Beleidsondersteunende paper

WHERE RAIL MEETS AIR CARGO.

THE POTENTIAL OF RAIL AS AN ALTERNATIVE TO ROAD TRANSPORT IN THE AIR CARGO CHAIN

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Het Steunpunt Goederen- en personenvervoer doet beleidsrelevant onderzoek in het domein van transport en logistiek. Het is een samenwerkingsverband van het Departement Transport en Ruimtelijke Economie van de Universiteit Antwerpen en het Departement Business Technology and Operations (BUTO) van de Vrije Universiteit Brussel. Het Steunpunt Goederen- en personenvervoer wordt financieel ondersteund door de coördinerende minister Philippe Muyters, Vlaams minister voor Werk, Economie, Innovatie en Sport en Ben Weyts, Vlaams minister van Mobiliteit en Openbare Werken, de functioneel aansturende en functioneel bevoegde minister.

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Samenvatting

Ondanks het feit dat beleidsmakers in Europa en Vlaanderen vele maatregelen nemen om vrachtvervoer duurzaam te maken, is wegtransport nog steeds de dominante modus en wordt er zelfs een sterke groei voorspeld. De introductie van rekeningrijden voor vrachtwagens zal de kost van wegvervoer echter doen toenemen, waardoor het alsmaar noodzakelijker wordt om goede alternatieven te zoeken.

Wegvervoer speelt ook een belangrijke rol bij het vervoer van luchtvracht, zeker binnen Europa. Deze paper onderzoekt het potentieel van spoorvervoer als alternatief voor wegvervoer in de luchtvrachtketen. Eerder onderzoek hieromtrent focust eerder op het gebruik van hogesnelheidstreinen voor luchtvracht. Deze studie onderzoekt echter of er potentieel is voor klassiek spoorvervoer en speelt daarmee in op een hiaat in de literatuur. De literatuuranalyse geeft aan dat de karakteristieken van luchtvracht (zijnde een hoge waarde – monetair en tijdsgebonden – en kleine volumes) niet overeenkomen met de karakteristieken van spoorvervoer. Dit wordt ook bevestigd in de diepte-interviews met verschillende experts uit de industrie. De bevindingen van deze paper zijn nuttig voor academici, maar ook voor de industrie en beleidsmakers.

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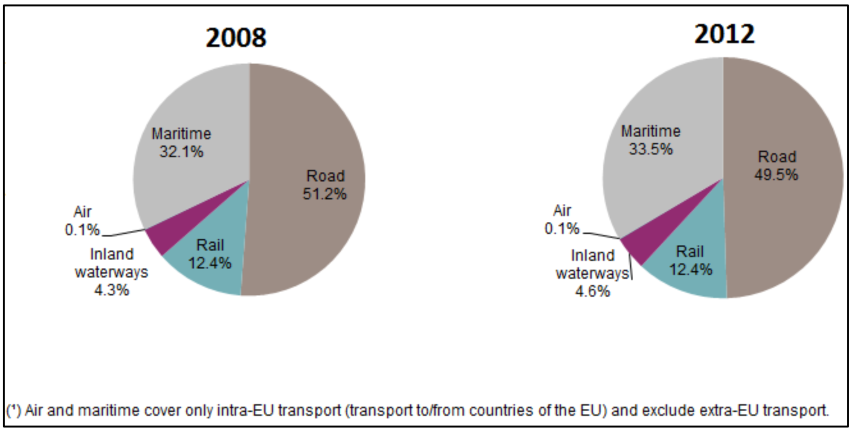
1 Introduction

At European level, more and more attention goes to sustainable transport (Behrends, 2012). In 1995 already, the European Commission called for a modal shift away from the road, due to unsustainable growth of road transport (European Commission, 1995). The European Transport White Paper of 2001 (European Commission, 2001) proposes measures to attain this goal, but, as shown in Figure 1, in 2012 almost 50% of all freight (in tonne-kilometres for EU-28) was transported by road. (Eurostat, 2014)

