RE Trans
Research & Education on Transport Logistics

Reader

Rail Transport
Basics

Section:

RE Rail
Research & Education on Rail Cargo Logistics

This reader supplements the Power Point presentation on rail transport basics doubling as a script.

FH Fachhochschule des BFI Wien
Wirtschaft Management Finance

LOGISTIKUM
CHALLENGE ACCEPTED

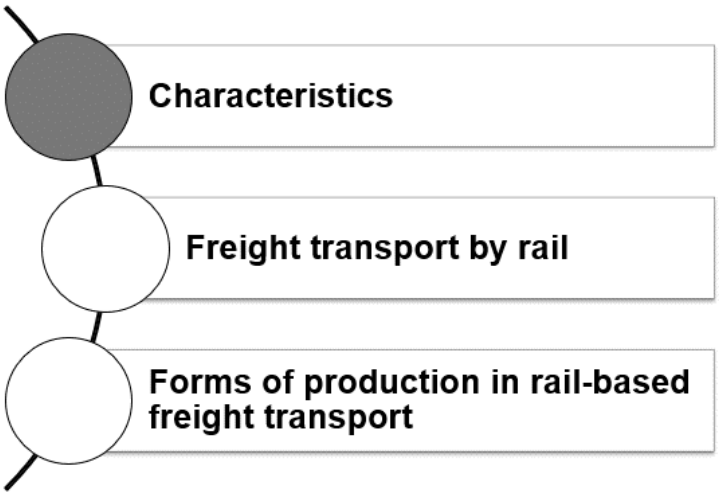
Bundesministerium
Verkehr, Innovation und Technologie

SCHIG
MOBILITÄT VERSTEHEN

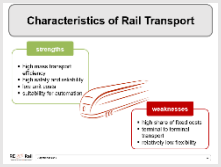
a project in cooperation with the University of Applied Sciences BFI Vienna, Logistikum Steyr, the SCHIG mbH and the Austrian Federal Ministry of Transport, Innovation and Technology

Overview

This reader on rail transport basics and the slide set it is based on are structured as follows:



Characteristics



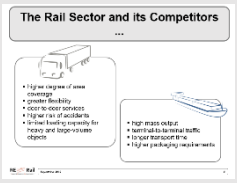
Characteristics of Rail Transport

Rail transport is strongly characterised by a competitive relationship with road transport. The shift of the modal split towards road transport is due to the characteristics of rail as a mode of transport in no small part. According to Kummer, rail transport is characterised by the following strengths and weaknesses:[1]

Strengths	Weaknesses
High mass efficiency: This means that a relatively high volume of people or goods can be transported per traffic transaction. **High safety and reliability:** Rail is considered a safe mode of transport because serious accidents are rare. **Low unit costs:** Low costs per transported unit. **Suitability for automation:**	**High proportion of fixed costs:** Fixed costs remain constant, regardless of how much is produced. Variable costs increase with production. The higher the share of fixed costs, the more a company is forced to increase its capacity utilisation. **Terminal to terminal transport:** If there is no direct connection between customer and rail, other

[1] Cf. Kummer (2010) p. 89 f.

There are already several driverless rail vehicles (e.g. the Dubai Metro).	modes of transport (essentially road transport) must be used in pre- and post-carriage. **Relatively low flexibility:** Destinations and times are very often linked to a timetable, and changing routes is not possible. Furthermore, due to high cost and time involved in building and maintaining the infrastructure, it is only possible to adapt slowly to changing economic conditions.



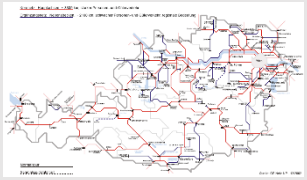
The Rail Sector and its Competitors ...

