Final Report

A comparative study from a competition perspective of mileage-related accidents caused by technical failure in vehicles/rolling stock and resulting in personal injury

commissioned by the

UIP International Union of Wagon Keepers, Brussels
VPI Vereinigung der Privatgüterwagen-Interessenten, Hamburg

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1. Objectives and executive summary

In recent years the rail freight sector has witnessed the implementation of various measures to enhance the operational safety of freight cars. They include:

- implementation of technical provisions for wheelset (axle) maintenance based on the European Common Criteria for Maintenance (ECCM)
- implementation of a database to facilitate wheelset traceability (EWT)
- implementation of a European Visual Inspection Catalogue for wheelsets (EVIC).

Wagon keepers have been confronted with additional requirements from the regulatory sector in recent years. Article 14a of Safety Directive 2004/49 (amended by Directive 2008/110) provides that a certified Entity in Charge of Maintenance (ECM) must be allocated to every freight car.

Moreover, a decision was taken to create a Rolling Stock Reference Database to address the demands set out in the various maintenance regulations: wagon keepers are to use this database to provide railway undertakings with information about rolling stock, which also enables them to meet TAF-TSI requirements.

Apart from the above-mentioned measures designed to enhance the operational safety of freight cars, wagon keepers face the challenge of meeting the standards set out in the TSI Noise for new rolling stock and ensuring compliance with noise abatement targets. In some countries noise levels have been a topic of significant debate. In Switzerland, for example, it is likely that no freight wagon will be permitted to use cast-iron brake shoes from 2020 on; Germany envisages 2021 as the cut-off date. Consequently, wagon keepers may also need to convert their existing fleet to other brake blocks[1]in order to prepare for this development.

Taken as a whole, the above-mentioned measures to enhance freight wagon safety, combined with regulatory measures and noise abatement measures, could result in an increase of up to 60% in the cost of keeping wagons, depending on type of wagon, size of fleet and mileage.[2]

Wagon keepers have been monitoring the current situation in rail freight with some concern and believe that the modal shift targets associated with rail freight are at risk. The wagon keepers are well aware that rail freight traffic needs to be safe if it is to meet with the approval of shippers, the general public and the political community. It is, therefore, in the interests of all stakeholders in the rail freight sector to review and optimise the safety of rail operations on an ongoing basis. Freight cars have a significant role to play in this.

At the same time, no statistics are available to assess the impact of the measures already or still to be implemented on the safety levels of rail freight. Statistical data about rail and road traffic accidents are in principle available at EU level. So far, however, there has been no research as to how many accidents in rail and road freight are caused by technical failures in vehicles or rolling stock and how many fatalities and injuries are suffered as a consequence.

This study therefore examines the safety record of rail freight, comparing it with road freight in general and also considering the numbers of fatalities and injuries suffered as a result of technical failures in vehicles or rolling stock. Particular attention has been paid to the comparability of

[1] K-blocks or LL-blocks
[2] Cf. UIP International Union of Wagon Keepers, “Economic Impact of New Rules and Regulations”, Final Report, Brussels, 2011, p. 20.

information about the two modes. To this end, statistical calculations are placed in the context of loads and distance covered by the two traffic modes road and rail.

A comparison of the accident statistics for road and rail traffic demonstrates that existing safety levels for rail freight are substantially higher than they are for road freight. From 2006 to 2010, 3.236 persons died on average for every billion tonne-kilometres on the roads. For rail freight, this average was 0.075, 43 times less than for road freight.

Although no statistics are kept at EU level about how many road freight accidents are caused by technical failures in vehicles, existing studies and evaluations of national traffic accident statistics can certainly be used to derive findings about the proportion of all road freight traffic accidents that can be attributed to this factor. This proportion lies within a range between approx. 1% and 5% of all road freight accidents. For rail freight accidents, there is a database maintained by the European Railway Agency (ERA) which can be used to evaluate the causes of accidents in rail freight. On this basis, a precise figure can be obtained for the number of fatalities and injuries in rail freight traffic caused by technical failures in rolling stock.

The present study performs a comparison between the two modes of transport in terms of the number of persons killed as a result of accidents caused by technical failures in vehicles or rolling stock. For the years 2006 to 2010, the average value for rail freight, expressed in terms of tonne-kilometres, is 0.018. This means that in the EU 27[3] in the years 2006 to 2010, on average 0.018 persons per billion tonne-kilometres (tkm) died as a result of rail freight accidents that had been caused by technical failures in rolling stock. In other words, in the rail freight sector during this period, one person died as a result of a technical failure in rolling stock every 55.5 billion tkm. It is worth noting that during the period covered by this study – i.e. 2006 to 2010– there was only one fatal accident (Viareggio in 2009 with 32 fatalities). Otherwise the calculations would have produced an indicator of zero for rail freight.
By comparison, the figure for corresponding fatalities per billion tonne-kilometres in road freight for the period 2006 to 2010 lies between 0.032 (lower assumption of 1%) and 0.162 (upper assumption of 5%), making it approx. 2 to 9 times as high as for rail freight. Once again, we can express this indicator another way by saying that in road freight one person died as a result of a technical failure in vehicles every 6.2 billion tkm to 31.2 billion tkm.

These indicators show that safety levels in rail freight, measured in terms of accidents caused by a technical failure in rolling stock, are currently very high. The fact that rail freight performs favourably compared with road freight should by no means serve to justify abandoning efforts designed to achieve continual improvements in the safety levels for rail freight. Rail accidents caused by technical failures in rolling stock should be ruled out as far as possible. A question does arise; however, as to how much technical, organisational and financial effort can and should be invested in further improving the already very high level of safety. The higher the cost of additional measures to enhance safety, the more pressing it becomes to answer this question.

To illustrate this, the present study describes the impact of rising freight car costs on the total costs of rail freight operation for the transport corridor from Rotterdam to Genoa. Even a 10% rise in freight car costs increases the total costs of rail freight transport along this corridor by a range of 1.9% to 2.6%, depending on the nature of the goods to be transported and on the type of wagon

[3] EU 27 excluding Bulgaria, Cyprus, Latvia and Malta.

deployed. If freight car costs rise by, for example, 20%, the overall costs accordingly increase by 3.8% to 5.3%. As price competition between trucks and trains is extremely intense and the profit margins for hauliers tend to be in lower single-digit figures, even a slight change on the overall cost position can contribute to a significant deterioration in the competitive position of rail as a mode of transport.

It is ultimately obvious that imposing a unilateral cost burden on one mode of transport without generating significant benefit (e.g. by enhancing the safety level) will harm the competitive position of that mode of transport. In the case of rail freight, this would mean more freight traffic shifting to the roads. This shift would be envisaged regardless of the fact that trucks are currently the mode of transport with the lower safety levels, both in general terms and with regard to the accident rate associated with the factor “technical failure in vehicles”. It can be assumed that with each additional measure the marginal utility to be gained by improving safety levels in rail freight will diminish. Further measures that drive costs upwards are likely to result in a relatively limited impact on what is already a very high safety level, and yet at the same time would considerably damage the competitive position of rail freight.

2. Introduction

Rail freight in Europe has been growing at a below-average rate in recent years. Altogether the share of traffic accounted for by rail in the countries making up the EU 27fell from 19.7% in the year 2000 to17.1% in 2010.[4] Until 2008 output (tkm) was at least increasing slowly, but since the pronounced dip in 2009 it has not yet returned to pre-crisis levels. At the same time, the general public and the political community have high expectations of rail. The EU's White Paper, for example, formulates the aim of shifting 30% of road traffic on distances over 300 km to rail, and 50% by 2050.[5]

These ambitious aims, however, come parallel with deteriorating framework conditions, and one consequence of this is that the potential offered by rail freight and freight car capacity are being insufficiently tapped. Even at current traffic levels, bottlenecks can be observed in the infrastructure along key corridors and at network nodes. If transportation by rail is to increase at all, the infrastructure will need to offer appropriate framework conditions.

In addition to this, the ability of rail to compete with road haulage has deteriorated in the last two to three years. Alongside general increases in the costs of energy, human resources and track use, railway operators are also confronting additional cost burdens in the wake of enhanced safety requirements, regulatory measures and noise abatement policies. According to a study published by the International Union of Wagon Keepers (UIP) in November 2011, the running costs for the factor freight cars have increased steeply following the introduction of new regulations.[6]It is to be assumed that implementation of the European Rail Traffic Management System (ERTMS) will generate further cost increases for railway operators. Furthermore, approval procedures for traction vehicles has still not been standardised across Europe, and this drives up costs further for rail companies. The Association of German Transport Companies (VDV) expects the costs of rail freight in Germany to increase by approx. 27% in the period until 2015 and predicts that the ability of rail to compete with other transport modes will decline as a result.[7]

Wagon keepers have been monitoring the current situation in rail freight with some concern and conclude that the modal shift targets associated with rail freight are at risk. Wagon keepers are well aware that rail freight traffic needs to be safe if it is to meet with the approval of shippers, the general public and the political community. It is, therefore, in the interests of all stakeholders in the rail freight sector to review and optimise the safety of rail operations on an ongoing basis. Freight cars have a significant role to play in this. For this reason, a number of measures have been implemented in recent years to further optimise the already high standards of safety applied to the operation of freight cars, e.g.:

- implementation of technical provisions for wheelset (axle) maintenance based on the European Common Criteria for Maintenance (ECCM)
- implementation of a database to facilitate wheelset traceability (EWT)
- implementation of a European Visual Inspection Catalogue for wheelsets (EVIC).

[4] Cf. Eurostat, http://epp.eurostat.ec.europa.eu/portal/page/portal/transport/data/main_tables
[5] Cf. European Commission (2011): White Paper "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system", Brussels, 2011, p. 10.
[6] Cf. UIP International Union of Wagon Keepers, "Economic Impact of New Rules and Regulations", Final Report, Brussels, 2011.
[7] Cf. Verband Deutscher Verkehrsunternehmen VDV (2012), position paper "Der Schienengüterverkehr muss wettbewerbsfähig bleiben", Köln, 2012.

Wagon keepers have been confronted with additional requirements from the regulatory sector in recent years. Article 14a of Safety Directive 2004/49 (amended by Directive 2008/110) provides that a certified Entity in Charge of Maintenance (ECM) must be allocated to every freight car.

Moreover, a decision was taken to create a Rolling Stock Reference Database to address the requirements set out in the various maintenance regulations.

These measures have, as described in the above-mentioned UIP study[8], substantially increased the costs of keeping and operating freight cars.

At the same time, no statistics are available to assess the impact of the measures already or still to be implemented on safety standards in rail freight. Statistical data about rail and road traffic accidents are in principle available at EU level. However, these accident statistics often do not distinguish between passenger and freight traffic. Besides, there is little information about the incidence in road- and rail-based freight traffic of fatal accidents caused by technical failure in rolling stock or vehicles.

This study examines the safety record of rail freight, comparing it with road freight in general and examining in particular the number of fatalities and injuries suffered as a result of technical failure in vehicles or rolling stock. Particular attention is paid to the comparability of data for the two modes.

First of all, Chapter 3 presents and evaluates general accident statistics for freight traffic in road and rail. This is followed by a description and analysis of detailed information about accidents caused by technical failure in rolling stock (freight cars) or vehicles (trucks).

Chapter 4 juxtaposes the statistical indicators derived for accidents in general and accidents caused by technical failure in vehicles/rolling stock for the two modes rail and road.[9]A comparison between road- and rail-based freight is performed based on the number of fatalities per tonne-kilometre. Drawing on this comparison with road, observations are made about the safety levels met by rail freight operations in general and by the safe operation of freight cars in particular.

Chapter 5 describes the measures to enhance freight car safety which wagon keepers have already undertaken in recent years.

Rail freight cannot absorb any further cost burdens if these cost burdens are not to be offset by any significant advantage or benefit elsewhere. If this is not the case, the sector’s ability to compete with road-based freight may be at risk. This is illustrated in Chapter 6 by observing three freight operations (oil, steel and containers travelling from Rotterdam to Genoa). If the costs of wagon-keeping are driven up further, the current competition landscape will result in rail losing freight to road – and accordingly the safety levels of those freight operations will fall towards the level afforded by trucks.

Chapter 7 draws conclusions from the present study.

[8] Cf. UIP International Union of Wagon Keepers (2011), “Economic Impact of New Rules and Regulations”, Final Report, Brussels.

[9] Accidents in road freight include technical failure in the traction vehicle or trailer. Accidents in rail freight include technical failure in freight cars.

3. Accident statistics in road and rail transport

Information and statistics on traffic accidents are widely available at both national and international level. Traffic accident statistics can be obtained from the Statistical Office of the European Union (Eurostat)[10] and also from the national statistics offices[11] – for the most part in electronic form as well. There are in addition a great number of further studies and publications on wide-ranging aspects of traffic accidents from research institutes, associations, companies and EU projects.[12]

Many – more generalised – illustrations only differentiate between different modes of transport in traffic accidents. Figure 1, for example, depicts the number of passenger fatalities in rail traffic accidents in the EU over the period of 1990 to 2010. This statistic only refers to rail passenger transport however, and not to rail freight traffic. Figure 1 also depicts the number of people killed in road traffic accidents in the EU from 1990 to 2010. Here too no differentiation is made in the first instance between passenger and freight traffic.