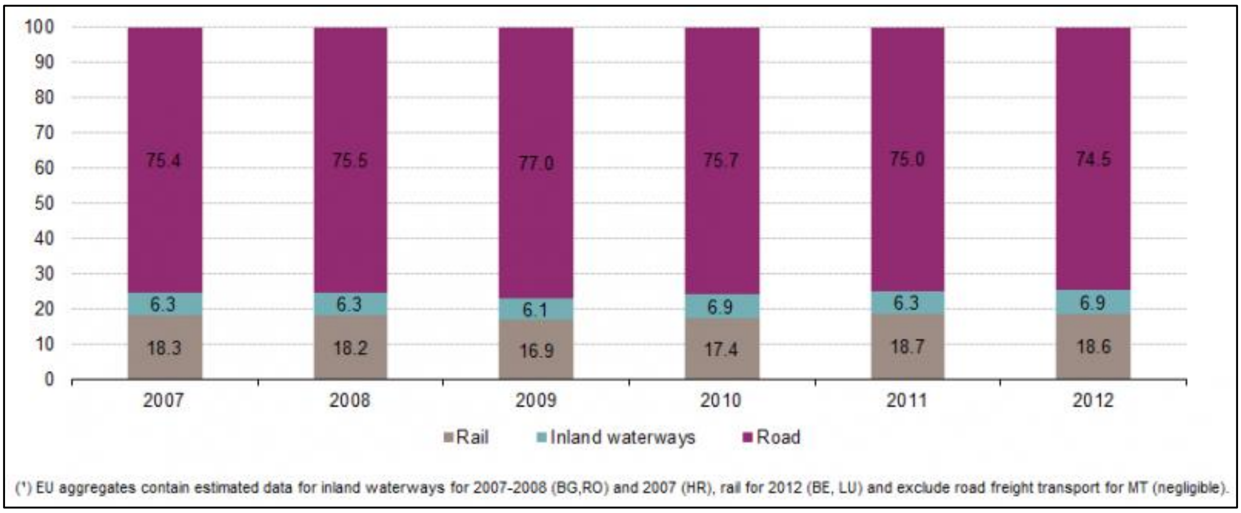
Figure 1: Modal split of freight transport in the EU-28 in 2008 and 2012 (% of total tonne-kilometres)



Source: Eurostat, 2014

Based on the TRANS-TOOLS-model, it is predicted that road transport will remain the dominant mode with only a small reduction to 46.5% in 2015 and 40.3% in 2050. (Sessa & Enei, 2010) Focusing only on the inland modes, figures from Eurostat (2014) (see Figure 2) show that road transport dominates with almost 75% in 2012.

Figure 2: Freight transport in the EU-28: modal split of inland transport modes (% of total tonne-kilometres)



Source: Eurostat 2014

In Flanders too, road transport is dominating. Taking into account the inland modes, about 80% of all freight is transported by road and the Federal Planning Office forecasts a growth of road transport in tonne-kilometers by 68% for the period 2008-2030. (Federaal Planbureau, 2012) However, road transport produces a lot of negative external effects (e.g. congestion, pollution). Therefore, governments, also on a national or regional scale, want to respond to this, amongst others by introducing road pricing. As a result, road transport might become more expensive in the future, which makes it even more necessary to consider alternatives to road transport solutions.

In this context, the objective of this paper is to analyse whether rail transport can be an acceptable alternative for the use of road transport in the air cargo chain. This paper focuses on the use of classical rail transport for air cargo for two reasons. First of all, research has already been carried out about the use of high-speed trains for air cargo (Conway, 2003; Liege Carex, 2011; Needham, 2009; Troche, 2005). However, important questions about the use of classical rail freight for the transport of air cargo are still open. Second, classical rail freight transport has the advantage to be less capital intensive in the beginning phase than high-speed transport and might thus offer more opportunities. Therefore, this paper focuses on the use of classical rail freight transport for air cargo.

By means of a literature review and semi-structured interviews with relevant stakeholders an insight is provided into the current situation as well as into the potential use of rail in the air cargo chain. The interviews are used to validate the findings from the literature analysis. The rest of this paper is structured as follows. Section 2 describes the supply and demand characteristics impacting modal choice variables for freight transport. In section 3, the supply and demand characteristics of road and rail transport are compared. Section 4 focuses on the use of rail in an intermodal transport chain. In section 5, the supply and demand characteristics of air cargo are examined. Section 6 looks at the potential of rail in the air cargo chain. Section 7 includes the results of interviews with industry stakeholders. Section 8 summarizes the conclusions of this research.

