READER – MULTIMODAL TRANSPORT AS A CONTRIBUTION TO SUSTAINABLE FREIGHT TRANSPORT

Collection of relevant contents for the slide set "Multimodal transport as a contribution to sustainable freight transport

1. Multimodal Transport Chain

There are different modes and means of transport. A mode of transport offers the infrastructure that must be available for the use of a particular mean of transport. Transport cannot take place without this infrastructure. The transport modes run on land, water and in the air. Road, rail and pipeline transport belong to the overland transport sector. Inland, deep-sea and coastal shipping are included in the water transport sector. Air comprises the air traffic mode of transport.

Means of transport are vehicles and equipment for transporting people and goods, such as inland waterway vessels, trucks or trains. It includes the technical equipment and devices used for transporting people and goods. Means of freight transport are, for example, inland waterway vessels, trucks or aircraft. Since transport cannot usually be carried out using a single mode or means of transport (e.g. due to geographical circumstances), various forms of transport have arisen, which are described below.[1]

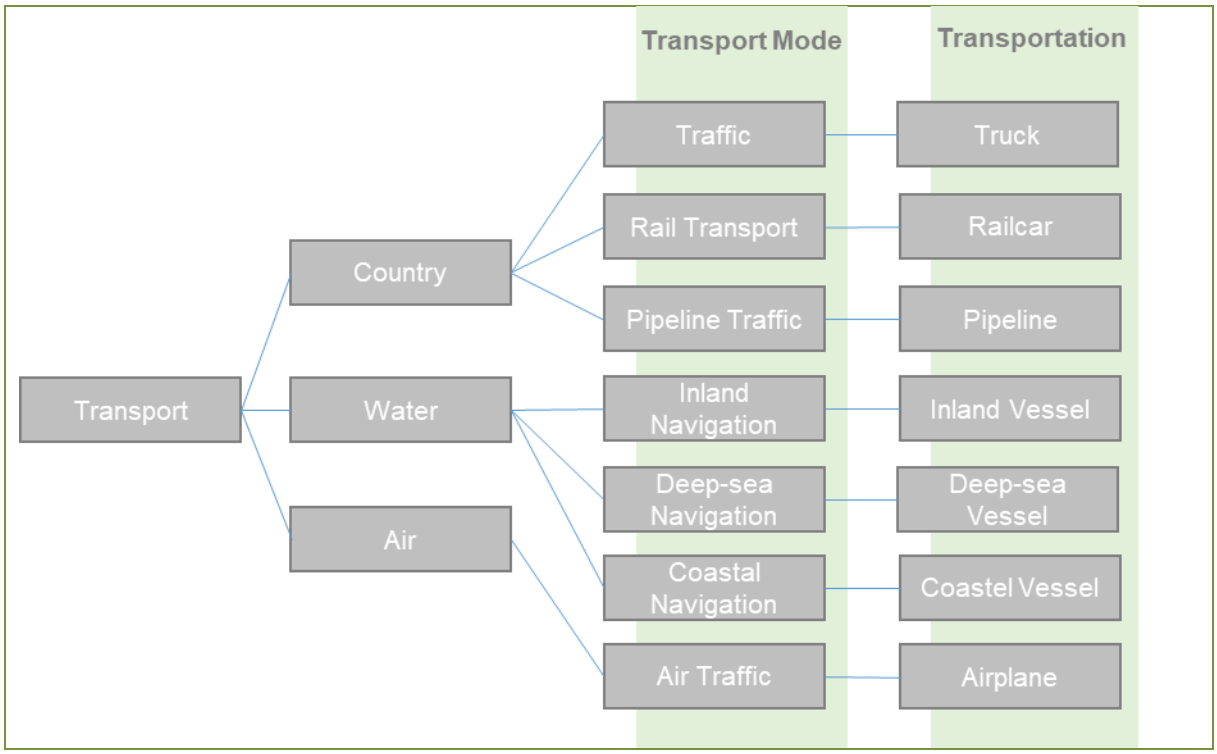

Figure 1 - Overview of modes and means of transport (Source: viadonau based on Gronalt et al.2010)

"Since transport can be provided in different forms (e.g. directly or using several modes of transport), a more detailed specification of these processes is necessary."[2] The different specifications are shown in Figure 2.

[1] Cf. Dolinsek et al., 2013, p. 174f
[2] Cf. Dolinsek et al., 2013, p. 175

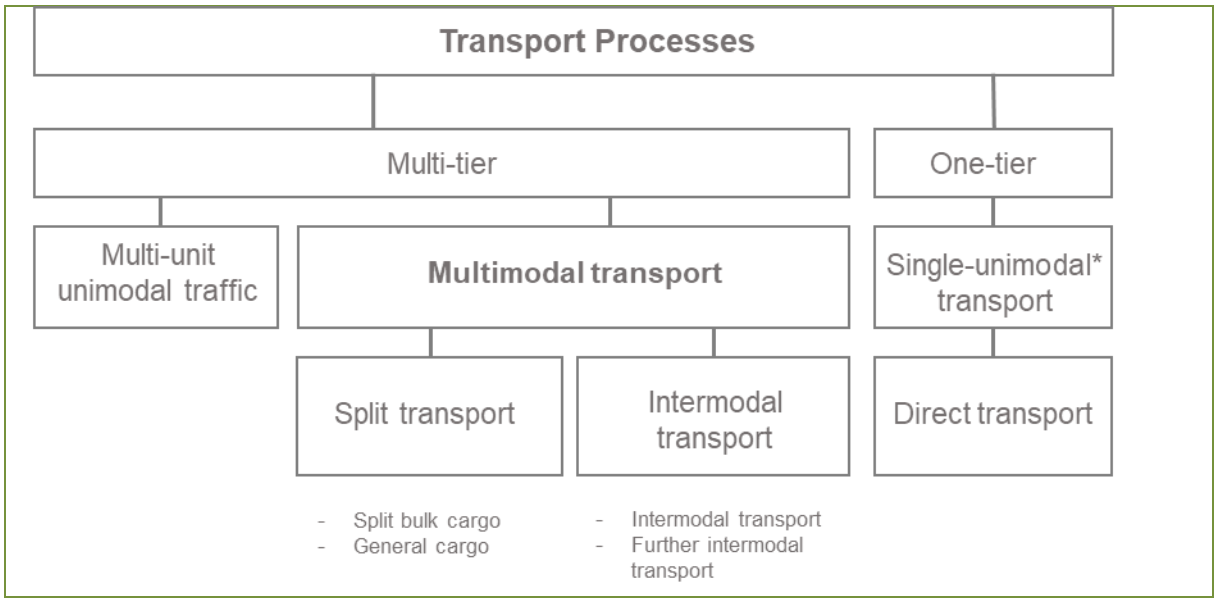

Figure 2 - Overview of transport processes (own representation, based on Posset et. al, 2014)

