parts has increased. These trends in travel demand act differently upon the modes. Those that offer the faster and more reliable services gain over modes that might offer a lower cost, but slower, alternative. For passenger services, rail has difficulty in meeting the competition of road transport over short distances and aircraft for longer trips. For freight, rail and shipping have suffered from competition from road and air modes for high value shipments. While shipping, pipelines and rail still perform well for bulkier shipments, intense competition over the last decades have seen road and air modes capture an important market share of the high revenue-generating goods. Road transport clearly dominates.

Although intermodal transportation has opened many opportunities for a complementarity between modes, there is intense competition as companies are now competing over many modes in the transport chain. A growing paradigm thus involves supply chain competition with the modal competition component occurring over three dimensions:

• **Modal usage.** Competition that involves the comparative advantage of using a specific or a combination of modes. Distance remains one of the basic determinants of modal usage for passenger transportation. However, for a similar distance, costs, speed and comfort can be significant factors behind the choice of a mode.

• **Infrastructure usage.** Competition resulting from the presence of freight and passenger traffic on the same itineraries linking the same nodes. Each level of capacity used by a mode is therefore at the expense of the other mode.

• **Market area.** Competition being experienced between transport terminals for using new space (terminal relocation or expansion) or capturing new markets (hinterland).

It is generally advocated that a form of **modal equality** (or **modal neutrality**) should be part of public policy where each mode would compete based upon its inherent characteristics. Since different transport modes are under different jurisdiction and funding mechanisms, modal equality is conceptually impossible as some modes will always be more advantageous than others. Modal competition is influenced by public policy. This particularly takes place over government funding of infrastructure and regulation issues. Roads are usually provided by the public sector, while many other transport infrastructures are financed by the operators using them. This is the case for rail, air and maritime transportation. For instance, in the United States the Federal Government would
finance 80% of the costs of a highway project, leaving the state government to supply the remaining 20%. For public transit, this share is 50%, while for passenger rail the Federal Government will not provide any funding. Under such circumstances, public policy shapes modal preferences.

5. Global Trend in Evolution of Transportation

The technological evolution in the transport industry aims at adapting the transport infrastructures to growing needs and requirements. When a transport mode becomes more advantageous than another over the same route or market, a modal shift is likely to take place. A modal shift involves the growth in the demand of a transport mode at the expense of another, although a modal shift can involve an absolute growth in both of the concerned modes. Anderton, (2011). The comparative advantages behind a modal shift can be in terms of costs, convenience, speed or reliability. For passengers, this involved a transition in modal preferences as incomes went up, such as from collective to individual modes of transportation. For freight, this has implied a shift to faster and more flexible modes when possible and cost effective, namely trucking and air freight.

There are important geographical variations in modal competition. The availability of transport infrastructures and networks varies enormously, with corridors being subject to the most modal competition. Some regions possess many different modes that in combination provide a range of transport services that ensure an efficient commercial environment. Thus, in contrast to the situation in the European Union, rail freight transport occupies a more important market share in North America but passenger rail has a negligible share. In many parts of the world, however, there are only limited services, and some important modes such as rail may be absent altogether. This limits the choices for passengers and shippers, and acts to limit accessibility. People and freight are forced to use the only available modes that may not be the most effective to support their mobility. Areas with limited modal choices tend to be among the least developed. Advanced economies, on the other hand possesses a wide range of modes that can provide services to meet the needs of society and the economy.

Since 2000 fuel prices gave increased significantly as well as their volatility, illustrated by significant price declines in 2009 and 2015. All modes are affected by fuel price volatility, from the individual car owner to the corporation operating a fleet of hundreds of aircraft or ships. Different pricing mechanisms are used, namely direct rate adjustments, as is the case of shipping, or indirect adjustments as is the case of airlines, with the reliance on fuel surcharges when energy prices are increasing. In the context of higher energy prices, and therefore higher input costs for transportation, the following can be expected:

- Higher transport costs increase the friction of distance and constrain mobility. As a major consumer of petroleum the transport industry has to increase rates. Across the board increases causes people to rethink their patterns of movement and companies to adjust their supply and distribution chains.
- Because the impact of higher fuel costs hits the modes differentially, a modal shift is anticipated. Road and air transport are more fuel intensive than the other modes, and so fuel price increases are likely to impact upon them more severely than other modes. This could lead to a shift towards water and rail transport in particular.
• A further impact of fuel price increases is greater fuel economy across the modes. One of the best ways for all modes to reduce consumption is to lower speeds.

