Effects of the EUROCOMBI on the automotive industry logistics in Austria

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"Master of Business Administration"

supervised by

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Affidavit

I, **CHRISTIAN MOSER**, hereby declare

1. that I am the sole author of the present Master's Thesis, "Effects of the EUROCOMBI on the automotive industry logistics in Austria", 75 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted this Master's Thesis as an examination paper in any form in Austria or abroad.

Vienna, 09.09.2014

Signature

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Abstract

The implementation of the EUROCOMBI has been politically discussed for several years and now there are no signs from the Austrian government that this type of truck will be allowed in the near future. The reasons for this strict refusal are manifold, but this thesis takes into account the economic reasons only, especially those of the Automotive Industry.

To identify the possible benefits for the industry, the Automotive Industry in Austria is briefly described as well as in the following chapter the different modes of transport and their usage for the Automotive Industry. Afterwards transport units and the different variations of trucks are described briefly, finalizing the chapter with an overview of the different variations of the EUROCOMBI and the idea behind.

Having a look at selected countries in the European Union, this thesis puts an emphasis on Germany and the running field test of the EUROCOMBI in some federal states to have a fair comparison with the Austrian circumstances.
The main part of the thesis is the detailed and standardized calculation of a theoretical case of the Austrian Automotive industry with different scenarios to investigate possible savings of a possible implementation of the EUROCOMBI.

As a conclusion, the EUROCOMBI is suitable to save costs by more than 20 % on selected lanes and businesses, without greater investments in infrastructure, vehicle fleets or premises.

1 Introduction

The reduction of costs is one of the main driver of the industry in matured economies in order to stay competitive in a globalized world. Increasing production costs caused by increasing salaries, energy and transportation costs lead to a dislocation of the production units to low cost and emerging markets beyond Western Europe. Austria was highly affected by this development during the last 25 years, but could stay competitive due to the diversified structure of the mainly small and middle-sized companies and the transformation to a service economy. Nevertheless the ratio of the producing industry remained at an European wide high level of 18,2 % of the GDP in 2012[1], which ranks Austria among the TOP five nations in the EU [2]and is still considered as one of the most competitive industries in Europe.

The Austrian Automotive Industry itself with some 150.000 employees working in 7.000 companies and a yearly turnover of 21.5 billion Euros ranks this industry among the top five within the Austrian economy as a whole [3]. Lacking a national OEM (Original Equipment Manufacturer), MAGNA STEYR in Graz is producing for DAIMLER, PSA and BMW, as well as GM and BMW are running own factories on the territory. Not to forget the truck production of MAN in Steyr and Vienna.

Despite the vehicle production mentioned above, the supplier industry is the backbone of the Austrian Automotive Industry with a yearly turnover of 16.5 billion Euros in 2013, and an export rate of more than 90 %.[4] Well-known Austrian companies, such as MAGNA INTERNATIONAL, MIBA, VOEST and AVL LIST, are part of this industry as well as subsidiaries of international companies such as JOHNSON CONTROLS, DELPHI or GEORG FISCHER.

[1]https://www.wko.at/Content.Node/iv/presse/wkoe_presse/presseaussendungen/Anteil_der_Industrie_an_der_Bruttowertschoepfung.pdf, 20.08.2013, 1
[2] http://library.fes.de/pdf-files/wiso/06831.pdf, 03.2009, 13
[3]http://investinaustria.at/DE/Home/Sektoren/Automobilindustrie/Die+%C3%B6sterreichische+Automobilindustrie.aspx, 15.05.2014
[4] http://investinaustria.at/DE/Home/Sektoren/Automobilindustrie/Zuliefer-Industrie+in+%c3%96sterreich.aspx, 15.04.2014

Geographically Austria shows three centres of the Automotive Industry:

- Graz/Southern Styria with the car production at MAGNA STEYR in GRAZ and suppliers nearby.

- Upper Austria with a strong and very diversified supplier industry benefitting from the close German market and its automotive centres in Bavaria and Baden-Wurttemberg. Next to leading companies such as MAN and BMW in Steyr, the FIAT/CNH production in St. Valentin, VOEST Alpine in Linz as well as MIBA are the most notable companies representing the Automotive Industry in this area..

- Vienna and the surrounding Lower Austria with the GM Powertrain plant in Aspern and GEORG FISCHER AUTOMOTIVE in Herzogenburg are the main companies, benefitting from the close OEM production facilities in Bratislava and Trnava (Slovakia), GYÖR (Hungary) and KOLIN (Czech Republic).

Each region has its own automotive cluster to promote the activities of their members internationally.

Fig. 1: Automotive cluster in Austria (own drawing)

It goes without saying, that logistics is one of the key factors besides research and development, productivity and diversification for the Austrian Automotive Industry.

Due to very flexible and cost effective supply chains, the industry is heavily depending on the usage of the motor- and expressways, whereas the railway system cannot guarantee the demanded flexibility and costs structure. Furthermore, the distances to the main customers and/or suppliers are mainly less than 800 km one way, which is too short to run own trains or to use block trains from logistics providers. Fast changes in the demand and production lead to very complex supply and delivery chains, especially for the suppliers who have to provide not only the availability of the goods, but also the capacity of the transport unit.
Following this logic, this Master Thesis wants to investigate whether bigger transport units, such as the EUROCOMBI, are able to reduce the costs of logistics while maintaining the challenging requirements in the Austrian automotive industry.

The Automotive Industry understands itself as the leading industry in regard of innovation and complexity. Some inventions of the automotive logistics have been quickly adopted by other industries, like the implementation of the Megatrailer, a redevelopment of the standard trailer, which is able to transport more cargo due to a higher loading height, 3.00 metres instead of 2.60 metres.

In the first part of this thesis, the legal background and possibilities of adaption shall be monitored as the legislation is heavily trimming the possibilities of transport, either due to socioeconomic reasons or to political circumstances.
The following chapter gives the reader a survey of the existing transport units and their usage and an overview of possible novelties with experiences from other European countries. Having an overview of the legal and physical backgrounds, the business case of the shuttle transport should give an example to calculate possible cost reductions. The business case itself is just an example and due to the high flexibility and the fluctuations in productivity, it is intended to show the way of calculation and should be easily adapted for other companies in the Automotive Industry as well as other industries for a feasibility study in the following chapter.

The different potentials and possible cost reductions are the conclusion and the core work of this master thesis, underlined by calculations and assumptions of the previous work and by best practice cases from existing flows.

This thesis does not intend to interpret or judge the Austrian or European law even though the restrictions are essential and hindering the logistics industry to invest in new equipment. It is needless to say that security and environmental issues have their importance in relationship with the implementation of new types of vehicles but the emphasis of this paper is to focus on the cost effect and the possible effects for the industry itself.

2 Increase of Capacity and Volumes

Having no explicit data and research material for the Automotive Industry in particular, the following chapter is focussing on a general view of the correlation between capacity, volume and the different modes of transport and their units.

2.1 Economic Growth and Productivity

According to various researches and following the trend of the last decades, [5] [6] there will be a significant growth in transport of goods and people. With the limited resources in infrastructure and their long lasting construction on the one hand and the lack of capital for sustainable investments on the other hand, the increase of productivity will be the key factor to maintain the growth and the economic development.

Despite the development of the external and direct costs, such as energy, salaries, implementation of road taxes and raw materials and the increased number of goods and people transported, the costs for the transport itself remained at a reasonable level without notable increase. Nevertheless, the transit times are facing a constant decrease and the bounded capital of the transported goods grew higher than average.[7] This leads to the assumption that the productivity of the transport units and systems increased faster compared to the steady demand in services.

Beside the GDP (Gross Domestic Product) and the industrial production of a single country, the global exchange of goods and services is considered as the main factor for the increase in worldwide transport. The worldwide trade is considered as the main driver of the future development and is expected to grow also during the next periods. The main drivers for the increase of the exchange of goods are:

[5] IMFO: Zukunft der Mobilität, 2005,
[6] ICKERT, L. ; MATTHES, U. ; WEYAND, E. ; SLESINGER, M. ; LIMBERS,J.: Abschätzung der langfristigen Entwicklung des Güterverkehrs in Deutschland bis 2050, 05.2007, 1, 127, 128
[7] QUINET, E. ; VICKERMANN, R.: Principles of Transport Economics, 2004, 2, 22, 75, 88

- Worldwide adjustment of the GDP
- Growth of the GDP
- Globalization and removal of trade barriers such as customs and taxes
- Rise of demands in raw materials
- Decreasing transport costs due to increase of productivity

The increase of productivity in transport systems is a precondition for the worldwide growth of trade, even though it is not clear where and how these costs are included. Therefore, the total costs of logistics, with all direct and indirect costs, cannot be determined because of due to the huge complexity and numerous factors of influence. The experience shows that at least constant rates, for example in the ocean freight shipping during the last decades of the 20th century, are not hindering the positive development of the international trade. [8]

Furthermore, this concept is not only a matter of the recent development. Even in the ancient world, the Romans gained a huge economical advance with the construction of a paved road network and boosted – next to the military purpose – the trade. This, development is similar to the effects of the railroad networks in the 19th century. The enterprises involved in the transport adapted their business models and processes according to the development and were forced to work in a productive way to survive in an increasing competitiveness.

2.2 Determinants of the Effectiveness from Transport Units

The transport unit is the core factor of the productivity of all transport systems.[9] The unit itself is always depending on other elements of the transport systems, but out of experience, it is the main driver for innovation to increase the productivity and to adopt on the given systems. One example is the containerized maritime transport with its tailor-made container vessels, where ports with their terminals were influencing the pre-haulage and the on-carriage systems in the hinterland. This leads beside a strong centralization to a significant decrease in the maritime freight

[8] HUMMELS, D.: Have international transport costs declined? , 07.1999, 3, 2, 8
[9] LÜPSCHEN, B.: Kostendegressionspotenziale in Logistiksystemen, 2004 16, 11, 29

rates. To determine the impact, it is necessary to have a look on the different factors of influence on the size of the transport units:

2.2.1 Environmental Conditions

These factors are lying beyond the influence of the transport systems but are determining the size and the mode of the transport very often decisively. They mainly consist of:

- Infrastructural framework: as already mentioned, the infrastructure is a very cost intensive and sustainable factor, which is heavily influencing the chosen unit. Furthermore, the construction and maintenance of the infrastructure is mainly in public hands. Of course, the infrastructure has a different impact on each transport system. Some systems need barely any infrastructure such as air and sea transport, other are not even possible without rail or road transports.

- Legal framework: national and supranational legislative are playing a major role. In Chapter 3 the specific legislation is specified for the usage of the EUROCOMBI, but there is no single transport system without a legal background. Road taxes are also directly influencing the transport system.

- Public interest: influenced by media and personal emotions, the public interest can steer the legal framework and therefore also the mode of transport.

- Physical properties: being by far the most important factor even though the technical progress is increasing exponentially - the technical and physical possibilities are limited by natural laws and by the production costs due to limited raw materials.

2.2.2 Direct market demand

It goes without saying that a free market guarantees the permanent optimization of its participants to reduce their costs and to maintain competitive. Due to this fact, all

participants seek to find optimized size of the transport unit within the framework. Nevertheless, their market share and the demand of the market itself restrict them.

- Demand for Transport: An increasing demand on a single line automatically leads to an increasing demand of bigger transport units, as the increasing market demand can cover the utilisation of the unit. For forecasted emerging markets with a steady increase for a longer period, it is even interesting to research for invention of new transport units. For example, the demand in coal exploded in the 19th century and it was - correctly - forecasted that this resource of energy would dominate the energy production for several decades. As a result special coal wagons were invented to transport the goods in a more cost efficient way and lead to a price decrease for the consuming industry.

- Batch size: mainly depending on the modularity and ability to combine the different batches. For non-modular products, such as liquid or break bulk, the transport unit itself can be the mode of transport. Whereas in road carriage for example, the standardization of packaging lead to a high number of possibilities to combine each other. Hub and Spoke systems in the national and international general groupage service networks are a result of the high modularity.

- Quality and time requirements: whereas the quality itself is fairly standardized due to the increased geographical extensions of international standards, i.e. ISO, the transit time plays an important role, mainly influenced by the growing tied capital and by the specific demands of certain industries. The Automotive Industry with its high demands lead to the invention of supply chain concepts like Just-in-Time and Just-in-sequence where the transit time has a crucial impact on the whole production process.

- Regularity: peak and low seasons in the demand have an impact on the right size of the transport mode. This is shown in the price development as well as in the fluctuating capacity. A good example are flows from Far East to Europe, where two peak seasons (Christmas and Chinese New Year) are leading to an increased yearly demand on capacity and would make larger

transport units than standard container thinkable, if they could be used during the whole period of amortization.

- Balancing: the utilization of the capacity is increasing with rising balancing flows. Therefore, the building of networks in the transport system has a decisive role for cost reduction.[10]

- Networks: To ensure above-mentioned conditions, worldwide networks are needed to cover those. Following the increase of the demand and the trade, worldwide logistics integrators came to existence through either natural growth, acquisitions or the building of global networks.

2.2.3 Indirect Market Factors

Among the factors which do not have a direct influence but are influencing the demand and hence, the transportation system indirectly, the most significant are:

2.2.3.1 Packaging

The ability to increase the utilization of transport units is linked to the different packaging of the producing industry and the wrapping of the traded goods. Based on different measurement units worldwide, the standardization is not optimized and there is no concrete political intention visible to change the situation. Local or even regional standards have already established traditionally and the majority of the involved parties are accepting the discrepancy. A typical example is the non-conformity of “Europool pallets” and “ISO container”. Europool pallets, also called “Euro-pallets” is a European standardized pallet with the dimensions of 1200 mm length, 800 mm width and 144 mm height. (24) Since the 1960s, this format is used in the European industry and fits perfectly to the standard sizes of the most frequent trucks and trailers to load a maximum of 34 pallets at the ground surface of 1360mm length and a width of 245 mm width.

Furthermore the industry adopted the frequently used measures for standard adjustments for conveyer belts, forklifts or similar during the past 50 years. In addition to this development on the European continent, the ISO Container, pushed

[10] Ihde und Kloster, 2001, 30

by the growing intercontinental trade, became the standard transport unit in the maritime shipping industry. As the first containers were established in the US market for local shipping, the American measurement units “foot” and “inch” was decisive for the final construction. As a result, a forty feet standard container, which was intended to carry the comparable goods of a European standard truck, has with its ground dimensions of 12032 mm length and 235 mm width a tremendous loss of utilization while carrying Europool pallets.[11]

2.2.3.2 Reuse and Recycling

Whereas for some transport systems this factor is not relevant because of tailor-made solutions or a non-usability of the raw materials, some loading units are completely knocked down and reused, especially in times of high prices for raw materials such as steel. One example for the complete usage in the aftermarket is the container shipping industry having old vessels wracked down manually in low cost countries. But not only raw materials are used in the aftermarket, some units are still kept as a spare-parts warehouse for units which are not produced anymore or spare parts have to be expensively rebuild, like in the aviation industry.

2.2.3.3 Intermodal Competition

Most of the transport modes have a different historical development and different owners on the one hand and public interest on the other hand. Therefore, the competition among the different transport systems can – in some cases, especially when one supporting actor has a legal power – decisively influence the demand and the utilisation of the transport unit. As each mode is affected differently by the framework and has a different appearance in the public opinion this factor can play a major role.

2.2.3.4 Industrial Policy

Beside the Automotive Industry in Germany, the shipbuilding industry in countries as if South Korea can play a major role in direct demand and influence of the modal split. Due to the fact of high investments, the producing industry faced a high concentration with a strong influence of the public sector, formally with a governmental stakeholder or informally with a product friendly legislation. Even in

[11] http://www.europoolsystem.com/UploadBestanden/Product%20datasheet%20pallets%20wood.pdf, 05.2014

Austria, tax advantages to boost sales were tailor made to type of car to ensure the local production.[12] In any case, the truck producing companies have a special standing within the automotive industry itself, as they combine the purchasing of goods and services with the selling of their products. As an example, DAIMLER AG in Stuttgart has a straight link from the logistics purchase on Full Truck Routes with the ACTROS selling organization. This means, that the selling of the transport unit is directly linked to the purchase of their services and vendors of their products are preferred.