"In the first step, the transport processes are divided into multi-carriage and one-carriage traffic. When goods are reloaded in multi-carriage traffic, they are not reloaded in single-carriage traffic. In direct transport (single link transport chain), transport takes place directly from the delivery point to the receiving point, which is why it is also referred to as door-to-door transport. There is no change of transport means (e.g. truck, rail, ship) or transport mode (e.g. rail or inland waterway). Direct transport is therefore always unimodal (goods are transported from their source to their destination by one means of transport). Examples are port-to-port transport by inland waterway (e.g. mineral oil transport from warehouse A to warehouse B). In multimodal transport, goods are transported using two or more different transport modes (e.g. switching from water to rail). The goods are transferred from one mode of transport to another. The positive characteristics of the respective carrier can be used and the most cost-effective and environmentally friendly combination can be selected. Multimodal transport tends to be used for longer and less time-sensitive transports, as time is lost and additional costs are incurred for each transhipment."[3]

1.1 Types of Multimodal Transport

Split Shipment

"Split shipment is the transport of goods by two or more means of transport or transport modes, with the goods being transhipped. This is the big difference to intermodal transport, which does not handle the goods themselves but only the loading units (goods included). Split goods transport can be subdivided into bulk goods transport and general cargo transport according to the type of load:

- In the case of **split bulk cargo transport**, lumpy, granular, dusty, liquid or gaseous goods are transported in their unpackaged state. Since bulk goods cannot be transported piecewise, they are measured in units of measurement such as tonnes or litres. Examples include liquid cargo such as oil, bulk goods such as coal or ore and absorbable material such as grain.

[3] Cf. Dolinsek et al., 2013, p. 175f

- In contrast to bulk cargo transport, individualised and distinguishable goods are transported **in general cargo transport**. The goods can be handled individually, whereby the stock is indicated in number of pieces or containers (e.g. pallets, bales, crates). General cargo basically means everything that can be transported in one piece and does not require any special transport containers. Examples of general cargo are the transport of machines, pallets or heavy goods parts".[4]

Intermodal and Combined Transport

"Intermodal transport is a special form of multimodal transport. The goods are transported in the same loading unit or with the same road vehicle on two or more transport modes. This means that when switching from one mode of transport to another, only the loading unit or the vehicle is transhipped - but the goods always remain in the same containers (e.g. containers or swap bodies). Since only the loading units or vehicles and not the goods themselves have to be transhipped, costs and time can be saved. The risk of damage to the transported goods during transhipment is also minimised.

Combined transport is a special form of intermodal transport in which the majority of the route is covered by inland waterway or rail and the pre- and on-carriage by road is kept as short as possible. Since the main leg of the transport is by rail or inland waterway, combined transport is a very environmentally friendly alternative. An example of this is the transport of a container by truck from a Viennese company to the port of Vienna. The container is then shipped by inland waterway to Romania. The consignee takes the container over with the truck and brings it to his business location."[5] Figure 3 gives an overview of the different types of combined transport.

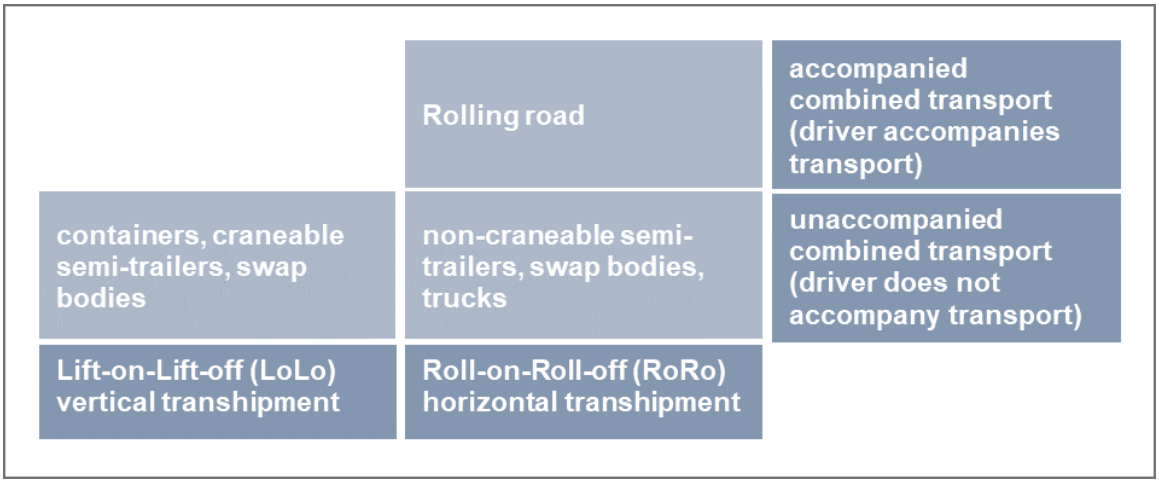

Figure 3 – Different types of combined transport (source: viadonau)

"With regard to the transhipment, a distinction can be made between the lifting and non-lifting of the intermodal loading units as follows:

[4] Cf. Dolinsek et al., 2013, p. 177

[5] Cf. Dolinsek et al., 2013, p. 177f

- Lift-on-Lift-off (LoLo) is the vertical form of transhipment. The loading unit or the semi-trailer is loaded into a terminal. As an example, a crane or reach stacker lifts the cargo from one means of transport to another.
- In contrast, the loading unit or semi-trailer is solely rolled during roll-on roll-off (RoRo) transhipment (horizontal transhipment). The great advantage is that the loading units can also be reloaded without a crane or reach stacker (e.g. rolling loading via a ramp).

Moreover, combined transport is also distinguished according to whether the drivers of articulated vehicles accompany the transport or not:

- The best known representative of accompanied combined transport is the so-called Rolling Highway (RoMo). Here, articulated trucks are loaded onto particularly low railway wagons using their own wheels and a ramp. The driver accompanies the transport in a separate couchette car, where he / she can take the legally prescribed driving and rest periods.

