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MULTIMODAL AND INTERMODAL TRANSPORTATION SYSTEMS

The aim of this paper is to provide information on the general characterization of multimodal transport, intermodal and combined transport. There is also mentioned the distribution of basic transport processes and types of transshipment. Finally, this paper describes the practical examples of multimodal transport.

Keywords: Multimodal transport, intermodal transport units, transshipment, transport process.

1. Introduction

Transport is at the foundation of any economy as it constitutes the heart of the supply chain. Without good transport networks the proper functioning of markets is impossible – particularly the European Market. Transport infrastructure investments boost economic growth, create wealth, and enhance trade, accessibility and the mobility of people. Transport is also a key ingredient for a high quality of life, ensuring accessibility and bringing people together. The transport industry is also an important component of the EU economy: when considering the whole logistic chain it directly employs around 10 million people and accounts for about 4.6 % of GDP. Furthermore, many European companies are world leaders in infrastructure, logistics, traffic management systems and manufacturing of transport equipment [1].

Transport and distribution are key considerations when planning for international trade. Choosing the right mode of transport is essential to ensure your import or export operation is efficient and cost-effective. There are four ways of importing and exporting - road, rail, air and sea - although the using more than one type of transport.

2. Modes and means of transport

There are several transport modes and means of transport (see Fig. 1). A transport mode provides the necessary infrastructure for using a certain means of transport. Without this infrastructure, no transport would be possible. The transport modes are situated on land, on the water and in the air, land transport comprises road, rail and pipeline transport, waterborne modes are inland

waterway, deep sea and short sea shipping, the air mode comprises air traffic.

Means of transport are technical facilities and equipment for the transport of people or goods. Transport means in freight transport are, for example, the inland vessel, the truck or the plane. Due to the fact that transport cannot usually be handled using a single mode or means of transport, varying forms of transport have been developed, which are described as transport processes.

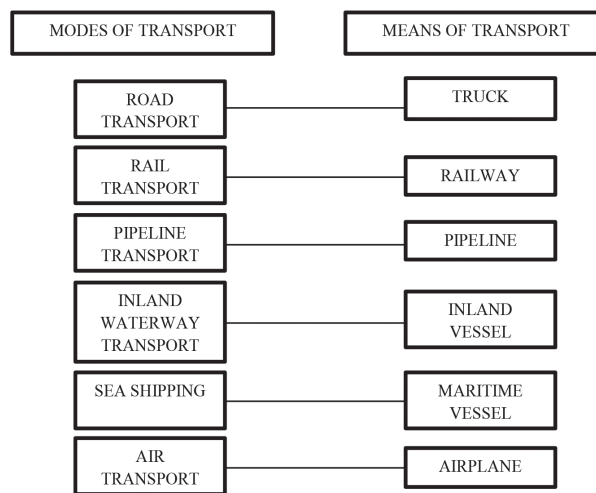


Fig. 1 Modes and means of transport [Source: authors]

3. Transport processes

Transport can be processed in several forms (e.g. either directly or by making use of several modes of transport) and it

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is therefore necessary to specify these processes more clearly. Transport processes can be initially classified into direct and non-direct transport. In the case of a non-direct transport process, the transshipment of goods takes place, whereas in direct transport no such transshipment is needed.

In **direct transport**, goods are transported directly from a point of departure to the destination. For this reason, it is also called door-to-door transport. In this case, the means of transport (e.g. truck, vessel or railway) is not changed and there is also no change of transport mode (e.g. rail or inland waterway). Direct transport can always be classified as unimodal, goods are transferred from the starting point to the end point by one means of transport.

Multimodal transport is characterized by the transport of goods using two or more different transport modes. In order to change the means of transport, transshipment of goods is required. In doing this, the strengths of the several individual transport modes can be used and cheapest and most environmentally friendly combination can be chosen. Main characteristics of multimodal transportation are transshipment terminals that allow efficient cargo handling between short-distance and long-distance traffic as well as application of standardized and reusable loading units. However, combined freight transport can be organized in different ways. In general, trucks cover short distances between the loading area and the transshipment point or between the place of arrival and the recipient. Long-distance haulage is conducted by other means of transport such as train, ship or even plane. Multimodal transport is a very interesting approach that solves a big part of cargo mobility problems [2].

Combining private and state transport in a multimodal transport system offers the opportunity to capitalize the best rates and transit time possible.

As many understand, multimodal transport refers to a transport system usually operated by one carrier with more than one mode of transport under control or ownership of one operator. It involves the use of more than one means of transport such as a combination of truck, railcar, railways, aeroplane or ship in succession to each e.g. container line which operates both a ship and rail system of double stack trains.

Advantages of multimodal transport:

- Coordinated and planned as a single operation, it minimizes the loss of time and risk of loss, pilferage and damage to the cargo at trans-shipment points.
- The market is psychically reduced by faster transit of goods; Reference to Globalization challenge, the distance between origin or source materials and customers is getting to be insignificant thanks to the development of multimodal transport.
- The burden of issuing multiple documentation for each segment of transport is reduced to minimum.