In comparison to road transport, rail has a higher mass efficiency (thus more suitable for heavy or voluminous transport objects) not least due to its larger dimensions, as well as higher requirements in connection with safety agendas. Road transport, on the other hand, scores with its door-to-door service for its customers. Like inland navigation, rail transport can only offer terminal-to-terminal transport. Only very few customers have access to direct rail or waterway. This in turn necessitates the use of road traffic to overcome the first and last mile and means less flexibility for the customer and the operator of the respective means of transport. One of the topics often discussed in connection with inland navigation is transport time. Many companies do not generally rely on inland navigation with its longer running or transport time and its higher packaging requirements. Particularly the high demands placed on packaging are of great importance for the protection of the transported object due to existing weather conditions. [2]

Another difference between rail and road is that road transport usually runs "on sight". This means that speed must be adapted to visibility based on the resulting braking distance: unfavourable visibility conditions mean slower speeds, while good visibility allows higher speeds. Railway traffic, on the other hand, is different, as it runs at block intervals. A certain track section may only be occupied by one train at a time. Modern train control systems no longer secure a fixed block system but ensure a sufficient distance between two consecutive trains. The advantage of these systems is that it is unnecessary to run on sight, which would only allow low speed in view of the long

[2] Cf. Kummer (2010) p. 86 ff.

braking distance of trains. A disadvantage is that the infrastructure edges cannot be used so densely.[3]



Austrian Rail Network

As of 31.12.2015, the rail network operated by ÖBB-Infrastruktur AG comprises a total of 4,846 line kilometres, of which 3517 km are spanned by overhead electrical lines, and 1095 traffic stations. The route network also includes 290 electronic signal boxes, 246 tunnels and galleries, approx. 6,327 bridges and viaducts and approx. 3,398 railway crossings.[4]

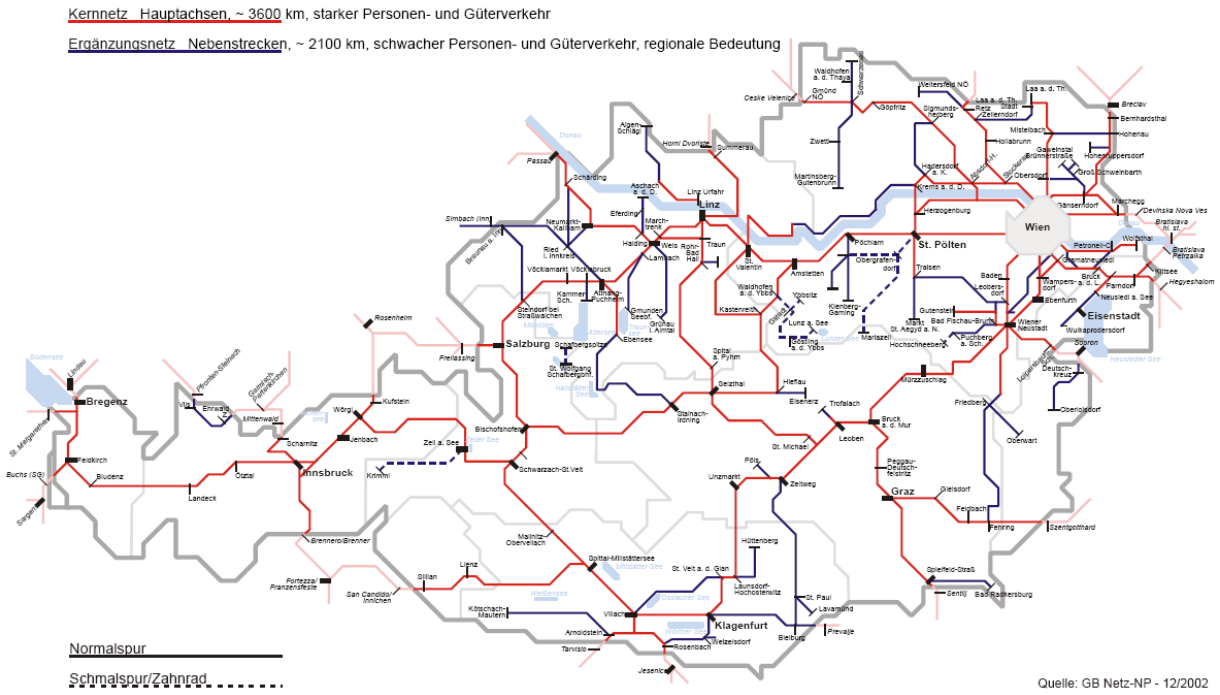


Figure 1: Rail network in Austria[5]