- In unaccompanied combined transport (UCT) the driver does not accompany the transport. This includes all transports of containers, swap bodies and semi-trailers. Even when whole trucks are transported on an inland waterway vessel ("floating country road"), the drivers are not on board because of safety and legal reasons. The majority of combined transport is unaccompanied".[6]

Elements of the Multimodal Transport

In principal, the multimodal transport chain consists of the elements pre-carriage, transhipment, main carriage and subsequent carriage. In some cases, stuffing and stripping - the loading and unloading of the loading unit (e.g. container) - also belongs to the elements of the multimodal transport chain.[7]

[6] Cf. Dolinsek et al., 2013, p. 178f

[7] Cf. Posset et al., 2014, p. 48

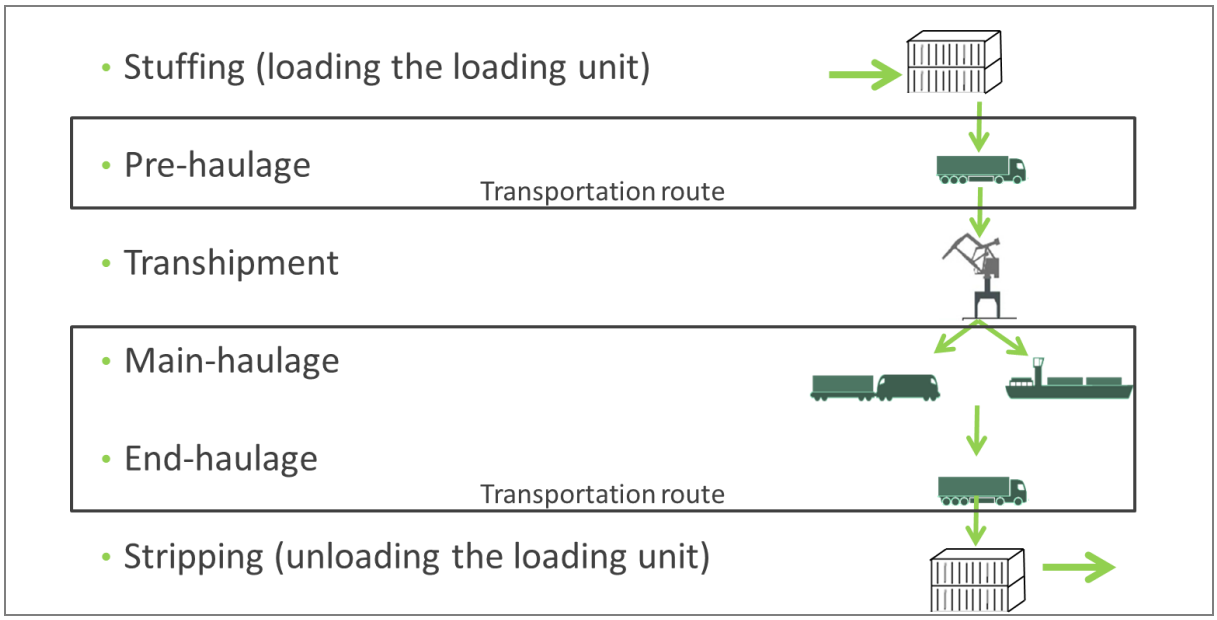

Figure 4 – Elements of multimodal transport (own picture)

2.1 Stuffing and Stripping[8]

When loading the loading unit (stuffing), the goods must be stowed both to save space and to minimize the risk of damage. Other important criteria when using a loading unit such as a container are the maximum weight (varies for rail and road depending on the country) and the distribution of this weight in the container. In addition, an optimal stowage plan guarantees efficient and safe loading and unloading of the container. The packaging of the goods also serves to secure the load and label the goods in the container. Recommendations for packing cargoes for sea and land transport modes are contained in the CTU packing guideline (see: http://www.tis-gdv.de/tis/ls/ctu/ctu.pdf). Optimum loading of the container means that it can also be stripped in an optimal way. Container unloading is often offered as an additional service - for example, if several goods from different consignors have been transported together in one container.

2.2 Transport process[9]

Forward (planning): The first stage of the shipment is referred to as the preliminary leg. The loading unit or the goods themselves are transported to the first, dispatching transhipment point (hub). Groupage transports can also serve as a preliminary run if several consignments from different senders are transported to a transhipment point (hub). The pre-carriage is mainly organised by truck.

Main leg: The main leg is the transport of the loading unit or goods from the sending transhipment point (hub) to the receiving transhipment point (hub).

On-carriage: The transport of the loading unit or goods from the receiving transhipment point (hub) to the consignee is referred to as "on-carriage" or "last-mile". The goods collected in the main leg are distributed to the individual recipients.

[8] Cf. Posset et al., 2014, p. 51ff

[9] Cf. Posset et al., 2014, p. 51ff

2.3 Transhipment[10]

In order to enable a change of transport mode (mode change), a transhipment of the loading unit (e.g. container) is necessary. Terminals or transhipment facilities are usually required to handle this transhipment. Depending on the type of handling equipment used, a distinction is made between vertical and horizontal transhipment.

Vertical transhipment is the classic type of transhipment in which the loading unit is lifted with the aid of cranes or other equipment and loaded from one mode of transport to another. This type of handling has been tried and tested for many years and there is accordingly a lot of equipment for this type of handling.

In horizontal transhipment, the loading unit is not lifted. This means that a terminal infrastructure is not necessarily required. The loading of a truck onto a train ("rolling road") falls into horizontal transhipment. The equipment required for transhipment is described in the following subchapter.

2.4 Tranship Equipment

Cranes and Ramps

"Cranes are divided into bridge cranes, slewing cranes, mobile cranes and floating cranes. The cranes differ in their characteristics and therefore also in their purchase and operating costs. The use or purchase of cranes for certain terminals therefore always heavily depends on the goods to be loaded.

Bridge or gantry cranes are mainly used for handling containers, but can also be used for other goods such as sheet metal and pipes. The average capacity is 25 containers per hour. Full performance in container handling is achieved by using a spreader - that is specific lifting equipment.