Figure 1: Railway and road fatalities in the EU, 1990-2010

RAILWAY FATALITIES										
NUMBER OF RAILWAY PASSENGERS KILLED IN ACCIDENTS INVOLVING RAILWAY										
	1990	2000	2003	2004	2005	2006	2007	2008	2009	2010
EU-27					65	83	70	89	37	62
EU-15	165	117	91	75	51	53	44	29	20	46
EU-12					14	30	26	60	17	16

ROAD FATALITIES										
	1990	2000	2005	2006	2008	2009	2010		CHANGE 1990/ 2010	CHANGE 2000/ 2010
EU-27	75,977	56,427	45,346	43,104	38,941	34,814	31,030		-59.2%	-45.0%
EU-15	55,888	41,421	31,384	29,521	25,430	23,457	21,247		-62.0%	-48.7%
EU-12	20,089	15,006	13,962	13,583	13,511	11,357	9,783		-51.3%	-34.8%

Source: European Commission (2012), EC Statistical Pocket Book, Transport in figures 2012, p. 107 and p. 101, Luxemburg

In addition to the general data about traffic accidents in the EU however, there are also statistics which offer detailed information about instances of rail and road traffic accidents (see chapter 3.1 and chapter 3.2).

[10] Cf. http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/
[11] For example, the Deutsches Statistisches Bundesamt in Wiesbaden, cf. https://www.destatis.de/DE/Startseite.html.
[12] See, for example, European Railway Agency ERA, International Road Transport Union IRU, L'Observatoire pour la sécurité routière IBSR, EC FP7 project DaCoTa, DEKRA Automobil GmbH, etc.

3.1 Accident statistics for rail freight traffic

In 2011 there were 2,685 railway accidents throughout the 27 EU member states (EU 27), resulting in a total of 2,325 persons killed or injured (cf. Figure 2).[13]

Figure 2: Number of people killed in railway accidents in the EU 27 in 2011.

	Number of tonne-kilometres (millions)	Number of passenger-kilometres (millions)	Total number of accidents	Total number of persons killed or seriously injured in accidents
EU-27	398,310	359,263	2,685	2,325
Belgium	1,359	9,649	52	50
Bulgaria	3,168	2,059	124	118
Czech Republic	14,316	6,714	99	103
Denmark	2,615	6,432	18	17
Germany	113,160	84,875	329	323
Estonia	6,261	242	28	16
Ireland	105	1,638	1	-
Greece	614	1,383	25	28
Spain	8,643	22,482	65	43
France	34,132	42,668	154	141
Italy	14,624	39,959	122	107
Cyprus	-	-	-	-
Latvia	21,410	7,363	35	34
Lithuania	15,088	269	37	41
Luxembourg	85	347	1	2
Hungary	7,526	7,763	147	160
Malta	-	-	-	-
Netherlands	5,452	17,793	24	18
Austria	18,288	10,263	90	86
Poland	51,095	17,648	843	543
Portugal	2,027	4,143	27	24
Romania	13,924	5,044	217	251
Slovenia	3,584	689	11	16
Slovakia	7,600	2,431	84	88
Finland	9,395	3,882	14	13
Sweden	22,864	11,379	56	40
United Kingdom	20,974	58,606	82	63

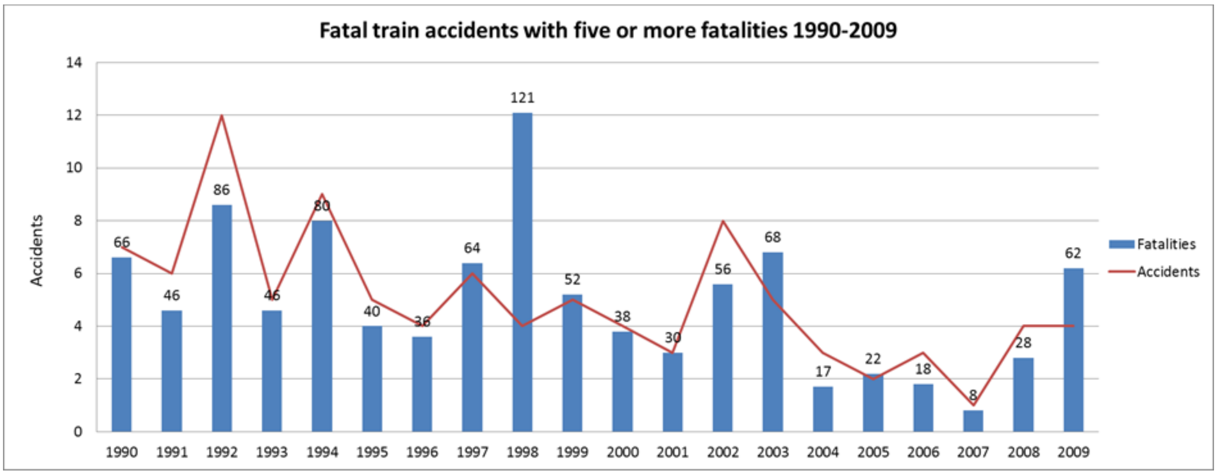
Source: Eurostat (2011), EU Statistics 2011 for railway accidents, http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Railway_safety_statistics, consulted on 11 July 2013.

Figure 3 shows the incidence of train accidents in the EU from 1990 to 2009with five or more people killed or injured. Overall there has been a decline in serious train accidents in recent years. While

[13] These accident statistics summarise all rail accidents with fatalities. These figures therefore include accidents caused by suicides.

there were at least four serious train accidents every year throughout the 1990s, the situation improved significantly in the years 2000 to 2009.

Figure 3: Train accidents in the EU with 5 or more fatalities, 1990 to 2009



Source: European Railway Agency ERA (2010), Railway Safety Performance in the European Union 2010, p. 27, Valenciennes

The cause of railway accidents can also be differentiated, e.g. collisions, derailments, level crossings, persons on the track, fire in train carriages, or as to whether the persons killed were passengers, railway workers or others (cf. Figure 4). By far the most common cause of railway accidents in the EU in 2011 was persons on the track[14], followed by accidents involving level crossings. Accidents such as collisions and derailments, like fires in the carriage, are much less common.

Although data about the cause of railway accidents is available in these statistics, they still do not differentiate between passenger and freight services. Moreover accidents due to technical failures in rolling stock are not shown separately here.

[14] This category of accidents includes inter alia suicides.

Figure 4: Fatalities in the EU 27 in 2011 by type of accident

	Number of persons											
	Killed				Seriously Injured				Total			
	Passengers	Employees	Other	Total	Passengers	Employees	Other	Total	Passengers	Employees	Other	Total
Collisions	9	3	3	15	33	11	5	49	42	14	8	64
Derailments	2	2	-	4	43	2	-	45	45	4	-	49
Accidents involving level-crossings	6	-	311	317	24	14	291	329	30	14	602	646
Accidents to persons caused by rolling stock	22	25	856	903	123	36	453	612	145	61	1,309	1,515
Fires in rolling stock	-	-	-	-	-	-	-	-	-	-	-	-
Others	-	1	2	3	6	20	22	48	6	21	24	51
Total	39	31	1,172	1,242	229	83	771	1,083	268	114	1,943	2,325

Source: Eurostat (2011), EU Statistics 2011 for railway accidents, http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Railway_safety_statistics, consulted on 11 July 2013.

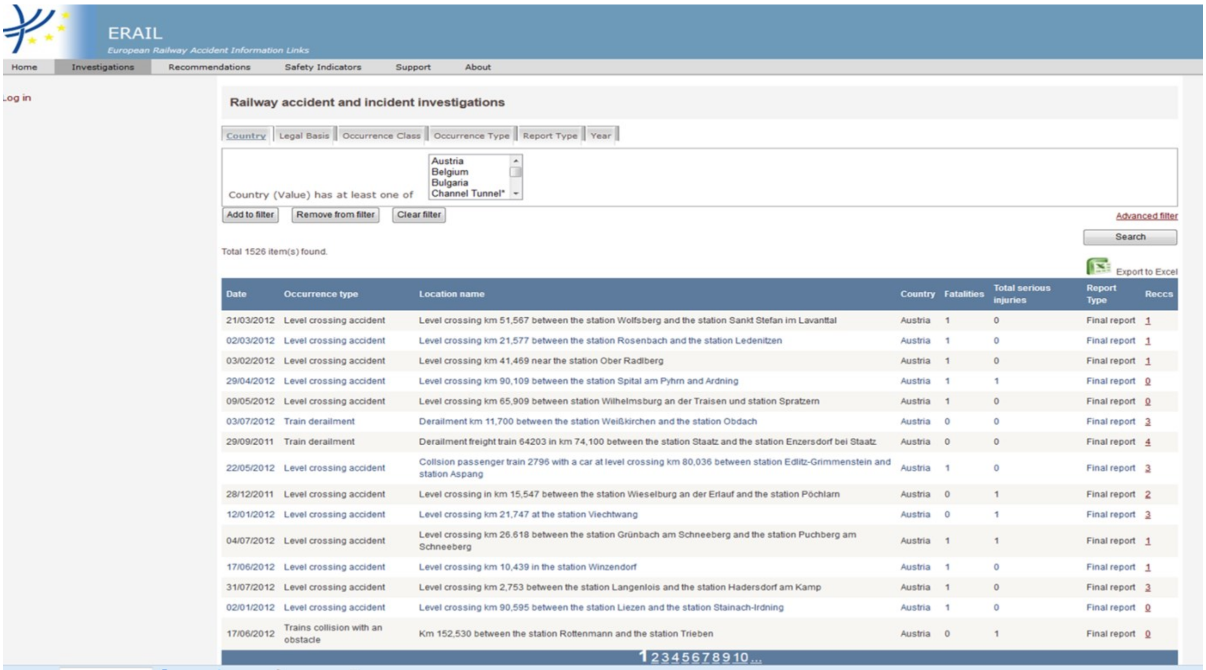
The Railway Safety Directive 2004/49/EC and the Agency Regulation 881/2004 made the European Railway Agency responsible for collecting data on railway accidents and preparing it for publication.

In order to generate a consistent European database of railway accidents, the European Railway Agency ERA has built a database called European Railway Accident Information Links (ERAIL), in which railways accidents are recorded (cf. Figure 5). Searches in the database can be filtered according to specific criteria. Along with the year and country in which an accident occurred, the causes of accidents can also be evaluated. There are various categories, including:

- incidents involving moving trains (collision between trains, derailment, level crossing incidents, accidents caused by persons on the track, ...)
- incidents involving rolling stock (fire in the carriage, leakage of hazardous materials, broken axles or wheelsets, …)
- incidents involving faulty infrastructure (signal failure, defective track/points...)
- others.

The database also permits access to short descriptions of each accident. The national agencies which investigate accidents are required to pass on their final accident reports to the ERA. These are added to the database.

Figure 5: ERAIL-database – Railway accidents in the EU



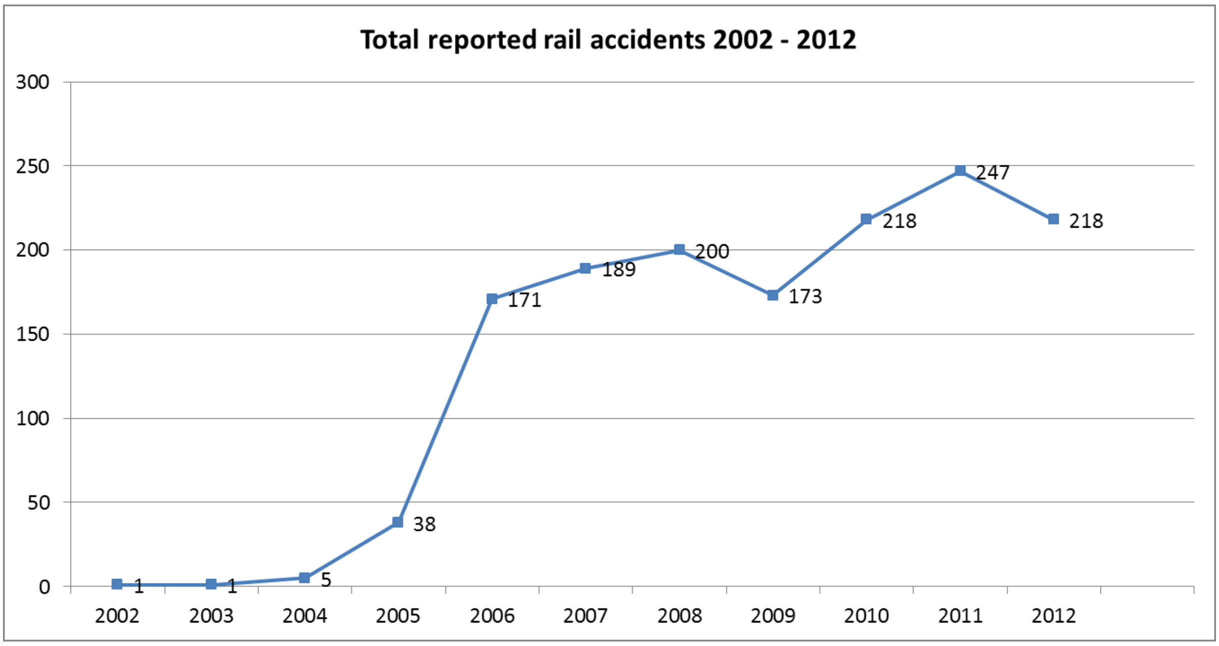
Date	Occurrence type	Location name	Country	Fatalities	Total serious injuries	Report Type	Reccs
21/03/2012	Level crossing accident	Level crossing km 51,567 between the station Wolfsberg and the station Sankt Stefan im Lavanttal	Austria	1	0	Final report	1
02/03/2012	Level crossing accident	Level crossing km 21,577 between the station Rosenbach and the station Ledenitzen	Austria	1	0	Final report	1
03/02/2012	Level crossing accident	Level crossing km 41,469 near the station Ober Radlberg	Austria	1	0	Final report	1
29/04/2012	Level crossing accident	Level crossing km 90,109 between the station Spital am Pyhrn and Ardning	Austria	1	1	Final report	0
09/05/2012	Level crossing accident	Level crossing km 65,909 between station Wilhelmsburg an der Traisen und station Spratzern	Austria	1	0	Final report	0
03/07/2012	Train derailment	Derailment km 11,700 between the station Weißkirchen and the station Obdach	Austria	0	0	Final report	3
29/09/2011	Train derailment	Derailment freight train 64203 in km 74,100 between the station Staatz and the station Enzersdorf bei Staatz	Austria	0	0	Final report	4
22/05/2012	Level crossing accident	Collsion passenger train 2796 with a car at level crossing km 80,036 between station Edlitz-Grimmenstein and station Aspang	Austria	1	0	Final report	3
28/12/2011	Level crossing accident	Level crossing in km 15,547 between the station Wieselburg an der Erlauf and the station Pöchlarn	Austria	0	1	Final report	2
12/01/2012	Level crossing accident	Level crossing km 21,747 at the station Viechtwang	Austria	0	1	Final report	3
04/07/2012	Level crossing accident	Level crossing km 26.618 between the station Grünbach am Schneeberg and the station Puchberg am Schneeberg	Austria	1	1	Final report	1
17/06/2012	Level crossing accident	Level crossing km 10,439 in the station Winzendorf	Austria	1	0	Final report	1
31/07/2012	Level crossing accident	Level crossing km 2,753 between the station Langenlois and the station Hadersdorf am Kamp	Austria	1	0	Final report	3
02/01/2012	Level crossing accident	Level crossing km 90,595 between the station Liezen and the station Stainach-Irdning	Austria	1	0	Final report	0
17/06/2012	Trains collision with an obstacle	Km 152,530 between the station Rottenmann and the station Trieben	Austria	0	1	Final report	0