2 Modal choice of freight transport

When freight has to be shipped, the decisive actor will have to choose the most suitable transport mode. A lot of factors, categorised as supply and demand factors, impact this choice. A supply factor which is of high importance is the cost. Many studies have ranked it as the most important attribute. However, it will be traded off against other quality characteristics such as the transport time, punctuality, reliability and frequency. (Ballou, 2004)

Next to these supply characteristics, modal choice is also influenced by demand characteristics. The first demand characteristic impacting modal choice is the attributes of the shipper. For example, the size of the firm will have an impact on the mode chosen. Attributes of the goods (e.g. weight, size) will also determine the modal choice. Finally, attributes of the shipment (such as distance and destination) might determine the mode used (Jiang, Johnson, & Calzada, 1999). Sandberg Hanssen et al. (2012) stress that the selection criteria are strongly dependent on the industry sector.

It is based on this division that the supply and demand characteristics of road are compared to those of rail in the next section. In section 5, the characteristics of air cargo are added in order to analyse whether these are compatible with rail freight.

3 Supply and demand characteristics of road versus rail transport

When it comes to the generalized transport cost, road transport is an expensive mode. For example, average fuel costs and driver wages represent large cost items for road transport which will prevail less for rail transport. Moreover, given the high external costs, internalization through road pricing[1] increases the costs of road transport.

Rail transport, however, does involve high fixed costs: the rail sector is capital- and labor-intensive and there is a high need for extensive infrastructure. This entails high barriers to entry, often resulting in the existence of a strong, monopolistic incumbent (as is the case in Belgium) and in some cases thus high prices. (MarketLine, 2014)

Road transport offers quality measures which cannot be delivered by rail transport. Road transport is the only mode that can offer door-to-door delivery. Furthermore, the fact that it is a very flexible mode results in high frequency, the possibility to quickly respond to demand changes, etc. The infrastructure network is also more elaborated for road transport (roads versus tracks). Rail transport is confronted with a lot of organizational and administrative issues such as the acquirement of train paths, which makes it a rigid mode. Also in a study from Eurostat (2003) it is stressed that rail has a higher share over longer distances, but it struggles to offer the flexibility of road haulage over shorter distances. When considering the transport speed, the modes can be ranked as follows from slow to fast:

deepsea → inland navigation → rail → road → air → air express

On the other hand, road transport is increasingly dealing with congestion, which is a difficulty that rail transport is not confronted with. Rail transport has also other environmental advantages; it has a lower energy and environmental impact compared to road transport (Mortimer, 2008). The potential of rail transport to reduce accidents, air pollution, noise and road maintenance costs is present (Regué and Bristow, 2013). For example, the energy usage of rail transport is 75% lower than that of road transport (Dorner, 2001).

[1] In Belgium, road pricing for goods vehicles of >3.5t is introduced since April 2016.

Regarding the demand characteristics of road and rail freight, Maes and Vanelslander (2011) and Robinson and Mortimer (2004) show that non-time-sensitive, low value commodities are suitable for rail transport. Dorner (2001) adds that time-sensitive goods are not appropriate to be transported by rail. Standardized units can be used by both road and rail transport (Dorner, 2001). Furthermore, a certain critical mass is needed to make rail transport profitable (Comi et al., 2014). This critical mass is often different from the critical mass needed to make road transport profitable (Arvidsson and Browne, 2013; Maes and Vanelslander, 2011; Mortimer, 2008). Large volumes can be obtained from big retailers which already ship large volumes (Comi et al., 2014; Ruesch, 2001). Alternatively, freight of different suppliers can be consolidated (Comi et al., 2014). Also the study of MarketLine (2014) describes typical rail customers as being large companies transporting high volumes[2] of bulk or containerized freight. They use automotive manufacturers, coal mining companies or cement producers as examples. Regarding transport distances, Jiang et al. (1999) conclude that as the transportation distance increases, the share of rail freight rises.

Table 1 compares the supply and demand characteristics of road and rail freight transport.