2.4 Modal Split of Land Transport Production

In general, it can differ between three large transport systems concerning the transportation of goods. Air and maritime traffic play an important role and due to the ongoing globalization, this trend will surely continue in the future. In regard of direct deliveries and the last mile, these two transport systems do not play a role as they are limited to given systems such as airports, ports and terminals. Also in regard of the question whether a more spacious transport unit can decrease the logistics costs of the Automotive Industry it is necessary to focus on inland transport systems. Especially as they also influence air and maritime traffic in their role as pre- and on-carriage for both systems. The continental modal split in the European Union differs between three different systems: Railways, Road and Inland waterways.[13] To compare and to discuss the split it is necessary to define those three systems and put an emphasis on their strengths, weaknesses, opportunities and threats.

2.4.1 Inland Waterways

With a portion of 3.9 % in 2012 and only one industrial used river, the Danube river, inland waterways do not play a role in Austria, even though since the opening of the Rhine-Main-Danube Channel in the early 1990 the volumes went up from 8 million tonne-kilometre to some 11 million in 2012 including transit shipments with no added value generated in Austria.[14] European-wide, the portion of inland waterways is slightly higher, 6.7 percent for the European Union in 2013 – dominated by countries like Belgium, Netherlands and Germany which benefit from the Rhine, as the

[12] SZEMELIKER, Der Standard, 26.05.2002
[13] http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=tran_hv_frmod&lang=en, ß6.05.2014
[14] http://www.bmvit.gv.at/bmvit/verkehr/schifffahrt/binnen/downloads/bsta_pdf.pdf, 26.08.2014, 2

traditional and fully adapted waterway and his link to the North Western European Sea Ports. The carriage of FORD cars from the production in cologne is the only example where an OEM transports vehicles via Barge to the transhipment port in Vlissingen[15] There is no significant notice about another usage of inland waterways in the Automotive Industry and therefore negligible for the further considerations.

2.4.2 Railway Systems

The railway system is heavily influenced by the competition with the road network within Europe as well as in Austria, which shows following characteristics:

- Ability for efficiency of masses
- Providing high security for goods transported
- Reliability
- Ability for automation
- Low unit costs / high fixed costs
- Low flexibility in services
- Low competition due to small number of providers
- High portion of terminal – terminal traffic
- Considered as environmental friendly technology

Even though the railway network is open for any providers since a EU directive in the early 1990ies[16], the implementation of this directive is not yet implemented in all member countries with full efforts. Nevertheless, an increasing number of private providers are turning this former state owned monopoly industry into a customer orientated market economy.
The infrastructure of the network is de facto available for any provider after the directive; nevertheless, the system is completely regulated, as slots have to be acquired from any provider. Different methods of production within the national and international rail transport are[17]:

[15] http://www.at.ford.com/news/Publications/Publications/2009_FOE/118/@Ford118%20-%20October%202011%20-%20Fordreport.pdf, 22.08.2014, 6
[16] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31991L0440&from=DE, 21.07.1991
[17] SIEGMANN, Zukünftige Entwicklung des deutschen und europäischen Einzelwagenverkehrs, 16.05.2012

- Block train; a complete train is taken into account as transport unit, either with one involved party or as a bundle of different shippers or consignees which are combining their shipments to achieve the advantages of the block train such as economies of scale and the service advantage due to few handling processes.

- Wagon groups; bundling of several wagons to a transport unit, which have to be combined with other groups or with single wagons to a block train to run within the system.

- Single wagon: The shipper can "purchase" the service of running a single wagon from his named origin and final destination. The railway company is combining single wagons and groups to block trains and is responsible for the dispatching of the single containers. Single wagon traffic is heavily affected by completion to road and is losing market share year by year. To sustain in the market a further market liberalization would affect it in a positive way.[18] Another strategy would be to focus more on (standard-)containerized transports to benefit from the worldwide increasing sea transports with ISO standard containers, which almost doubled between 2003 and 2013 up to some 160 Mio TEU p.a.[19]

One of the main differences to other means of transports is that the rail transport industry is dominated by totally or partially state owned former monopolists with a historical background. Nevertheless, most of this rail companies acquired or established transport and logistics companies with or without involvement of the rail system. Popular examples are *Schenker Stinnes* for *Deutsche Bahn, Rail Cargo Austria* for *ÖBB* and *GEODIS* for French *SNCF*.

2.4.3 Road Transport

The road network has by far the highest net density of all modes of transports and access is possible for almost all participants of the economy without physical restrictions. Due to the relatively fast and cost saving production, the road transport

[18] REINHOLD, ROMETSCH, Eisenbahn in Deutschland 2025 - Perspektiven für den Güterverkehr, 23.03.2012
[19] http://unctad.org/en/PublicationsLibrary/rmt2012_en.pdf, 2012, 20

system is easily adoptable to the economic development. Regional specific features can be taken into account and expansions or reductions of the existing network can be implemented. Following points are the major characteristics of the road network:

- High coverage and density within Europe
- Possibility of door-to door deliveries
- High flexibility of the participants
- Individuality and self-determination of the involved parties
- Strong dependency of external influences such as weather conditions, peak seasons, driving restrictions
- Negative impact on the environment
- Limited loading capability

The main criteria as mentioned above are the free access to the infrastructure. This and a deregulated market lead to a very competitive and dynamic development. This competitiveness among the participants, shippers as well as transport and logistics providers conducts to a permanent pressure of optimization within the given network or by pressure on legislation to change the framework conditions. This market is driven by the macroeconomic situation as well as through technical progress, like GPS navigation systems and web-based freight platforms.

2.5 Capacity of transport units

Having mentioned all-important modes of transport, each transport unit has preferred loading units. Historically, these units were developed for each mode separately, following the economic progress and the global extension of the economy. Once the units were used for different modes, the multimodal transport with the same transport unit was born. According to the different needs of the different industries and the preconditions of the different modes of transport, there is no single transport unit for all purposes and all countries in the world.
Talking about the EUROCOMBI and the effects on the costs of the logistics in a specific industry, the capacity for road transport vehicles and its transport units is decisive.

Road transport is in regard of the effects highly affected by the dimension and the payload of the used transport unit. The other modes of transport are not facing the same restrictions in space for their shipments like in road transport.
The utilization can be measured in different dimensions: by weight and by volume. This relationship is established in the frequently used weight/measurement assumption of one cubic meters equals 333 kilograms in the road transport.
The loading factor determines the utilization per driven kilometre and indicates a percentage utilization of the available capacity per kilometre.[20]
The generation of the data is easy as Statistics Austria provides the figures[21]. This data is considering the following traffics:

- Exports/Imports
- Transit
- National transit
- Various (i.e. site to site transports)

Not only the driven kilometres and their weights are counted but also the number of trucks used. Out of this statistics, the average utilization of the trucks is less than 50%, taking into account the loaded transports only, the value remains at 69.4 %. For a truck with 24 tons loading weight, this result would mean, that this transport unit is carrying on average not more than 17 tons, in total less than 12 tons.

2013	Transported tons	Transports in 1000tkm	Utilization of loaded trucks	Utilization total	Average Transport frequency per shipment in tons
Total	**181.069.510**	**17.441.620**	**69,4 %**	**46,8 %**	**14,8**

Tab. 1: – Statistics Austria, average weight per truck 2013

Nevertheless, this statistics does not give an indication which size of trucks are used and which utilization they have. As there is no reference for Austria, the figures from Germany as the main trading partner and with a similar legislation can be considered as reference for Austria. The German evaluation showed the trend, that the utilization of the trucks increases with the size and the capacity.[22] This leads to

[20] McKinnon, 1999, 8f
[21] STATISTIK AUSTRIA, 2013, http://www.statistik.at/web_de/statistiken/verkehr/strasse/gueterverkehr/022425.html

[22] NAGL, 2007, 160

the assumption that the weight is not the main reason for limitation of the capacity for trucks.

The ongoing trend and increased used of standardized packaging units, i.e. the EURO pallet limits the capacity as well, even though the size of these units were often tailored to the common dimensions, a stowage loss due to the actual dimensions of the shipment is unavoidable even if the packaging is standardized. Furthermore, the space for the manipulation of loading and unloading of the cargo has to be added as well. Because in some industries the volumes are even higher than in others, new types of trucks were implemented to react to their special needs. The Jumbo Road Trains with 120 m^3 and Megatrailer with a maximal capacity of 100 m^3 are frequently used in the i.e. in the Automotive Industry, the insulation industry as well in the packaging industry.

3 Present Regulations of Road Transport Units

3.1 Definition

The diversity of the road haulage transport units includes a huge number of different types. They are made by different requirements of the particular industry and differ by dimensions, motorization, chassis, age, weight – net as well as tare – by drive engineering and by purpose. This Master Thesis is focussing on road haulage for transportation of goods for commercial purpose. Even with this restriction, the variety is huge and the terminology is not even standardized. One of the most common and worldwide used methods to group road haulage, is to differ between three major parts by size and driving permission:

- The light motor vehicle as the first segment, can be driven with a standard driving license for passenger cars with a gross weight of less than 3.500 kgs, the EU driving license type “B” is sufficient to steer such a vehicle even for professional usage. In the automotive industry, such cars are sometimes called LCV (Light commercial vehicles) and are mainly used in handcraft, in parcel distribution and in express deliveries. Due to the fact that there are no bigger financial or legal restrictions and can be driven by every owner of the driving license, the light motor vehicles are often used to avoid strict restrictions concerning safety, education and rest-period which are compulsory for professional transports, mainly for local parcel distribution and inter-European express services.

- Medium Heavy motor vehicles have a total weight band between 35 to and 12 to and require the possession of a “C” within the European Union. The main usage of this kind of vehicles is the distribution of groupage cargo, handcraft with heavier raw materials and transports from or to construction sites, as well as municipal services such as garbage disposal or shuttle transports. After the implementation of the weight-limited road tax in Germany, vehicles out of this class became rather widespread.

- Heavy Motor Vehicles require also the driving license “C”. In addition for carrying a trailer the driving license of the category “E” is mandatory and compromise a total weight of more than 12 to per vehicle. The usage of this type is nearly only for commercial use for heavy and high volume transports. Main hauls as well as short distance shuttle transports are mainly done with this kind of trucks, which are the only scope of this work. The exact limits of the transport units will be observed in the following chapter.

3.1.1 National Restrictions in Austria

The Austrian KFG (KRAFTFAHRGESETZ), literally translated as “motor vehicle law”, is regulating and defining which types of trucks are allowed to drive on which road. This law is in accordance with the technical and physical preconditions the main driver for the implementation of new transport units. Having the focus on truck measurements, the §4 KFG exactly describes the maximum lengths, width and heights as well as the maximum weights of the vehicles. Whereas widths and heights are mainly critical for the security of the infrastructure, both the length and the weight have a bigger allowance for exceeding the tolerances.
Speaking about vehicles dedicated to transport goods, the maximum measurements for regular transports in Austria are limited by:

- Width: 2.55m
- Height: 4 m
- Length: 18 m

The total weight is limited by a maximum of 40 tons and in connection with an intermodal transport by 44 tons. Surprisingly, the maximum weight was officially limited with 38 tons for national transports until 2009.
The following type of trucks is most frequently used; the dimensions vary from producer to producer, but in general a Semi-trailer with the dimensions of the loading platform counting 2.48 m width, 2.35 m height and a length of 13.6 meters is considered a standard truck. In this connection, the “loading”- or “truckmeter” is a frequently used term of dispatchers for planning the load of the truck. Therefore, a typical trailer consists of 13.6 loading-/truckmeters.

3.1.2 EU Directive

The term ‘Longer Heavier Vehicle’ (LHV) is generally used to describe vehicles that exceed the maximum vehicle lengths set out in Directive 96/53/EC or exceed the gross vehicle weight that must allow to freely circulate and is limited by 40 tons for standard road transports.
The Directive 96/53/EC contains the following regulation regarding vehicle weight and dimensions for freight traffic within the EU as following:

Length:	Motor vehicle	12,00 m
	Trailer	12,00 m
	Articulated vehicle	16,50 m
	Road train	18,75 m
Width:	All vehicles (except conditioned vehicles)	2,55 m
	Superstructures of conditioned vehicles	2,60 m
Height:	All vehicles	4,00 m
Weight:	Two-axle motor vehicle	18 tonnes
	Three-axle motor vehicle	26 tonnes
	Four-axle motor vehicle	32 tonnes
	Two-axle trailer	18 tonnes
	Three-axle trailer	24 tonnes
	Road trains with 5 or 6 axles	40 tonnes
	Articulated vehicle with 5 or 6 axles	40 tonnes
	40” container in intermodal transports	44 tonnes

Tab. 2: Vehicle dimensions listed in Directive 96/53/EC

In addition to the restrictions mentioned in chart 2, the maximum length of a road train is limited with 15.65 meters.

3.1.3 Other Regulations within the EU Directive

Despite the before mentioned directive 96/53/EC, the national legislations within the EU shows some exceptions.

3.1.3.1 National Weight Limits

As shown in Chart 3, the Scandinavian EU members Denmark, Sweden and Finland are exceeding the weight limit but are in line with their national legislations, requirements and of course historical experience made with the weight limits.

The Netherlands on the other side are restricting their weight by a total of 60 tons, underlying special local requirements.

PERMISSIBLE MAXIMUM WEIGHTS OF TRUCKS IN EUROPE (in tonnes)							
Country	Weight per non-drive axle	Weight per drive axle	Lorry 2 axles	Lorry 3 axles	Road Train 4 axles	Road Train 5 axles and +	Articulated Vehicle 5 axles and +
Albania	10	11.5 (3)	18	26 (2)	36	40	44
Armenia	10	10	18	22	36 (19)	36 (19)	36 (19)
Austria	10	11.5	18	26	36	40	40
Azerbaijan	10	10	18	24	36	42	44
Belarus	10	10 / 11.5	18 / 20	25	38 / 40	40 / 42	42 / 44
Belgium	10	12	19	26	39	44	44 (1)
Bosnia-Herzegovina	10	11.5	19	26	38	40	40
Bulgaria	10	11.5	18	26 (2)	36	40	40
Croatia	10	11.5	18	24	36	40	40
Czech Republic	10	11.5	18	26 (2)	36	44 (2)	42 / 48
Denmark	10	11.5	18	26	38	42 / 54 (35)	42 / 54 (35)
Estonia	10	11.5	18	26 (2)	36 (4)	40 (5)	40
Finland (6)	10	11.5	18	26 (2)	36	44 / 60 (7)	42 / 48
France	13/12 (31)	13/12 (31)	19	26	38	40/44 (32)	40/44 (32)
FYROM	10	11.5	18	25	31	40	40
Georgia	10	11.5			44	44	44
Germany	10	11.5	18	26 (2)	36	40	40
Greece	7 / 10	13	19	26	33/38	40/42(20)	40/42(20)/44(13)
Hungary	10	11.5	18	25	30	40	40 / 44 (8)
Iceland	10	11.5	18	26 (2)	36	40	44
Ireland	10	11.5 (9)	18	26 (2)	36	44 (2)	44 (2)
Italy	12	12	18	26 (2)	40	44	44
Latvia	10	11.5	18	26 (2)	40	40	40
Liechtenstein	10	11.5	18	26 (2)	36	40	40
Lithuania	10	11.5	18	26 (2)	36	40	40 / 44 (10)
Luxembourg	10	12 (11)	19	26	44	44	44
Malta	10	11.5	18	25	36	40	40 / 44 (8)
Moldova	10	10	18	24	36	40	40
Montenegro	10	11.5	18	26 (2)	36	40	40 / 44 (8)
Netherlands (12)	10	11.5	21.5	21.5 / 30.5 (22)	40	50	50
Norway	10	11.5	19	26	39	46 / 56 (23)	43 / 50 (24)
Poland	10	11.5	18	26 (2)	36	40	40
Portugal	10	12	19	26	37	40 / 44 (25)	40 / 44 (26)
Romania	10	11.5	18	25	36	40	40
Russia	10	10 / 11.5 (27)	18	25 / 28(28)	36 / 32 (29)	40	40
Serbia	10	11.5	18	26	32	40	40
Slovakia	10	11.5	18	26 (2)	36	40	40
Slovenia	10	11.5	18	26 (2)	36	40	40/ 44 (8)
Spain	10	11.5	18	25/26 (34)	36 (33)	40	44 (13) / 42 (14)
Sweden	10	11.5	18	26 (2)	38	48/60 (30)	48/60 (30)
Switzerland	10	11.5	18	26 (2)	36	40	40
Turkey	10	11.5	18	25/26 (16)	36	40	40/44 (10)
Ukraine	11	11	16 (17)	22 (17)	38 (17)	38 (17)	38 (17)
United Kingdom	10	11.5	18	26 (2)	36	40 (18)	40 / 44 (10, 18)

Tab. 3: ITF Permissible max. weights of trucks in Europe in tons (15/01/2013)

3.1.4.2 National Size Limits

Interesting enough and as can be seen in chart 4, some EU member countries have no defined restrictions at all for some dimensions of the trucks. France, Sweden and the United Kingdom do not restrict the height of the vehicles at all.