ÖBB Infrastruktur AG with its approx. 18,000 employees in the ÖBB Infrastructure subgroup, plans, develops, maintains and operates the entire ÖBB railway infrastructure: railway stations, lines, buildings, terminals, telecommunications facilities and hydroelectric power plants for environmentally friendly railway power generation. In

[3] Cf. Kummer (2010), p. 89f.
[4] ÖBB Infra (2017a), online.
[5] All important information about the railway infrastructure in Austria: http://www.oebb.at/infrastruktur/de/2_0_Das_Unternehmen/Daten_und_Fakten/_DMS_Dateien/_Zahlen_Daten_Fakten.jsp

addition, it manages all property assets, making it one of the largest property owners and developers in Austria. A large part of ÖBB's apprenticeship system and railway-specific in-company and technical training are integrated into the company. ÖBB-Infrastruktur AG is a wholly owned subsidiary of ÖBB-Holding AG, which in turn is held 100 percent by the Republic of Austria.[6]

Figure 2: Rail planning and construction projects[7]

Track Widths

Track gauge is defined as the distance between the inner edges of the rails. Since the invention of the railway, the so-called **standard gauge** (1435 millimetres) has spread from Britain and established itself in most European and countries all over the world. It was defined as the "European standard gauge".[8]

[6] Cf. ÖBB Infra (2016a), p. 2
[7] All important information about the railway infrastructure in Austria: http://www.oebb.at/infrastruktur/de/2_0_The_Company/Data_and_Facts/_DMS_Files/_Figures_Data_Facts.jsp
[8] Cf. Forschungsinformationssystem (2016a), online

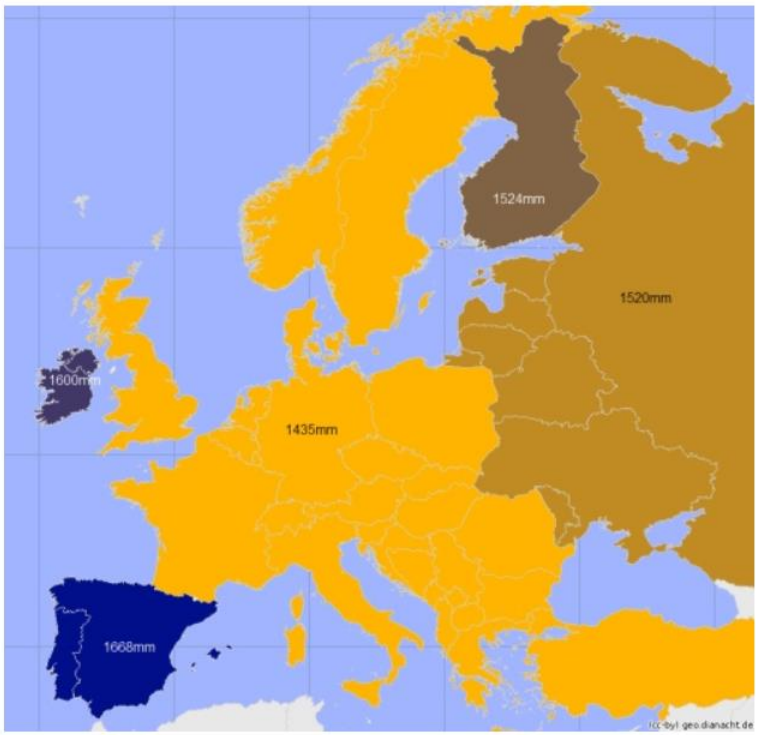


Figure 3: Main track widths in individual countries[9]

However, there are also deviations from the standard gauge:

Narrow gauge: this is narrower and occurs in private, museum or factory railways and does not play a major role.