Source: European Railway Agency, ERAIL European Railway Accident Information Links, http://erail.era.europa.eu/, consulted on 07 June 2013

Figure 6 (below) shows that the national investigation agencies have been sending reports of railway accidents to the European Railway Agency since 2002, but it also shows that in 2002 to 2005 only a few incidents were added to the ERAIL database. It can therefore be concluded that all relevant railway accidents been only been reported to the European Railway Agency since 2006. For this reason the following statements will only take into account data in the ERAIL database from 2006 to 2012. Data from the ERAIL database on railway accidents in the EU 27 states will not include Bulgaria, Cyprus, Latvia and Malta.

As there is no rail freight traffic in Malta or Cyprus, the data from these two countries on road traffic accident statistics has been left out (cf. Chapter 3.2). As the available road accident statistics include no information from Bulgaria or Latvia, these countries have been excluded, for the sake of comparability, from the railway accident statistics.

Figure 6: **Total reported rail accidents in the ERAIL database**



Source: Author's evaluation of ERAIL European Railway Accident Information Links, http://erail.era.europa.eu/, consulted on 07 June 2013

As the statistics on rail accidents illustrated above do not yet differentiate between passenger rail services and rail freight, the ERAIL database was then analysed to see how many persons were killed in rail freight accidents – regardless of the cause of accident (cf. Figure 7).

Figure 7: **Total fatalities in rail freight accidents 2006 to 2012**

Source: Author's evaluation of ERAIL European Railway Accident Information Links, http://erail.era.europa.eu/, consulted on 07 June 2013

In total 181 persons were killed in rail freight accidents in 2006 to 2012 in the EU, not including Bulgaria, Cyprus, Latvia and Malta.

Most fatal rail freight accidents involved level crossings (62 fatalities), followed by accidents caused by rolling stock in motion (38 fatalities). 34 people died in derailments during this period, as well as 33 in collisions between trains (cf. Table 1).

Table 1: Causes of fatal rail freight accidents, 2006 to 2012

Cause of accident	Number of fatalities 2006 to 2012
Level crossing	62
Rolling stock in motion	38
Derailment	34
Collisions between trains	33
Train in collision with obstacle	9
Fire in rolling stock	1
Other	4
Total	181

Source: Author’s evaluation of ERAIL European Railway Accident Information Links, http://erail.era.europa.eu/, consulted on 07 June 2013

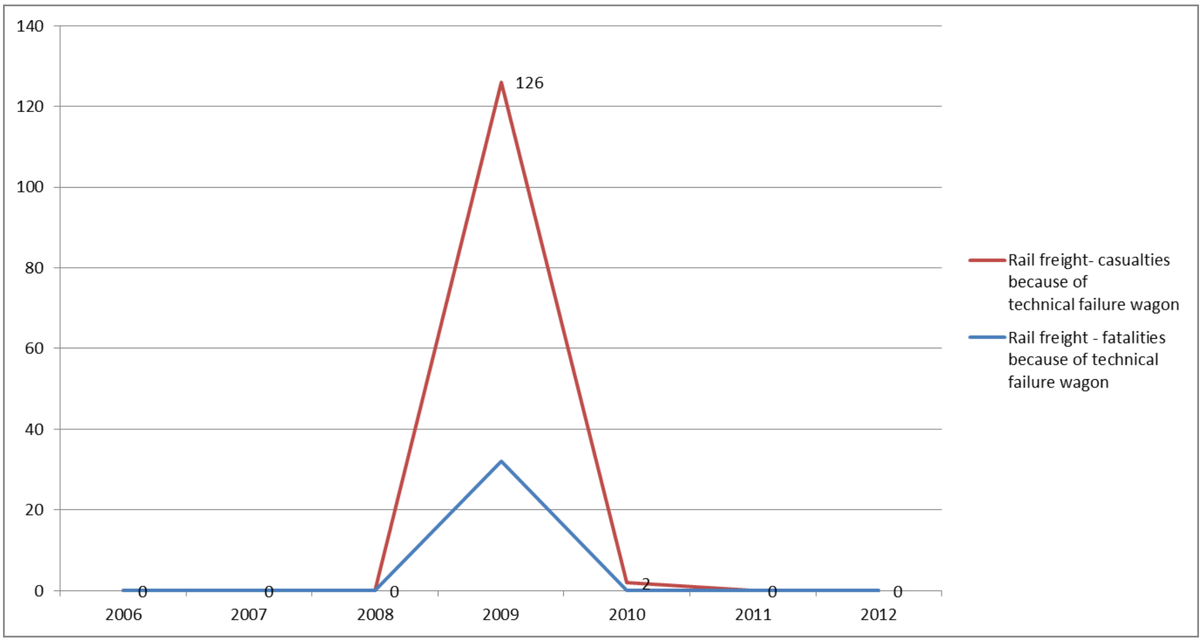
Relevant incidents in the ERAIL database were evaluated in order to analyse how many rail freight traffic accidents caused by technical failures in rolling stock there have been in the EU in recent years. Particular attention was paid to the categories “rolling stock”, with its sub-categories “fire in carriages”, “leakages of hazardous material” and “broken wheelsets/axles”, as well to “rolling stock in motion”, and here in particular the sub-category “derailments”, in order to establish whether a technical failure in rolling stock had caused the accident. The details of each incident in the ERAIL database were analysed, together with the closed, or open, findings. In this way an overview was compiled, showing all the rail freight incidents caused by technical failures in freight cars alongside the resulting number of persons killed and injured.

Figure 8 shows the number of persons killed and injured in rail freight accidents caused by known (or sometimes suspected)[15]technical failures in rolling stock during the years 2006 to 2012.

In the years 2006 to 2008, 2011 and 2012 there were no railway incidents resulting in death(s) caused by technical failures in freight cars.[16]

[15] In the cases where accidents were not conclusively investigated.
[16] Cf. ERAIL Database http://erail.era.europa.eu, consulted in June 2013.

Figure 8: **Number of persons killed and injured in rail freight accidents caused by technical failures in rolling stock in the years 2006 to 2012.**



Source: Author's evaluation of ERAIL European Railway Accident Information Links, http://erail.era.europa.eu, consulted on 07 June 2013

On 29 June 2009 train no. 50325 operated by Trenitalia, with a total of 7 compressed gas tank wagons containing butane, derailed because of a broken axle on the first wagon of the train in Viareggio, Italy. In the explosion that ensued a total of 32 persons were killed and 126 injured.[17]

In 2010 the ERAIL database lists two rail freight incidents caused by technical failures in freight cars, resulting in two injured persons. In Austria on 16 June 2010, on ÖBB section 10105 between Innsbruck and Lochau, a defect in the suspension system of the main brake pipe between the two halves of the first wagon (2x2 axle unit) resulted in a rupture, causing a one-sided lock to the main brake pipe, leading to the derailment of a freight train with loaded double decker automotive transport wagons. As a result of insufficient braking power on a downhill slope, 13 wagons derailed along with the locomotive. The driver was injured in the derailment.[18]

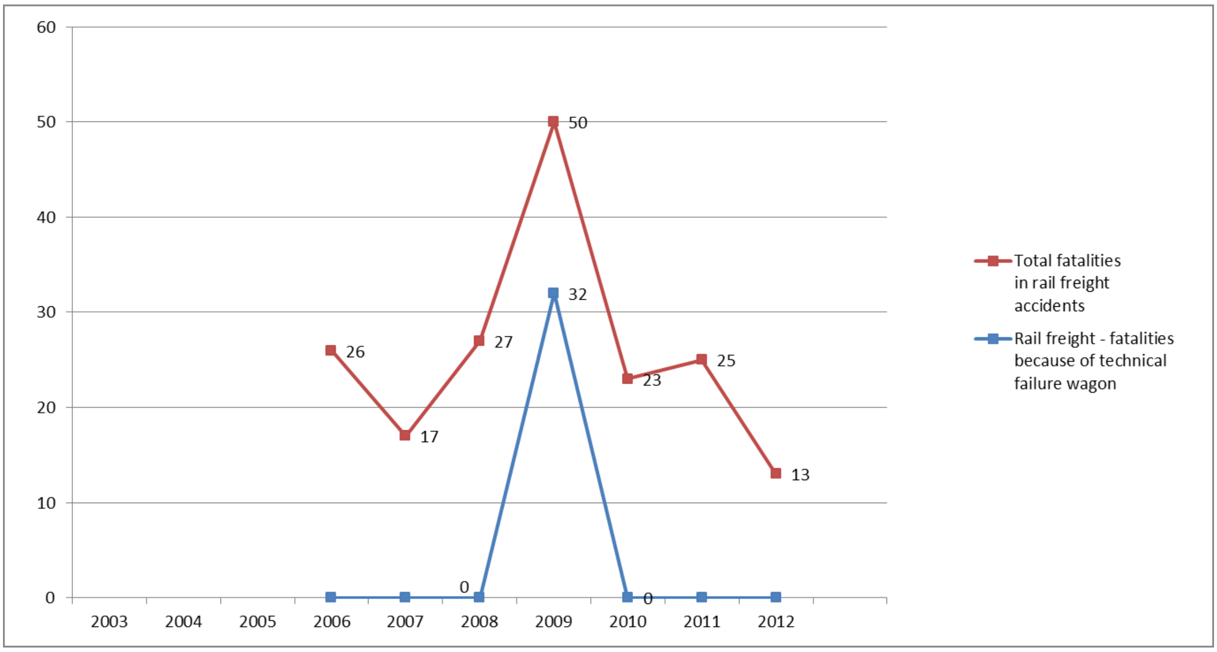
In Peine, Germany, also on 16 June 2010, a freight train with several wagons derailed. This resulted in a collision with a passenger train travelling on the neighbouring track. One person was seriously injured in the incident.[19] It is suspected that a damaged wheel tyre on the freight train may have been the cause of the accident.

In total 32 people were killed and 128 people injured in the EU 27in rail freight accidents caused by technical failures in freight cars in the period 2006 to 2012.[20]

[17] Cf. ERAIL Database http://erail.era.europa.eu, consulted in June 2013.
[18] Cf. ERAIL Database http://erail.era.europa.eu, consulted in June 2013.
[19] Cf. Eisenbahn-Unfalluntersuchungsstelle des Bundes (2010), Eisenbahn-Unfalluntersuchung – Jahresbericht 2010, p. 18, Bonn.
[20] Excluding Bulgaria, Cyprus, Latvia and Malta

Figure 9 clearly shows that in the period under consideration there was only one rail freight accident caused by a technical failure in rolling stock which had fatal consequences (Viareggio accident in 2009 with 32 fatalities). In all other fatal rail freight accidents, such as level-crossing accidents or train collisions, the causes are to be found elsewhere.