Table 1: Supply and demand characteristics of road and rail freight transport

<table>
<tr><th colspan="2"></th><th>Road</th><th>Rail</th></tr>
<tr><td rowspan="2">Supply characteristics</td><td>Cost</td><td>High cost due to fuel, driver wage, road pricing, …</td><td>High fixed costs</td></tr>
<tr><td>Quality measures</td><td>Door-to-door, flexible</td><td>• More rigid due to organizational issues
• Often in need of pre- and/or post-haulage</td></tr>
<tr><td rowspan="2">Demand characteristics</td><td>Attributes of goods</td><td>• All types of goods
• Standardized units</td><td>• Non-time-sensitive
• Large volumes
• Low value
• Standardized units</td></tr>
<tr><td>Attributes of shipment</td><td>Rather short distances</td><td>Long distances</td></tr>
<tr><td colspan="2">Other</td><td>High external costs</td><td>Environmentally friendly</td></tr>
</table>

Source: own composition

[2] To illustrate, one block train of Jan de Rijk Logistics constitutes of 32 forty-five-foot containers (Kleppers, 2015). Container trains in The Netherlands transport 1500 tons of cargo (Scheepers & Van Himbergen, 2015).

4 Intermodal rail freight transport

Rail transport often only offers a part of the door-to-door transport chain. In most cases, a rail connection is missing at the origin and/or destination, which entails pre- and/or post-haulage by another mode (often road transport). This means that rail transport can often be considered as part of intermodal transport and that the advantages and disadvantages of road still have to be taken into account.

The pre- and post-haulage causes long lead times (Ruesch, 2001) and is responsible for a large share of the total transport costs (Behrends, 2012; Gevaers, 2013). Moreover, it causes additional handling and thus increases in time and costs (Behrends, 2012; Bergqvist, 2007; Comi et al., 2014; Dorner, 2001; Ruesch, 2001). Therefore, the distance covered by rail has to be extensive in order to make intermodal transport the preferred alternative. The cost advantage of intermodal transport depends upon the distance (door-to-door): from 900 km onwards, intermodal transport is cheaper when taking into account the operational cost. If the external costs are also taken into consideration, intermodal transport is preferred from 1050 km onwards. The external costs of the distances covered by road contribute increasingly to the external costs of the whole trip (40% to 50%). The distance covered by rail must thus be extensive in order to let the cost advantage (of rail transport) prevail. (Janic, 2007) Also Bärthel & Woxenius (2004) stress that the extra cost due to pre- and post-haulage as well as transshipment must be offset by the lower costs of the long-haul transport.

5 Supply and demand characteristics of air cargo

The transport cost of air cargo is much higher than that of road, rail or ocean freight. This means that there has to be a compelling reason for customers to use air cargo.

The speed with which air cargo can be transported, is its main selling point. Due to the short delivery time, air cargo perfectly suits with the Just-In-Time principle. So, using air transport to carry freight also offers the possibility to eliminate the cost of carrying inventory. Another advantage of air cargo is the safe and secure way in which the freight is transported. Air transportation is a mode with a low risk of damage to the goods thanks to the fact that there is no en-route handling and that there are little periods in which the goods are under minimum security.

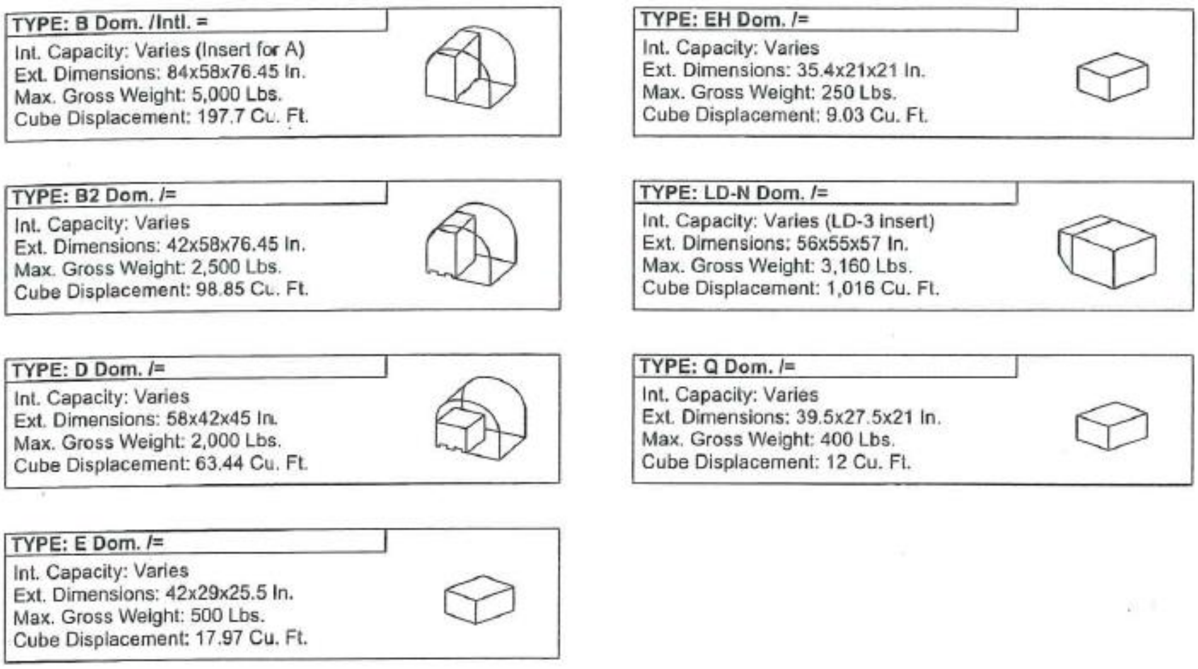
Even though the high transport expenses for air cargo can be traded-off against cost savings in a few other domains, the cost of air cargo is still high. Therefore, the goods are often of high value; either in monetary terms or with a high value of time. For example, high-tech companies regularly ship by air because the added cost of air transportation is more than offset by getting the product to market and into service earlier (Wensveen, 2011).