PERMISSIBLE MAXIMUM DIMENSIONS OF TRUCKS IN EUROPE					
COUNTRY	HEIGHT	WIDTH	LENGTH		
			Lorry or Trailer	Road Train	Articulated Vehicle
Albania	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Armenia	4 m	2.55 m	12 m	20 m	20 m
Austria	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Azerbaijan	4 m	2.55 m	12 m	20 m	
Belarus	4 m	2.55 m (3)	12 m	20 m	24 m
Belgium (8)	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Bosnia-Herzegovina	4 m	2.55 m	12 m	18.75 m	16.50 m
Bulgaria	4 m	2.55 m	12 m	18.75 m	16.50 m
Croatia	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Czech Republic (4)	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Denmark	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Estonia	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Finland (1)	4.20 m	2.60 m (6)	12 m	25.25 m	16.50 m
France	not defined	2.55 m (3)	12 m	18.75 m	16.50 m
FYROM	4 m(2a)	2.55 m(3)	12 m	18.75 m	16.50 m
Georgia	4 m	2.55 m (3)	12 m	20 m	20 m
Germany	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Greece	4 m	2.55 m	12 m	18.75 m	16.50 m
Hungary	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Iceland	4.20 m	2.55 m (3)	12 m	22 m	18.75 m
Ireland	4.65 m	2.55 m (3)	12 m	18.75 m (7)	16.50 m
Italy (2)	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Latvia	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Liechtenstein	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Lithuania	4 m	2.55 m (3)	12 m	18.75 m (4)	16.50 m
Luxembourg	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Malta	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Moldova	4 m	2.50 m	12 m	20 m	16.50 m
Montenegro	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Netherlands (8)	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Norway	not defined	2.55 m (3)	12 m	19.50 m	17.50 m (10)
Poland	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Portugal (2)	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Romania	4 m	2.55 m	12 m	18.75 m	16.50 m
Russia	4 m	2.55 m (3)	12 m	20 m	20 m
Serbia	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Slovakia	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Slovenia	4.2 m	2.55 m (3)	12 m	18.75 m	16.50 m
Spain	4 m (11)	2.55 m (3)	12 m	18.75 m (12)	16.50 m
Sweden	not defined	2.55 m (3)	24 m	25.25 m (5)	24 m
Switzerland	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Turkey	4 m (13)	2.55 m (3)	12 m	18.75 m	16.50 m
Ukraine	4 m (9)	2.60 m	22 m	22 m	22 m
United Kingdom	not defined	2.55 m (3)	12 m	18.75 m	16.50 m

Tab. 4: ITF, Permissible maximum dimensions of trucks in Europe (15/01/2013)

Furthermore, Sweden limits the trailer with 24 meters only that leads to a maximum length of 25.25 meters.

3.2 Non-Standard Vehicle Types within these Limits

To adapt the common regulations, the industry as well as the transport and logistics companies, developed truck types which are within the maximum weight and dimension limit and within the EU directive, but not considered as standard vehicles. For Austria these vehicles are:

- MEGA TRAILER/SEMI-Trailer
  Encouraged by the Automotive Industry, the height of 3 m allows stacking the frequent used steel box pallet three times, increasing the loading capability of these frequently used boxes by 50 %. The maximum loading capability represents 100 m^3.

- JUMBO ROAD TRAIN
  Frequently used in the Automotive Industry is a road train with a maximum loading of 120 m^3. In contrast to the MEGATRAILER and the standard truck, the Road train consists of a carrying unit and a trailer. Unloading is more time consuming than with other equipment. Beside the Automotive Industry the insulation, household and consumer goods industry demand such kind of trucks in a higher number.

- Double Stack truck
  Double-deck trailers are very common in the UK and frequently used to transport voluminous goods. The average height of such a trailer amounts 4.9 meters, which align to the given British infrastructure.

Nevertheless, the cost pressure in the industry and the high competiveness in the forwarding and haulier business led to adaptations in the measurements with the result of two new types. Again the Automotive Industry as one of the most developed and worldwide active industries was the driver of the development.

3.3 High Capacity Vehicles (HCV)

In the English language ‘High Capacity Vehicles’ (HCVs) is frequently used to describe trucks with a large capacity but respecting the current weight limits for trucks in the single countries. The term should not be confused with ‘LHVs’ (Longer Heavier Vehicles), which has been used to describe vehicles that exceed the maximum vehicle lengths set out in Directive 96/53/EC and that exceed the gross vehicle weight that EU member states must allow to freely circulate. In the German language, the term EUROCOMBI is not the single expression used in the context about trucks with a length of 25.25 m and within the actual weight limits. There are many terms used in the media, logistics industry and especially in the political discussion, quite often mixed and used to emphasise the positive or negative impacts of this mode of transport. These are some of this most common expressions, without claiming completeness:

- “Monstertruck”
- “RiesenLKW”
- “Ecocombi”
- “Longliner”
- “Gigaliner”

Some expressions already tend to the negative such as “Riesen” or “Monster”. The expressions are not aligned or internationally standardized. Size and weight of exceptional transports which are as well allowed on European streets, exceed the actual limits sometimes by far, but are not considered in the discussion neither in safety nor in infrastructural matters.

One of the main and most decisive topics in the discussion is the maximum weight of the truck. In the public discussion about the EUROCOMBI, it is given that an increase of capacity leads to an increase of weight, which is of course correct but not considering that the average weight – especially in the automotive industry – is below the half of the allowed limit, as stated from Michael Brandl, the responsible Overland Manager from GEFCO Austria, a logistics service provider specialized on Automotive industry. This means that even with a double capacity the weight limit is not going to be touched. Based on the evaluation of a dedicated truck fleet for tier 1

suppliers in Austria delivering OEMs such as PSA, MAN, DAIMLER and VOLKSWAGEN the average weight does not exceed 12 tons per truck

Following the data of the evaluation, an extension of the weight limit is definitely not a priority to gain a cost reduction for the transports in the automotive industry.

3.3.1 Principle Combinations

Following the constraints in the previous sections and the principal of a massive cost awareness in the Automotive Industry the investments for the implementation of a new truck type have to be as little expensive as possible, therefore the industry as well as the transport companies intend to use equipment, which is already in use.

The possible combinations below with symbolic drawings:

- Truck (rigid) with Dolly Axle and trailer (A-Variant)
  It is also called A-Train and is by far the most commonly used combination in the Bavarian field test. Main investment, but crucial for the security is the so-called “Dolly Axle”, a trailer which can be coupled to a truck to support a semi-trailer and which can be steered separately. The “Dolly Axle” with a mechanical steering and a weight of 3.5 tons was invented by the company KRONE in Germany and allows this combination to fulfil all requirements of the German road rules. The costs of such a dolly axle are around 17.000 EUR and the only additional investment, which have to be taken if a logistics company decides to equip their fleet with a EUROCOMBI.

- Tractive unit with tandem trailer (B-Variant)

  This combination consists of a tractor unit, a trailer and a tandem trailer with an inflexible draw bar. Due to the fact that no additional investments have to be taken, this combination is quite frequently in use.

- Truck (rigid) with two tandem trailers (C-Variant)

  Adding two tandem trailers with an inflexible draw bar to a three axle truck results in a C-Variant Truck. Frequently used especially in the Netherlands.

- Tractive unit with two trailers (D-Variant)

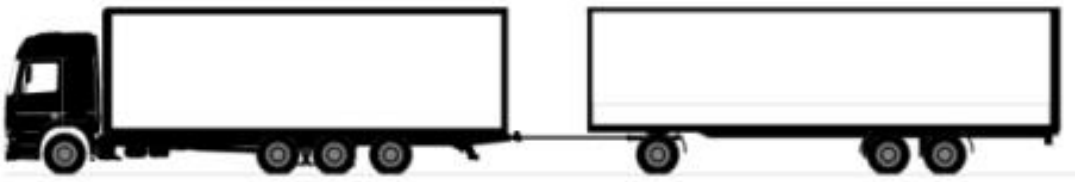
  This combination, sometimes also called B-Train, consists of a tractor and two trailers and is mainly used in Sweden where a total gross weight of 60 tons is allowed to run.

- Truck (rigid) with trailer (E-Variant)

  A special truck with four axels carries a trailer, equipped with a steering axle is called E-Variant. This rarely used variant does not utilize the maximum allowed length of 25.25.

- Truck (rigid) with ponytrailer (F-Variant)

  This truck with a three axle trailer is easy to equip with standard equipment; therefore the F-Variant is frequently used in Europe.



- Truck (rigid) with three axle trailer (G-Variant)

  This version reminds of already Jumbo Road train trucks and differs from the F-Variant with its centrally located axes. Using not the maximum allowed 25.25 meters with two same sized trailer bodies, this variant is not popular.

- Tractor unit with three axle trailer

  This standard trailer is extended with a turntable three-axle trailer. The small trailer at the end is intended to carry an ISO 20'Standard container and is frequently used with this combination.

3.3.2 The European Modular System (EMS)

The European Union intended to use already existing truck and trailer equipment to avoid the implementation of new equipment. The idea of the EMS consists of the intention to combine three different trucks to two different combinations, which do not exceed the given maximum total length of 25.25 meters.

The EMS consists of the longest semi-trailer with a maximum length of 13.6 meters and the longest load-carrier with a maximum length of 7.82 meters, already allowed in European Union, which results in a length of 25.25 meters.

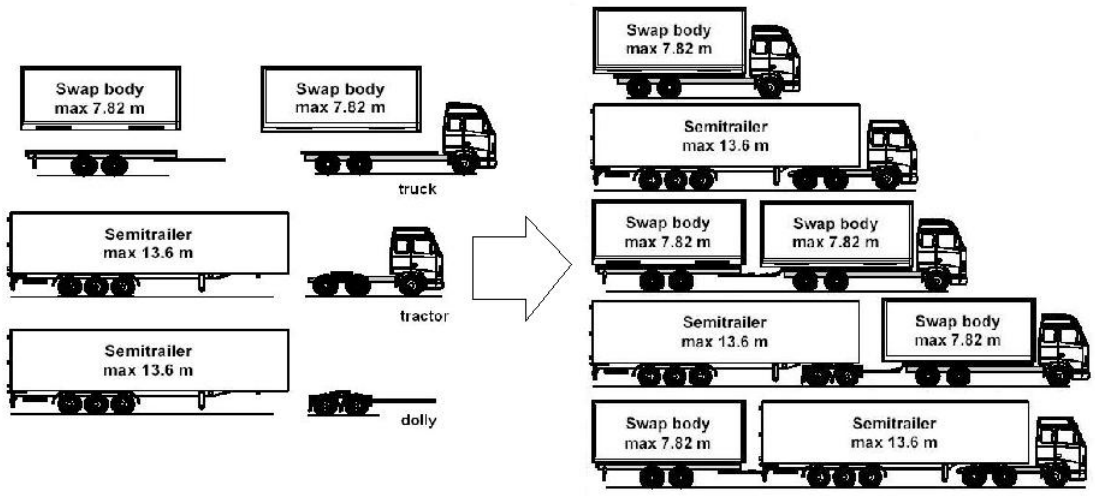


Fig. 2: Possible combinations of the EMS (symbolic drawing)

Following the logic from the EMS, the right combination of the trucks – respecting the directive – leads to a saving of one out of three transports.

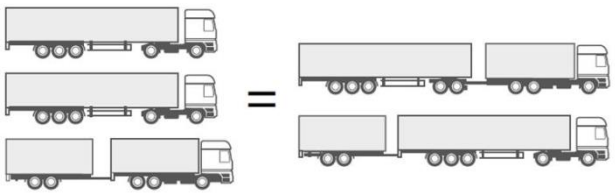


Fig.3: Saving of tractor units (symbolic drawing)

The saving as published in the symbolic picture above represents the main idea to reduce the costs on the one hand and to reduce the CO2 emissions on the other hand.

3.3.3 Dimensions of the German Field test

Assuming the similarity in geographical and economical similarities, the field test in the German federal state of Bavaria is most suitable for a comparison to the needs of the Austria market. The field test started in January 2012 and in July 2014 39 companies with 79 trucks received the permission to run those trucks on defined routes.[23] Five different types of trucks are allowed to participate on the field test with a maximum length of 25.25 meters. The maximum weight remains limited with 40 tons for standard transports and 44 tons for transports for multimodal solution. This thesis assumes that these five combinations will be a reference for Austria as well.
As given in the German "LKWÜberlStVAusnV from 19. December 2011", § 3 determine the five possible combinations:

- Tractor with trailer (max. length 17,80 meters)
- Tractor with trailer and an centralized axle trailer (max. length 25,25 meters)
- Truck with trailer (max. length 25,25 meters)
- Tractor with two trailers (max. length 25,25 meters)
- Truck with trailer (max. length 24 meters)

[23] http://www.bast.de/DE/FB-V/Fachthemen/v1-lang-lkw/v1-lang-lkw.html;jsessionid=3691EFD8C272D7E166B871437D670A58.live1043?nn=605096, 07.2014

The maximum gross weight remains at 40 tonnes, like for standard trucks and for 44 tons for multimodal usage

4 European Experience of the usage of the EUROCOMBI

As already mentioned in Chapter 3, the European Union limits the maximum allowed size and weight within the valid directive, the single member countries have the right to make their own restrictions in regard of these measurements. The following chapter gives a brief overview of the backgrounds, experiences and also of the connection to the Automotive Industry where possible or where a connection could be drawn. The countries presented in the following chapter are not the only countries having experience with the EUROCOMBI. Countries such as the Czech Republic, Belgium or Finland grant exceptions for the usage of the EUROCOMBI, but to judge the feasibility for the implementation of the EUROCOMBI and its effect on the logistics costs, the Netherlands, Sweden and Germany show certain similarities to the Austrian situation and are well described in the literature.

4.1 The Netherlands

Counting less than 50.000 units produced in 2012 – 28.000 cars and 21.800 trucks[24] – the automotive production in the Netherlands is not remarkably compared with their neighbouring countries. The Netherlands employ approximately 45.700 people divided over OEM's, suppliers, Research and Development institutions and other automotive companies.[25] Compared to other countries, the industry itself plays a minor factor in the Automotive Industry. Nevertheless the Netherlands play an important role in regard of the logistics aspect, also for the Automotive Industry as a transit country for inbound logistics as well as for car distribution. Because of the biggest European Port, Rotterdam, a logistics friendly topography and the proximity to the main industrial zones in Western Europe as well as an exemplary logistics infrastructure in rail, waterways and road network, the logistics industry is one of the most important business lines in this country.[26] In addition to the fact that logistics is an important factor in the whole country, a liberal legislation has a long tradition in the Netherlands.