Transport Costs and Rates

Transport systems face requirements to increase their capacity and to reduce the costs of movements. All users (e.g. individuals, corporations, institutions, governments, etc.) have to negotiate or bid for the transfer of goods, people, information and capital because supplies, distribution systems, tariffs, salaries, locations, marketing techniques as well as fuel costs are changing constantly. There are also costs involved in gathering information, negotiating, and enforcing contracts and transactions, which are often referred as the cost of doing business. Trade also involves transactions costs that all agents attempt to reduce since transaction costs account for a growing share of the resources consumed by the economy.

Frequently, corporations and individuals must take decisions about how to route passengers or freight through the transport system. This choice has been considerably expanded in the context of the production of lighter and high value consuming goods, such as electronics, and less bulky production techniques. It is not uncommon for transport costs to account for 10% of the total cost of a product. This share also roughly applies to personal mobility where households spend about 10% of their income for transportation, including the automobile which has a complex cost structure. Thus, the choice of a transportation mode to route people and freight between origins and destinations becomes important and depends on a number of factors such as the nature of the goods, the available infrastructures, origins and destinations, technology, and particularly their respective distances. Jointly, they define transportation costs.

Transport costs are a monetary measure of what the transport provider must pay to produce transportation services. They come as fixed (infrastructure) and variable (operating) costs, depending on a variety of conditions related to geography, infrastructure, administrative barriers, energy, and on how passengers and freight are carried. Three major components, related to transactions, shipments and the friction of distance, impact on transport costs. Givoni, & Banister, (2012).

Transport costs have significant impacts on the structure of economic activities as well as on international trade. Empirical evidence underlines that raising transport costs by 10% reduces trade volumes by more than 20% and that the general quality of transport infrastructure can account for half of the variation in transport costs. In a competitive environment where transportation is a service that can be bid on, transport costs are influenced by the respective rates of transport companies, the portion of the transport costs charged to users. Kapoor, (2013).

Rates are the price of transportation services paid by their users. They are the negotiated monetary cost of moving a passenger or a unit of freight between a specific origin and destination. Rates are often visible to the consumers since transport providers must provide this information to secure transactions. They may not necessarily express the real transport costs.

The difference between costs and rates either results in a loss or a profit from the service provider. Considering the components of transport costs previously discussed, rate setting is a complex
undertaking subject to constant change. For public transit, rates are often fixed and the result of a political decision where a share of the total costs is subsidized by the society. The goal is to provide an affordable mobility to the largest possible segment of the population even if this implies a recurring deficit (public transit systems rarely make any profit). It is thus common for public transit systems to have rates that are lower than costs and targeted at subsidizing the mobility of social groups such as students, the elderly or people on welfare.

For freight transportation and many forms of passenger transportation (e.g. air transportation) rates are subject to a competitive pressure. This means that the rate will be adjusted according to the demand and the supply. They either reflect costs directly involved with shipping (cost-of-service) or are determined by the value of the commodity (value-of-service). Since many actors involved in freight transportation are private, rates tend to vary, often significantly, but profitability is paramount.

Costs and Time Components

Transportation offers a spectrum of costs and level of services, which results in substantial differences across the world. The price of a transport service does not only include the direct out-of-the-pocket money costs to the user but also includes time costs and costs related to possible inefficiencies, discomfort and risk (e.g. unexpected delays). However, economic actors often base their choice of a transport mode or route on only part of the total transport price. For example, motorists are biased by short run marginal costs. They might narrow down the price of a specific trip by car to fuel costs only, thereby excluding fixed costs such as depreciation, insurance and vehicle tax. Many shippers or freight forwarders are primarily guided by direct money costs when considering the price factor in modal choice. The narrow focus on direct money costs is to some extent attributable to the fact that time costs and costs related to possible inefficiencies are harder to calculate and often can only be fully assessed after the cargo has arrived. Among the most significant conditions affecting transport costs and thus transport rates are:

Geography. Its impacts mainly involve distance and accessibility. Distance is commonly the most basic condition affecting transport costs. The more it is difficult to trade space for a cost, the more the friction of distance is important. It can be expressed in terms of length, time, economic costs or the amount of energy used. It varies greatly according to the type of transportation mode involved and the efficiency of specific transport routes. Landlocked countries tend to have higher transport costs, often twice as much, as they do not have direct access to maritime transportation. The impact of geography on the cost structure can be expanded to include several rate zones, such as one for local, another for the nation and another for exports. Bildman & Prochorov, (2015).