Shipping commodities by air is the most desirable form of distribution when one or more of the following characteristics is present:

- When the commodity is
  - Perishable
  - Subject to obsolescence
  - Required on short notice
  - Valuable relative to weight
  - Expensive to handle or store
- When the demand is
  - Unpredictable
  - Infrequent
  - In excess of local supply
  - Seasonal
- When the distribution problems include
  - Risk of pilferage, breakage or deterioration
  - High insurance costs for long in-transit periods
  - Heavy or expensive packaging required for surface transportation
  - Need for special handling or care
  - Warehousing or stocks in excess of what would be needed if air freight were used

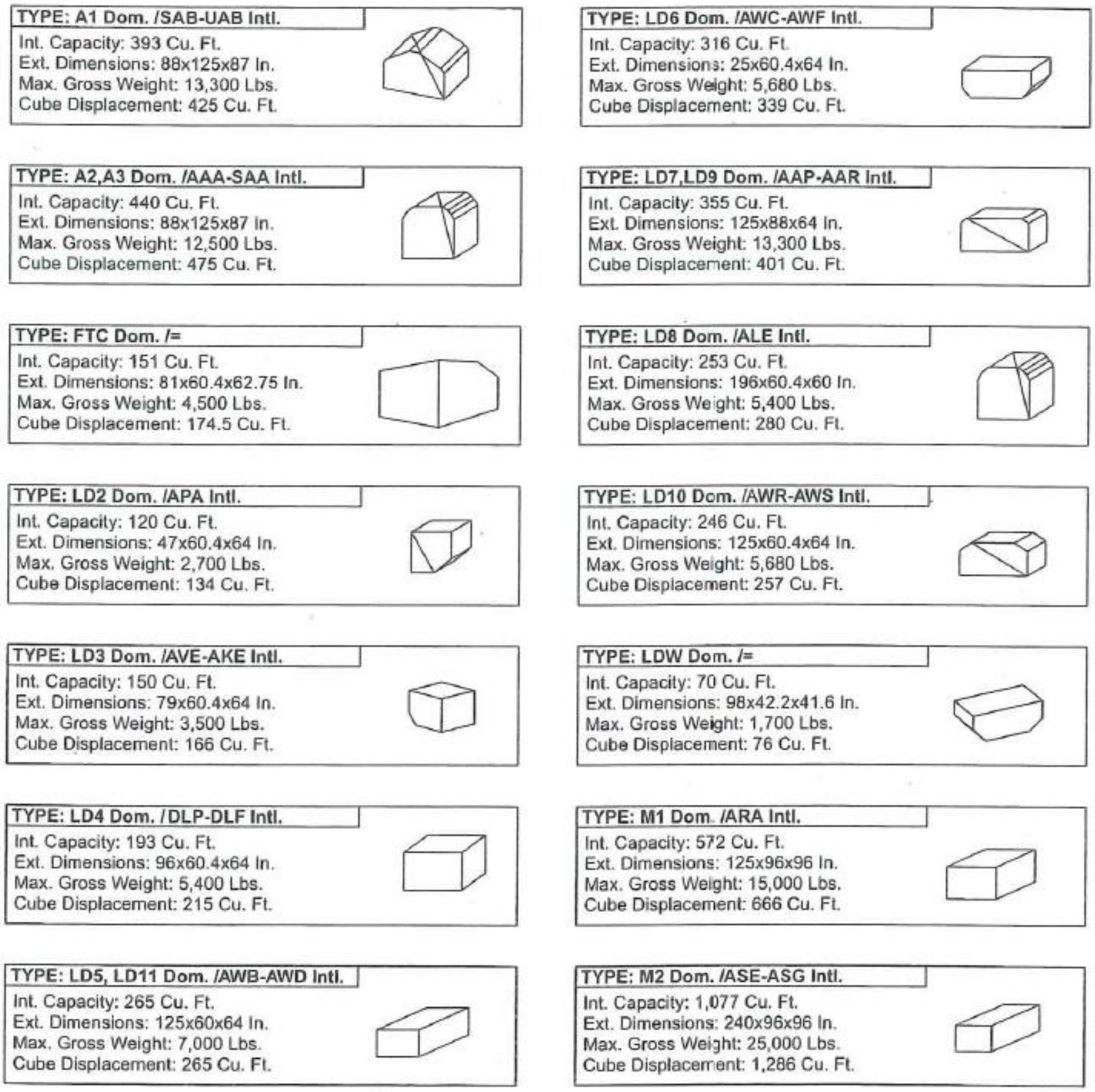
Another important aspect in this analysis is the Unit Loading Devices (ULDs). The choice for a certain unit determines partly the transport possibilities. There are many containers designed for air freight. Those aircraft Unit Loading Devices (ULDs) are contoured to the aircraft fuselage. The cabin door size and cabin cross-section of the main deck of the aircraft determine what size of consignment can be accommodated (Shaw, 2011). Due to the measurements of aircraft loading doors, some pallets are only 1m63 high. Some ULDs are 2m44 or 3m in height. Some containers are owned by the airlines and made available to the shipper on request; others are purchased by the shippers for regular use or rented from various sources (Wensveen, 2011). Different containers, with their characteristics, are shown in Figure 3 and Figure 4.