[24] http://www.acea.be/uploads/statistic_documents/POCKET_GUIDE_13_37.pdf 2012
[25] http://www.automotive-industry.nl/page/wb/automotive-industry-overview.php, 2014
[26] http://ec.europa.eu/transport/themes/strategies/studies/doc/2008_12_logistics.pdf, 2008, 67

The first trials with EUROCOMBI-similar trucks, which are locally called LZV (**L**angere en **Z**waardere **V**rachtautocombinatie), were launched already in 1999, but with the restrictions of a total weight of 50 tons and a maximum of 22 metres.[27] Based on the experiences of this trial, a first test phase was initiated in 2001 and lasted until 2004. During this period, LZV trucks were allowed with a maximum of 60 tons and a maximum length of 25.25 metres.[28] This phase was intended to check the usage especially for the multimodal transport and was linked to strict restrictions in regard of the security and environmental protection. The success of this trial led to a second trial phase, with more than EUROCOMBI trucks from 2004 to 2006 with 72 hauliers and 162 trucks.[29] After some minor adoptions in the following year, a third and last test period was started with a duration of four years, covering almost the whole Netherlands as a testing area. An important change to the previous test phase was that the number of applicants was not restricted. This led to a doubling either of the number of the transport companies or of the number of the EUROCOMBI trucks.

In addition to the success and the acceptance either of the public or the transport industry, it is significant that not only large hauliers but also small and middle-sized companies took part. Furthermore, 22 % of the actual running EUROCOMBI are not run by logistics companies, but the industry itself.[30]

The Dutch Ministry of Transport, Public Works and Water Management, launched a survey among the logistics provider in 2011 to indicate the average weight of the loadings of the used EUROCOMBI trucks. Interestingly enough, excluding waste and bulk industry, the average load was not or barely exceeding 24 tons.

Market segment	Outbound journey	Return journey
Retail	22 tonnes	18 tonnes
Containers	3 TEU	3 TEU
Ornamental horticulture	14 tonnes	11 tonnes
Waste/bulk	35 tonnes	empty
Volume	14 tonnes	5 tonnes
Packaging	7 tonnes	5 tonnes
Other	26 tonnes	16 tonnes

Tab. 5: Average load journey analysis of Dutch LHV[31]

[27] Doll, 2009, 16
[28] Rijkswaterstaat, 2011 ,11
[29] Rijkswaterstaat, 2011 ,19
[30] Rijkswaterstaat, 2011 ,34
[31] Rijkswaterstaat, 2011 ,40

The similarity of the Austrian Automotive Industry and the Dutch Automotive Industry is the high dependency to the German automotive industry, the lack of a local car producer - VDL NEDCAR consider itself as an automotive contract manufacture[32] - and the membership to the EU. Assuming that the Dutch automotive and supplier industry has a similar average weight and is considered as a volume cargo, the average of 14 respectively 5 tons does not utilize the maximum allowed weight by far. A total weight of 40/44 tons is sufficient for the Automotive Industry.

4.2 Sweden

For decades, Sweden's Automotive Industry was widely known for its local car brands VOLVO and SAAB as well as for the trucks from SCANIA. After the overtaking of VOLVO Cars from FORD in 1999[33] and the stepwise acquisition from GENERAL MOTORS of SAAB AB starting in 1989,[34] Chinese GEELY group now owns VOLVO and SAAB as a car brand does not even exist anymore. VOLKSWAGEN group mainly owns SCANIA AB[35]; it is only VOLVO trucks, which is still owned by Sweden. In 2012 some 160.000 passenger cars were produced[36], the country has a ranking midfield in the European Union only.

Including the supplier industry, with SKF as the most known Swedish Tier-1 supplier, some 110.00 people are directly employed in the automotive sector of Sweden.

Even though the Swedish Automotive Industry has a different set up than the Austrian one, the aspect of the long usage of trucks makes it worth to have closer look. Since the late 1960ies, these trucks have been in use. Back then, there was not even a length restriction in place. This usage of trucks with a length of more than 18 metres makes it worth to have closer look. In addition to that, not only the length, but also the maximum allowed weight of 60 tons is among the highest ones in Europe. EUROCOMBIS have almost no restrictions in the whole country and Long and Heavy vehicle feature prominently the image of the streets in Sweden. A study sponsored by the Swedish Ministry of Ministry of Enterprise, Energy and Communications concludes, that the Swedish economy is depending on the

[32] VDL NEDCAR Business Brochure, 2007, 3
[33] http://corporate.ford.com/our-company/heritage/company-milestones-news,
[34] http://www.gm.com/company/historyAndHeritage/globalization.html
[35] http://www.scania.com/investor-relations/
[36] http://www.acea.be/uploads/statistic_documents/POCKET_GUIDE_13_37.pdf

EUROCOMBI as 74 % of the ton-kilometre is transported by trucks with EUROCOMBIS, heavier than 40 tons and more than 7 axes.[37]

A weight and length-restriction to maximum which is used for example in Austria, would increase the transport the truck traffic by 30 - 35 % and would lead to an increase of logistics costs as well as to an increase of the carbon dioxide emission to a serious environmental impact.[38]

Of course the Swedish topography and the road network have hardly any similarities to the Austrian one and are heavily influenced by the timber and mining industry, but the acceptance and the neutral political discussion as well as the rail industry using the advantage for the pre-carriage and the last mile delivery, shows that the usage of Long and Heavy Vehicles led to advantages for the local industry and later for the Swedish economy as a total.

4.3 Germany

After the references of countries with approximately the same size as Austria, but with a different industrial set up, Germany is not only the main trading partner of the Austrian industry, counting 37 % of the imports and 30.1 of the exports in 2013[39], also in regard of the historical context, the German mentality and industrial focus can be seen as rather close to the Austrian one. The German Automotive Industry is one of the main drivers of the German industry and is a driver for innovation and export of the whole industry.

4.3.1 Automotive Industry in Germany

In 2013, more than 5.7 million vehicles were produced in Germany, which is ranking fourth in largest vehicles manufacturing counties right after China, the United States and Japan[40] with the local brands of the VOLKSWAGEN group, DAIMLER, BMW but also with production sites from non-German owned countries such as FORD, GENERAL MOTORS. CONTINENTAL and BOSCH, which are the main players in

[37] http://www.vti.se/sv/publikationer/pdf/langa-och-tunga-lastbilars-effekter-pa-transportsystemet.pdf, 2008, 9
[38] http://www.vti.se/sv/publikationer/pdf/langa-och-tunga-lastbilars-effekter-pa-transportsystemet.pdf, 2008, 13
[39] http://www.statistik.at/web_de/services/wirtschaftsatlas_oesterreich/aussenhandel/, 2014
[40] http://www.vda.de/de/zahlen/jahreszahlen/allgemeines/ 01.04.2014

the TIER-1 industry worldwide, and have their headquarters at their historic locations in Germany.[41]

With more than 750.000 employees in 2013, the German Automotive Industry – taken into account the car and truck producing industry, the trailer production and automotive suppliers – generated a total sales volume of 361Bn. EUR. Two thirds of it were generated not in Germany itself, but in foreign countries.[42] This makes the German Automotive Industry to the leading industry in Germany and is responsible for the positive trade balance during the past years.[43] These figures are published by the VDA, the German Automotive association, a privately organized organisation representing more than 600 German companies and one of the most powerful lobbying organisations in the world. This VDA is also considering itself as a main driver for research and development in all areas connected with the Automotive Industry. Their portion of the research and development expenses were more than 18 Bn EUR in 2013[44], which makes great sense when considering the fact that innovation is the main driver for the worldwide competitiveness of their represented industries. Besides, the VDA is one of the most powerful supporters of the implementation of the EUROCOMBI in Germany.

4.3.2 Test phase Germany

After a first test phase 2006 - 2008 on single lanes for dedicated trucks, the German government launched a countrywide test phase in 2012 under the direction of the ministry of Traffic, Construction and Urban development. Nevertheless, the single federal states in Germany have the right to permit or to reject the routes on their territory.

The “Deutsche Bundesanstalt für Straßenwesen” defines the possible combinations within the EU directive which is limited by a length of 25.25 meters and a loading weight of 40 tons, except pre- and on carriage to a rail terminal in the combination with a multimodal transport with a maximum loading weight of 44 tons.[45] The regulations are in place since January 1st, 2012 and are limited until December 31st, 2016.[46] To secure the reliability of the outcome of this study and to give the public as

[41] http://files.vogel.de/vogelonline/vogelonline/files/6235.pdf, 04.2014, 24
[42] http://www.oica.net/category/production-statistics/ 2013
[43] http://www.vda.de/de/zahlen/jahreszahlen/allgemeines/
[44] http://www.vda.de/de/zahlen/jahreszahlen/allgemeines/
[45] http://www.bwvl.de/sixcms/media.php/2492/Ausnahme-Verordnung%20Lang-Lkw.pdf
[46] www.bmvbs.de/cae/servlet/.../broschuere-kombinierter-verkehr.pdf , 2011, 1

much transparency as possible, the field test is divided into three phases of research:

- First Examination period: approximately one year where mainly the generic truck data is examined, freight papers are checked and transported goods were evaluated

- Second examination period: external effects such as involvement in accidents, special behavior in tunnels or bridges are examined

- Third examination period: will take place in half a year before the field test will terminate. All examinations of the first two periods are collected, subsequently checked and rechecked, and a final control report will be issued by the "Bundesanstalt für Straßenwesen", the official German institute for all streets.

In the directive of the exceptions ("LKWÜberlStVAusnV) the German legislation defines the allowed routes, including all roads, such as motorways, federal streets and local roads, to give the applicants the possibility to apply for door-door routes or for transports from and to multimodal terminals. In addition to the defined routes, some federal states took the opportunity to allow test routes on the road network on their territory. These federal states are Bavaria, Hamburg, Hessen, Lower-Saxony, Saxony, Schleswig-Holstein and Thuringia, mainly states with a conservative majority or with the geographical proximity to northern countries where the EUROCOMBI is widespread and accepted by the public. A special role hast the state Bremen, which is not participating itself but allows the transit of EUROCOMBI vehicles on the motorways A1 and A27 which are lying on the territory of this state. Federal States with a high stake on Automotive Industry such as Baden-Württemberg and North Rhine-Westphalia are not taking part in this field test. Furthermore, the German industry is not taking into account the location of different federal states and many highly industrialized metropolitan areas such as the Rhine-Main area or the Rhine-Neckar area are separated by local boarders and could have an influence on the transport planning. Nevertheless, it is possible to have a north-south corridor and the important sea freight gateway Hamburg can be served if needed from all participating states.

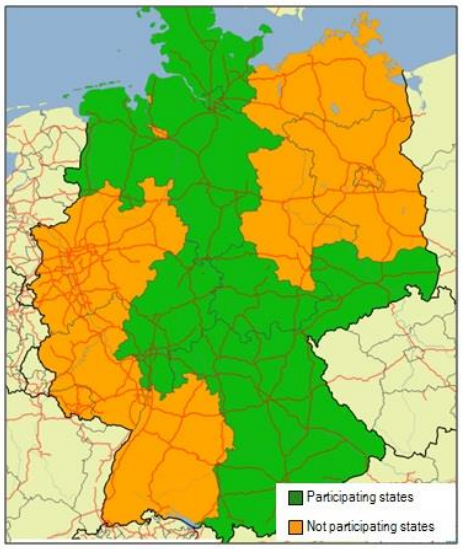


Fig. 4: German states with participation in the field test

In addition to the defined routes, this directive also stipulates additional technical equipment and restrictions for driver to ensure the security on the streets. According to the information from the BASt, which is providing the scientific support to the test, in May 2014 70 trucks from 37 involved companies are participating in this test.[47]

4.3.3 Field Test Examples

In the following chapter, practical examples from various industries as well as from the automotive industry will be described:

4.3.3.1 Various Industries

- Field Test Bavaria sanitary and packaging

ANSORGE LOGISTIK is a middle-sized logistics company with approximately 500 employees in a couple of branches and with it's headquarter in Biessenheim, Bavaria. Besides the warehousing, the focus is the FTL transport. During the logistics exhibition organized by the Austrian Logistics Council (BVL) in April 2013, Mr. Thoma, the general manager and owner of ANSORGE LOGISTIK, explained briefly the experiences of the field test of his company. Due to his customer portfolio in the sanitary and food industry and their increasing volumes, he was facing a lack of capacity as well as a shortage on experienced professional truck drivers. The company realized savings of 51 journeys during a period of 49 days on a 265 km

[47] http://www.bast.de/DE/FB-V/Fachthemen/v1-lang-lkw/v1-lang-lkw.html?nn=605096 05.2014

long roundtrip compared to a standard truck. The cargo was in one-way ceramic goods and backwards packaging material. The average transported amount of goods was 42 in the used EUROCOMBI unit compared with 28 in a standard truck. The CO2 reduction was almost 33 % and reduced the transport costs for the company.[48]

- Field test food industry

Since April 2014 the German middle-sized logistics company RIGTERINK based in Nordhorn, close to the Dutch boarder in Lower-Saxony, is running an EUROCOMBI, using the experience of a first trial from 2006 to 2008 on the same route. The company is focussing on food industry and provides next to transports, warehousing and commissioning to their customers from the industry.[49] The route of the EUROCOMBI is a shuttle transporting rusk from the companies owned warehouse in Bolldorf to their customers' factory in Ohrdruf (both Thuringia), doing 90 km per one-way trip.

- Field test retail industry

Already since February 2013, the global logistics integrator KÜHNE + NAGEL[50] is running a shuttle with a single EUROCOMBI unit from the central warehouse of the German company TCHIBO in Gallin (Mecklenburg – Western Pomerania) to the distribution centre in Bremen (190 km one way) three times per day. The company decided to use the EUROCOMBI after failing for several years to establish rail traffic between the two locations. Despite the fact that Mecklenburg-Western Pomerania and Bremen are not supporting the field test, the company achieved to get special permissions for the first and last miles kilometres, as the vast majority of the route is in Lower-Saxony.

4.3.3.2 Automotive Industry

- Field Test Automotive industry DAIMLER Bremen, short distance

The middle sized PAUL SCHOCKEMÖHLER from Lower-Saxony transport and logistics company with a fleet of more than 300 trucks and trailers and more than 75.000 sqm covered warehouse is service provider with a strong link the German

[48] http://www.ansorge-logistik.de/news-anzeigen/items/halbzeit-feldversuch-lang-lkw.html
[49] http://www.rigterink.com/unternehmen.html
[50] http://www.kn-portal.com/de/nc/about_us/media_relations/news/news_single_display/?cHash=e3b3c485790a4155a0f1b9164be57f6a&tx_knnews_pi1%5Buid%5D=3281

Automotive Industry, especially to his customer DAIMLER AG.[51] Since February 2014, SCHOCKEMÖHLER is running an existing flow from his owned logistics centre in Holdorf to the DAIMLER AG plant in Bremen on a 90 km route with the usage of an EUROCOMBI. The carrier, that is transporting seats in the inbound and empty equipment on the back flow is using one EUROCOMBI unit as a shuttle running the route two times per day[52], which led to a reduction of three trips daily in average compared to a standard truck.