Figure 9: Number of fatal rail freight accidents, 2006 to 2012: total and those caused by technical failure in rolling stock



Source: Author's evaluation of ERAIL European Railway Accident Information Links, http://erail.era.europa.eu, consulted on 07 June 2013

3.2 Road freight accident statistics

There is also a multitude of statistics covering road traffic at international and national level. The collected data is generally presented according to various criteria in the serial statistical publications. The German Federal Statistical Office, for example, differentiates according to the following categories:[21]

- type of accident, e.g. accidents involving personal injuries, serious accidents with exclusively material damage
- parties involved
- parties responsible
- casualties, broken down into fatalities, serious and minor injuries
- cause of accident
  - driver compromised by, e.g., alcohol, other intoxicants, tiredness etc.
  - vehicle user error, e.g. road use, speed, braking distance, overtaking, passing, driving alongside, priority, turning/making a U-turn/reversing/entering or driving off, misconduct towards pedestrians, stationary traffic/traffic safety, loading/passengers carried etc.)
  - technical failure, faulty maintenance, e.g. lights, brakes, tyres, steering, towing system, other deficiencies
  - pedestrians at fault
  - general causes, e.g. road conditions, bad weather, obstructions
- nature of motion, e.g. forward travel, turning off, crossroad/junction, cutting across etc.
- type of accident, e.g. collision with another vehicle that is driving off or stopping or stationary, collision with a vehicle travelling ahead or waiting, etc.
- road users involved, e.g. moped, motorcycle, car, goods vehicle etc.

The most significant factors for the present investigation are the road users involved (e.g. goods vehicle) and accident causes (e.g. technical failure, faulty maintenance).

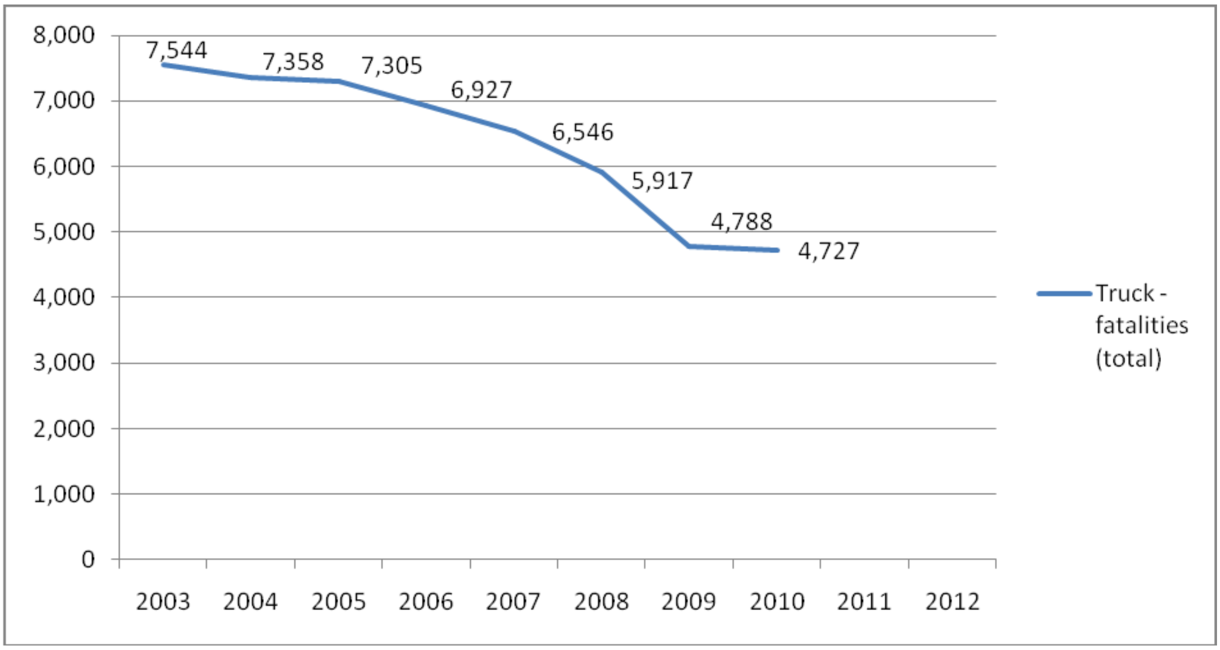
At EU level, while there is data about traffic accidents involving trucks, statistics are not available from all EU states regarding the extent to which technical failure is a factor.

Unlike the railway accident statistics from the ERAIL database in the previous chapter, the road traffic accident data covers the period from 2003 to 2010 in the EU 27, not including Bulgaria and Latvia. Furthermore, in the following road accident statistics the information from Malta and Cyprus will not be used since these two states have no railway accident statistics.

[21] Cf. Statistisches Bundesamt (2012), Verkehr, Verkehrsunfälle, Fachserie 8 Reihe 7, pp. 11-20, Wiesbaden.

Figure 10 shows how many people were killed in road freight accidents in the period 2003 to 2010 in the EU, not including Bulgaria, Cyprus, Latvia and Malta. While 7,544 persons were killed in road freight accidents in 2003, this number declined year by year to 4,727 in 2010.[22]

Figure 10: Number of road freight accident fatalities, 2003–2010



Source: Pace, J.F., et al. (2012), Basic Fact Sheet Heavy Good Vehicle and Buses, Deliverable D3.9 of the EC FP7 project DaCoTa

What is not yet clear from this is how many persons were killed or seriously injured in road freight accidents as a result of technical vehicle failure.

In order to identify the proportion of road freight accidents due to technical vehicle failures, the available literature was reviewed for the purposes of this study. The following sources supplied information about the share of road freight accidents due to technical failure in vehicles:

- Volvo Trucks, European Accident Research and Safety Report 2013,
- International Road Transport Union IRU, European Truck Accident Causation (“ETAC”), 2007,
- Belgium: L’Observatoire pour la sécurité routière IBSR, Rapport thématique Accidents de camion 2000-2007,
- Germany: Statistisches Bundesamt, Verkehr, Verkehrsunfälle, Fachserie 8 Reihe 7, 2007 to 2011,
- France: Bureau d’enquetes sur les accidents de transport terrestres, Études sur les accidents mortels ayant impliqué des poids lourds en 2004,
- United Kingdom: Department for Transport statistics 2010 und 2012
- Poland: Head Office of Polish Police, Dept. Analysis and Prevention, 2010 to 2012.

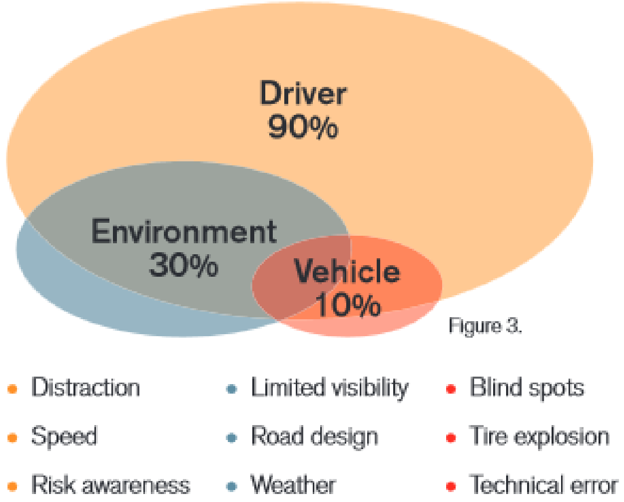
[22] Cf. Pace, J.F., et al. (2012), Basic Fact Sheet Heavy Good Vehicle and Buses, Deliverable D3.9 of the EC FP7 project DaCoTa

The findings from these sources which proved relevant to the present study are described below.

Volvo Trucks, European Accident Research and Safety Report 2013:

A study conducted by Volvo Trucks[23] in 2013 identifies possible contributing factors to road freight accidents. According to Figure 11, the biggest contributing factor is the driver (90%), followed by environmental factors, e.g. weather or road conditions (30%). A further factor named in the study is the vehicle (10%), under which fall technical failures (e.g. bad maintenance), exploding tyres, but above all the blind spot in the rear mirror.

Figure 11: Contributing factors in road accidents



Source: Volvo Trucks (2013), European Accident Research and Safety Report 2013, p. 11

However, Volvo Trucks also point out that truck accidents are often caused by a combination of these factors, and so the study does not permit a precise analysis of the percentage of road freight accidents in which technical failure is the cause.[24]

International Road Transport Union IRU, European Truck Accident Causation ("ETAC"), 2007

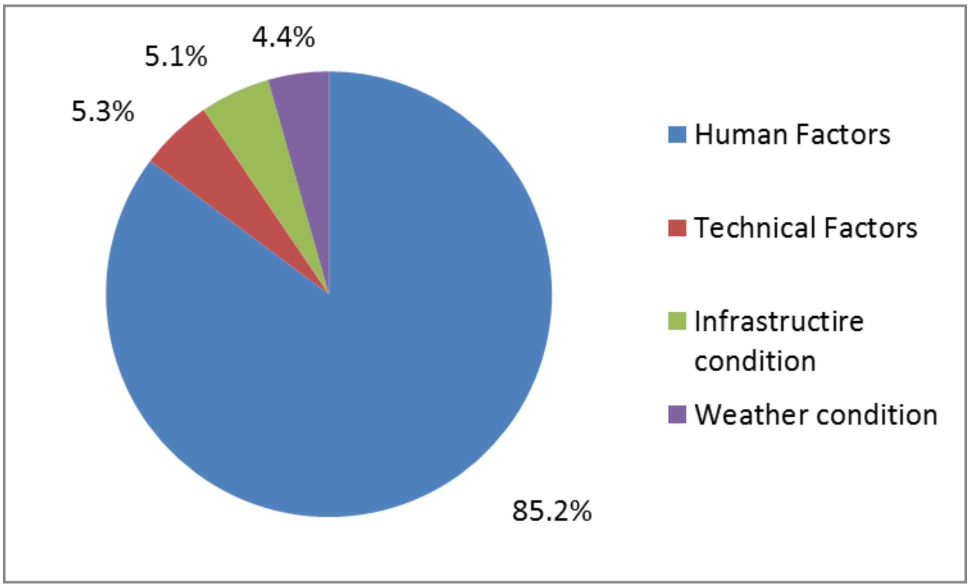
The International Road Transport Union IRU[25]conducted a scientific study in 2007 in collaboration with various national agencies[26] and on behalf of the EU[27], in which the main causes of road freight accidents were analysed. On the basis of 3,000 different parameters, a total of 624 truck accident reports were collated and examined using scene-of-the-accident reports, as well as follow-up interviews with the various persons involved.

Figure 12 shows that, according to the International Road Transport Union study, the main causes of road freight accidents come down to human factors, such as driving at excessive speed, or failing to observe traffic regulations (approx. 85% of accidents). Road conditions (approx. 5%) and weather

[23] Cf. Volvo Trucks (2013), European Accident Research and Safety Report 2013.
[24] As a result the percentages in Figure 11 also add up to more than 100%.
[25] Cf. http://www.iru.org/
[26] DEKRA, CIRRS, IbB, TNO Automotive Safety, Rekonstrukcija, Cidaut, Ceesar, Applus Idiada.
[27] ETAC European Truck Accident Causation, cf. International Road Transport Union IRU (2007), A Scientific Study "ETAC" European Truck Accident Causation, Geneva.

conditions (4%) are further causes of road freight accidents. Of interest is the study's conclusion that 5% of truck accidents are caused by technical failures.[28]

Figure 12: Principle causes of road freight accidents



Source: International Road Transport Union IRU (2007), A Scientific Study "ETAC" European Truck Accident Causation, p. 4, Geneva

As noted, there is no available statistical information on a European level with regard to road freight accidents due to technical vehicle failure. In order to validate the 5% figure for road freight accidents caused by technical failures indicated by the International Road Transport Union study, various national accident statistics were analysed.[29] Statistics for Belgium, Germany, France, the United Kingdom and Poland were identified from which the proportion of road freight accidents caused by technical failures could be derived from the total number of road freight accidents.

Belgium

A statistic on technical vehicle failure as a cause of road freight accidents is provided by the Belgian institute L'Observatoire pour la sécurité routière IBSR for 2007.[30] This cites 47 road freight accidents caused by technical failure in vehicles. Unfortunately it does not provide any further information on the number of persons killed or injured in these accidents. Out of a total of 2,866 road freight accidents in Belgium, 1.6% are stated to have been caused by "technical vehicle failure" (cf. Figure 13).

[28] Cf. ETAC European Truck Accident Causation, cf. International Road Transport Union IRU (2007), A Scientific Study "ETAC" European Truck Accident Causation, p. 4, Geneva.
[29] The research included the national statistics agencies in Austria, Belgium, France, Germany, Italy, Poland, Switzerland and the U.K.
[30] Cf. L'Observatoire pour la sécurité routière IBSR (2008), Rapport thématique Accidents de camion 2000-2007.