- The consignor / consignee have to deal with only the MTO (multimodal transport operator) in all matters related to the goods transportation.

Intermodal transport can be classified as a special type of multimodal transport, whereby two and more modes of transport are used to transport the same loading unit or road vehicle. This means that, when changing transport means, only the loading units or the road vehicles are switched, while the goods remain in the same transport receptacles (such as containers or swap bodies) [2]. An example for intermodal transportation would be the transport by ship to a port, from which the containers are either loaded directly on the wagons or are transported by truck to the rail terminal. The containers are transported to the nearest hub by rail and are then transported to the final destination. Since only loading units or the road vehicles (and not the goods themselves) have to be handled, changing the transport mode requires very little time and helps saving on costs for transshipment. In additional, the risk of damage to the goods during transshipment is minimized.

Advantages of intermodal transport:

- The possibility of seamless door-to-door transport.
- Consolidation in the longer distance trunk line move. Consolidation leads to economies of scale and the possibility of transporting goods more economically.
- It has been proven to effectively reduce CO₂ emissions and improve the environment, which has become an important policy issue [3].

Combined transport is a special type of intermodal transport in which the major part of the trip is performed by inland vessel or railway and any pre- and/or end-haulage carried out by track is minimized. When rail or waterway transport is used for the main leg, combined transport represents an environmentally friendly transport alternative. Combined Transport will only be able to live up to its full potential, and deliver the modal shift expected of it by European transport policy-makers as well as the general public, if the regulatory conditions which presently do not fully support fair competition - either between the different modes of transport, or on rail - are corrected by the legislator [4].

A good example is the transport of a container from a Bratislava's company to the Port of Bratislava by truck. This is followed by transport to Romania, which is handled via inland vessel and finally, a truck carries the container to the consignee's location.

4. Types of transshipment

Transshipment can be divided into processes in which intermodal loading units are lifted and processes in which units are not lifted:

- **Lift-on-Lift-off (Lo-Lo)** is defined as the vertical form of transshipment. In a terminal, the loading unit or semi-trailer is lifted by crane or reach stacker from one means of transport to another (see Fig. 2) [5].



Fig. 2 Lo-Lo transshipment process [6]

- **Roll-on-Roll-off (Ro-Ro)** is defined as a transshipment, where loading units or semi-trailers are rolled in horizontally via a ramp (see Fig. 3). The main advantage here lies in the fact that loading units can be transhipped without cranes or reach stocker [5].



Fig. 3 Ro-Ro transshipment process [7]

- **RoLo** (roll-on/lift-off) vessel is another hybrid vessel type, with ramps serving vehicle decks but with other cargo decks only accessible when the tides change or by the use of a crane (see Fig. 4) [5].



Fig. 4 Ro-Lo vessel [8]

4.1 Intermodal transport units

To reduce time and costs during the transshipment process, standardized loading units are used in intermodal transport (see Fig. 5). Because of the standardization of the loading unit's size and the necessary equipment (spreader), easier handling, better scheduling and higher exploitation of space (stackability of containers) can be achieved. Intermodal loading units – also intermodal transport units (ITUs) are transhipped between road, rail and waterway using specialized facilities.

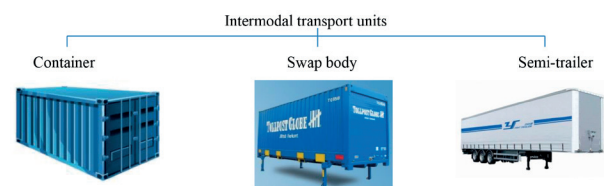


Fig. 5 Intermodal transport units [9]

Swap bodies and containers are dominating in continental European Combined Transport (road/rail). Semi-trailers are important in some markets e.g. RoRo process (see Fig. 6).

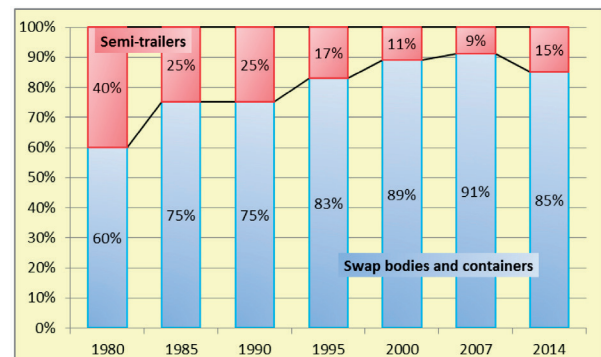


Fig. 6 Techniques in combined transport (1980-2014) [9]

Containers are standardized receptacles made of metal and available in different sizes and forms. Their many advantages are their extreme robustness and high stackability, resulting in optimum utilization of space minimizing risk of damage, reduction of packing expense, etc. Containers are available in various shapes and sizes for special purpose. Basic dimensions and permissible gross weights of intermodal containers are largely determined by two ISO standards: **ISO 668:2013** and **ISO 1496-1:2013** [2]. The most common sizes of container available are 20 feet, 40 feet and 45 feet in length.