A slewing crane is a universal handling crane and is suitable for hooks and grab material. The acquisition costs are significantly lower than those of a bridge crane. Mobile cranes can be used as initial equipment for a port or to support existing crane systems."[11]

Figure 5: Bridge crane at the port of Krems (source: Mierka Donauhafen Krems)
Figure 6: Mobile crane with crawler chassis (source: viadonau)

[10] Cf. Posset et al., 2014, p. 52f
[11] Cf. Dolinsek et al., 2013, p. 82f

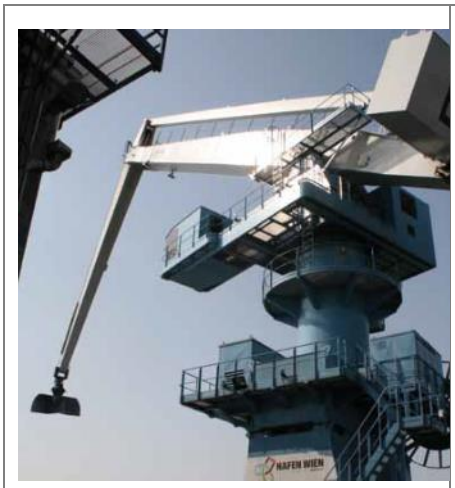

Figure 7: Slewing crane at the port of Vienna (source: viadonau)
Figure 8: RoRo-Ramp at the port of Vienna-Freudenau (source: viadonau)

“The handling of rolling units such as passenger cars requires the installation of so-called Roll-on-Roll-off (RoRo) ramps. Many Danube ports are equipped with RoRo-ramps. A compensation ramp can be adapted to the respective water level with a cable winch, and ensures optimum usability of the ramp. The angle of the ramp must not be too steep, especially when handling trucks, large agricultural machinery or heavy goods.”[12]

Loading Hopper

"Loading hoppers are used for bulk cargo handling from inland waterway vessels to rail or truck. Since the barge has loaded far larger quantities than a single truck trailer or railway wagon can handle, a loading hopper is required to split-up the handling process. The crane fills the hopper from above with the bulk material from the ship, while trucks or railway wagons located under the hopper are loaded independently. Some of these hoppers are also used as intermediate storage."[13]

Figure 9: Loading hopper at the port of Krems (source: Mierka Donauhafen Krems)

[12] Cf. Dolinsek et al., 2013, p. 84
[13] Cf. Dolinsek et al., 2013, p. 84f

Suction System and Pumping Stations

“Special suction and pumping devices are required for handling liquid cargo. These devices, so-called filling stands, are attached to the tanker by means of a swing-out arm and the cargo is pumped into storage facilities or directly into waiting wagons or trucks. Conversely, tankers are filled from the warehouse. Since the majority of the liquid goods handled are hazardous goods, these handling facilities are subject to high safety requirements."[14]

Figure 10: Transhipment facility for liquid goods at the port of Vienna-Lobau (source: viadonau)
Figure 11: Reach Stacker at the port of Vienna-Freudenau (source: WienCont Containergesellschaft mbH)

Material Handling Equipment

"Material handling equipment is for the horizontal transport of goods. Internally they are mostly used at ground level. A reach stacker is a wheeled vehicle with which containers can be handled using a spreader container. Such vehicles are usually used in addition to cranes or bridge cranes. In contrast to a forklift truck, the Reach Stacker cannot only lift containers vertically upwards, but can also move them forwards - into the stack - using an extendable lifting arm. This means that container stacks with a height of 4 to 6 containers can be served. In addition to reach stackers, full and empty container stackers are used for the horizontal handling of containers.

For efficient and damage-free handling of numerous goods such as round timber, paper rolls or steel rolls special equipment such as clamps or pliers are required."[15]

3. Actors at the Multimodal Transport[16]

A large number of different actors are involved in the multimodal transport chain. In the following figure these actors are shown, as well as their connection regarding information and flow of goods.

[14] Cf. Dolinsek et al., 2013, p. 85
[15] Cf. Dolinsek et al., 2013, p. 85f
[16] Cf. Posset et al., 2014, p. 63-65

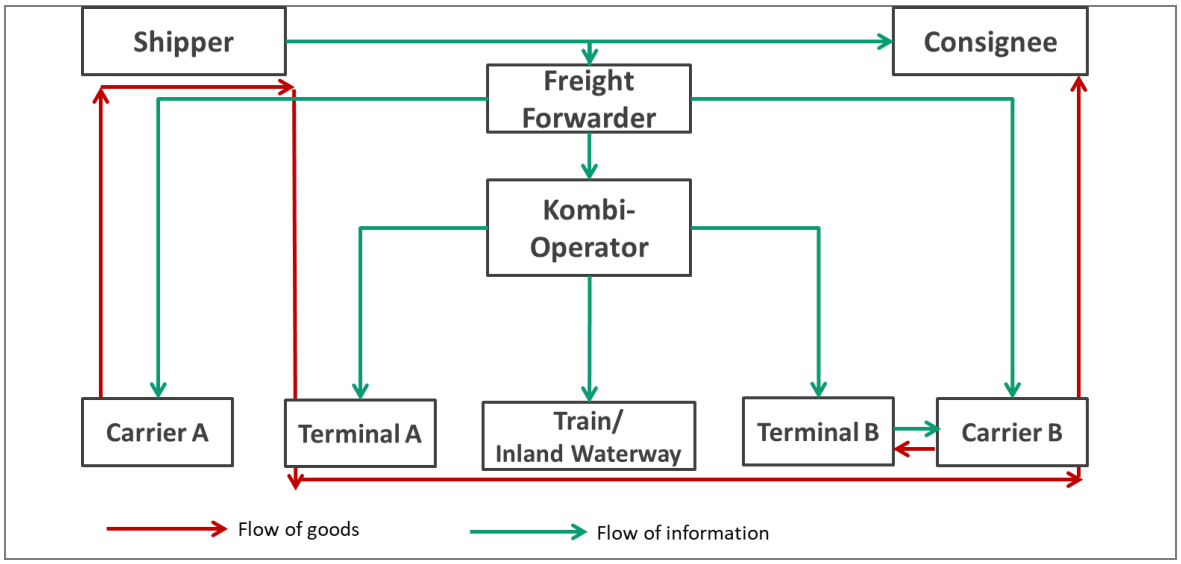

Figure 12: Actors involved in multimodal transport (own research following Posset et. al, 2014)

Shipper: The shipper - also the consignor - hands over the goods to the care of the forwarder or carrier, who is responsible for the delivery to the consignee. The shipper can organise the transport himself or instruct an intermediary (forwarder or combined transport operator) to organise the transport. A freight contract is concluded in that case. The actual consignor of the goods can be the shipper himself, the forwarding agent or combination operator or also the consignee of the goods ("collection order"). The original shipper is the owner/provider of the transported goods.