Type of product. Many products require packaging, special handling, are bulky or perishable. Coal is obviously a commodity that is easier to transport than fruits or fresh flowers as it requires rudimentary storage facilities and can be transshipped using rudimentary equipment. Insurance costs are also to be considered and are commonly a function of the value to weight ratio and the risk associated with the movement. As such, different economic sectors incur different transport costs as they each have their own transport intensity (Ballou, 2016). With containerization the type of product plays little role in the transport cost since rates are set per container, but products still
need to be loaded or unloaded from the container. For passengers, comfort and amenities must be provided, especially if long distance travel is involved.

Economies of scale. Another condition affecting transport costs is related to economies of scale or the possibilities to apply them as the larger the quantities transported, the lower the unit cost. Bulk commodities such as energy (coal, oil), minerals and grains are highly suitable to obtain lower unit transport costs if they are transported in large quantities. A similar trend also applies to container shipping with larger containerships involving lower unit costs.

Energy. Transport activities are large consumers of energy, especially oil. About 60% of all the global oil consumption is attributed to transport activities. Transport typically account for about 25% of all the energy consumption of an economy. The costs of several energy intensive transport modes, such as maritime and air transport, are particularly susceptible to fluctuations in energy prices.

Empty backhauls. Many transport interactions involve empty backhauls since it is uncommon to have a perfect match between an inbound and a return trip. Commuting patterns involve imbalanced flows and empty return trips. For international trade, imbalances between imports and exports have impacts on transport costs. This is especially the case for container transportation since trade imbalances imply the repositioning of empty containers that have to be taken into account in the total transport costs. Consequently, if a trade balance is strongly negative (more imports than exports), transport costs for imports tend to be higher than for exports. Significant transport rate imbalances have emerged along major trade routes. The same condition applies at the national and local levels where freight flows are often unidirectional, implying empty backhaul movements. Langen (2015).

Infrastructures. The efficiency and capacity of transport modes and terminals has a direct impact on transport costs. Poor infrastructures imply higher transport costs, delays and negative economic consequences. More developed transport systems tend to have lower transport costs since they are more reliable and can handle more movements.

Mode. Different modes are characterized by different transport costs, since each has its own capacity limitations and operational conditions. When two or more modes are directly competing for the same market, the outcome often results in lower transport costs. Containerized transportation permitted a significant reduction in freight transport rates around the world.

Competition and regulation. Concerns the complex competitive and regulatory environment in which transportation takes place. Transport services taking place over highly competitive segments tend to be of lower cost than on segments with limited competition (oligopoly or monopoly). International competition has favored concentration in many segments of the transport industry, namely maritime and air modes. Regulations, such as tariffs, cabotage laws, labor, security and safety impose additional transport costs, particularly in developing countries.

Surcharges. Refer to an array of fees, often set in an arbitrary fashion, to reflect temporary conditions that may impact on costs assumed by the transporter. They also take place when fares are regulated, leaving the operator to find alternative sources of revenue. The most common are
fuel surcharges, security fees, geopolitical risk premiums and additional baggage fees. The passenger transport industry, particularly airlines, has become dependent on a wide array of surcharges as a source of revenue for operators.

**Taxes and tolls.** Transport activities are often taxed, such as vehicle sales taxes and registration fees. Fuel taxes are the most significant form of taxation levied by governments with revenues often used to cover maintenance and infrastructure investment costs. Tolls are also commonly levied on the usage of transportation assets, particularly at bottlenecks such as bridges and tunnels.

**Cross-subsidies.** If an infrastructure is particularly expensive to develop and maintain, this costs should be reflected in fares to cover the amortization of the asset. If a government or a corporation uses other parts of its activities to subsidize the full costs of a transport infrastructure, then this cross-subsidy is having in impact on its costs. Taxes and tolls are commonly used to cross-subsidize public transit.

The transport time component is also an important consideration as it is associated with the service factor of transportation. They include the transport time, the order time, the timing, the punctuality and the frequency. For instance, a maritime shipping company may offer a container transport service between a number of North American and Pacific Asian ports. It may take 12 days to service two ports across the Pacific (transport time) and a port call is done every two days (frequency). In order to secure a slot on a ship, a freight forwarder must call at least five days in advance (order time). For a specific port terminal, a ship arrives at 8AM and leaves at 5PM (timing) with the average delay being six hours (punctuality).

Mobility is influenced by transport costs. Empirical evidence for passenger vehicle use underlines the relationship between annual vehicle mileage and fuel costs, implying the higher fuel costs are, the lower the mileage. At the international level, doubling of transport costs can reduce trade flows by more than 80%. The more affordable mobility is, the more frequent the movements and the more likely they will take place over longer distances. Empirical evidence also underlines that transport costs tend to be higher in the early or final stages of a movement, also known as the first and the last mile. A wide variety of transport costs can be considered.