Figure 4: Narrow-gauge railways in Austria[10]

[9] Forschungsinformationssystem (2016a), online
[10] Schmalspurbahnen (2017), online

Broad gauge: this is wider and occurs nationwide in different widths in individual countries, for example in Spain, Portugal, Finland and the states of the former Soviet Union.

The deviations from the normal gauge had different reasons: on the one hand, for military strategic reasons, a different gauge than in the neighbouring countries was deliberately chosen to make it more difficult for hostile supplies to be transported in the event of a military conflict. On the other hand, track gauges were based on different national measurement systems.[11]

Freight Stations

Freight stations are railway facilities where[12]

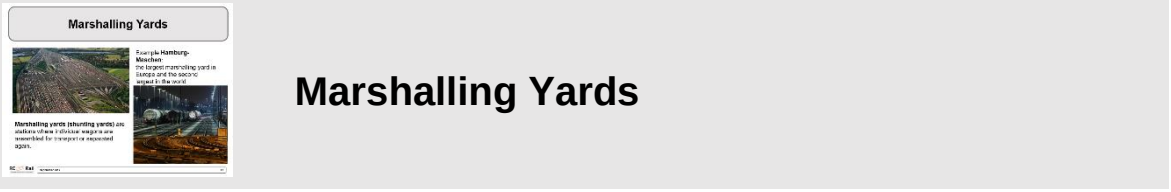
- goods are received or distributed
- goods are transhipped to rail
- goods are transhipped from rail
- freight wagons are handed over to siding tracks
- freight wagons are shunted

Figure 5: Freight centre Vienna South[13]

As part of the concentration of intermodal freight traffic processing in the Vienna area, a multifunctional freight centre is being built at the Inzersdorf site. The freight centre was

[11] Cf. Forschungsinformationssystem (2016a), online
[12] Cf. Kummer (2010), p. 149
[13] ÖBB Infra (2016b), online

planned for facilities for wagonload traffic, combined freight transport (German: KLV Terminal) and contract logistics including the necessary buildings as well as traffic and operating facilities. The cargo centre Vienna South will be built in several stages according to the respective capacity requirements. On 5 December 2016 the Güterzentrum Wien Süd was officially opened.[14]



Marshalling yards (shunting yards) are stations where individual wagons are assembled for transport or divided up again.

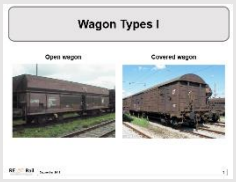
The Zentralverschiebebahnhof Wien-Kledering is the largest marshalling yard in Austria. It is in Favoriten, the 10th district of Vienna on its south-eastern border, as well as in the cadastral district of Kledering, which belongs to the city of Schwechat (Lower Austria). It is operated by Austrian Federal Railways (ÖBB) and is designed for a capacity of 6100 cars per day with a track length of 120 kilometres. The central marshalling yard operates only for freight traffic. However, the cargo trains are only disassembled and reassembled, so there are no facilities for cargo handling. In addition, long-distance trains are formed which also freed up capacity at other marshalling yards in Austria.[15]

Figure 6: Central transfer station Vienna-Kledering

[14] Cf. ÖBB Infra (2017b), online
[15] See Wikipedia (2017), online

The largest marshalling yard in Europe, the Maschen marshalling yard, lies south of Hamburg. It serves as an international hub to Scandinavia and is particularly important for the collection and distribution of individual wagons in the Lüneburg, Hamburg and Schleswig-Holstein areas as well as for hinterland connections, especially to the major North Sea ports of Bremerhaven and Hamburg.[16]

Figure 7: Hamburg Maschen marshalling yard[17]



Wagon Types

Selected wagon types used by Rail Cargo Austria are presented below.