Freight forwarder: The freight forwarder acts as an intermediary on behalf of the consignor and organises transport with a carrier or sea-going vessel carrier or provides other services. The freight forwarder's tasks include, among other things, concluding the contract of carriage, organizing the shipping documents, completing customs formalities and inspecting the goods and documents at the place of destination. He is also entitled to reimbursement of actual costs and commission.

Carrier: The carrier is specifically responsible for the transport of goods and carries it out himself or has it performed by others. Unlike the freight forwarder, who mainly organizes the transport, the carrier makes the means of transport available for the transport.

Combined transport operator: The combined transport operator or multimodal carrier concludes a multimodal freight contract and, as the carrier, is responsible for fulfilling it. They often offer transport routes to the most important centres in Europe, especially in the area of maritime and continental traffic. The customer first submits a transport request to the combined transport operator, who then finds the best and cheapest connection for the customer's loading unit. The combined transport operator organises either the transport from terminal to terminal (pre- and on-carriage must be organised by the customer himself) or the entire transport chain.

Consignee: The consignee is entitled to take delivery of the goods. By means of the freight contract, the consignee may require the carrier to hand over the goods at the place of delivery and issue instructions to the carrier. However, the consignee may also act as the principal if he concludes a forwarding contract with the freight forwarder.

Shippers, freight forwarder, combined transport operators, freight forwarders and consignees are natural and legal persons.

4. Advantages and Challenges in the Multimodal Transport

For various reasons multimodal transport can be more advantageous than unimodal transport.

4.1 Advantages

Many shipments, for example, cannot be carried out unimodally for geographical reasons or there is not enough truck capacity available. In practice, the most important reason for choosing a particular transport option is of course the economic aspect - which transport alternative is the most cost-effective? The organisation of a multimodal transport is naturally much more complex due to the many actors involved and the necessary handling processes require more planning effort. It is therefore often difficult to guarantee cost-effectiveness in comparison to truck transport and is often only necessary for longer transports. Multimodal transport is therefore usually not competitive on short distances.[17]

The following factors are therefore essential for the economic design of multimodal transport:[18]

- Efficient design of handling processes
- Cost reduction for pre-carriage and onward carriage
- Bundling in the main run to compensate for additional costs
- Offer additional services

A combination of modes also allows the specific advantages of each mode to be exploited and the disadvantages of each to be minimised. Some strengths and weaknesses of each mode are listed in the table below.

Due to the high network density and the speed of short transport distances, road transport is particularly suitable for the pre- and post-carriage of multimodal transports. Due to the low environmental impact and the relatively low transport costs of rail and waterway for medium and long distances and high volumes, these two modes of transport are suitable for the main leg of multimodal transport. By bundling freight transport, appropriate transport volumes can be achieved which justify transport with these modes from an economic point of view.[19]

Transport mode	Strenghts	Weaknesses
Road	• High network density • Speed regarding short transport distances	• Low transport volumes • High external costs
Rail	• Low environmental impact (CO2, pollutant, noise) • More dense rail network (in comparison to waterway) • Low-cost and fast on medium haul routes	• Lower rail network density than the road
Inland Waterway	• Low transport costs and low negative effects at high volumes • Safety and security	• Transport duration (low transport speed • Low waterway network density

Table 1 – Strengths and Weaknesses of the transport modes (own research, source: BMVIT, audit court 2012)

[17] Cf. Posset et al., 2014, p. 48
[18] Cf. Posset et al., 2014, p. 48
[19] Cf. bmvit/ Rechnungshof, 2012, p.260

However, multimodal transport is not always the optimal solution. Different requirements must be met in order to be used as an option. The goods must be suitable for transport in loading units and an appropriate transport volume must also be available. Above all bulk goods or high and heavy piece goods are suitable for multimodal transport. In addition, the appropriate infrastructure must be available so that multimodal transport is possible. Access to the various means of transport and carriers is particularly important. Terminals and hubs also play an important role in multimodal transport. On the one hand, they enable transhipment processes between the modes of transport, serve as warehouses for asynchronous delivery and collection and offer additional services if required. These include, for example, the repair, maintenance or cleaning of loading units or the stuffing or stripping of containers.[20]

4.2 Challenges[21]

Since several actors and modes of transport are involved in multimodal transport, the transport must be organised accordingly and is associated with a higher organisational effort. In addition, appropriate loading facilities and thus the infrastructure must be available in order to realise multimodal transport and access to the various modes of transport must be given. The duration of transport is also an important factor, which can be extended by transhipment processes and also requires appropriate coordination of collection, transhipment and delivery. The use of different modes of transport and transhipment processes can lead to additional costs that may not be competitive against unimodal transport. In addition, security is an important issue, as cargo handling processes are more likely to damage goods or cause delays.

5. Multimodal Transport in Europe

In Europe, a large part (76%) of freight transport is organised by road, which is also reflected in the modal split (see Figure 13).[22] The modal split is the share of the respective mode of transport in the total volume of freight transport.

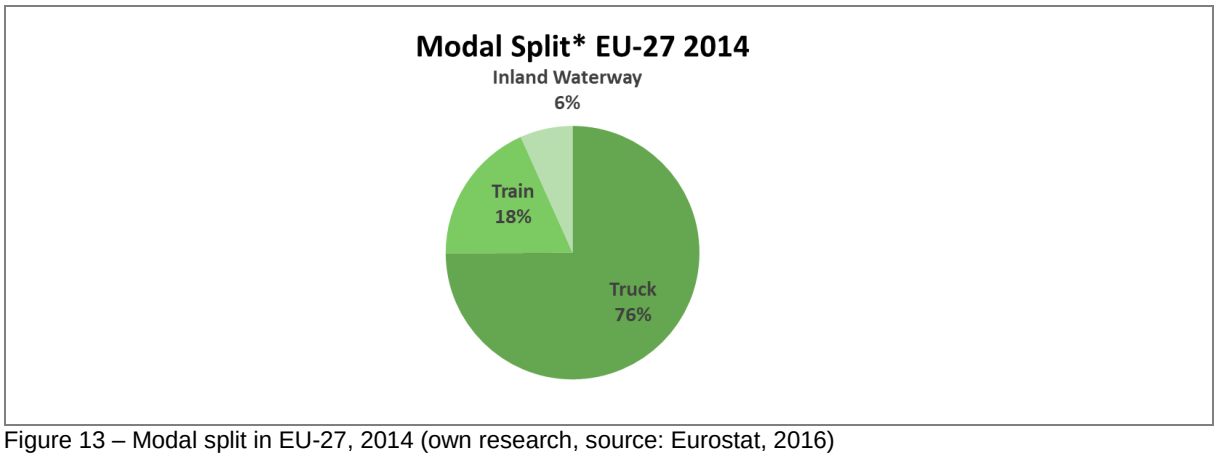

Figure 13 – Modal split in EU-27, 2014 (own research, source: Eurostat, 2016)