- Field test automotive industry BMW mid-range

The Bavarian based GILLHUBER, a small transport company with around 120 employees, runs a EUROCOMBI truck daily from Munich to the production site in Leipzig, doing some 800 km per roundtrip every day. The company uses one single EUROCOMBI dedicated to one business and is saving – according to their own calculations – 20-30 % of their transport costs.[53]

- Field test automotive industry AUDI long range

HELLMANN logistics with more than 10.000 employees worldwide is one of the largest German forwarding companies, headquartered in Osnabrück. The company was already participating in the first tests in 2006 and is considering itself as one of the drivers for the implementation of the EUROCOMBI in Germany. Currently Hellmann is running a small fleet of trucks and has up to date three EUROCOMBI units in Germany. One of them is supplying AUDI in Dingolfing from a consolidation centre in Lehrte with a stopover in Leipzig, a 700 km one-way milkrun. A route, which can be covered without leaving states, is yielding cost savings of up to 30 % in the field test.[54]

- Field Test combination standard truck BMW, DAIMLER

The Bamberg based forwarding company ELFLEIN is a middle-sized transport company with some 450 employees and with a fleet of 270 trucks. It is by number of the trucks the largest participant on the field test.[55] In May 2014 the company ran nine EUROCOMBI trucks; the trucks almost exclusively used for the automotive

[51] http://www.schockemoehle.de/home.html
[52] http://www.dvz.de/rubriken/strasse/single-view/nachricht/schockemoehle-faehrt-autoteile-per-lang-lkw-nach-bremen.html 10.02.2014
[53] http://www.g-logistik.com/de/aktuelles/detail/?news_id=129 17.12.2013
[54] http://www.hellmann.net/de/austria/#237_automotive_logistics
[55] http://www.elflein.de/en/news/news-details/article/8-cosub2sub-reduktion-innerhalb-eines-jahres.html 09.2012

industry. Seven trucks were in place to supply BMW: from Dingolfing or Landshut to Leipzig (some 400 km) and from Treuen to Regensburg (200 km).
As stated in an interview with the transport magazine "TRANSAKTUELL"[56] the managing director is satisfied with the test and is planning to apply for more trucks, especially because of the daily mileage of approx. 950 km per truck.
As already mentioned, the federal state Baden-Württemberg is not participating the field test; the local based automotive industry cannot be served via EUROCOMBI. To serve the flows from a supplier in Bautzen to the production plant in Sindelfingen, Elflein runs two EUROCOMBI from Bautzen to Bamberg (330 km), and from Bamberg, the cargo is transported via three standard trucks to the final destination in Sindelfingen (250 km) for a total one-way route of 580 km.

4.3.4 Field Test from the Point of View of a German OEM

As stated in a written interview on 01.08.2014 from Mr. Gerd Pomberger, the responsible Manager for inbound FTL flows from DAIMLER AG, he is achieving savings of around 20%, which are not achievable with standard purchasing procedures on FTL flows. The DAIMLER AG runs EUROCOMBIs on eight different relations and is considering the LHV as a transport unit of the future, with a high acceptance of their suppliers. The three main points according to Gerd Pomberger to use the enlarged capacity are:

- Economic efficiency
- Ecology
- Innovation

Out of his experience, he is expecting a share of 15% if the EUROCOMBI will be allowed on all streets like in the Netherlands. Savings of 20% on 15% of their lanes, will lead to a decrease of the logistics costs of an OEM of 3% overall. Furthermore, DAIMLER AG as one of the largest producers of trucks in Europe will benefit from the boost in truck sales to equip the new EUROCOMBI fleet with modern trucks.

[56] http://www.eurotransport.de/news/elflein-spedition-groesster-lang-lkw-betreiber-deutschlands-6548406.html, 12.04.14

4.3.5 Field Test Results

Despite the big concern from the public and a big part of the politics, the industry is accepting the EUROCOMBI and benefits from the savings in the logistics costs. The examples shown above should demonstrate that:

- Because of the restrictions and participating of some important states the customers and the logistics industry cannot cover every demand or have tests on every route

- There is no significant trend either in industry or in the length of the tested routes.

- The Automotive Industry as an innovation driver has an above average usage of the EUROCOMBI and is supporting the development even though there is no selling intention of OEM without a truck production.

- The participating transport companies in the field test are representing the whole logistics industry in Germany – from global integrators to local carriers with a regional focus.

- Every country has a different set up in regard of the producing industry as well as different topography. Nevertheless, the economies are extremely linked within the EU member countries; the EU gives a framework to work on with the directive of the usage of longer vehicle and due to the de facto borderless and intense competition, the logistics companies are drivers for innovative products.

- The results of field tests in Germany, the largest economy in the EU, and the actions taken from the conclusion have a big impact on other countries, especially for those, which have an above average dependency in trade like Austria, the Czech Republic or Poland.

4.4 European dimension of the EUROCOMBI

On April 15 th 2014, the European Parliament rejected the proposal from *Siim Kallas,* European Commissioner for Transport, to allow cross border transport of vehicles between two countries with the same exceptions in regard of weight and size.[57] Nevertheless, two countries with a direct border can allow the transport with EUROCOMBIS on their territories. This defeat for the supporters of a European-wide implementation of the EUROCOMBI is a setback in their efforts to ease the free flow of goods within the European Union. As the majority of the trade of the single members is within the European Union and the free flow of goods is one of the main principles, a common legislation in regard of the implementation and usage of the EUROCOMBI is definitely preferable. The directive is a first step to give all countries the framework, but in most of the countries, the lobby against the implementation or even a field test is in majority. For the Austrian Automotive Industry with its close neighboring countries with a strong automotive industry, the benefits would be much greater than a local solution.

[57] NZZ, 15.04.2014, http://www.nzz.ch/aktuell/wirtschaft/wirtschaftsnachrichten/eu-ueberarbeitet-lastwagen-vorschriften-1.18064848

5 External Effects of the Implementation of the EUROCOMBI in Austria

In fact, the topic of the EUROCOMBI has a vast media coverage, especially during the discussions about the cross boarder admission of transports within the European Union, not only in the trade press but also in the mass media. Very often, the EUROCOMBI is not clearly defined and the maximum weight is assumed with 60 tons.[58] The Austrian ministry of infrastructure published a fact sheet to underline the negative effects of the implementation of the EUROCOMBI with a maximum weight of 60 tons. Especially the comparison with the rail transportation plays an important role in the sheet, as the ministry fears the extension of the consecutive trend of shifting goods from the rail to the street.[59] In the following chapter, the possible effects of the implementation of the EUROCOMBI with a maximum gross weight of 40 or 44 tons will be observed only due to the fact that an adjustment of the maximum weight has no priority for the Automotive Industry.

5.1 Infrastructure

5.1.1 Tunnels

As an alpine country, Austria has more tunnels within its road network than other countries. Therefore, the security in tunnels plays an important role. Considering some bottleneck tunnels in the Alps, like the “Tauerntunnel” or the the “Bosruck” tunnel, the importance is even higher to prevent being blocked for longer times. Fire incidents are most dangerous and usually occur due to technical or electronically reasons (50%).[60] An increase of transported goods will automatically lead to an increase of the possibility for such an incident. An easy and cheap way for prevention would be the extension of the distances between the trucks to keep the possibility at the same level even though the EUROCOMBI will be implemented.

[58] Salzburger Nachrichten, 16.03.2013, 25
[59] https://www.bmvit.gv.at/verkehr/strasse/personengueter/gigaliner_faktenblatt.pdf 2008
[60] Robatsch, 2010, 4

There are no studies regarding the fire-load in place, but generally, the Automotive Industry has a low amount of dangerous goods transported.

5.1.2 Resting Places

Due to the increased security measurements in regard of the resting phases of the driver, the resting places on the high-level road network play an important role nowadays. All of these resting places are built and equipped for a maximum length of 18.75 meters, a reconstruction would be time- and cost intense. Nevertheless, savings on the production costs would allow using a second driver so the trucks are not depending on official resting places. Furthermore, dedicated parking places on the large resting places for a small number of EUROCOMBIs can be implemented fast and with almost no extra expenses.

5.1.3 Bridges

Due to the fact, that the weight will not be changed, the bridges will be not affected infrastructure wise with an implementation of the EUROCOMBI in Austria. The maximum allowed axle weight remains at 11 tons per axle, which would on the other hand treat the constructions of the bridges with more care than a standard truck carrying the same weight.[61]

5.2 Security and Accident Prevention

Having no dedicated road network for commercial trucks, the security issue is one of the most discussed issues when it comes to the EURCOMBI as every member of the public traffic is affected. Of course, there is a trade off as the number of trucks will be reduced but the risk of accidents is increasing with an increasing length and mass. The risk of accidents will increase at the crossroads and due to an increase of the kinetic energy once an accidents occurs. In regard of the small numbers of EUROCOMBI in Germany and Netherlands, a meaningful comparison is not appropriate. The main points out of various studies are:

[61] Glaeser et al., 2006

- Acceleration and Breaking system: due to the higher weight of the truck, two engines drive shafts are needed and due to the length of the trailers in total, the possibility of jack-knifing if it comes to an accident

- Blind spot: due to the length, the blind spot is larger than for standard trucks and increases the risk of accidents.

- Railroad crossing: the actual times, especially for closing, are calculated with regular lengths of trucks.

- Turning: when it comes to the usage of smaller roads or gates to premises, the turning of the vehicle takes more space than a usual truck and cannot always be considered from other traffic participants.

- Clearance time at crossroads: Also, the calculation of traffic lights at crossroads have to be considered for the extended time of EUROCOMBIS.

- Rear-end collisions: Because of the kinetic energy, the masses, which will affect in rear-end collisions, especially on passenger cars, will increase heavily.

- Overtaking: especially for single lane roads, the overtaking procedure will take longer and fewer possibilities will occur for passenger cars.

- Limited maneuverability: leaving the standard free traffic flow on the appropriate route, unpredictable occasions will underline the difficulties in the maneuverability of a LCV.

Knowing the above-mentioned facts and considering the general safety on the streets, there are possibilities to prevent, minimize or even improve the safety in general:

    - Automatic distance sensor: in combination with an automatic connection to the break system, the sensor is measuring the distance between the vehicles. In case of an unusual change in the distance, the system breaks automatically.

- Lane guard system: this system realizes automatically if the truck leaves the standard lane and warns the driver or can even correct the direction automatically if desired.

- Disc brakes on every wheel: The producers of the trailers are pushing for this development, but for LCV this should be standard to improve the intensity of the break system.

- GPS system: compulsory for every truck to have a visibility and to react in real time for the dispatching teams in case of unforeseen incidents on the route.

- Camera system: Cameras at the rear and at the long side improve the maneuverability and the security for others dramatically and give the driver an overview of the incidents around. In case of an accident, it is helpful as well to identify the reason causing it.

- Electronic stability program: Electronic support of the steering and breaking of the driver to stabilize the truck and to facilitate the work of the driver.

- Electronic logbook: Supports the dispatchers and the fleet managers to examine the driving style of the driver to identify improvements and to analyze the data of the truck to prevent technical problems in advance.

All these mentioned installations are suitable and available for standard trucks as well and their mounting would increase the safety on the roads dramatically.

5.3 Environmental Effects

As mentioned in Chapter4, rather often the effects of the EUROCOMBI – especially when it comes to environmental effects – are compared with the traffic, without taking into account that a comparison between those two transport units does not reflect the demand of the economy. A truck – either standard, light or a EUROCOMBI – will always have worse influence on the environmental than a

solution via rail. In the following chapter, the effects on nature and people should be analyzed and not the decision on the modal split:

5.3.1 Noise Pollution

Having the weight separated on more axes than a standard truck, the noise pollution cannot be higher than with a standard truck. Assuming that the implementation of the EUROCOMBI will lead to less truck units, which are the main noise polluters, it can be expected that less noise will be produced. If the transport volumes will exceed the savings in fulfilled transports due to the implementation of the EUROCOMBI, the noise pollution will go up.
There is hardly any research for the noise pollution in combination with LCV or EUROCOMBI, which makes it difficult to determine.

5.3.2 Air Pollution

Having diesel engines combustion engines dominating the truck industry, the CO2 emission is a predominate topic in regard of environmental effects. Besides the development of fuel saving engines and the advantages on tax and tolls, the number of driven kilometers determines the grade of the environmental pollution.
As mentioned in this thesis, the EUROCOMBI can save one out of three trips using the same carrying trucks, reducing the CO2 emissions by 33% carrying the same goods.
Fuel consumption is the main driver for CO2 emission, the effects of the fuel consumption will be described in the chapter 6.3 in relation with the cost aspect.

5.4 Social Effects

According to an interview with the Austrian Newspaper “Wirtschaftsblatt” Wolfgang Herzer, the chairman of the haulage – representative section at the Austrian Chamber of Commerce – expects a lack of professional drivers in Austria in September 2014 [62] because of the changed restrictions to apply for a professional driving license. In addition, the haulage industry is facing a declining demand in

[62] http://wirtschaftsblatt.at/home/nachrichten/1387872/Transportbranche-steuert-auf-Fahrermangel-zu, 11.03.2014

driver’s position from local applicants, due to high cost and time pressure the attractiveness as a work place and the low labor costs of providers from South Eastern Europe are endangering the local supply of skilled and trained driver. These trainings are needed to ensure the required safety on the roads and to maintain the high quality standards required, especially in the Automotive Industry. Assuming that three trips can be replaced by two trips, the lack of drivers would not be as critical as expected. In addition the demand of well skilled and trained driver will increase because of the additional safety and technical installments into the LCV in combinations with savings on the transport costs to allow higher salaries, it can be a chance for the local Austrian labor market to source and train local drivers with a positive effect for low educated job seekers.

5.5 Public revenue

A reduced fuel consumption because of the implementation of the EUROCOMBI will automatically lead to a decrease of the revenues for the Austrian government in the fuel tax (MÖSt) and the assumed reduced number of trucks needed to cover the increase of transported goods can lead to a reduction of the motor vehicle tax.
The Austrian road pricing on motorways has to be adopted for trucks with more than seven axes. This could be an important level to influence the profitability of EUROCOMBIS in general and to compensate the losses mentioned above for the public revenue.
The savings for the diminished abrasion of the streets caused by the reduced axle weight on the highways are difficult to determine and heavily depending on the actions involving of the implementation. The same can be said for a reduced frequency of accidents caused by a reduced number of trucks on the streets.

6 Cost effects of the implementation of the EUROCOMBI

Having analyzed the legal background as well as the experiences with the EUROCOMBI in other European countries, the following chapter takes into account an Austrian Business case with several scenarios to have a clear and transparent picture of the costs effects of the implementation of the EUROCOMBI in the Austrian Automotive industry.

6.1 Logistics Costs

Because the logistics costs itself include an enormous amount of different factors along the supply chain, the logistics costs in this thesis are mainly focusing on transport costs related to a route or traffic. The most important cost factors will be calculated and analyzed, such as fuel costs, handling costs and costs of the transport units as well as the effect of the packaging.

6.2 Case Study Automotive Industry – Reference Calculation Based on WU Wien Model

6.2.1 Background

It is obvious that almost every transport lane and every truck has slight differences in the way of calculating the exact costs. Multiple internal and especially external factors such as traffic, weather conditions, and human behavior influence the costs and give room for interpretation for results of the evaluation. Therefore, this Master Thesis overtook a clear and standardized calculation model from the University of Economics and Business Administration Vienna, developed by Dr. Schramm an Ass. Professor at the Institute for Transport and Logistics Management. This approach preserves the objectivity in the way of calculation and was designed to judge the understanding of cost structures in the transportation business for the students. Nevertheless, this example is adaptive and can be easily adjusted to changed

preconditions as well as to different types of vehicles. [63] In the following chapter, the logic and the assumptions of the calculation model will be introduced as well as a concrete example of the comparison of a Standard truck combinations and a EUROCOMBI type “A”. As previously mentioned, the advantage and idea of the EUROCOMBI is, that no new equipment has to be installed or produced. The extensions are possible with the already allowed and used equipment. This makes it easy to give a fair and transparent calculation. Having said that it is required for a transparent calculation to compare the following types:

- Draw bar combination (Motor vehicle with 2-axle trailer)
- Semi-trailer combination (tractor with semi-trailer)
- EUROCOMBI (Motor vehicle and semi-trailer) with a dolly axle

The dolly axle is the only additional technical equipment used in this comparison, as the standard equipment of the tractor units is steadily improving.

6.2.2 Route

According to the different experiences mentioned in chapter 4 in Germany, it is clear that there is no significant trend for the usage of the EUROCOMBI in regard of different lanes and distances. Nevertheless, the economies of scale in respect of the costs per driven kilometer have of course an impact on the length of the chosen route. As mentioned in the introduction, the Austrian Automotive Industry is centralized in three areas with a high local dependency and complete different structure. Adding the fact, that according to the new EU legislation the usage of the EUROCOMBI is limited to a single country, a short distance run will be the most suitable one to examine the effects of the EUROCOMBI on the logistics costs of the Austrian Automotive Industry.

This example is based on the assumption that MAGNA PRESSTECH in 8160 Weiz is delivering daily to the MAGNA STEYR plant in 8042 Graz. The distance is some 30 km one way and delivery takes place several times daily to ensure the shift production in Graz with pressed chassis. This route is most likely to be tested, as

[63] SCHRAMM, 2014, 3

the main run is taken on motorways only (70 %) with the plants being located proximately to the motorway. Due to the dense traffic and the speed limit on the federal street, an average speed of 50 km/h is assumed and is realistic for this distance.