Figure 8: Open wagon[18]

[16] See Deutsche Bahn (2017), online
[17] Abendblatt.de (2017), online
[18] Rail Cargo Wagon (2017a), online

An open cargo car is an all-round closed rail freight car without a roof. This is particularly suitable for weather-independent goods such as bulk goods (e.g. coal, stones).

Figure 9: Covered wagon[19]

A covered freight wagon is a railway freight wagon whose loading space is formed by the side walls and a roof. These wagons are preferably used for the transport of goods which are to be protected against weather influences, loss or theft.

Figure 10: Flat wagon[20]

Flat wagons are particularly suitable for transporting wood, steel or machinery. These are cargo wagons that have a flat superstructure and no or at most low superstructures that are open at the top.

[19] Rail Cargo Wagon (2017b), online
[20] Rail Cargo Wagon (2017c), online

Figure 11: Container wagon[21]

Container wagons are flat wagons specially equipped with fastening devices for container transport.

Figure 12: Low-floor cargo cars[22]

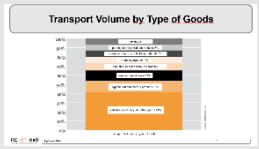
Low-floor cargo cars can transport trucks, semitrailers, motor vehicles or trailers at max. 100 km/h.[23]

[21] Rail Cargo Wagon (2017d), online
[22] Rail Cargo Wagon (2017e), online
[23] Cf. Rail Cargo Wagon (2017d), online

Figure 13: Tank truck[24]

A tank wagon is a special rail cargo wagon with one or more closed containers (tanks) used for the transport of gaseous or liquid goods. Most of these are bought or rented by the shipping industry itself (chemicals and mineral oil).[25]

Rail Cargo Transport



Traffic Volume by Type of Goods

[24] Rail Cargo Wagon (2017f), online
[25] Cf. Becker (2014), p. 32

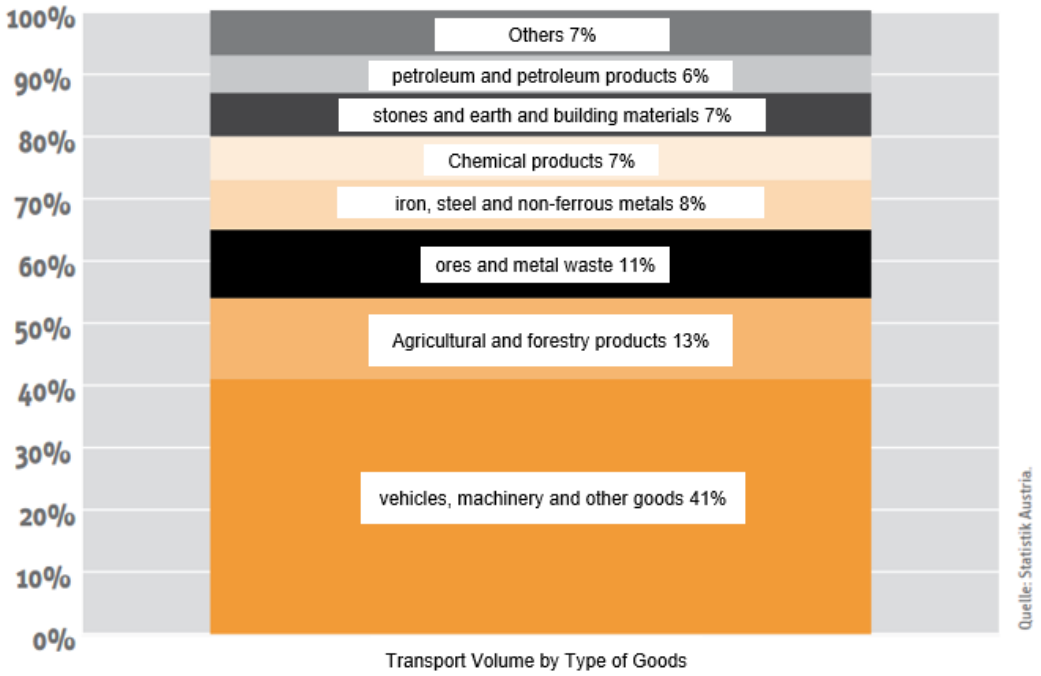
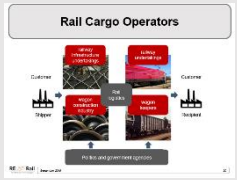