Figure 13: Number of road freight accidents caused by technical vehicle failure

Technical Failures Truck Accidents 2007 in Belgium

Technical Failure	Number of accidents	
Electric lighting	2	
Old Tires	8	
Flat tire	11	
Trailer / Cargo	26	
Total	**47**	

Fatalities and injured persons all truck accidents 2007 in Belgium

All Truck accidents	Fatalities	Injured Persons
Total: 2.866 accidents	**154**	**3,870**

Share of accidents caused by technical failure:	1.6%

Source: L'Observatoire pour la sécurité routière IBSR (2008), Rapport thématique Accidents de camion 2000-2007, p. 50

Germany

Figure 14 below gives the number of persons killed and injured in road freight accidents caused by technical vehicle failures in Germany in 2011. A total of 5 persons died and 376 were injured as a result of various technical truck defects. These include defective lights, tyres, brakes, steering, towing systems and other defects. Compared to the overall total of fatalities and persons injured in road freight accidents in Germany in 2011 (889 fatalities, 7,835 injured), the number caused by technical vehicle failure is relatively low. Technical vehicle failure in Germany in 2011 accounted for 0.6% of the total number of road freight fatalities and 4.8% of those injured.[31]

Figure 14: Number of persons injured and killed in road freight accidents caused by technical vehicle failures in Germany, 2011

Technical Failures Truck Accidents 2011 in Germany

Technical Failure	Fatalities	Injured Persons
Electric lighting	-	20
Tires	1	172
Brakes	2	63
Steering	1	17
Towing device	-	18
Others	1	86
Total	**5**	**376**

Fatalitites and injured persons all truck accidents 2011 in Germany

All Truck accidents	Fatalities	Injured Persons
Total	**889**	**7,835**

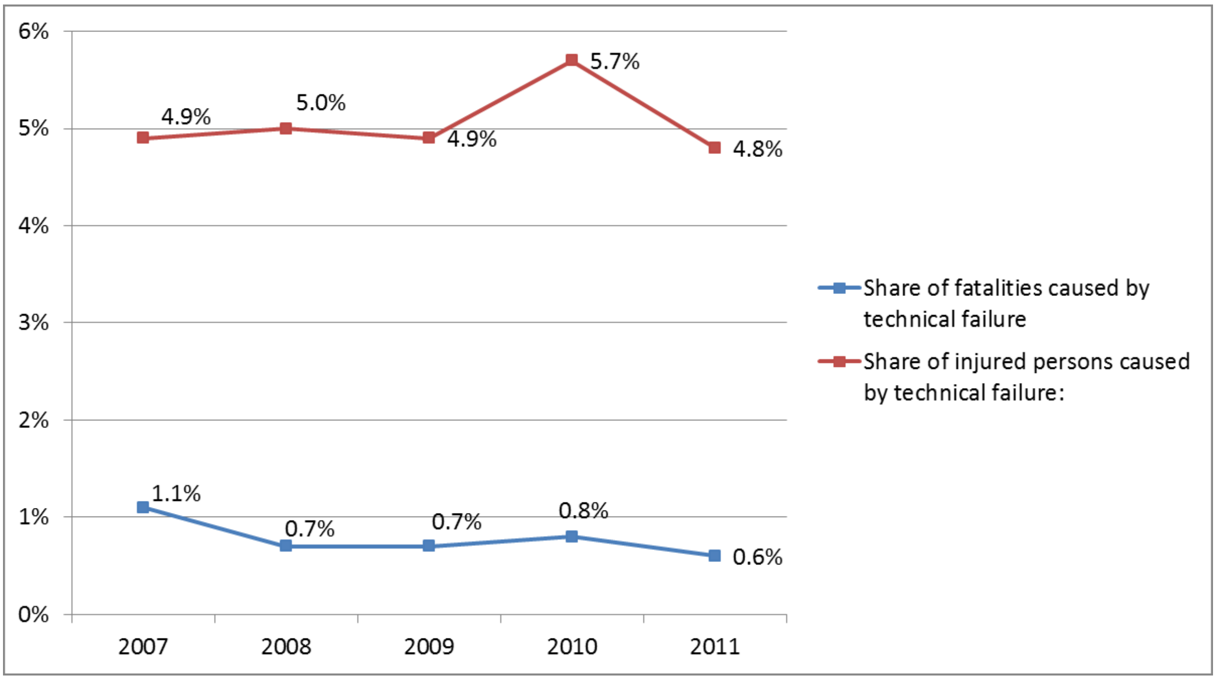
Share of accidents caused by technical failure:	0.6%
Share of injured persons caused by technical failure:	4.8%

Source: Statistisches Bundesamt (2012), Verkehr, Verkehrsunfälle, Fachserie 8 Reihe 7, p. 85 and p. 274, Wiesbaden

The figures stated above from the German Federal Statistical Office are also available for the years 2007 to 2010.[32] Figure 15 shows the proportion of fatalities and injured persons resulting from road freight accidents caused by technical failure in Germany in 2007 to 2011. At the same time it shows that the number of persons killed or injured because of technical failure falls, during this timeframe, from 1.1% to 0.6%. The proportion of persons injured in accidents caused by technical failure remains relatively constant, however, at ca. 5%.

[31] Cf. Statistisches Bundesamt (2012), Verkehr, Verkehrsunfälle, Fachserie 8 Reihe 7, Wiesbaden, p. 85 and p. 274.
[32] Cf. Statistisches Bundesamt (2007-2011), Verkehr, Verkehrsunfälle, Fachserie 8 Reihe 7, Wiesbaden.

Figure 15: Share of fatalities and injured persons in road freight accidents in Germany attributed to technical failure, 2007-2011



Source: Statistisches Bundesamt (2007, 2008, 2009, 2010, 2011), Verkehr, Verkehrsunfälle, Fachserie 8 Reihe 7, Wiesbaden

France

For France, a study of fatal truck accidents from the year 2007 was discovered and analysed.[33] The accident data drawn upon by this study dates from 2004. Alongside various other factors, the study examines the causes of road freight accidents, differentiated by various accident scenarios.

Technical failure was the cause of 2.4% of road freight accidents involving no other road users[34], and 1.3% of road freight accidents involving other vehicles.[35]

[33] Cf. Bureau d'enquetes sur les accidents de transport terrestres (2007), Études sur les accidents mortels ayant impliqué des poids lourds en 2004, Amiens, 2007.
[34] Cf. Bureau d'enquetes sur les accidents de transport terrestres (2007), Études sur les accidents mortels ayant impliqué des poids lourds en 2004, Amiens, 2007, p. 43.
[35] Cf. Bureau d'enquetes sur les accidents de transport terrestres (2007), Études sur les accidents mortels ayant impliqué des poids lourds en 2004, Amiens, 2007, p. 64.

United Kingdom

In the United Kingdom figures on road traffic accidents, including road freight accidents, are available from the Department for Transport Statistics.[36]The number of accidents caused by technical failure is provided for the years 2010 and 2011.[37]In 2011 technical truck failure was responsible for 140 accidents. The largest share of these (91) comes under the category overloading or inadequate securing of loads, followed by faulty brakes (29 accidents). Damaged tyres accounted for 12 accidents, faulty steering for 6, while 4 accidents were caused by faulty lights or indicators and one by a faulty or defective rear mirror.

Out of a total of 7,126 accidents involving trucks in the UK in 2011, 2.0% were caused by “technical failures” in trucks. In 2010 the proportion was 1.8%.[38]

Poland

For Poland we have information for the years 2010 to 2012 (cf. Table 2). The proportion of road freight accidents caused by technical vehicle failure lies within a fairly constant range between 1.2% and 1.5%. However, the proportion of road freight fatalities caused by technical vehicle failure accounts for between 1.3% and 4.9% of all road freight fatalities.[39]

Table 2: Number of road freight accidents in Poland caused by technical vehicle failure, 2010-2012

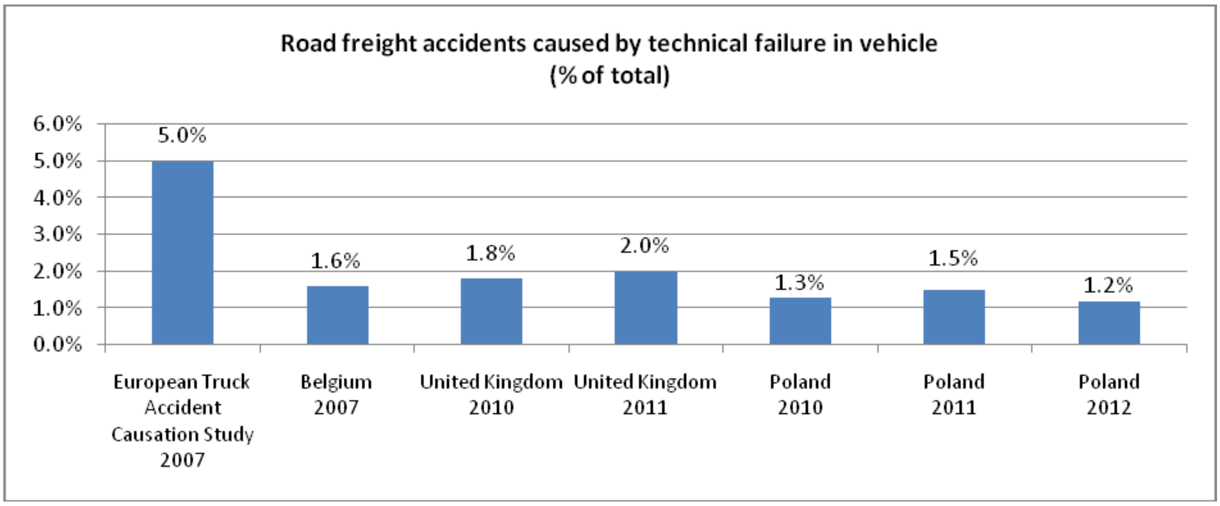
Year	Truck accidents: total	Fatalities from truck accidents: total	Truck accidents caused by technical failure in vehicle	Truck accidents caused by technical failure in vehicle (%)	Fatalities due to truck accidents caused by technical failure in vehicle	Fatalities due to truck accidents caused by technical failure in vehicle (%)
2010	2,394	292	31	1.3%	4	1.4%
2011	2,341	288	34	1.5%	14	4.9%
2012	2,096	235	25	1.2%	3	1.3%

Source: Head Office of Polish Police, Dept. Analysis and Prevention

The figures provided in the table above are summarized in Figure 16, showing what percentages out of the total number of road freight accidents were caused by technical vehicle failure. The EU European Truck Accident Causation study cites the proportion of road freight accidents caused by technical vehicle failure.

[36] Cf. Department for Transport Statistics, https://www.gov.uk/government/publications/reported-road-casualties-great-britain-annual-report-2011
[37] Cf. http://www.dft.gov.uk/statistics/releases/road-accidents-and-safety-annual-report-2011/table ras5005,
[38] 140 road accidents caused by technical failures in trucks as against a total of 7,615 truck accidents in the United Kingdom in 2010, cf. http://www.dft.gov.uk/statistics/releases/road-accidents-and-safety-annual-report-2010/table ras5005,
[39] Data provided by the Head Office of Polish Police, Dept. Analysis and Prevention

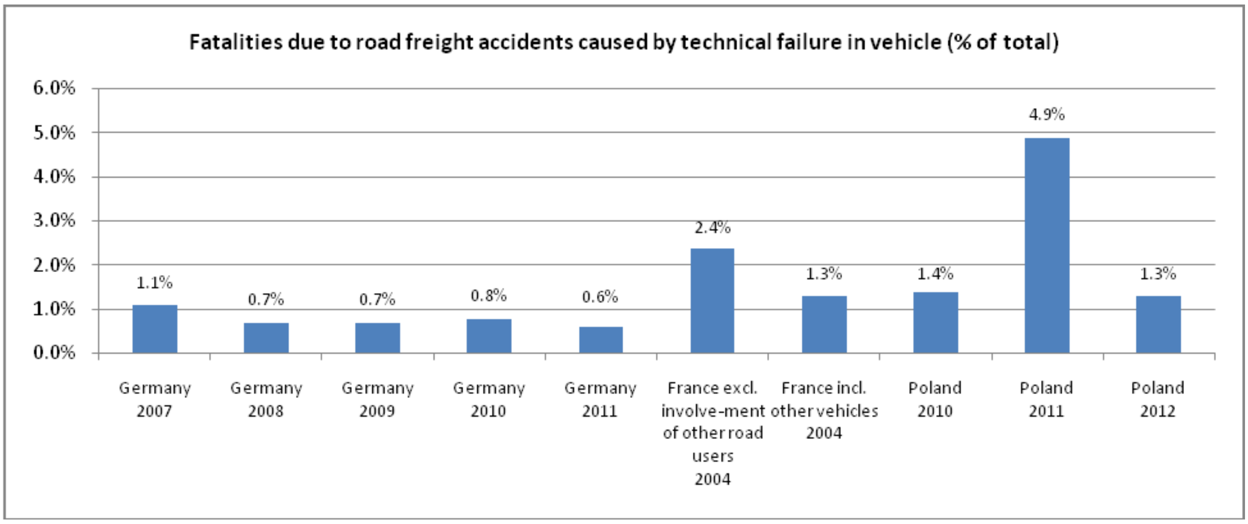
Figure 16: Share of road freight accidents caused by technical failure



Source: International Road Transport Union IRU (2007), A Scientific Study "ETAC" European Truck Accident Causation, p. 4, Geneva, L'Observatoire pour la sécurité routière IBSR (2008), Rapport thématique Accidents de camion 2000-2007, p. 50, Statistisches Bundesamt (2007, 2008, 2009, 2010, 2011), Verkehr, Verkehrsunfälle, Fachserie 8 Reihe 7, Wiesbaden, Bureau d'enquetes sur les accidents de transport terrestres (2007), Études sur les accidents mortels ayant impliqué des poids lourds en 2004, Amiens, 2007, p. 43 and p. 64, Department for Transport Statistics http://www.dft.gov.uk/statistics/releases/road-accidents-and-safety-annual-report-2011/table ras5005, Head Office of Polish Police, Dept. Analysis and Prevention

Some of the national accident statistics do not provide the proportion of road freight accidents caused by technical failure, but rather the proportion of road accident fatalities caused by technical failure. This value falls between 0.6% (Germany 2011) and 4.9% (Poland 2011) in the accident statistics analysed.