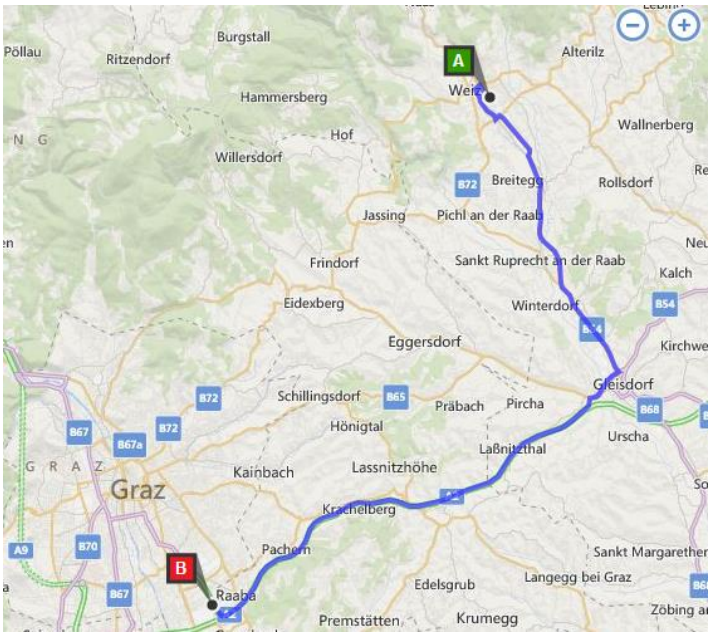


Fig. 5: preferred route Weiz - Graz

6.2.4 Cost Assumptions

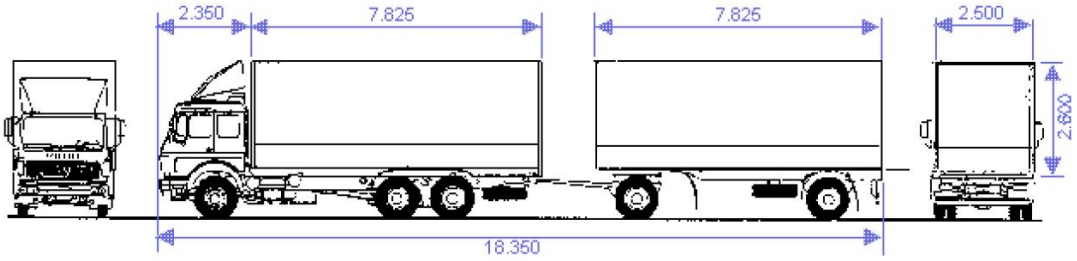
To have a fair comparison, a ACTROS 1855 E5 was chosen, which is a widespread model in Austria and is frequently used as a motor vehicle and as a tractor semitrailer combination as well. Furthermore, ACTROS models are already in use in Germany to run several field tests. The net acquisition costs including a set of 10 tires (each tire costs 320 EUR) are considered with approximately 135.000 EUR for a motor vehicle and 115.000 for the tractor unit itself. This EURO V vehicle is calculated with a 5 year – 250 working days per year – service and a residual value of EUR 5.000. The repair costs are assumed with an average of 5.000 EUR per year. The 2-axles semi-trailer is considered with a purchasing rate of 18.000 EUR and duration of 14 years in service whereas the Semi-trailer costs 28.000 EUR with a life time of also 14 years and a residual value of 5.000 EUR. Both are estimated with 3.000 EUR of repair costs each year, and the replacement for a tire with 320 EUR per device. The costs of a new two axle dolly with eight tires amounts to 25.000 EUR and a duration for writing off of 14 years.

Fuel costs are 1.334 EUR per litre according to the official diesel price monitor released by the Federal Ministry of Science, Research and Economy in March 2014, minus a standard 6% discount by local fuel supplier. The snow chains needed for both vehicle combinations are compulsory in Austria and account for 2.000 EUR total investments, which can be written off over a period of five years with annual maintenance costs of 300 EUR.

6.2.5 Technical Specifications

6.2.5.1 Draw Bar Combination (Motor vehicle with 2-axle trailer)

This combination is frequently used and with following characteristics:
Dimensions as described in the sketch, in total a length of 18.350 m, width of 2.50 m and a loading height of 2.60 m.



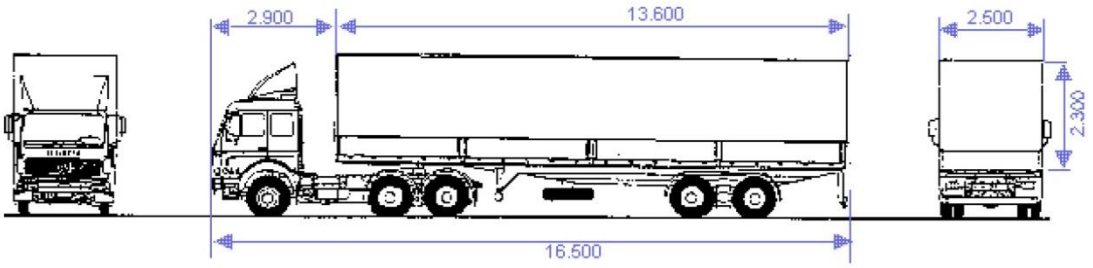
		Motor Vehicle (Actros 1855 E5)	Trailer
Total vehicle weight		20,500 kg	30,500 kg
Tare weight(fueled up with driver)		8,250 kg	6,250 kg
Net loading capacity		12,250 kg	24,250 kg
Number of axles		3 axles (6x4)	2 axles
Number of tires needed		10	4
Running distance tires		80,000 km	80,000 km
Fuel consumption of the vehicle		33 l /100 km	0
Lubricant costs		8% of fuel costs	

Tab. 5: Technical specifications of a Draw Bar combination

6.2.5.2 Semi-trailer Combination (tractor with semi-trailer)

This frequently used truck is the standard equipment used in the automotive industry in Austria. Its total length is 16.5 m, with a loading of 13.6 m length and a height of

2.60 m inside. The main advantage is the easy swap of the trailers needed for shuttle services and the possible mix of tractor and trailer units.

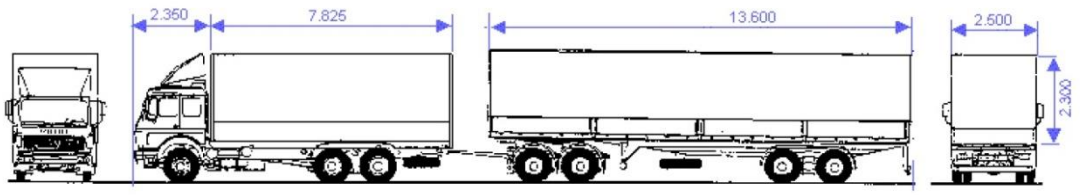


		Tractor (Actros 1855 E5)	Semi-trailer
Total vehicle weight		17,400 kg	30,500 kg
Tare weight(fueled up with driver)		7,400 kg	6,250 kg
Net loading capacity		0	24,250 kg
Number of axles		3 axles (6x4)	2 axles
Number of tires needed		10	4
Running distance tires		80,000 km	80,000 km
Fuel consumption of the vehicle		35 l/100 km	0
Lubricant costs		8% of fuel costs	

Tab. 6: Technical specifications of a Semi Trailer combination

6.2.5.3 EUROCOMBI with a Dolly Axle

According to the experience in Germany, this is the most frequently used EUROCOMBI now. It consists of a combination of the above-mentioned trucks. The link is a dolly axle, which is frequently used already in the Netherlands and is covering all security restrictions. The length itself with a total of 25.25 is exceptionally as well as the increased fuel consumption for the tractor unit.



		Motor Vehicle (Actros 1855 E5)	Semi-trailer
Total vehicle weight		20,500 kg	30,500 kg
Tare weight(fueled up with driver)		8,250 kg	6,250 kg
Net loading capacity		12,250 kg	24,250 kg
Number of axles		3 axles (6x4)	2 axles
Number of tires needed		10	4
Running distance tires		80,000 km	80,000 km
Fuel consumption of the vehicle		38 l / 100 km	
Lubricant costs		8% of fuel costs	

Tab. 7: Technical specifications of a EUROCOMBI combination

6.2.6 Loading Units and Handling

To restrict the cargo and to increase the complexity of the calculation, average load and loading/unloading time have to be considered as well. This represents of course the reality but to focus on the costs the results can be mentioned only, as the restrictions are the same for all type of trucks. Furthermore, processes to optimize the loading and unloading according to the used truck type cannot be taken into consideration, as these actions have to be taken by the shipper or the receiver. The same reflections are valid for the possibility of usage of swap trailers.

The cargo is described as following:

"*The cargo transported between these two plants consists of standardized, non-collapsible loading equipment (SLE) with dimensions of 1,200 x 1,000 x 1,000 mm each and an average gross weight of 400 kg. During transport, two SLEs are stacked on top of each other. Due to an existing out-sourcing contract between the […] freight forwarding company and the metal-working industrial manufacturer, not less than 200 SLEs have to be transported each day MO to FR from 6 am to 3 pm with a total of 250 working days p.a. In doing so, the same number of full or empty SLEs has to be loaded after each unloading of full (or empty) SLEs. The local warehouse staff carry out the loading and unloading operations. With the help of a forklift, 120 units (or 240 SLEs with two SLEs stacked on top of each other) can be loaded or unloaded per hour."*

6.2.7 Salaries and Administrative Costs

For salaries, the Austrian legislation provides a minimum payment for each job category with the “Kollektivvertag”, which makes the assumption regarding payments easy. The total costs per Truck driver with the given restrictions is 38.501 EUR per year. These costs include special payments as well as employer contribution and possible replacements in case of holidays or sick notes.

The example based on a calculation with a middle-sized forwarding company seems realistic based on the observations of involved companies off the EUROCOMBI field test in Germany. With a fleet of 20 trucks, the company is flexible enough to cover the needs of a typical Tier 1 supplier to supply for the local demand. According to the experience and stated of Michael Brandl, local forwarding companies offer big advantages for local traffic in the automotive industry because of their flexibility compared with huge international haulers. In addition, the drivers are more skilled and know the local lanes perfectly, which is also a plus for the possibility of the usage of the EUROCOMBI.

Regarding the overhead costs, the cost structure of a small or middle-sized forwarding company bears more flexibility but has to cover all costs for services by themselves. Assuming that one dispatcher is able to handle 20 trucks, the annual costs for these amounts to 2,575 EUR per truck. To cover all other expenses and to gain a profit for a sustainable growth of the company an average margin of 12 % is given and realistic on the market.

6.2.8 Calculation

Based on the above-mentioned assumptions, an estimated inflation of 2% and a yearly 60,000 kilometers for the draw bar and the semi-trailer and a 45,000 km driving, the calculation can be observed in detail on the following pages:

			Motor Vehicle				
Vehicle Provision Costs						60.000 km/year are	240 km/day
Depreciation by Time		30%				240 km/day are	60.000 km/year
	Acquisition costs	EUR	135.000,00				
	Vehicle being in service	Years	5				
	Residual value	EUR	5.000,00	**7.800,00**			
Maintenance							
	Maintenance Costs (year before)	EUR	5.000,00	**5.100,00**			
Imputed Interest							
	Acquisition costs	EUR	135.000,00				
	Interest rate p.a.		6%	**8.100,00**			
Insurance							
	Third Party Insurance						
	monthly payment	EUR	400,00				
	Comprehensive Insurance						
	monthly payment	EUR	310,00	**8.520,00**			
Motor Vehicle Tax							
	Tax rate as per KFzStG	EUR/t	1,9	**223,20**			
Costs due to Snow Chains Directive a. p. BGBl. I 57/2006 idF BGBl. I 5/2008)							
	Original price snow chains	EUR/Rate	2.000,00				
	Service life	Years	5				
	Maintenance costs p.a.	EUR	300,00	**640,00**	**30.383,20**	121,53 /day	Vehicles provision costs
						19,6%	of total costs
Despatching Costs							
Transport Manager / Dispatcher							
	Annual costs for dispatcher						
	according to calc sheet	EUR	51.502,04				
	or imputed entrepreneurial profit	EUR					
	No. of vehicles dispatched		20	**2.575,10**	**2.575,10**	10,30 /day	Despatching costs
						1,7%	of total costs
Time-Related Costs							
Driver							
	Annual costs for driver						
	according to calc sheet	EUR	38.493,42				
	Multiplier for full staffing p.a.		1,2	**46.192,11**			
Time-Related Overhead Costs							
	Total direct costs	EUR	46.192,11				
	TC-Rate according to BAB		0%	**0,00**	**46.192,11**	184,77 /day	Time-related costs
						29,8%	pf total costs
Driving performance-related Costs							
Depreciation by Usage		70%					
	Acquisition costs	EUR	135.000,00				
	Time of writing off	Years	5				
	Residual value	EUR	5.000,00	**18.200,00**			
Tires							
	Tires replacement after	km	80.000				
	Price of tires	EUR/Piece	320,00				
	Number of required tires	Piece	10	**2.400,00**			
Fuel Costs							
	Cost price (gross)	EUR/l	1,254			1,334 EUR/l	Last update 03.03.2014
	Cost price (net)	EUR/l	1,045				
	Fuel consumption	l/100 km	33,0	**20.690,34**			
Engine Oil							
	Cost price	EUR/l					
	Oil consumption	l/1.000 km		**1.655,23**			
Other operating supply items							
	Cost/Rate according to BAB	EUR/km		**0,00**			
Driving performance-related overhead costs							
	Total direct costs	EUR	42.945,57				
	TC-Rate according to BAB		0%	**0,00**	**42.945,57**	0,72 /km	Driving performance-rlated co
						27,7%	of total costs
Road Charges							
	Km on tolled roads / motorways	km	42.000				
	Rate of road charge	EUR/km	0,3885	**16.317,00**	**16.317,00**	0,39 /km	Road Charges
						10,5%	of total costs
General Overhead Costs´							
Employees, Material and other Expenses as far as not calculated elsewhere)							
	Total direct costs	EUR	138.412,97				
	TC additional rate according to BAB		12%	**16.609,56**	**16.609,56**	26,79 /day	General Overhead Costs
						4,3%	of total costs
Total Annual Costs (net)				**EUR**	**155.022,53**		