Figure 14: Transport volume by type of goods[26]

The category "Vehicles, machinery and other goods" is the most important type of goods on rail and represents 41 percent of the goods transported by domestic railway companies. However, this category also includes all goods which cannot be classified elsewhere or for which the contents of the containers are not known.

Agricultural and forestry products follow in second place with 13 percent of the transport volume. The share of "wood and paper products as well as data carriers" contained therein accounts for around 5.8 percent of the transport volume. This is followed by "ores and metal waste" (11 percent) and "iron, steel and non-ferrous metals" with 8 percent. A total of twelve percent of the tonnage is declared as dangerous goods, predominantly "flammable liquid substances".[27]

Forms of Production in Rail Cargo Transport



Rail Cargo Operators

[26] Economica (2013), p. 18
[27] Cf. Economica (2013), p. 18f.

Figure 15: Players in rail cargo transport[28]

Transport of goods by rail is carried out by railway undertakings (RUs). They are public RUs if they are operated on a commercial or business basis and if anyone can use them for passenger or goods transports. All others are non-public RUs.[29]

The classic resources of a railway undertaking include:[30]

- locomotives (diesel or electric)
- cargo wagons and
- staff (e.g. locomotive driver, shunter)

The railway network is maintained and operated by a railway infrastructure undertaking (RIU). There are public companies, which must grant access to their railway infrastructure. All other companies, e.g. factory and industrial infrastructure, connecting railway lines, are non-public.

The resources of an RIU include track systems, signalling equipment, level crossings, signal boxes, railway stations and terminals.[31]

One of the most important resources in rail freight transport is rail cargo wagons. They are kept or owned by:[32]

[28] Following Becker (2014), p. 45
[29] Cf. Becker (2014), p. 45f.
[30] Cf. Becker (2014), p. 45f.
[31] Cf. Becker (2014), p. 64
[32] Cf. Becker (2014), p. 77

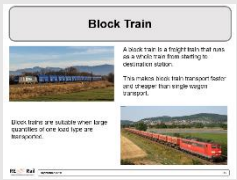
- railway undertakings (RUs)
- rental companies
- forwarding companies
- shippers from industry and trade

Customers of rail cargo services, are also called shippers. The shipping industry consists of many partly very different companies from various sectors. Correspondingly, the requirements shippers place on providers of rail freight transport services are diverse:[33]

- competitive transport prices
- optimal and efficient railway business process
- one contract partner for the entire route
- personal and individual support and information
- reliable and predictable transport times
- Responsible care (transport safety)
- environmental compatibility

Forms of Production

In rail freight transport, various products (services) are offered for the transport of consignments. This form of production or type of service provision is decisive for the efficiency and economy of rail freight transport. A distinction can be made between conventional traffic (block trains, wagon groups and single wagons) and combined traffic.[34]



Block Train

[33] See Becker (2014), p. 67f.
[34] See Becker (2014), p. 37 ff.; Kummer (2010), p. 94.