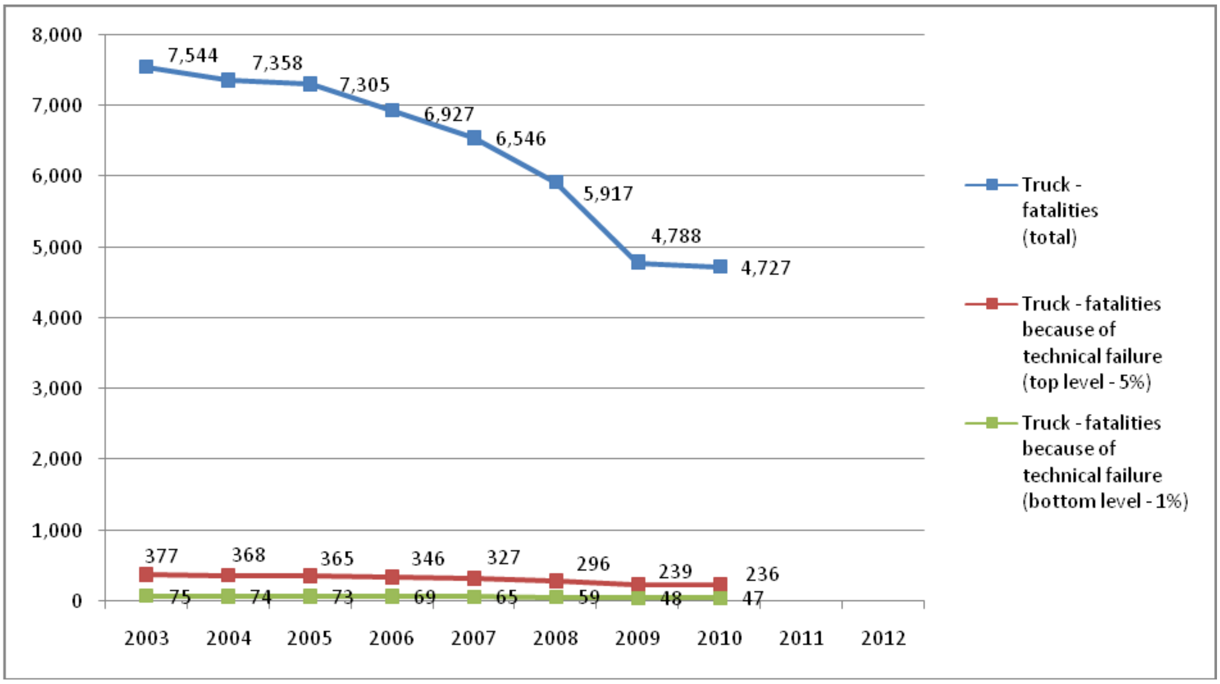
Figure 17: Proportion of fatalities resulting from road freight accidents caused by technical failure



Source: International Road Transport Union IRU (2007), A Scientific Study "ETAC" European Truck Accident Causation, p. 4, Geneva, L'Observatoire pour la sécurité routière IBSR (2008), Rapport thématique Accidents de camion 2000-2007, p. 50, Statistisches Bundesamt (2007, 2008, 2009, 2010, 2011), Verkehr, Verkehrsunfälle, Fachserie 8 Reihe 7, Wiesbaden, Bureau d'enquetes sur les accidents de transport terrestres (2007), Études sur les accidents mortels ayant impliqué des poids lourds en 2004, Amiens, 2007, p. 43 and p. 64, Department for Transport Statistics http://www.dft.gov.uk/statistics/releases/road-accidents-and-safety-annual-report-2011/table ras5005, Head Office of Polish Police, Dept. Analysis and Prevention

Since there are no precise figures on a EU level for road freight accidents caused by technical vehicle failure, an assumption is derived below from the statistics in Figures 16 and 17 that the proportion of road freight fatalities resulting from accidents caused by technical vehicle failure is at least 1% and at most 5% of the total number of road freight accident fatalities. Figure 18 therefore visualises how many persons in total would have died in road freight accidents caused by technical vehicle failure based on the lower assumption of 1% and the upper assumption of 5%.

Figure 18: Total road freight accident fatalities and total fatalities due to technical vehicle failure, 2003–2010



Source: Pace, J.F., et al. (2012), Basic Fact Sheet Heavy Good Vehicle and Buses, Deliverable D3.9 of the EC FP7 project DaCoTa

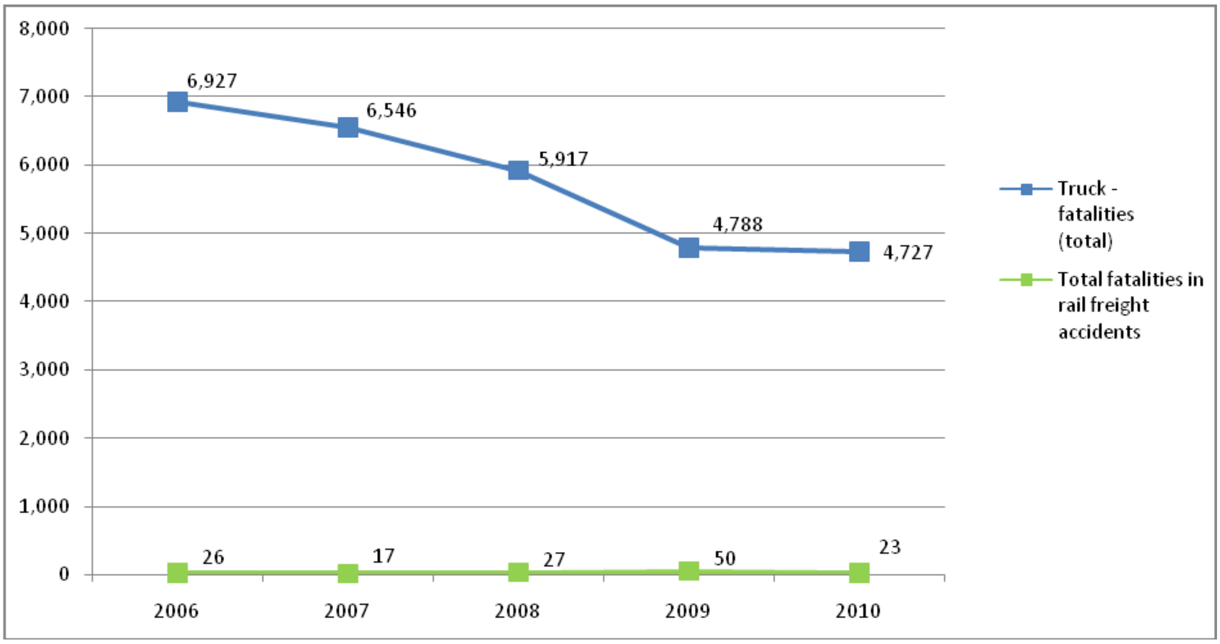
Expressed in absolute numbers, it will be assumed below that in 2010, for example, between 47 and 236 persons were killed in road freight accidents in the EU due to technical failure in vehicles, depending whether we apply the lower value of 1% or the upper value of 5% as the proportion of road freight fatalities caused by technical failure in vehicles.

4. Comparison of railway and road freight accident numbers

In this chapter we will compare the accident statistics for rail and road freight described in Chapter 3.1 and Chapter 3.2. As noted above, road freight accident statistics are available for the period 2003 to 2010, and rail freight accident statistics for the period between 2006 and 2012. To compare the two transport modes, therefore, the following analysis will focus on the years 2006 to 2010, as data for both transport modes is only available for these years. In addition, this comparison of the modes will only draw on data from those EU states which have data available for both. The following findings are therefore drawn from the EU 27 states with the exception of Bulgaria, Cyprus, Latvia, and Malta.

Figure 19 shows that significantly more persons were killed in road freight accidents than in rail freight accidents. During the same period of 2006 to 2010 a total of 28,905 persons were killed in road freight accidents, while 143 persons were killed in rail freight accidents. Therefore over 200 times as many persons were killed in road freight accidents than in rail freight accidents.

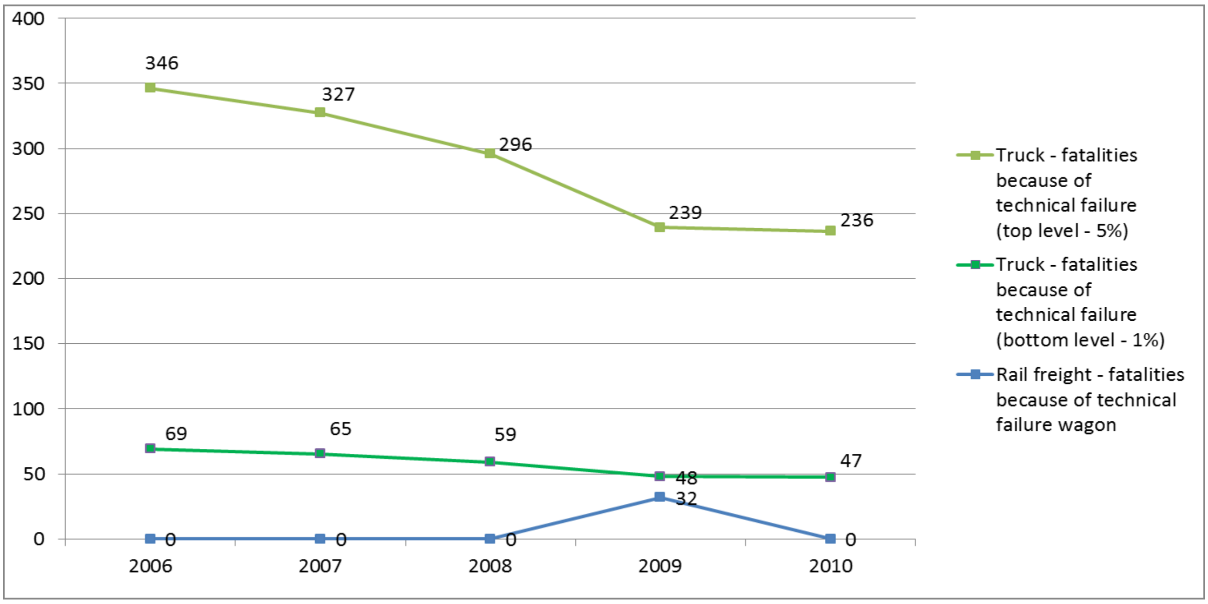
Figure 19: Total number of persons killed in road and rail freight accidents, 2006 to 2010



Source: Pace, J.F., et al. (2012), Basic Fact Sheet Heavy Good Vehicle and Buses, Deliverable D3.9 of the EC FP7 project DaCoTa and authors' evaluation of ERAIL European Railway Accident Information Links, www.erail.era.europa.eu/investigation.aspx, consulted on 7 June 2013

Figure 20 visualises the data calculated in the previous chapter on the proportion of road and rail freight accidents caused by technical failure in vehicles or rolling stock. The absolute number of road freight fatalities is greater than the number of rail freight fatalities, whether the upper assumption (5% of all road freight accidents caused by technical vehicle failure) or the lower assumption (1% of all road freight accidents caused by technical vehicle failure) is applied.

Figure 20: Total number of persons killed in road and rail freight accidents caused by technical failure, 2006 to 2010

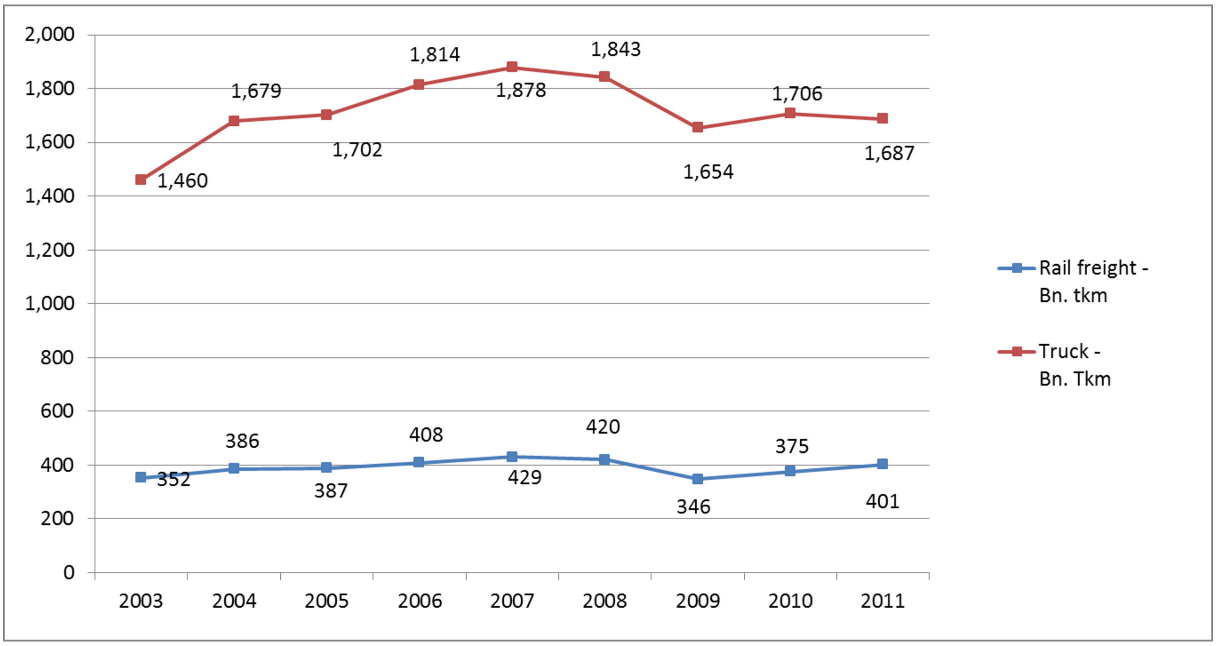


Source: Author's evaluation basedon Pace, J.F., et al. (2012), Basic Fact Sheet Heavy Good Vehicle and Buses, Deliverable D3.9 of the EC FP7 project DaCoTa und ERA (2013), ERAIL European Railway Accident Information Links, www.erail.era.europa.eu/investigation.aspx, consulted on 07 June 2013

It should be said that Figure 20 (above) does not take into account the fact that traffic volumes are far higher in road freight than in rail freight. A comparison of road and rail fatalities can only be performed when this number is placed in the context of respective traffic volumes.