Terminal costs. Costs that are related to the loading, transshipment and unloading. Two major terminal costs can be considered; loading and unloading at the origin and destination, which are unavoidable, and intermediate (transshipment) costs that can be avoided. For complex transport terminals, such as ports and airports, terminal costs can involve a wide array of components, including docking / gate fees, handling charges and pilotage / traffic control fees.

Linehaul costs. Costs that are a function of the distance over which a unit of freight or passenger is carried. Weight is also a cost function when freight is involved. They include labor and fuel and commonly exclude transshipment costs.
Capital costs. Costs applying to the physical assets of transportation mainly infrastructures, terminals and vehicles. They include the purchase or major enhancement of fixed assets, which can often be a one-time event. Since physical assets tend to depreciate over time, capital investments are required on a regular basis for maintenance.

Transport providers make a variety of decisions based on their cost structure, a function of all the above types of transport costs. To simplify transactions and clearly identify the respective responsibilities specific commercial transportation terms have been set. While the transport price plays an important role in modal choice, firms using freight transport services are not always motivated by notions of cost minimization. They often show “satisfying behavior” whereby the transport costs need to be below a certain threshold combined with specific requirements regarding reliability, frequency and other service attributes. Such complexities make it more difficult to clearly assess the role of transport price in the behavior of transport users.

The role of transport companies has sensibly increased in the general context of the global commercial geography. However, the nature of this role is changing as a result of a general reduction of transport costs but growing infrastructure costs, mainly due to greater flows and competition for land. Each transport sector must consider variations in the importance of different transport costs. While operating costs are high for air transport, terminal costs are significant for maritime transport. Several indexes, such as the Baltic Dry Index, have been developed to convey a pricing mechanism useful for planning and decision making.

Technological changes and their associated decline in transport costs have weakened the links between transport modes and their terminals. There is less emphasis on heavy industries and more importance given to manufacturing and transport services (e.g. warehousing and distribution). Indeed, new functions are being grafted to transport activities that are henceforward facilitating logistics and manufacturing processes. Relations between terminal operators and carriers have thus become crucial notably in containerized traffic. They are needed to overcome the physical and time constraints of transshipment, notably at ports. Anderton, (2011).

The requirements of international trade gave rise to the development of specialized and intermediary firms providing transport services. These are firms that do not physically transport the goods, but are required to facilitate the grouping, storage and handling of freight as well as the complex paperwork and financial and legal transactions involved in international trade. Examples include freight forwarders, customs brokers, warehousing, insurance agents and banking, etc. Recently, there has been a trend to consolidate these different intermediate functions, and a growing proportion of global trade is now being organized by multi-national corporations that are offering door to door logistics services. They are defined as third party logistics providers.

6. Advantages of Joint Operations

The main advantages of joint operations are:

- **High capital costs** can be justified and amortized more easily with a diverse revenue stream (rail, airlines, and ferries).
- **Maintenance costs** can be spread over a wider base (rail, airlines).
- The same modes or traction sources can be used for **both freight and passengers**, particularly for rail.

The main disadvantages of joint operations are:

- Locations of demand rarely match since the origins and destinations of freight flows are usually quite distinct spatially from passenger traffic.
- Frequency of demand is different as for passengers the need is for high frequency service, for freight it tends to be somewhat less critical.
- Timing of service. Demand for passenger services has specific peaks during the day, for freight it tends to be more evenly spread throughout the day. Several freight operations prefer night services since they insure that shipments arrive at their destination in the morning.
- Traffic balance. On a daily basis passenger flows tend to be in equilibrium, irrespective of the distance involved (e.g. commuting or air transportation). For freight, market imbalances produce empty flows that require the repositioning of assets.
- Reliability. Although freight traffic increasingly demands quality service, for passengers delays (diversion from posted schedules) are unacceptable.
- Sharing routes favors passenger traffic with passenger trains often given priority or trucks excluded from specific areas at certain times of the day.
- Different operational speeds where passengers demand faster service but specific cargo, such as parcel, facing similar requirements.
- Security screening measures for passengers and freight require totally different procedures.

The ongoing separation of passengers and freight on specific gateways and corridors is consequently a likely outcome, involving a growing divergence of flows, modes and terminals.

7. **Passengers and Freight Divergence**

Passengers and freight are increasingly divergent activities as they reflect different transportation markets. In several modes and across many regions passenger and freight transport is being unbundled.