Forecasts for the future also show that truck transport will continue to play an important role. An increase of 55 % in truck transport is forecasted for 2050, with the total transport volume

[20] Cf. Posset et al., 2014, p. 56,194,202
[21] Cf. Posset et al., 2014, p. 56
[22] Cf. Eurostat, 2016, without page number

also increasing by 57 %.[23] International freight traffic in particular will increase and thus the transport distances. This leads to the fact that the transport infrastructure is increasingly reaching its limits - congestion is the result.[24] In addition, rising energy costs are leading to increasing price pressure in freight transport, as the transport sector is dependent on oil as a key resource. The increasing pressure from the public and political sides with regard to the demand for sustainable transport solutions also points to the need for action in freight transport.[25]

Road freight transport can thus be identified as a central transport- and environmental policy problem: Trucks handle 45% of freight transport, but are also responsible for 80% of all traffic-related emissions and cause the highest CO2 emissions of all land transport modes.[26]

According to this study, there is great potential for reducing emissions in the transport sector, especially CO2 emissions. The EU has also taken up this approach and in its White Paper "*Roadmap to a Single European Transport Area - Towards a Competitive and Resource-Efficient Transport System*" (COM(2011) 144 final) has set out the cornerstones for the revision of European transport policy by 2050. The central objective is to shift transport from road to rail and waterway. In particular, those transports which exceed a transport distance of 300 km are to be transferred to inland waterway vessels or trains.

Since the infrastructure bottlenecks mentioned above make it difficult to shift transports to rail and waterways in isolation, it makes sense to intelligently combine the respective modes of transport and to make targeted use of their respective advantages by organising multimodal transports, in particular combined transports.[27]

For the purpose of illustration: compared to pure truck transport, multimodal transport has the potential to save up to 30% of energy and up to 90% of pollutants. In addition, the already overcrowded road network is relieved and road safety increased.[28]

The current share of multimodal transport in European freight transport is difficult to measure, as every mode of transport is recorded separately by the national survey method: A transport from Hannover (D) to Bologna (I), which uses the rolling highway (German “Rollende Landstrasse, RoLa) between Regensburg and Trento, is recorded in Austria, for example, as rail transit in combined transport. In Germany, road transport and rail transport are recorded separately. In the EU statistics, only road transport on the Italian side is recorded.

Eurostat, the statistical office of the European Union situated in Luxembourg, uses figures from the UIRR – the International Union for Road-Rail Combined Transport from 14 European countries that organises combined transport. The UIRR data was also used to present the evolution of consignments.[29] (Due to the UIRR's focus on the rail mode of transport, differentiated results are possible when using other data sources!)

Unaccompanied combined transport (UCT) includes the transport of containers (from 20 feet), swap bodies and semi-trailers loaded/unloaded onto railway wagons. In the case of

[23] Cf. European Union, 2013, p.39
[24] Cf. OECD/International Transport Forum, 2015, p.25ff
[25] Cf. Bretzke/Barkawi, 2010, p. 30ff
[26] Cf. Posset et al., 2014, p. 15-17
[27] Cf. European Commission, 2011, p. 4-6,9
[28] Cf. Posset et al., 2014, p. 15-17
[29] Cf. Posset et al., 2014, p. 22

rolling road (accompanied combined transport), the transport of lorries/semi-trailers with special low-floor wagons is recorded.[30]

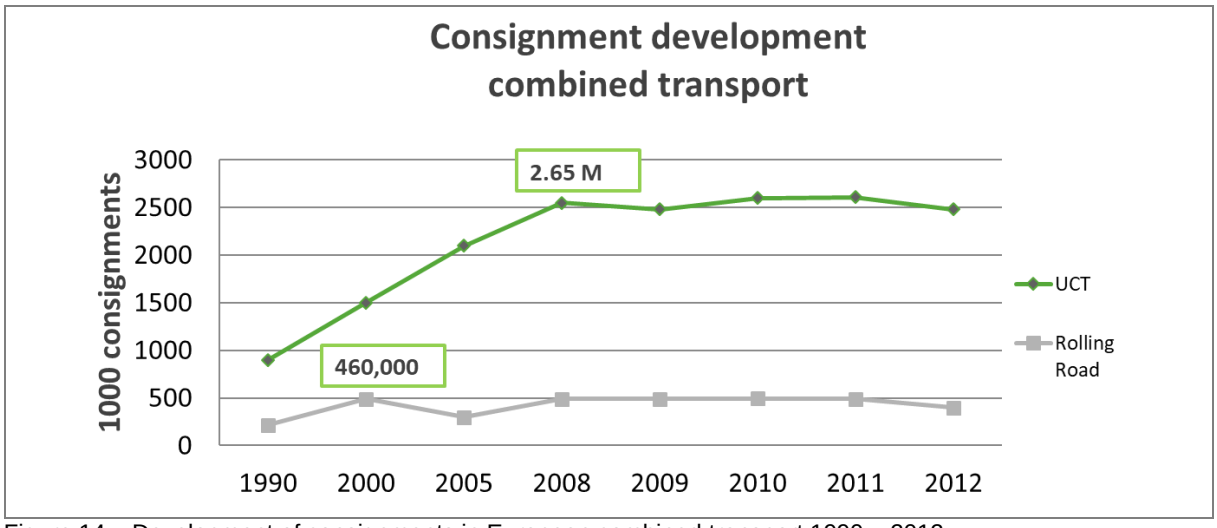

Figure 14 – Development of consignments in European combined transport 1990 – 2012

In 1990, almost 1 million consignments were transported in unaccompanied combined transport (UCT). In comparison, the volume of rolling road consignments amounted to only 215,000 consignments. The rolling road reached a transport record in 2000 (460,000 consignments) and UCT in 2011 (2.65 million consignments). The collapse of the rolling road in 2005 can be attributed to the accession of several states to the European Union. In 2012, both transports recorded a decrease in the volume of consignments.