Swap-bodies are trailers for trucks without a chassis and fully compatible with euro-pallets. The sizes of swap bodies are principally standardized [2]. The main advantage of a swap body is its ability to stand freely using four foldable legs that enable easy loading and unloading. The economic benefit for carriers is

that just one vehicle can use multiple different swap bodies. While loading is taking place at the ramp, the truck can be transporting other swap bodies. Therefore, the truck can park an empty swap body at the ramp, and straight away pick up a loaded body and begin a new trip. [10] This minimizes idle and waiting times for the vehicles. The disadvantage of a swap body is its difficulty to stack. The swap-body is transferred from road vehicle to rail wagon by means of an overhead straddle crane, which has four arms that locate into slots permanently fixed to the bottom of the swap-body.

Semi-trailer is a non-motorized vehicle used for the carriage of goods intended to be coupled to an articulated vehicle. It is a trailer without a front axle [2]. A large proportion of its weight is supported either by a road tractor or by a detachable front axle assembly called a dolly. A semi-trailer is equipped with legs that can be lowered to support it when it is unhooked from the tractor. When coupled together, the tractor and trailer combination is often referred to as a semi, 18-wheeler, big-rig, articulated lorry, or truck and trailer. The purpose of a semi-trailer is to carry freight.

5. Multimodal transport in practice

5.1 Mineral raw materials

Source and destination: From Rotterdam via Linz to the customer
Means of transport: Inland vessel, maritime vessel, truck and railway
Type of transport process: Split multimodal transport
Cargo: Mineral raw material (bulk cargo)



Fig. 7 Transshipment of mineral raw material in the port of the Linz AG [11]

On a site of around 150 hectares, including 45 hectares of water surface, the Port of Linz provides the latest facilities for efficient transshipment services. Transport and transshipment of mineral raw materials are undertaken at the Linz AG's port (see Fig. 7). The hygroscopic characteristics of this type of cargo (e.g. the raw material is extremely sensitive to moisture and pollution) make its handling difficult. Hence, the cargo hold of the inland vessel must be carefully checked before loading in order to avoid damage of the cargo [11].

At the start of the transport chain, the commodities are carried to Rotterdam by maritime vessels. In Rotterdam, the freight is transhipped to inland vessels by means of mobile cranes or luffing and slewing cranes. After this, the goods are transported from Rotterdam to the Port of Linz via the Rhine, the Main and the Main-Danube-Canal. Motor cargo vessels or pushed convoys are usually used for this, loaded with an average of 1,000 tons of cargo per vessel unit. After the arrival at the Port of Linz, the products are then transhipped to trucks or railway, depending on the customer, and transported to their final destination [11].

5.2 Steel products

Source and destination: From Linz via Moerdijk (the Netherlands) to overseas countries
Means of transport: Inland vessel, maritime vessel, truck and railway
Type of transport process: Split multimodal transport
Cargo: Steel products (general cargo)



Fig. 8 Transshipment of steel products in the covered transshipment hall of Industrie-Logistik-Linz [11]

The company Industrie-Logistik-Linz (ILL) provides logistics services throughout the entire supply chain. The company has offices in Austria (Linz and Steyr) and in the Netherlands (Moerdijk). 500,000 tons of steel are transported annually between Linz and Moerdijk on inland vessels. While ILL organizes transshipment in Linz and monitors the transport to the Netherlands, an inland navigation service provider or a partner company is responsible for the physical carriage by ship [11].

The steel products are collected by railway wagons from several warehouses on the production site. Following this, they are transported to the covered transshipment hall which is located at the factory port of the voestalpine in Linz (see Fig. 8). From there, the goods are directly transhipped from the wagons onto inland vessels. For this covered transshipment, a gantry crane with a maximum capacity of up to 35 tons is used. Subsequently, the goods are transported to Moerdijk by pushed convoy. There, the steel products are transhipped onto a maritime vessel and then transported to seaports located near the final customers. The latter are located in countries such as Brazil, the USA, Singapore, India, Malaysia or South Africa. In most cases, end-haulage is done by railway, though sometimes by trucks, as the best matching means of transport also depends on the size of the steel products [11].

6. Conclusion

The importance of freight transport for our society is beyond dispute, but transport volumes are ever growing and the problems to accommodate freight flows in an efficient and sustainable way become increasingly alarming. Traffic congestion is rapidly growing and the quality of freight transport is not able to keep pace with the rising ambitions: customers want higher reliability, lower prices, faster deliveries, more flexibility and higher service levels. This paper is primarily concerned with multimodal and intermodal transport.

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