Figure 21 shows that in the EU (excluding Bulgaria, Cyprus, Latvia and Malta) the roads carry approximately four times as much freight as the railways.

Figure 21: Road and rail freight volumes in the EU, 2003 to 2011



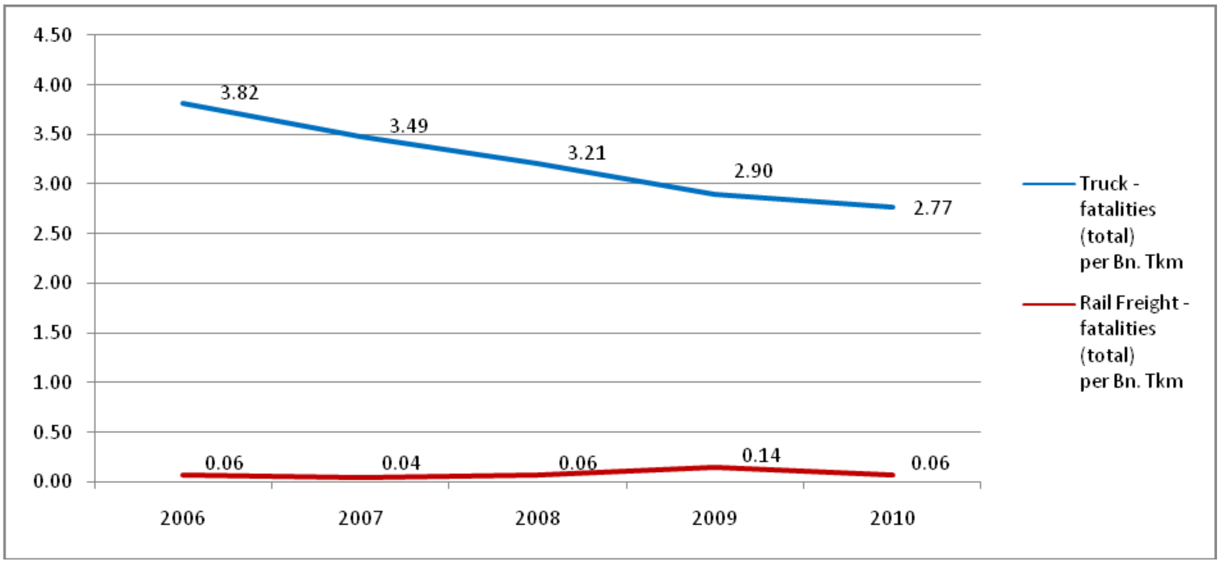
Source: EUROSTAT (2013)[40]

Even taking the significantly higher volume of road freight traffic into account, the number of road freight fatalities per billion tonne-kilometres is far greater than the number in rail freight (cf. Figure 22).

While the number of road freight fatalities per billion tonne-kilometres drops from 3.82 in 2006 to 2.77 in 2010, this value fluctuates at a comparatively low level in rail freight, between 0.04% (in 2007) and 0.14% (in 2009) fatalities per billion tonne-kilometres. This means that, even when factoring in the higher road freight volumes, far fewer persons are killed in rail freight per billion tonne-kilometres (from 20 times fewer in 2009 to 87 times fewer in 2007).

[40] http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do;jsessionid=9ea7d07d30e311876aec40d54504850a9edab928dbfb.e34MbxeSaxaSc40LbNiMbxeNaN0Qe0 und http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do, consulted on 10 June 2013, excluding Bulgaria, Cyprus, Latvia and Malta.

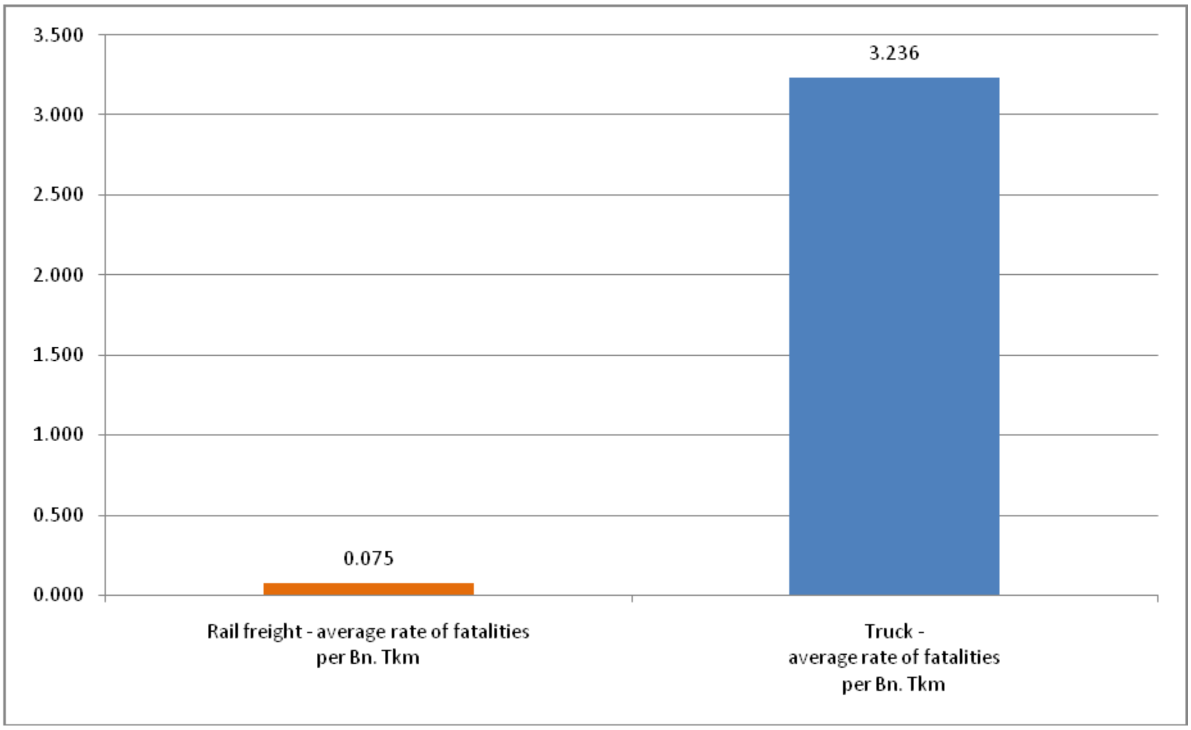
Figure 22: Number of persons killed in road and rail freight accidents per billion tkm, 2006 to 2010



Source: Author's evaluation based on EUROSTAT (2013), Pace, J.F., et al. (2012), Basic Fact Sheet Heavy Good Vehicle and Buses, Deliverable D3.9 of the EC FP7 project DaCoTa und ERA (2013), ERAIL European Railway Accident Information Links, www.erail.era.europa.eu/investigation.aspx, consulted on 07 June 2013

Figure 23 shows that, over the period 2006 to 2010, rail freight fatalities due to technical failures in rolling stock average out at 0.075 fatalities per billion tonne-kilometres, far lower than the equivalent road freight average of 3.236. This specific coefficient makes road freight fatalities 43 times more common than rail freight fatalities.

Figure 23: Average fatalities in road and rail freight accidents per billion tkm, 2006 to 2010



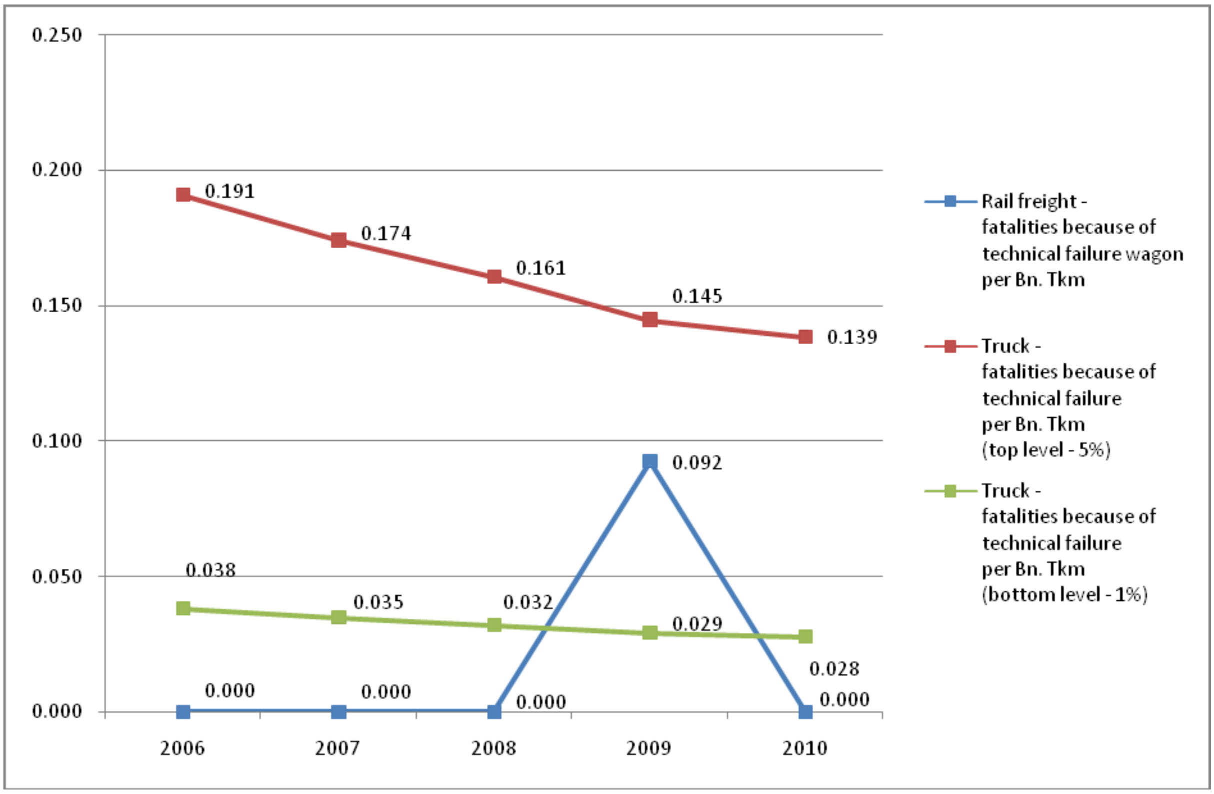
Source: Author's evaluation based on EUROSTAT (2013), Pace, J.F., et al. (2012), Basic Fact Sheet Heavy Good Vehicle and Buses, Deliverable D3.9 of the EC FP7 project DaCoTa und ERA (2013), ERAIL European Railway Accident Information Links, www.erail.era.europa.eu/investigation.aspx, consulted on 07 June 2013

The respective traffic volumes of the two transport modes will also serve as a basis for the absolute number of fatalities in road and rail freight accidents caused by technical vehicle failure depicted in Figure 20 (cf. Figure 24).

In the years 2006 to 2008, and again in 2010, this figure stood at zero for rail freight, there being no fatal accidents caused by technical failure in rolling stock during these time periods. In 2009, however, this figure stood at 0.092, meaning that 0.092 persons per billion tonne-kilometres were killed in accidents caused by technical failure in rolling stock.

In contrast to rail freight, for road freight this value stands above zero for every year between 2006 and 2010. The upper line on the graph (in red, for which 5% of road freight fatalities are attributed to technical vehicle failure) charts the fall of this value from 0.191 in 2006 to 0.139 in 2010. The lower (green) line on the graph (attributing 1% of road freight fatalities to technical vehicle failure) shows a range between 0.038 in 2006 and 0.028 in 2010.