Overall, combined transport with an average growth rate of approximately 5% represents a dynamic segment in European freight transport.[31]

5.1 Multimodal Transport in Austria[32]

In Austria, intermodal transport accounted for 7 % of total transport performance (tkm) in 2009. A large part of this transport performance was achieved in unaccompanied combined transport (UCT), which is also considered to have a higher growth potential for the future. Between 2000 and 2009, UCT increased by 85 %, while the share of rolling road in freight traffic decreased by 24 % in the same period.

The change in mode of transport takes place mainly between road and rail - inland waterways are comparatively insignificant. In 2009, inland navigation accounted for only 0.02% of intermodal transport in Austria. This can be attributed, among other things, to the lower network density of waterways compared to rail.

6. Best Practices

Four practical examples are presented hereafter in which multimodal transport is already used.

[30] Cf. Posset et al., 2014, p. 23
[31] Cf. Posset et al., 2014, p. 23
[32] Cf. bmvit/Rechnungshof , 2012, p.258-260

6.1 Organic Wheat

Figure 15 – Transhipment of wheat at the port of Vienna Albern (source: port of Vienna, Bioprodukte Pinczker GmbH)

"The company Bioprodukte Pinczker GmbH is located in the port of Vienna Albern and owns and operates a grain silo with a capacity of 10,000 tonnes - an extension of 8,000 tonnes is currently under construction. Three modes of transport (road, rail and water) are used to transport 900 tonnes of organic wheat from Vienna to Zurich, with the majority of the Vienna-Zurich route being covered by inland waterway. The transport takes about 10 days. The grain is transported by truck from the Pannonian region to the customer's own silo in the port of Vienna. There, the grain is temporarily stored in temperature-controlled silos and quality parameters are checked again. The complete cargo quantity is then loaded onto the barge in two days by means of conveyor systems (bucket elevators and troughed chain conveyors). In order to optimize the loading space, a swivel tube is used during loading. The goods reach the Auhafen in Basel via the Danube or Rhine, where the ship is unloaded using a grab crane. The grain is transported on to the end customer in Zurich by rail. Martin Pinczker, Managing Director of Bioprodukte Pinczker GmbH: "The transport solution with the inland waterway vessel is for our requirements the most efficient, both in terms of cost and environmental factors. With its location and infrastructure, the port of Vienna offers optimal conditions for the dispatch of Austrian surplus and export grain."[33]

6.2 Steel products

Figure 16 – Transhipment of steel products in the covered transhipment hall of Industrie-Logistik-Linz

[33] Cf. Dolinsek et al., 2013, p. 181f

"The company Industrie-Logistik-Linz (ILL) offers logistics services along the entire supply chain to its customers. ILL has locations in Austria (Linz and Steyr) and the Netherlands (Moerdijk). On the route from Linz to Moerdijk, 500,000 tonnes of steel are annually transported by inland waterway. ILL itself carries out loading in Linz and transport control to the Netherlands. The physical transport of the material by ship is carried out by third parties or partners of ILL. The steel products are transported in a wagon from various warehouses on the factory premises to the covered transhipment hall in the works harbour of the steel producer voestalpine in Linz. There, the goods are loaded directly from the wagons onto the inland vessel. A bridge crane, which can lift up to 35 t, is used for transhipment in the Linz port hall. The goods are then transported to Moerdijk by means of a pushed tow. There, the goods are transferred to a seagoing vessel and taken to the ports near the end customers. The end customers are located in Brazil, the USA, Singapore, India, Malaysia or South Africa, for example. In most cases, the final transport takes place by rail, but trucks are also used in some cases. The type of shipment depends not least on the size of the steel products".[34]

Mineral Raw Materials:

Figure 17 – Transhipment of mineral raw materials in the port of Linz AG (source: port of Linz (Linz AG))

"The Port of Linz has an area of 150 ha with a water area of 45 ha and state-of-the-art facilities for efficient transhipment. Transport and transhipment of mineral raw materials are carried out in the Linz AG port. Due to the hygroscopic properties of this cargo (i.e. the raw materials are extremely sensitive to moisture and contamination), transport is a difficult undertaking. The cargo space of the ships must be carefully inspected before loading in order to avoid possible damage from moisture and contamination. At the beginning of the transport chain, the mineral raw materials are transported to Rotterdam by deep-sea vessel. There, the goods are transferred to the inland vessel, usually with mobile equipment or a slewing crane. These raw materials are then transported from Rotterdam to Linz via the Rhine, the Main and the Main-Danube Canal. This is usually done by motorised freight vessels or pushed trains, which are loaded with an average of 1,000 tonnes per load carrier. In the port of Linz, the goods are again transferred to trucks or trains depending on which customer will receive them later and transported to the final location.[35]

[34] Cf. Dolinsek et al., 2013, p. 185
[35] Cf. Dolinsek et al., 2013, p. 184

6.3 Magnesium

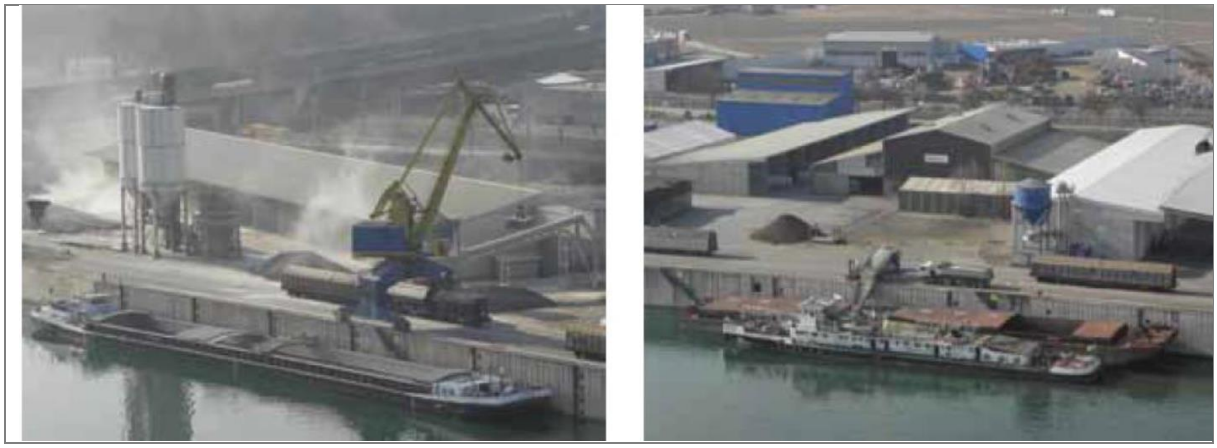

Figure 18 – Transhipment of magnesium at Ennshafen (source: Danubia Speicherei GesmbH)