Figure 3: Containers offered by shippers



Source: Wensveen (2011)

Figure 4: Containers provided by airlines



Source: Wensveen (2011)

The amount of air cargo to be transported, is not only dependent on the dimensions, also the weight is important. Containers used to ship air cargo are suitable for shipping quantities from 400 pounds (i.e. ± 182 kg) to 5 tons (Wensveen, 2011). Furthermore, the weight that can be carried, depends upon the type of aircraft. For example, a standard body can carry no more than 45 ton, while a medium wide-body accounts for 40 to 80 ton. A large wide-body is able to transport more than 80 ton (Van de Voorde & de Wit, 2013).

Moreover, not all cargo is transported in all cargo aircraft. Combination carriers also transport freight together with passengers, in the belly of the aircraft. Wide-bodied aircraft have a sizable lower deck to hold cargo, but narrow-bodied aircraft only have limited cargo capacity. For example, low-cost carriers using narrow-bodied aircraft have very limited lower deck cargo capacity once their usually full passenger loads and their checked bags have been taken into account. They then leave as little as 0,5 to 1 ton for cargo (Morrell, 2011). Wide-bodied aircraft can carry 25 tons or more of containerized and palletized cargo in its lower hold. Other wide-bodies have a freight capability of 12 tons or more, depending on the passenger payload and the fuel needed. (Shaw, 2011)

Distances covered by air transport are large. As Grandjot, Roessler & Roland (2007) state, air transport is attractive in case of exchange of goods between industrialized countries, between industrialized countries and developing countries and the minimum of transport mode switches between continents. Cross-border traffic such as air cargo involves customs clearance for which facilities are needed at origin and destination.

Table 2 provides an overview of the supply and demand characteristics of air cargo.