Daily Rate	**620,09 / d**
Hourly rate	**77,51 / h**
Kilometer rate	**2,58 / km**

Tab. 9: Cost calculation Motor Vehicle based on WU calculation model

			Trailer				
Vehicle Provision Costs						60.000 km/year are	240 km/day
Depreciation by Time		50%				240 km/day are	60.000 km/year
	Acquisition costs	EUR	18.000,00				
	Vehicle being in service	Years	14				
	Residual value	EUR	5.000,00	**464,29**			
Maintenance							
	Maintenance Costs (year before)	EUR	3.000,00	**3.060,00**			
Imputed Interest							
	Acquisition costs	EUR	18.000,00				
	Interest rate p.a.		6%	**1.080,00**			
Insurance							
	Third Party Insurance						
	monthly payment	EUR	20,00				
	Comprehensive Insurance						
	monthly payment	EUR	20,00	**480,00**			
Motor Vehicle Tax							
	Tax rate as per KFzStG	EUR/t	1,7	**357,00**			
Costs due to Snow Chains Directive a. p. BGBl. I 57/2006 idF BGBl. I 5/2008)							
	Original price snow chains	EUR/Rate	0,00				
	Service life	Years	4				
	Maintenance costs p.a.	EUR	0,00	**0,00**	**5.441,29**	21,77 /day	Vehicles provision costs
						69,8%	of total costs
Despatching Costs							
Transport Manager / Dispatcher							
	Annual costs for dispatcher						
	according to calc sheet	EUR	51.502,04				
	or imputed entrepreneurial profit	EUR					
	No. of vehicles dispatched		20	**0,00**	**0,00**	0,00 /day	Despatching costs
						0,0%	of total costs
Time-Related Costs							
Driver							
	Annual costs for driver						
	according to calc sheet	EUR	38.493,42				
	Multiplier for full staffing p.a.		1,2	**0,00**			
Time-Related Overhead Costs							
	Total direct costs	EUR	0,00				
	TC-Rate according to BAB		0%	**0,00**	**0,00**	0,00 /day	Time-related costs
						0,0%	pf total costs
Driving performance-related Costs							
Depreciation by Usage		50%					
	Acquisition costs	EUR	18.000,00				
	Time of writing off	Years	14				
	Residual value	EUR	5.000,00	**464,29**			
Tires							
	Tires replacement after	km	80.000				
	Price of tires	EUR/Piece	350,00				
	Number of required tires	Piece	4	**1.050,00**			
Fuel Costs							
	Cost price (gross)	EUR/l	0,000			1,424 EUR/l	Last update 05.03.2012
	Cost price (net)	EUR/l	0,000				
	Fuel consumption	l/100 km	0,0	**0,00**			
Engine Oil							
	Cost price	EUR/l	0,00				
	Oil consumption	l/1.000 km	0,0	**0,00**			
Other operating supply items							
	Cost/Rate according to BAB	EUR/km	0	**0,00**			
Driving performance-related overhead costs							
	Total direct costs	EUR	1.514,29				
	TC-Rate according to BAB		0%	**0,00**	**1.514,29**	0,03 /km	Driving performance-rlated cos
						19,4%	of total costs
Road Charges							
	Km on tolled roads / motorways	km	42.000				
	Rate of road charge	EUR/km	0,0000	**0,00**	**0,00**	0,00 /km	Road Charges
						0,0%	of total costs
General Overhead Costs´							
Employees, Material and other Expenses as far as not calculated elsewhere)							
	Total direct costs	EUR	6.955,57				
	TC additional rate according to BAB		12%	**834,67**	**834,67**	26,79 /day	General Overhead Costs
						86,0%	of total costs
Total Annual Costs (net)				**EUR**	**7.790,24**		

Daily Rate	**31,16 / d**
Hourly rate	**3,90 / h**
Kilometer rate	**0,13 / km**

Tab. 10: Cost calculation Trailer based on WU calculation model

			Tractor				
Vehicle Provision Costs					60.000 km/year are	240 km/day	
Depreciation by Time	50%				240 km/day are	60.000 km/year	
Acquisition costs	EUR	115.000,00					
Vehicle being in service	Years	5					
Residual value	EUR	5.000,00	**11.000,00**				
Maintenance							
Maintenance Costs (year before)	EUR	5.000,00	**5.100,00**				
Imputed Interest							
Acquisition costs	EUR	115.000,00					
Interest rate p.a.		6%	**6.900,00**				
Insurance							
Third Party Insurance							
monthly payment	EUR	400,00					
Comprehensive Insurance							
monthly payment	EUR	310,00	**8.520,00**				
Motor Vehicle Tax							
Tax rate as per KFzStG	EUR/t	1,7	**410,40**				
Costs due to Snow Chains Directive a. p. BGBl. I 57/2006 idF BGBl. I 5/2008)							
Original price snow chains	EUR/Rate	2.000,00					
Service life	Years	5					
Maintenance costs p.a.	EUR	300,00	**640,00**	**32.570,40**	130,28 /day	Vehicles provision costs	
						21,6% of total costs	
Despatching Costs							
Transport Manager / Dispatcher							
Annual costs for dispatcher							
according to calc sheet	EUR	51.502,04					
or imputed entrepreneurial profit	EUR						
No. of vehicles dispatched		20	**2.575,10**	**2.575,10**	10,30 /day	Despatching costs	
						1,7% of total costs	
Time-Related Costs							
Driver							
Annual costs for driver							
according to calc sheet	EUR	38.493,42					
Multiplier for full staffing p.a.		1,2	**46.192,11**				
Time-Related Overhead Costs							
Total direct costs	EUR	46.192,11					
TC-Rate according to BAB		0%	**0,00**	**46.192,11**	184,77 /day	Time-related costs	
						30,6% pf total costs	
Driving performance-related Costs							
Depreciation by Usage	50%						
Acquisition costs	EUR	115.000,00					
Time of writing off	Years	5					
Residual value	EUR	5.000,00	**11.000,00**				
Tires							
Tires replacement after	km	80.000					
Price of tires	EUR/Piece	320,00					
Number of required tires	Piece	10	**2.400,00**				
Fuel Costs							
Cost price (gross)	EUR/l	1,254			1,334 EUR/l	Last update 03.03.2014	
Cost price (net)	EUR/l	1,045					
Fuel consumption	l/100 km	35,0	**21.944,30**				
Engine Oil							
Cost price	EUR/l						
Oil consumption	l/1.000 km		**1.755,54**				
Other operating supply items							
Cost/Rate according to BAB	EUR/km		**0,00**				
Driving performance-related overhead costs							
Total direct costs	EUR	37.099,84					
TC-Rate according to BAB		0%	**0,00**	**37.099,84**	0,62 /km	Driving performance-rlated co	
						24,6% of total costs	
Road Charges							
Km on tolled roads / motorways	km	42.000					
Rate of road charge	EUR/km	0,3885	**16.317,00**	**16.317,00**	0,39 /km	Road Charges	
						10,8% of total costs	
General Overhead Costs´							
Employees, Material and other Expenses as far as not calculated elsewhere)							
Total direct costs	EUR	134.754,45					
TC additional rate according to BAB		12%	**16.170,53**	**16.170,53**	26,79 /day	General Overhead Costs	
						4,4% of total costs	
Total Annual Costs (net)				**EUR**	**150.924,99**		

Daily Rate	**603,70 / d**
Hourly rate	**75,46 / h**
Kilometer rate	**2,52 / km**

Tab. 11: Cost calculation Tractor based on WU calculation model

			Semi-Trailer				
Vehicle Provision Costs						60.000 km/year are	240 km/day
Depreciation by Time		50%				240 km/day are	60.000 km/year
	Acquisition costs	EUR	28.000,00				
	Vehicle being in service	Years	14				
	Residual value	EUR	5.000,00	**821,43**			
Maintenance							
	Maintenance Costs (year before)	EUR	3.000,00	**3.060,00**			
Imputed Interest							
	Acquisition costs	EUR	28.000,00				
	Interest rate p.a.		6%	**1.680,00**			
Insurance							
	Third Party Insurance						
	monthly payment	EUR	20,00				
	Comprehensive Insurance						
	monthly payment	EUR	20,00	**480,00**			
Motor Vehicle Tax							
	Tax rate as per KFzStG	EUR/t	1,9	**467,40**			
Costs due to Snow Chains Directive a. p. BGBl. I 57/2006 idF BGBl. I 5/2008)							
	Original price snow chains	EUR/Rate	0,00				
	Service life	Years	4				
	Maintenance costs p.a.	EUR	0,00	**0,00**	**6.508,83**	26,04 /day	Vehicles provision costs
						69,3%	of total costs
Despatching Costs							
Transport Manager / Dispatcher							
	Annual costs for dispatcher						
	according to calc sheet	EUR	51.502,04				
	or imputed entrepreneurial profit	EUR					
	No. of vehicles dispatched		20	**0,00**	**0,00**	0,00 /day	Despatching costs
						0,0%	of total costs
Time-Related Costs							
Driver							
	Annual costs for driver						
	according to calc sheet	EUR	38.493,42				
	Multiplier for full staffing p.a.		1,2	**0,00**			
Time-Related Overhead Costs							
	Total direct costs	EUR	0,00				
	TC-Rate according to BAB		0%	**0,00**	**0,00**	0,00 /day	Time-related costs
						0,0%	pf total costs
Driving performance-related Costs							
Depreciation by Usage		50%					
	Acquisition costs	EUR	28.000,00				
	Time of writing off	Years	14				
	Residual value	EUR	5.000,00	**821,43**			
Tires							
	Tires replacement after	km	80.000				
	Price of tires	EUR/Piece	350,00				
	Number of required tires	Piece	4	**1.050,00**			
Fuel Costs							
	Cost price (gross)	EUR/l	0,000			1,424 EUR/l	Last update 05.03.2012
	Cost price (net)	EUR/l	0,000				
	Fuel consumption	l/100 km	0,0	**0,00**			
Engine Oil							
	Cost price	EUR/l	0,00				
	Oil consumption	l/1.000 km	0,0	**0,00**			
Other operating supply items							
	Cost/Rate according to BAB	EUR/km	0	**0,00**			
Driving performance-related overhead costs							
	Total direct costs	EUR	1.871,43				
	TC-Rate according to BAB		0%	**0,00**	**1.871,43**	0,03 /km	Driving performance-rlated cos
						19,9%	of total costs
Road Charges							
	Km on tolled roads / motorways	km	42.000				
	Rate of road charge	EUR/km	0,0000	**0,00**	**0,00**	0,00 /km	Road Charges
						0,0%	of total costs
General Overhead Costs´							
Employees, Material and other Expenses as far as not calculated elsewhere)							
	Total direct costs	EUR	8.380,26				
	TC additional rate according to BAB		12%	**1.005,63**	**1.005,63**	26,79 /day	General Overhead Costs
						71,3%	of total costs
Total Annual Costs (net)				**EUR**	**9.385,89**		

Daily Rate	**37,54 / d**
Hourly rate	**4,69 / h**
Kilometer rate	**0,16 / km**

Tab. 12: Cost calculation semi-trailer based on WU calculation model

Motor Vehicle EUROCOMBI

Vehicle Provision Costs						45.000	km/year are	180 km/day
Depreciation by Time		50%				180	km/day are	45.000 km/year
	Acquisition costs	EUR	135.000,00					
	Vehicle being in service	Years	5					
	Residual value	EUR	5.000,00	**13.000,00**				
Maintenance								
	Maintenance Costs (year before)	EUR	5.000,00	**5.100,00**				
Imputed Interest								
	Acquisition costs	EUR	135.000,00					
	Interest rate p.a.		6%	**8.100,00**				
Insurance								
	Third Party Insurance							
	monthly payment	EUR	430,00					
	Comprehensive Insurance							
	monthly payment	EUR	480,00	**10.920,00**				
Motor Vehicle Tax								
	Tax rate as per KFzStG	EUR/t	1,9	**223,20**				
Costs due to Snow Chains Directive a. p. BGBl. I 57/2006 idF BGBl. I 5/2008)								
	Original price snow chains	EUR/Rate	2.000,00					
	Service life	Years	5					
	Maintenance costs p.a.	EUR	300,00	**640,00**	**37.983,20**	151,93	/day	Vehicles provision costs
								25,5% of total costs
Despatching Costs								
Transport Manager / Dispatcher								
	Annual costs for dispatcher							
	according to calc sheet	EUR	51.502,04					
	or imputed entrepreneurial profit	EUR						
	No. of vehicles dispatched		20	**2.575,10**	**2.575,10**	10,30	/day	Despatching costs
								1,7% of total costs
Time-Related Costs								
Driver								
	Annual costs for driver							
	according to calc sheet	EUR	38.493,42					
	Multiplier for full staffing p.a.		1,2	**46.192,11**				
Time-Related Overhead Costs								
	Total direct costs	EUR	46.192,11					
	TC-Rate according to BAB		0%	**0,00**	**46.192,11**	184,77	/day	Time-related costs
								31,0% pf total costs
Driving performance-related Costs								
Depreciation by Usage		50%						
	Acquisition costs	EUR	135.000,00					
	Time of writing off	Years	5					
	Residual value	EUR	5.000,00	**13.000,00**				
Tires								
	Tires replacement after	km	80.000					
	Price of tires	EUR/Piece	320,00					
	Number of required tires	Piece	10	**1.800,00**				
Fuel Costs								
	Cost price (gross)	EUR/l	1,254			1,334	EUR/l	Last update 03.03.2014
	Cost price (net)	EUR/l	1,045					
	Fuel consumption	l/100 km	38,0	**17.868,93**				
Engine Oil								
	Cost price	EUR/l						
	Oil consumption	l/1.000 km		**1.429,51**				
Other operating supply items								
	Cost/Rate according to BAB	EUR/km		**0,00**				
Driving performance-related overhead costs								
	Total direct costs	EUR	34.098,44					
	TC-Rate according to BAB		0%	**0,00**	**34.098,44**	0,76	/km	Driving performance-rlated cos
								22,9% of total costs
Road Charges								
	Km on tolled roads / motorways	km	31.500					
	Rate of road charge	EUR/km	0,3885	**12.237,75**	**12.237,75**	0,39	/km	Road Charges
								8,2% of total costs
General Overhead Costs´								
Employees, Material and other Expenses as far as not calculated elsewhere)								
	Total direct costs	EUR	133.086,60					
	TC additional rate according to BAB		12%	**15.970,39**	**15.970,39**	26,79	/day	General Overhead Costs
								4,5% of total costs
Total Annual Costs (net)				**EUR**	**149.056,99**			

Daily Rate	**596,23 / d**
Hourly rate	**74,53 / h**
Kilometer rate	**3,31 / km**

Tab. 13: Cost calculation Motor Vehicle EUROCOMBI based on WU calculation model

			Semi-Trailer EUROCOMBI				
Vehicle Provision Costs						45.000 km/year are	180 km/day
Depreciation by Time		50%				180 km/day are	45.000 km/year
	Acquisition costs	EUR	53.000,00	Semi-trailer and Dolly			
	Vehicle being in service	Years	14				
	Residual value	EUR	5.000,00	**1.714,29**			
Maintenance							
	Maintenance Costs (year before)	EUR	3.000,00	**3.060,00**			
Imputed Interest							
	Acquisition costs	EUR	53.000,00				
	Interest rate p.a.		6%	**3.180,00**			
Insurance							
	Third Party Insurance						
	monthly payment	EUR	20,00				
	Comprehensive Insurance						
	monthly payment	EUR	20,00	**480,00**			
Motor Vehicle Tax							
	Tax rate as per KFzStG	EUR/t	1,9	**367,20**			
Costs due to Snow Chains Directive a. p. BGBl. I 57/2006 idF BGBl. I 5/2008)							
	Original price snow chains	EUR/Rate	0,00				
	Service life	Years	4				
	Maintenance costs p.a.	EUR	0,00	**0,00**	**8.801,49**	35,21 /day	Vehicles provision costs
						61,0%	of total costs
Despatching Costs							
Transport Manager / Dispatcher							
	Annual costs for dispatcher						
	according to calc sheet	EUR	51.502,04				
	or imputed entrepreneurial profit	EUR					
	No. of vehicles dispatched		20	**0,00**	**0,00**	0,00 /day	Despatching costs
						0,0%	of total costs
Time-Related Costs							
Driver							
	Annual costs for driver						
	according to calc sheet	EUR	38.493,42				
	Multiplier for full staffing p.a.		1,2	**0,00**			
Time-Related Overhead Costs							
	Total direct costs	EUR	0,00				
	TC-Rate according to BAB		0%	**0,00**	**0,00**	0,00 /day	Time-related costs
						0,0%	pf total costs
Driving performance-related Costs							
Depreciation by Usage		50%					
	Acquisition costs	EUR	53.000,00				
	Time of writing off	Years	14				
	Residual value	EUR	5.000,00	**1.714,29**			
Tires							
	Tires replacement after	km	80.000				
	Price of tires	EUR/Piece	350,00				
	Number of required tires	Piece	12	**2.362,50**			
Fuel Costs							
	Cost price (gross)	EUR/l	0,000			1,424 EUR/l	Last update 05.03.2012
	Cost price (net)	EUR/l	0,000				
	Fuel consumption	l/100 km	0,0	**0,00**			
Engine Oil							
	Cost price	EUR/l	0,00				
	Oil consumption	l/1.000 km	0,0	**0,00**			
Other operating supply items							
	Cost/Rate according to BAB	EUR/km	0	**0,00**			
Driving performance-related overhead costs							
	Total direct costs	EUR	4.076,79				
	TC-Rate according to BAB		0%	**0,00**	**4.076,79**	0,09 /km	Driving performance-rlated cos
						28,3%	of total costs
Road Charges							
	Km on tolled roads / motorways	km	31.500				
	Rate of road charge	EUR/km	0,0000	**0,00**	**0,00**	0,00 /km	Road Charges
						0,0%	of total costs
General Overhead Costs´							
Employees, Material and other Expenses as far as not calculated elsewhere)							
	Total direct costs	EUR	12.878,27				
	TC additional rate according to BAB		12%	**1.545,39**	**1.545,39**	26,79 /day	General Overhead Costs
						46,4%	of total costs
Total Annual Costs (net)				**EUR**	**14.423,66**		

Daily Rate	**57,69 / d**
Hourly rate	**7,21 / h**
Kilometer rate	**0,32 / km**

Tab. 14: Cost calculation semi-trailer EUROCOMBI based on WU calculation model

6.2.9 Results of the Standard Example

The results, based on the assumption that the trucks are only used to perform this single business, from the calculation are showing that indeed all of the three chosen units are able to run this business, as the demanded amount of units (200) can be transported.