"Danubia Speicherei GesmbH is a handling, warehousing and forwarding agency company based in Ennshafen. It procures various raw materials from all over the world for its customers and stores them in its own storage facility. From Ennshafen, the goods are then transported carefully to the respective customer. Danubia Speicherei, for example, organizes the transport of fused magnesium or sintered magnesium from China. The goods are transported by ocean-going vessel from China to one of the ARA ports (Antwerp, Rotterdam, Amsterdam) or to the ports of Vlissingen or Terneuzen in the Netherlands. There, the goods are transferred to inland waterway vessels. The magnesium is transported via the Rhine, the Main and the Main-Danube Canal to the Enns port. Once there, the goods are transhipped with the aid of a 16t or 40t crane and then stored in boxes sorted by type. At the customer's request, the goods are removed from storage and taken to their final destination by rail or truck."[36]

7. Outlook

European and international legal regulations

The European Union has taken an important step towards increasing the use of combined transport by adopting a directive on the establishment of common rules for certain types of combined freight transport between Member States (European Commission 1992). The aim of this directive is to liberalise the pre- and post-carriage of combined transport and thus to increase the attractiveness of its use. The main points concern the facilitation of cross-border traffic. Tax relief is also provided for.

In addition, there are other important regulations that go beyond the European area. In the field of inland waterway transport, the Budapest Convention on the Contract for the Carriage of Goods by Inland Waterway (CMNI) applies. The provisions of the International Convention on the Contract for the International Carriage of Goods by Road (CMR) are mandatory law for international road haulage (for Austria: BGBl. 138/1961). Rail (CIM) enshrines international regulations for rail transport in the Uniform Rules concerning the Contract for the International Carriage of Goods.

[36] Cf. Dolinsek et al., 2013, p. 187

The CMR attaches great importance to the consignment note in order to facilitate cross-border traffic. The consignment note is a transport document that regulates the legal relationship between the carrier and the consignor. Among other things, it contains information about the sender, the consignee, the place of loading and unloading, the goods and the terms of delivery. The consignment note is applicable to road, rail and waterways, but the use of a bill of lading is more common in inland navigation.

"The TIR Carnet is an international customs document and contributes to simplifying the formalities of international road transport and to the supervision of cross-border movements of goods. However, it only applies if non-European areas are also affected during transport. In principle, the TIR procedure is only intended for use in road transport, but it can also be used in combined transport (road-rail or road-waterway) if at least part of the journey is by road".[37]

Support of the Combined Transport

The use of combined transport is promoted by numerous transport policy measures. This is intended to ensure an early shift to more environmentally friendly modes of transport, i.e. from trucks to ships or rail. Measures to promote the use of combined transport include tax and regulatory measures in addition to various financial support measures that are possible at national and international level.

In order to enable increased use of rail and waterways, transport networks in Europe must be further developed, capacities increased to make bundling more attractive and transport bottlenecks avoided. In addition, the increasing liberalisation of rail freight transport will enable competitive prices in rail transport. A technical improvement to improve optimal transport planning and the performance of the modes of transport can also favour the use of multimodal transport. Appropriate standards must be set for loading units so that they can be easily transported on different modes of transport and so that handling can be optimised.

The International Union for Road-Rail Combined Transport (UIRR) is an important European organisation active in the field of combined road-rail transport. The UIRR has set itself the goal of promoting modal shift by means of combined transport and also serves as a contact point for questions on the subject. The association is a registered lobby at the European Parliament and the European Commission.[38]

Megatrends[39]

A number of megatrends can be identified for the future that will influence logistics and hence freight transport in the future. These megatrends mean that new transport concepts are necessary or they also support the emergence of these:

- Security is always a decisive factor in the transport sector. Security checks at different points in the transport chain are becoming increasingly important. In addition, the various actors must ensure that the transport chain is not used for terrorist purposes.
- The consequences of climate change are becoming increasingly visible, making sustainable strategies necessary. Some measures have already been undertaken: emission limits for means of transport such as trucks have been introduced and the

[37] Cf. Dolinsek et al., 2013, p. 188
[38] Cf. Dolinsek et al., 2013, p. 189f
[39] Cf. Lehrmacher, 2015, p .9-15

increased use of alternative fuels such as liquefied natural gas (LNG), which is mainly used in inland navigation, is being promoted.

- The increasing size of cities leads to infrastructure bottlenecks in conurbations and poses a major challenge for logistics service providers. By bundling flows of goods outside cities (in consolidation centres), the flows of goods to/from cities can be optimally organised.

This clearly shows the advantage of multimodal transport concepts, which can react accordingly to these changed challenges. The following transport concepts have therefore developed from multimodal transport and integrate some of the megatrends mentioned above:

Intermodal transport can be classified as a special form of multimodal transport. At least two modes of transport are used, whereby only the loading unit (e.g. container) is transhipped and not the goods themselves. This allows the handling to be made even more efficient, which means that cost savings can be achieved. The risk of damage to the goods is also lower.

Politicians increasingly support a modal shift from road to other modes of transport. The concept of co-modality meets the requirements of this claim, as it aims to raise awareness of sustainable freight transport and thereby achieve optimum use of the various modes of transport.

The concept of synchromodality combines the concepts of intermodality and co-modality. Through an efficient and cooperative use of the different transport modes, the existing transport infrastructure should be optimally used. The exchange of real-time data will make it possible to switch between modes of transport in real time. This should avoid unimodal transport - whenever possible and reasonable.[40]

[40] Cf. Haider, et al. 2015, S.23ff ; Stead, 2006, p. 367 und European Container Terminals BV, 2011, p. 5-11

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