Table 2: Supply and demand characteristics of air cargo

		Air
Supply characteristics	**Cost**	High cost
	Quality measures	• High speed • Low damage rate
Demand characteristics	**Attributes of goods**	• High value • Time-sensitive • Special containers, made to fit the aircraft
	Attributes of shipment	Long distances

Source: own composition

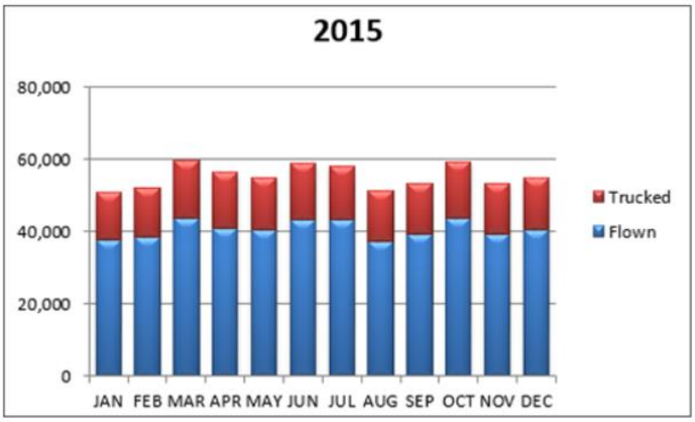
6 Rail instead of road in the air cargo chain: a possibility?

In order to analyse whether rail transport of air cargo can serve as a viable alternative for road transport, not all characteristics of the modes and goods need to be taken into account. Rather, it is important to investigate why and when trucks are used in the air cargo chain.

Road transport is increasingly used in the air cargo chain for hinterland distribution from airports, for feeder traffic to airports and to transport air cargo between airports. In the latter case, the air cargo is trucked under airwaybill, which is called air trucking or Road Feeder Services (RFS). The importance of RFS is growing worldwide and especially between the large hub airports in Europe. Airlines decide to complement their air network with RFS since trucking is cheaper than flying, more flexible and on short and medium distances often faster due to its door-to-door nature (Grandjot et al., 2007). Brakel (2012) showed that trucking is a better option than flying if the destination airport is located at less than six hours driving. According to Visser and Gordijn (2013) air trucking from Schiphol mostly takes place to and from other airports at distances between 200 and 600km. Next to the advantages mentioned before, RFS also play an important role in the hub- and-spoke networks of airlines since they are used to feeder the large hub airports from the small, regional spoke airports. This makes RFS also of high relevance for regional airports.

Figure 5 displays the air cargo handled at Brussels Airport, making a distinction between the trucked and the flown cargo. Almost 30% of the air cargo handled at Brussels Airport in December 2015 was trucked (Brussels Airport, 2016). Jan de Rijk Logistics, a large transport company, carries 90% of its air cargo between airports by road. The other 10% goes directly from the airport to the final destination or from the shipper to the airport (Kleppers, 2015).

Figure 5: Air cargo at Brussels Airport



Source: Brussel Airport (2016)

However, the dimensions of air cargo are not always compatible with road transport. Conventional trailers are well adapted for traditional pallets, but given the strict dimensions of aircraft ULDs, unusable capacity is to be expected. Pallets used for air cargo are too low to fill a truck, but too high to stack two on top of each other. Other ULDs however are too high for standard trailers. (Grandjot et al., 2007)

As said before, trucks are often used in the air cargo chain for short and medium distances because its rather high cost is then compensated by its flexibility and speed. It is exactly on those three variables (short to medium distance, flexibility and speed) that rail transport does not perform well. Since it is only viable on long distances, it cannot offer the same flexibility and comes with a longer travel time.

Taking into account the fact that rail transport of air cargo often involves pre- and/or post- haulage by truck, entails also more transshipment. This means an extra cost, even more time loss and a higher risk of damage of the expensive and/or vulnerable air freight.

The problems with interoperability (due to the specific dimensions of air cargo) will also be an issue in rail transport and the incompatibility regarding volumes is an additional concern. The volumes carried on an airplane do not fill a trainload. A possible solution for this is consolidation, but that is not that evident for air cargo given the fact that also this involves some storage before shipping, resulting in time loss.

7 Validation of findings through interviews

Nowadays, freight is transported by rail in numerous ways. Owners of goods can opt for the use of entire trains (block trains), loaded with only their freight or they can opt for attaching some freight filled railway coaches onto coaches filled with freight from others (single wagon load). Freight can then be transported in containers or by loading (road) trailers – with or without driver – on the train. As indicated before, freight can be transported by high speed trains or through classical rail.