**Shipping**

Mention has been made already how in the maritime sector passenger services have become separated from freight operations. The exception being ferry services where the use of RORO ships on high frequency services adapt to the needs of both market segments. Deep sea passenger travel is now dominated by cruise shipping which has no freight-handling capabilities, and bulk and general cargo ships rarely have an interest or the ability to transport passengers.

**Rail**

Most rail systems improved passenger and freight services. Where both segments are maintained the railways give priority to passengers, since rail persists as the dominant mode for inter-city
transport in India, China and much of the developing world. In Europe the national rail systems and various levels of government have prioritized passenger service as a means of checking the growth of the automobile. Significant investments have occurred in improving the comfort of trains and in passenger rail stations, but most notable have been the upgrading of track and equipment in order to achieve higher operational speeds. Freight transport has tended to lose out because of the emphasis on passengers since such systems were optimized for passenger flows. Because of their lower operational speeds, freight trains are frequently excluded from day-time slots, when passenger trains are most in demand. Overnight journeys may not meet the needs of freight customers. This incompatibility is a factor in the loss of freight business by most rail systems still trying to operate both freight and passenger operations.

It is in North America where the separation between freight and passenger rail business is the most extensive. The private railway companies could not compete against the automobile and airline industry for passenger traffic, and consequently withdrew from the passenger business in the 1970s. They were left to operate a freight only system, which has generally been successful, especially with the introduction of intermodality. The passenger business has been taken over by public agencies, AMTRAK in the US, and VIA Rail in Canada. Both are struggling to survive. A major problem is that they have to lease trackage from the freight railways, and thus slower freight trains have priority.

Roads

Freight and passenger vehicles still share the roads. The growth of freight traffic is increasing road congestion and in many cities concerns are being raised about the presence of trucks. Already, restrictions are in place on truck dimensions and weights in certain parts of cities, and there are growing pressures to limiting truck access to non-daylight hours. Certain highways exclude truck traffic – the parkways in the US for example. These are examples of what is likely to become a growing trend; the need to separate truck from passenger vehicle traffic. Facing chronic congestion around the access points to the port of Rotterdam and at the freight terminals at Schiphol airport, Dutch engineers have worked on feasibility studies of developing separate underground road networks for freight vehicles.

Air transport

Air transport is the mode where freight and passengers are most integrated. Yet even here a divergence is being noted. The growth of all-freight airlines and the freight-only planes operated by some of the major carriers, such as Singapore Airlines, are heralding a trend. The interests of the shippers, including the timing of the shipments and the destinations, are sometimes better served than in passenger aircraft. The divergence between passengers and freight is also being accentuated by the growing importance of charter and “low-cost” carriers. Their interest in freight is very limited, especially when their business is oriented towards tourism, since tourist destinations tend to be lean freight generating locations.

8. Conclusion

Transport plays a crucial role in economic and social development and its contribution goes beyond what is normally captured in traditional cost-benefit analyses. Transportation
investments can have large long-term economic, social and environmental impacts. Integrated transport system is successful when it is attractive for passengers in terms of offered services and advantageous fares. If the passenger has to decide for the public passenger transport in the form of integrated transport system and not for an individual automobile transport, he has to have the reason for such decision. The time of journey and the price for journey can be said as the key decision maker factors. The time of journey in terms of integrated transport system can be competitive to individual automobile transport when the time and space coordination is provided for all the involved transport modes. Together with the suitable fares it can influence the decision of passenger.

In spite of the presence of alternatives, road transport possesses significant advantages over other modes:

- The capital cost of vehicles is relatively small, which makes it comparatively easy for new users to gain entry. This helps ensure that the trucking industry, for example, is highly competitive. Low capital costs also ensure that innovations and new technologies can diffuse quickly through the industry.
- Another advantage of road transport is the high relative speed of vehicles, the major constraint being government-imposed speed limits.
- One of its most important attributes is the flexibility of route choice, once a network of roads is provided. Road transport has the unique opportunity of providing door to door service for both passengers and freight.

These multiple advantages have made cars, buses and trucks the modes of choice for a large number of trip purposes, and have led to their market dominance for short distance trips. The success of cars and trucks has given rise to a number of serious problems. Road congestion has become a feature of most urban areas around the world. In addition, the mode is behind many of the major environmental externalities linked to transportation, particularly CO2 emissions. Addressing these issues is becoming an important policy challenge at all levels of jurisdiction, from the local to the global. A symbiosis between types of roads and types of traffic with specialization (reserved lanes and hours) is to be expected.
9. References