Figure 16: block train[35]

A block train is a cargo train that runs as a whole train from starting to destination station. It is essential for block trains that no further shunting operations (e.g. adding wagons to the train or removing wagons from the train) take place during transport. Block train services are frequently used for the transport of bulk goods (e.g. coal, ore, mineral oil) but also in the automotive industry. Further advantages are short transport times (mainly due to the relatively low shunting effort), relatively low organisational costs for train dispatching, planning departure and arrival times, and safety during transport (also due to low shunting effort). In summary, it can be said that large quantities of goods can be transported safely over long distances with relatively low energy consumption.[36]

Block train transports by rail have cost advantages over trucks over almost all distances. This applies not only to conventional cargo transport, but also to unaccompanied combined transport and the Rolling Highway (ROLA). Trucks have competitive advantages over single wagon transports by rail in the low distance ranges. In single wagon traffic of conventional freight traffic (for domestic journeys), the truck causes lower costs than rail in distance ranges up to 150 km. For distances of 150 km and more, the cost advantage of the truck shrinks and disappears for distances of 250 km and more.[37]

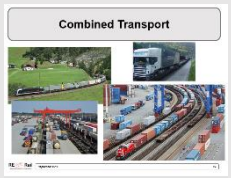
Single Wagon Traffic
Wagon Group Traffic

[35] Bahnbilder (2016), online
[36] See Kummer (2010), p. 94; Clausen / Geiger (2013), p. 169 ff.
[37] Economica (2013), p. 6

Figure 17: single wagon traffic[38]

If there is not a sufficient volume of consignments, individual wagons or groups of wagons can also be transported on the rail network. Individual wagons from different consignors are assembled into new freight trains in so-called train formation facilities.[39]

These types of production are very similar to general cargo road haulage. By bundling the individual wagons, better utilisation of trains and thus a reduction in transport costs can be achieved. On the other hand, however, there are higher costs due to the provision of train formation facilities, shunting facilities and shunting staff. Due to the increased shunting effort, there are significantly longer transport and waiting times in the train formation facilities compared to block train traffic.[40]



Combined Transport

Combined transport is defined as "intermodal transport in which the major part of the distance travelled in Europe is covered by rail, inland waterway or sea, and the pre- and on-carriage distances by road are kept as short as possible".[41]

Combined transport is thus characterised by transport chains in which standardised loading units, such as containers, swap bodies, trucks or their trailers are transported successively on different modes of transport. When changing modes of transport in terminals, only the loading units are handled, i.e. the goods remain in the same cargo container during the entire transport.

The loading units (e.g. containers, swap bodies) are usually transported individually between the place of dispatch and the point of transhipment (pre-carriage) or point of

[38] Rail Cargo (2017), online
[39] Cf. Clausen / Geiger (2013), p. 169 ff.
[40] Cf. Clausen / Geiger (2013), p. 170
[41] UN/ECE (2011), P.18

transhipment and point of receipt (post-carriage). The main leg is the distance between the transhipment points (e.g. transhipment terminal).

Another characteristic of combined transport is that the main leg is covered by an environmentally friendly means of transport, e.g. by rail, but also by inland waterway or sea, while pre- and post-carriage by road is kept as short as possible.[42]

Bibliography

Abendblatt.de (2017): http://www.abendblatt.de/hamburg/harburg/article114456407/Endlich-Laermschutz-am-Rangierbahnhof.html (3.2.2017)

Bahnbilder (2016): http://www.bahnbilder.de/bild/deutschland~e-loks~br-151/212065/151-138-5-mit-einem-falny-ganzzug.html (16.11.2016)

Becker, K. G. (Hrsg., 2014): Handbuch Schienengüterverkehr, Hamburg: DVV Media Group Eurorailpress

Clausen, U, / Geiger, Ch. (2013, Hrsg.); Verkehrs- und Transportlogistik, 2. Auflage, Berlin-Heidelberg: Springer Verlag

Deutsche Bahn (2017): Rangierbahnhof Maschen, in: http://www.deutschebahn.com/presse/hamburg/de/hintergrund/themendienste/8597856/faktenblatt_rangierbahnhof_maschen.html (3.2.2017)

Economica Institut für Wirtschaftsforschung (Hrsg., 2013): Schienengüterverkehr: Markt- und Wettbewerbssituation, Wien, in: http://www.esce.at/eco3/wp-content/uploads/2016/04/2013-Schieneng%C3%BCterverkehr-Markt-und-Wettbewerbssituation-Folder.pdf