Ewals Intermodal transports freight, using trailers and fills entire trains this way. However, this transport does not involve air cargo. Moreover, transporting freight through trailers on trains entails that the distance covered, or at least the time traveled, needs to be large enough to save on the drivers' wage. In case of long distances (and thus long travel times), a trailer needs to be accompanied by two or more drivers because of the regulation regarding resting times. If the distance is covered through rail transport, the trailer does not need to be accompanied by two or more drivers, leading to lower wage costs. (Pirenne, 2015)

DHL also uses block trains to transport freight to ports. Moreover, they used rail transport to feeder air cargo into Leipzig Airport (from Frankfurt Airport), but this project failed due to the fact that trains were not flexible enough and that there was not enough critical mass to account for the costs of an entire traction. (Gouweloose, 2015)

Also *Jan de Rijk* invested in rail cargo. They cooperated with KLM to transport intermodal containers across the Alps. Furthermore, they attached 12 rail coaches with 45-feet containers onto passenger night trains to provide overnight express rail transport, but this project failed due to the fierce competition of low-cost passenger airlines. Also the KLM-cooperation failed. A successful project they set up is Green Rail. Flowers from the Aalsmeer flower auction are transported from Venlo to Milan using block trains. They stress that they still have to rely on road for pre- and post-haulage, but that they do save on toll and road taxes by using rail for the bulk of the route. They had a successful pilot project to transport air cargo the same way, but encountered some resilience from the airlines due to several reasons. First, the volumes of air cargo are too low to fill an entire train and feedering air cargo from different airlines (i.e. consolidation) would entail time loss. Moreover, block trains involve a lot of risk with respect to delays and damage. If something goes wrong with a block train, a lot of cargo is involved. Block trains of cargo also entail too low frequencies to provide a good service for air cargo. This could be solved by attaching freight coaches to passenger trains, but this entails difficulties with cost allocation and regulations regarding safety. Lastly, rail loses flexibility due to the complex organizational issues: it involves slot acquisition, the reservation of coaches, etc. (Kleppers, 2015)

These projects stress that rail freight transport is not suitable for air cargo. However, a project that would have more potential is the use of trams or light rail for air cargo transport. Brussels Airport analysed – in line with the policy of banning cars and trucks from the cities – the possibility of trams to get air cargo from the airport into the city of Brussels. Freight would then be consolidated at the airport and transported with dedicated trams, which involve smaller volumes but higher frequencies compared to trains. The fact that the trams have to be dedicated to freight transport is important, since taking passengers on board would involve time loss when they have to get on or off (Polmans, 2014). An application of this transport by trams could be the transport of perishables directly to the shops instead of through a distribution center. In contrast to failed rail projects, this could have some potential, since evidence for using trams for freight transport can be found both in the Belgian history and in foreign countries. Between the late 1800s and the beginning of the twentieth century, trams were used in Belgium for the transport of freight. In Bruges for example, life stock was transported by means of trams. Another example is the use of freight trams in the port area of Bruges (Annys et al., 1994) and for the transport of sugar beet to sugar refineries (G/Geschiedenis, 2015). After World War II, road transport became more popular. This trend lead to the disappearing of freight trams in Belgium (Annys et al., 1994). Nowadays however, freight trams are also used in some foreign cities. In Dresden, Volkswagen transports its automotive parts by means of a freight tram. In Zurich, municipal waste collection happens by a waste tram (Arvidsson & Browne, 2013; De Langhe, 2013). In Paris, a study is taking place on examining the use of a freight tram for the transport of different goods (Levifve, 2012). Similarly, Monoprix is using trains to transport textile, beauty products, sodas, hobby and household products, etc. to its stores in the centre of Paris (Jochen Maes & Vanelslander, 2011). Other cities, such as Amsterdam and Vienna experimented with a freight tram, but their efforts did not lead to a success (Arvidsson & Browne, 2013).

8 Conclusions

Freight transport in Europe and Flanders needs to become more sustainable. Therefore, policymakers are since many years promoting alternatives to cars and trucks such as rail transport. In the air cargo chain too, the role of road transport is important, especially for hinterland distribution and feeder traffic. Nevertheless, road charging policies increasing the cost of road transport make it even more necessary to consider alternatives to road transport, also in the air cargo chain.

A review of the literature shows that there is no potential for rail freight to replace road transport in the air cargo chain. The speed and frequency of rail freight are too low, the risks are too high and the volumes are too large. This does not match with the time-sensitive nature of the high-value goods shipped by air and with the small volumes in terms of weight shipped by air cargo.
Also the projects implemented by different industry stakeholders in the past showed that the potential of rail freight for air cargo is almost non-existent. Instead of trains, trams could however play a future role in the transport of air cargo since they involve higher frequencies and smaller volumes.

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