Figure 24: Number of fatalities in road and rail freight accidents caused by technical failure per billion tkm, 2006 to 2010

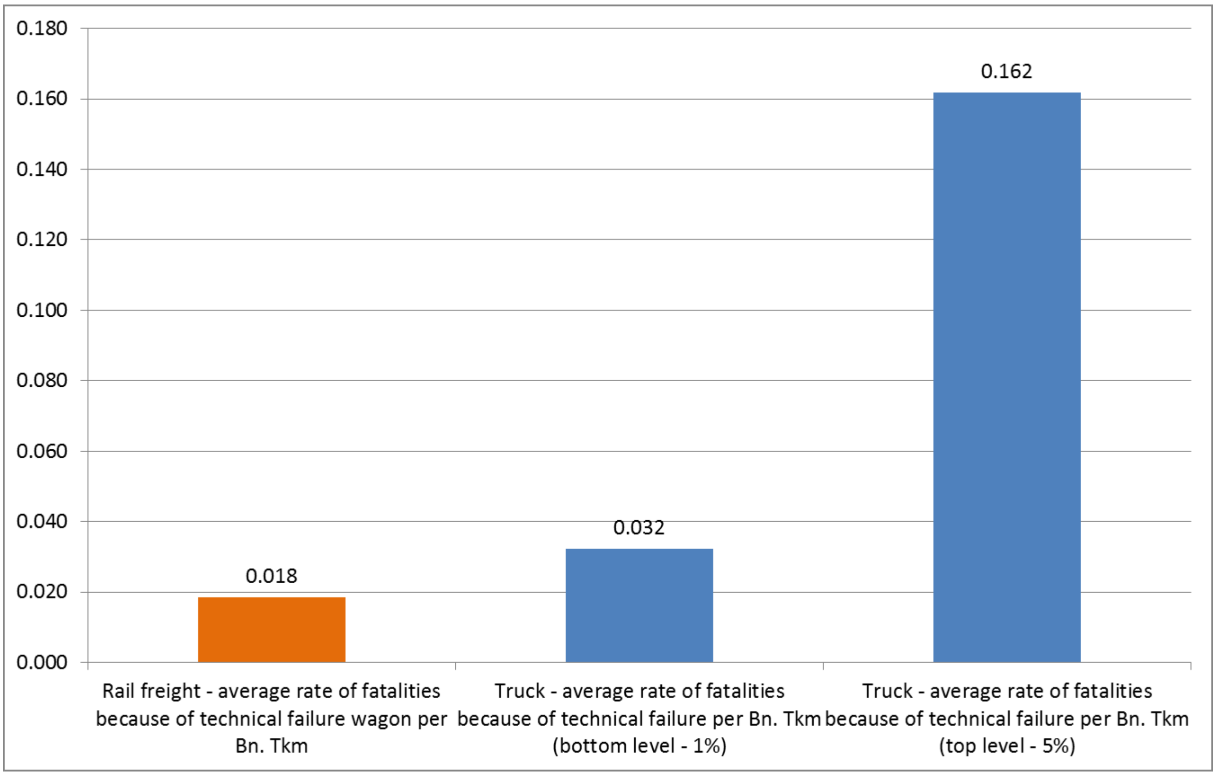


Source: Author's evaluation based on EUROSTAT (2013), Pace, J.F., et al. (2012), Basic Fact Sheet Heavy Good Vehicle and Buses, Deliverable D3.9 of the EC FP7 project DaCoTa und ERA (2013), ERAIL European Railway Accident Information Links, www.erail.era.europa.eu/investigation.aspx, consulted on 07 June 2013

The number of rail freight fatalities per billion tonne-kilometres in accidents caused by the technical failure of rolling stock is lower than the respective road freight values for every year except 2009.

Figure 25 shows that over the period 2006 to 2010 the figure of 0.018, signifying the average number of persons killed in rail freight accidents caused by technical failure per billion tonne-kilometres, is significantly lower than the two corresponding values for road freight at 0.032 (lower value of 1%) and 0.162 (upper value of 5%) respectively. This specific safety coefficient is approx. 2 to 9 times higher for road freight than it is for rail freight.

Figure 25: Average number of fatalities in road and rail freight accidents caused by technical failure per billion tkm, 2006 to 2010



Source: Author's evaluation based on EUROSTAT (2013), Pace, J.F., et al. (2012), Basic Fact Sheet Heavy Good Vehicle and Buses, Deliverable D3.9 of the EC FP7 project DaCoTa und ERA (2013), ERAIL European Railway Accident Information Links, www.erail.era.europa.eu/investigation.aspx, consulted on 07 June 2013

In Figure 25 it is apparent that in the years 2006 to 2010 the number of rail freight fatalities in accidents caused by technical failure in rolling stock is relatively low, particularly compared to the respective numbers in road freight. From this it can be deduced that rail freight vehicles displayed fundamentally high levels of safety even before the safety enhancement measures and regulatory measures outlined in this study. Following the implementation of those measures, safety levels probably improved further, without being able to alter the coefficient for the years in question.

5. Measures to enhance freight wagon security

There already exists a generally high level of safety in rail freight, as confirmed by the accident statistics outlined in Chapter 3, especially when these are compared with road-based freight (see Chapter4).

Before a waiting train can depart, it must be examined by a specially trained member of staff for faults or damage to the freight cars. There are rules laying down the types of damage which must result in the car being immediately released from the set.

Freight cars must be submitted to preventive inspection at intervals established under regulations, and this is so meticulous that under normal operating conditions the car will remain safe and fully functional until the next inspection. Wagon keepers have a duty to designate an ECM for every individual car. The ECM is responsible for compliance with the provisions of EU Regulation 445/2011. This includes creating and developing a maintenance system which defines maintenance principles. Under this maintenance system set up by the ECM, inspections can, among other things, be set at either time-based or mileage-based intervals. The dates and maximum mileage parameters are set out in individual maintenance plans. Apart from this preventive maintenance, corrective maintenance is of course carried out should the need arise.

In recent years the following measures have additionally been implemented in rail freight to enhance safety levels for freight cars operation.

For freight car wheelsets, the **European Common Criteria for Maintenance (ECCM)** were introduced. The main focus of the ECCM is as follows:

- "Improve the status of the axle surface […];
- Treatment of large and heavily corroded areas, strongly and uniformly pitted surface;
- Complete NDT on all axle sections in the medium wheelset maintenance
- level;
- Complete Magnetic Testing (MT) on the total axle surface in the highest wheelset maintenance level."[41]

Because the inspection requirements in ECCM are more stringent, wagon keepers to see a higher percentage of wheelsets scrapped, which increases costs to the wagon keeper.

Following the rail accident at Viareggio in 2009, the European Railway Agency (ERA), the national safety agencies and the Joint Sector Group (JSG) (made up of CER, ERFA, UIP, UIRR and UNIFE) agreed to introduce a **European Wheel Set Traceability database (EWT)**. Setting up the IT systems required and compiling and processing this data on an ongoing basis has incurred one-off and continuing costs.

Since 1 May 2011 the **European Visual Inspection Catalogue for Wheelsets (EVIC)** has been an integral part of GCU and is hence binding on the signatories. The aims of EVIC are:

- "to judge the axle status according the criteria in the European Visual Inspection
- Catalogue (EVIC);

[41] Cf. UIP International Union of Wagon Keepers (2011), "Economic Impact of New Rules and Regulations", Final Report, p. 14, Brussels.

- to remove axles from service not being in an admissible state (immediately / after unloading);
- to record a set of minimum data for the inspected axles;
- to hand over removed axles to maintenance with appropriate treatment and Non Destructive Testing (NDT)."[42]

The cost of visual inspection ranges across Europe from € 10 to € 26 per wheelset.[43]

Wagon keepers have been confronted with additional requirements from the regulatory sector in recent years. Article 14a of Safety Directive 2004/49 (amended by Directive 2008/110) provides that a certified Entity in Charge of Maintenance (ECM) must be allocated to every freight car. One-off and annual costs for ECM have been required in order to certify and maintain the safety management system.

Moreover, a decision was taken to create a **Rolling Stock Reference Database (RSRD)** to address the demands set out in the various maintenance regulations: although railway undertakings have a duty under Article 15.2 GCU[44] to inform wagon keepers how much use they have made of the cars they are deploying, full coverage has still not been secured. As mileage figures are relevant to safety, the UIP began in 2011 expending the **Rolling Stock Reference Database** envisaged in TAF TSI, which wagon keepers use to provide railway undertakings with the technical and operational data on their rolling stock free of charge, to include data relating to mileage. One-off costs and running costs are being incurred by the wagon keepers to adapt their own IT systems to RSRD and to process RSRD data in their own IT systems.

The above-mentioned measures to enhance freight wagon safety, combined with regulatory measures, have considerably driven up the costs of keeping and operating freight cars, as a UIP study in 2011 describes.[45]

However, the question does arise, particularly in light of the measures that have been implemented in the industry as described above and the associated increase in the cost of freight cars, whether further measures can actually generate and additional safety gain or whether the additional cost burden might not, indeed, be counterproductive. It is extremely probable that any further pressure on costs would further weaken the competitive position of rail compared with trucks, with the result that freight is shifted to a mode of transport which, statistically at least, is less safe than rail freight.

[42] Cf. UIP International Union of Wagon Keepers (2011), "Economic Impact of New Rules and Regulations", Final Report, p. 10, Brussels.
[43] Cf. UIP International Union of Wagon Keepers (2011), "Economic Impact of New Rules and Regulations", Final Report, p. 10, Brussels.
It is obligatory for the visual inspection of wheelsets to be performed at every single visit to the workshop, even if the car has only recently been subjected to this test.
[44] GCU = General Contract for the Use of Wagons
[45] Cf. UIP International Union of Wagon Keepers (2011), "Economic Impact of New Rules and Regulations", Final Report, Brussels.

6. Impact of increased costs on the competitive status of rail freight

The following section draws on examples of freight dispatched by rail and road along the Rotterdam-Genoa corridor to illustrate the additional impact that further cost increases for wagon keepers and operators could have on the current ability of rail to compete in the freight market.

To this end, calculations were performed for the transportation by rail of the following types of cargo in the types of wagon indicated:

- Rotterdam – Genoa: Steel transported in Shimmns cars
- Rotterdam – Genoa: Oil transported in four-axle tank cars
- Rotterdam – Genoa: Containers transported in 80'container wagons

Results of calculations

In the light of the costs currently incurred in rail freight for track, energy, traction car, freight cars, operating staff and overheads, the share of the overall costs accounted for by freight wagons on the Rotterdam to Genoa route amounts – depending on the type of car and its turnaround time – to between 20%and 30%. If freight wagon costs now increase as a result of additional regulations or other measures, the total costs of rail freight will rise accordingly. Total cost sensitivities to an increase in freight wagon costs are shown in Figure 26.

Figure 26: Sensitivities of rail freight to increased freight car costs

	Increase in rail freight costs (%) assuming x% increase in wagon costs					
	10%	**20%**	**30%**	**40%**	**50%**	**60%**
Containers **20 x 80' container wagons**	2.4%	4.8%	7.1%	9.5%	11.9%	14.3%
Steel **20 x Shimmns**	2.6%	5.3%	7.9%	10.6%	13.2%	15.8%
Oil **20 x four-axle tank car**	1.9%	3.8%	5.7%	7.6%	9.5%	11.4%

Source:Author's calculations

Even if freight wagon costs were to increase by 10%, the total costs of the rail freight operation would rise by anything between 1.9%and 2.6%. If freight wagon costs increase by 20%, for example, total costs will be driven up by between 3.8 %and 5.3%etc.As price competition between trucks and trains is extremely intense and the profit margins for hauliers tend to be in lower single-digit figures, even a slight change on the overall cost position can contribute to a significant deterioration in the competitive position of rail as a mode of transport.

7. Conclusions

The comparison of accident statistics for road- and rail-based freight described in Chapter 4 shows that the current level of safety in rail freight is higher than for road freight. Whereas from 2006 to 2010 on average 3.236 persons per billion tonne-kilometres died annually in road freight accidents, for rail freight this average stands at 0.075 persons per billion tonne-kilometres, which is 43 times lower than the figure for road freight.

Whereas human factors, such as inappropriate speed and flouting traffic rules, are the main cause of accidents in road freight operations, in rail freight most fatal accidents occur at level crossings, followed by rolling stock in motion, derailments and collisions between trains. During the reporting period from 2006 to 2012, only one fatal accident due to a technical failure in rolling stock was identified. As there are no EU statistics on road freight accidents caused by technical failure in vehicles, the present study draw on an academic study and on the data kept by several national statistics agencies to arrive at some assumptions. In summary, the figures derived suggest that in at least 1% and at most 5% of all fatal accidents involving road freight the cause of the accident was a technical failure in the vehicle. The ERAIL database maintained by the European Railway Agency provided precise figures for rail freight fatalities attributed to technical failures in rolling stock.

Here again, it emerged that in the period from 2006 to 2010 there were on average far fewer deaths on the railways than on the roads in freight accidents caused by technical failure in vehicles or rolling stock (0.018 fatalities per billion tkm in rail freight compared with 0.032 to 0.162 fatalities per bill. tkm in road freight).

With regard to all fatal traffic accidents in general and to accidents caused by technical failure in vehicles in particular, this means that the safety level of rail freight is much higher than that for road freight.

Drawing on a significant example, the Report was able to show how intense competition between rail and road is and what impact even minor cost increases can have on the modal split.

In the final analysis, it is clear that if one mode of transport suffers a unilateral cost burden without this being offset by a significant benefit (e.g. enhanced safety levels) that mode of transport will witness a deterioration in its competitive standing. In the case of rail freight, this would mean cargo shifting increasingly to the roads. Such a shift would, both in general terms and with regard to accidents caused by the factor “technical failure in vehicles”, imply an acceptance of the lower safety level on the roads.

The rail freight sector recognizes that accidents caused by technical faults in rolling stock must be ruled out as far as possible. A question does arise, however, as to how much technical, organisational and financial effort can and should be invested in further improving the already very high level of safety. It can be assumed that with each additional measure the marginal utility to be gained by improving safety levels in rail freight will diminish. Further measures that drive costs upwards are likely to result in a relatively limited impact on what is already a very high safety level, and yet at the same time would considerably damage the competitive position of rail freight.

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