Forschungsinformationssystem (2016a): in: https://www.forschungsinformationssystem.de/servlet/is/325077/ (21.12.2016)

Forschungsinformationssystem (2016b): in: http://www.forschungsinformationssystem.de/servlet/is/306087/ (21.12.2016)

Kummer, S. (2010): Einführung in die Verkehrswirtschaft, 2. Aufl., Wien: Facultas WUV

ÖBB Infra (2016a): Zahlen – Daten – Fakten, in: http://www.oebb.at/infrastruktur/de/2_0_Das_Unternehmen/Daten_und_Fakten/_DMS_Dateien/_Zahlen_Daten_Fakten.jsp (3.2.2017)

ÖBB Infra (2016b): Projektbroschüre Errichtung Güterzentrum Wien Süd, in: http://www.oebb.at/infrastruktur/de/5_0_fuer_Generationen/5_4_Wir_bauen_fuer_Generationen/5_4_1_Schieneninfrastruktur/Grossraum_Wien/Gueterzentrum_Wien_Sued/__Dms_Dateien/_Printproduktionen_Terminal_Wien_Inzersdorf.jsp (30.1.2017)

ÖBB Infra (2017a): Schieneninfrastruktur, in: http://www.oebb.at/infrastruktur/de/_p_3_0_fuer_Kunden_Partner/3_2_Schienennutzung/3_3_Schieneninfrastruktur/index.jsp (30.1.2017)

ÖBB Infra (2017b): Güterzentrum Wien Süd, in: http://www.oebb.at/infrastruktur/de/5_0_fuer_Generationen/5_4_Wir_bauen_fuer_Generationen/5_4_1_Schieneninfrastruktur/Grossraum_Wien/Gueterzentrum_Wien_Sued/ (3.2.2017)

Rail Cargo (2017): http://www.leitbetriebe.at/de/leitbetriebe/?mode=detail&id=3645e428-22f8-155f-5b47-4f9410a88b45#wrap-content (21.1.2017)

Rail Cargo Wagon (2017a): http://www.railcargowagon.at/de/Unsere_Fahrzeuge/_Factsheets_pdf/Fals_RCW.pdf (3.2.2017)

[42] Cf. Kummer (2010), p. 57; Becker (2014), p. 39f; Forschungsinformationsystem (2016b), online

Rail Cargo Wagon (2017b): http://www.railcargowagon.at/de/Unsere_Fahrzeuge/_Factsheets_pdf/Gabs_RCW.pdf (3.2.2017)

Rail Cargo Wagon (2017c): http://www.railcargowagon.at/de/Unsere_Fahrzeuge/_Factsheets_pdf/Ros_RCW.pdf (3.2.2017)

Rail Cargo Wagon (2017d): http://www.railcargowagon.at/de/Unsere_Fahrzeuge/_Factsheets_pdf/Lgjnss_RCW.pdf (3.2.2017)

Rail Cargo Wagon (2017e): http://www.railcargowagon.at/de/Unsere_Fahrzeuge/_Factsheets_pdf/Sdmmrs_Web.pdf (3.2.2017)

Rail Cargo Wagon (2017f): http://www.railcargowagon.at/de/Unsere_Fahrzeuge/_Factsheets_pdf/Uacs_RCW.pdf (3.2.2017)

Schmalspurbahnen (2017): Schmalspurbahnen in Österreich, in: http://schmalspur.bahnen.at/ (3.2.2017)

UN/ECE (2001): Terminologie des kombinierten Verkehrs, in: http://www.unece.org/fileadmin/DAM/trans/wp24/documents/term.pdf (30.1.2017)

Wikipedia (2017): Zentralverschiebebahnhof Wien-Kledering, in: https://de.wikipedia.org/wiki/Zentralverschiebebahnhof_Wien-Kledering (3.2.2017)

https://de.wikipedia.org/wiki/Zentralverschiebebahnhof_Wien-Kledering (3.2.2017)