	Drawbar	Semi-trailer	EuroCombi
Daily Rate	€ 651.25	€ 641.24	€ 653.92
Hourly rate	€ 81.41	€ 80.16	€ 81.74
Kilometer rate	€ 2.71	€ 2.67	€ 3.63
Transport performance	224.00	208.00	240.00
Costs per SLE	€ 2.91	€ 3.08	€ 2.72

Tab. 15: Results WU calculation model

The cost advantage of the EUROCOMBI is clearly visible in this example. The additional costs are easily compensated with the high capacity allowed. This example also shows that the cargo has to be available or needed to fill this capacity. If the OEM requires only a smaller amount of units per day – i.g. 200 – the Semi-Trailer would be sufficient and the less expensive solution. A EUROCOMBI per se is not the best solution for each lane, but the cost advantage compared with the other units allows using this type for high volume cargo and for a big demand.

6.3 Fuel Consumption

In the Automotive Industry in Austria, between 20 - 40 % are considered as the portion of fuel in the transport costs, according to the statement of Mr. Michael BRANDL, Overland Manager at GEFCO Austria given 25.06.2014. As mentioned in chapter 4.3 the main savings of the implementation of the EUROCOMBI are the saving in fuel costs, reported the interviewed people. The calculation model of the WU Wien is also suitable for calculating the development of the fuel costs and allows comparing the effects on the price per km for the different truck types. The fuel consumption of the tractor unit of a EUROCOMBI is estimated with 38 liter per km, whereas the consumption of the regular tractor-trailer unit is calculated with 35 liter per km and the motor vehicle with the smallest capacity only an average consumption of 33 liter. The fuel price is transferred from the calculation example

and the capacity is rounded to average cubic meters to have an easy visibility of the relation

	Drawbar	Semi-trailer	EuroCombi
Capacity in cbm	100	80	120
Fuel costs per km	€ 0.3449	€ 0.3658	€ 0.3971
Fuel costs per cbm/km	€ 0.0034	€ 0.0046	€ 0.0033

Tab. 16: Results fuel costs WU calculation model

Even though the EUROCOMBI has a 15 % higher consumption than the draw bar combination, the surplus in the capacity equalizes this disadvantage and leads to a cost advantage per kilometer of 4 % in total. This seems not much, but with an average of 200.000 driven kilometers per year, when the trucks are also used in additional shifts for other businesses, this leads to a massive saving of costs for the owner of the truck.

Taking into account the calculation model of 200.000 km and a 97% percentage on tolled roads, to have a comparison with a high fuel consumption, the comparison between the Draw bar and the EUROCOMBI on a 40% fuel price range based on the starting level shows a slight reduction in the total costs per kilometer the lower the fuel price gets.

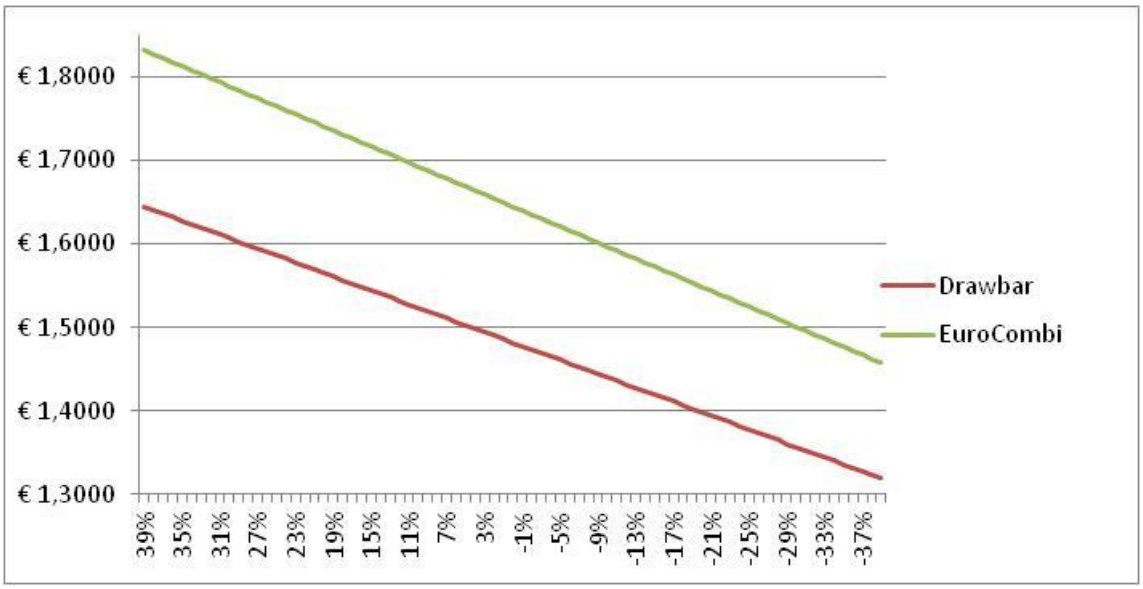


Fig. 6: Relationship fuel price development Draw Bar and EUROCOMBI

Starting with a price difference of 0.17 EURO per km advantage at the zero level, the difference is 0.19 EURO assuming a fuel increase by 40% and a difference of only 0.13 with a decrease by 40%. The fuel develops from a difference of 11.4 % at the highest assumed level to 10.48 % at the lowest level, starting with a 10.8 % difference at the calculated zero level. This leads to the result that even a high fluctuation of the fuel price does not lead to a dramatic change in the cost structure even if the EUROCOMBI has a bigger fuel consumption.

Interesting enough, that for example ANSORGE LOGISTIK, published their internal data to the public, which showed no significant increase in fuel consumption using an EURCOMBI.[64] This data and the announced savings of more than 20 % from other field test members, indicates that the fuel consumption may not be notable higher than a standard truck, especially carrying only 20 % more cargo. Again the loading weight of the cargo is decisive and for the Automotive Industry itself the capacity is the limit.

The main saving in fuel consumption is clearly done by replacing three standard truck routes with the usage of two EUROCOMBIs on the same track. Saving one third of the tractor units, automatically leads to a saving in fuel of at least 20 %, or taking the consumption of the example 23% for the draw bar combination and 27% for the trailer unit.
In an interim report of the German BaSt 2013, the asked participants of the field test stated a decrease of fuel consumption between 20% and 30% out of their experience with the EUROCOMBI[65].
A Swedish study from 2002 already showed a significant decrease of fuel consumption by transporting the same cargo with a EUROCOMBI than with motor vehicles or Semi-trailer combinations.

6.4 Handling Costs

Handling costs cover manipulation of the goods, meaning the loading and unloading of the cargo as well as the decupling of the used trailers. These factors can be measured with the time used for it and the relevance on the total transit times.

[64] ANSORGE, 04.2013, 16
[65] http://www.bga.de/fileadmin/freigabe/Downloads/Publikationen/Verkehr_Logistik/Zwischenbilanz_130722.pdf

It is understood that the longer the distance one drives, the less important this factor is. In the calculation example with an extremely short distance, the EUROCOMBI already has its advantages, bearing in mind that a semi-trailer combination is unbeatable, as it does not have to be manipulated. Coming back to the calculation model with the loading/unloading time:

	Drawbar	**Semi-trailer**	**EuroCombi**
Loading/Unloading time	28	26	40

Tab. 17: Results loading and unloading time WU calculation model

This means that the difference between the Semi-trailer and the Drawbar combination is less than 8 % whereas it takes 154% longer to load or unload the truck. Of course, a higher amount of units can be manipulated. Regarding this, it can be an advantage for companies with a large number of trucks to manipulate to organize the time schedule for their warehouse staff.

To understand the dependency of a shuttle service on the driving time, the driving time is assumed from 26 minutes up to a maximum of 210 minutes in the simulation. The base data of the original calculation is taken and the loading and unloading time remains the same. The Drawbar combination has space for 56 SLEs, the Semi-trailer combination for 52 whereas the EUROCOMBI can load 80 SLEs with one loading. The loading/unloading time also remains at 0.5 minutes per pile and the average speed remains at 50 km/h as well.
This simulation intends to show the connection of the driving time and its effects on the number of turns to produce a cost efficient shuttle service. As a result the EUROCMBI needs one turn less to transport the required SLEs with a driving time of 26, 36, 62 and 107 minutes. Whereas, the number of turns remain the same at the driving time of 27.5, 50, 95 and 200 minutes. The numbers indicated in the calculation are the numbers of transported SLEs.

	Driving time	Turn 1	Turn 2	Turn 3	Turn 4	Turn 5	Turns/day
Drawbar combination	26'					540	5
Semi-trailer combination	26'					520	5
EuroCombi	26'				528	⇔	4
Drawbar combination	27,5'				444		4
Semi-trailer combination	27,5'				428		4
EuroCombi	27,5'				540		4
Drawbar combination	36'				512		4
Semi-trailer combination	36'				496		4
EuroCombi	36'			456	⇔		3
Drawbar combination	50'			468			3
Semi-trailer combination	50'			456			3
EuroCombi	50'			540			3
Drawbar combination	62'			540			3
Semi-trailer combination	62'			528			3
EuroCombi	62'		408	⇔			2
Drawbar combination	95'		492				2
Semi-trailer combination	95'		484				2
EuroCombi	95'		540				2
Drawbar combination	107'		540				2
Semi-trailer combination	107'		532				2
EuroCombi	107'	294	⇔				1
Drawbar combination	200'	456					1
Semi-trailer combination	200'	452					1
EuroCombi	200'	480					1
Drawbar combination	210'	476					1
Semi-trailer combination	210'	472					1
EuroCombi	210'	500					1

Tab. 18: Simulation relationship driving time to transported SLEs

The simulation allows two conclusions: Firstly, the driving time itself does not have a direct impact on the choice of the truck without the consideration of the volumes loaded. Secondly, the EUROCOMBI does not always save costs to fulfill the optimized transport as it is still restricted by the maximal capacity and the availability of the goods to be transported.

Nevertheless, the EUROCOMBI spends more time at the ramp and can make less driving kilometers per day, 25 % in our example. To maximize the output, the usage of the EUROCOMBI has to use these times for other actions, such as driver changes and resting breaks. Interestingly, as described in Section 4.3.3.2 the forwarder ELFLEIN uses the time for decoupling and mounting from EUROCOMBI

to a standard combination to change the drivers. With this action, he can run 1,300 km per day with the EUROCOMBI, between his terminal in BAMBERG and a TIER 1 supplier of DAIMLER in Bautzen.
The Semi-trailer is the most time effective, flexible transport unit, but the draw bar combination and the EUROCOMBI can almost equalize this disadvantage with every additional kilometer.

6.5 Packaging Costs

As one of the first industries, the Automotive Industry identified the importance of the loading units for their supply chain. Therefore, most of the OEMs and their suppliers are using mainly standardized container for the transport. Their dimensions are optimized and very often part of an internal or external a pooling system. As the EUROCOMBI uses the same dimensions as already existing truck units do, there is no cost effect in regard of the packaging or loading units visible.

6.6 Acquisition and maintenance costs

In Section 6.2.4. the dolly axle is the only additional purchase which has to be taken. Considering the experience of the field test in Germany, the EUROCOMBI has to be equipped with additional items to provide safety on the streets.
A German newspaper of the trucking industry identified and named the costs and the additional equipment of the truck. In modern trucks most of these items are standard equipment, some of them only brands, and some have to be bought by the trucking company.
The costs are average costs evaluated by the “Verkehrsrundschau” in 2011.[66] The items, which are not standard equipment for every new unit:

- Difflock or traction control system: 800 EUR
- Disc brake and retarder: 5.000 - 8.000 EUR
- Electronic driving dynamics control system: 2,000 EUR
- Automatic distance control system: 2,500 – 3,000 EUR

[66] http://www.verkehrsrundschau.de/sixcms/media.php/4513/Fragen_Antworten_Lang_LKW_2011.pdf , 11.2011

The following items are not part of the standard equipment of a new truck and are obligatory for EUROCOMBIs in Germany:

- Automatic axle weight control system: 400 EUR per axle
- Lane departure warning system: 2,200 EUR
- Rear camera system: 1,000 - 1,500 EUR
- Official sign “Lang-LKW”: 20 EUR

In total, this leads to a minimum spending of 7,700 EUR and a maximum of 21,500 EUR for the additional equipment of a EURCOMBI. Adding an average value of 14,600 EUR to the acquisition costs, the costs per driven km increase by 0.07 EUR or by 2.6 %. Of course, these installments are also increasing the security and the reliability of the truck, which leads to a plus in costs compared with standard truck types.
Additional costs may occur, as by German law the driver of a EUROCOMBI has to have at least five years of driving experience and it is comprehensible that this driver has a higher income than an average driver does. This was not taken into account in the calculation model.
For maintenance costs, there is no comparable study available and the field test in Germany not long enough in place. Dutch studies are not mentioning any difference to the maintenance costs of standard equipment.

6.7 Summary and Conclusion

Summarizing the different cost models, the acquisition and handling costs are factors that are playing an important factor in the automotive industry and these costs are definitely higher implementing a EUROCOMBI on an existing route compared to a standard model like a draw bar combination or a semi-trailer. Nevertheless, these costs are not remarkably higher and even the investments which are causing the slight increase do make sense to reduce costs in a long view with the improved security and the upgraded monitoring of the transport units to prevent dispatching mistakes. Those OEMs with a truck production, such as DAIMLER, FIAT or FORD, can even benefit from higher sales equipping the new trucks with the needed technical equipment.

The saving in fuel is the main driver for the Automotive Industry and the forwarding companies to advocate the implementation of the EUROCOMBI. The cost argument is clearly on the EUROCOMBI side and even – like in the calculation example – feasible for a short route.

This should not lead to the impression that all trucks can be replaced by the EUROCOMBI. There are several lanes and routes, which can be served by other truck types and the additional costs, are visible.

Nevertheless, the EUROCOMBI can be placed for a number of traffics in the Automotive Industry and can help to reduce the costs also in Austria. The German field test – limited by the geographical restrictions – is giving no clear picture where the EUROCOMBI should be used so far, but it should not be difficult to identify the appropriate lanes where it is worth to run it. The chance of this type of truck is to find a niche for high dense cargo with a high frequency and well connected industrial places. All of this fits perfectly to the majority of the Automotive Industry, thinking of linking a Tier1 supplier with an OEM plant.

This thesis tries to investigate the chances for the EUROCOMBI on a local Austrian level to support the cost savings and the increase of competitiveness for the Austrian Automotive Industry, but is not considering that the globalization took already place. A solution for a single country, especially for an internationally networked industry such as the Automotive Industry, a local decision for the implementation would not be as effective as a European solution. Especially the results of the German field test have a direct influence on the Austrian decisions. As mentioned in the introduction, the Austrian Automotive Industry is heavily depending on the German manufactures. A possible implementation in Germany will put great pressure on the Austrian suppliers to stay competitive with their German competitors. Besides the security issues, the cost saving is the decisive topic regarding the implementation and its effect on the industry.

Closing with the words of Gerd POMBERGER from DAIMLER AG, “if I had found another solution to decrease the costs by 20%, I would have done a really bad job during the last years.”

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Figures

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