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EXPLORING OPTIONS FOR REDUCING CO_2 EMISSION FROM FREIGHT TRANSPORT

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Abstract: The harmful emissions from transport participants - including carbon dioxid -, are largery responsible for the climate change. As freight transport is a significant part of transport, nowadays serious emphasis should be placed on the investigation and reduction of the emissions of freight vehicles. In this article, we made calculations about CO_2 emissions of freight transport related to each transport in sub-sector. The aim of our examination is to describe the possibilities of reducing harmful substances emitted during the movement of goods through calculations, so that the emission values meet the targets set by the European Union.
Keywords: road freight transport, emissions, CO_2 reduction, environmental protection, sustainable logistics, European emission standards system

1. INTRODUCTION

Nowadays one of the most important environmental, social and economic problems is climate change, one of the causes is the emission of transport pollution including the level of CO_2 emissions, whereas it is the most harmful substance emitted into the atmosphere in terms of global warming. During the logistics material handling and freight transport, a large amount of pollutant emissions is generated, thus the connection between material handling activity and pollutant emissions should be examined in terms of environmental impact.

We are investigating this topic because nowadays environmental pressures is a significant problem not only in the fields of scientific research, but also in society. It endangers the living conditions of humanity, and the living conditions of the future generations.

The European Union is committed to reducing greenhouse gas emissions, one of its main goals is to reduce 60% of the CO_2 emissions from transport by 2050 compared to 1990 data [European Parliament, 2008]. One of the main goal, what is necessary to check on every process, which has a significant impact on climate change.

In the EU the road transport is responsible for 72% of CO_2 emissions from transport, of which 38.1% it can be related to freight transport. [European Environment Agency, 2016.]

According to the current direction of development, a smaller and smaller amount of goods is constantly being moved and the deadlines are getting shorter. This trend is accompanied by a gradual decrease in inventory costs, however it increases the load of the environment.

2. THE WAY OF TRANSPORT USED FOR THE MOVEMENT OF GOODS

In the case of the movement of goods, several factors determine the way of transport we choose, thus the form of the goods, physical, chemical, and biological characteristics, and also important to know the transit process [Fülöp-Vincze, 1997]. The transport distance determines the choice of vehicle (land, sea, air), but it is very important to know how combine different ways of transports. The time period and the handling of goods also have a significant influence on the transport.

The subdivision of freight vehicles is mainly selected by transport sector:

- means of rail transport
- means of road transport
- means of water transport
- means of air transport
- means of transport by pipeline

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The different type of goods determines the way of transport, such as size and construction in vehicles. Determine factors of the goods:

- type and characteristics of the goods
- method of transport packaging (bag, barrel, chest, unit load)
- shape, size and quantity of the goods
- the interaction between the substance and the environment, the goods should be protected from the environment (for example: rapidly deteriorating goods), or whether the environment should be protected from the goods (dangerous goods).

The increment of freight transport can be observed in the field of services, related to the supply of goods and production by the population.
The main reasons of the increment in transport demand are [D. Kiss, 2008]:

- increase the proportion of deliveries based on the Just In Time principle. In the production area increasing the frequency of deliveries, and the inventory reduction can be achieved
- increasing cooperation with service companies
- the number of product types is increasing and the size of consignments is decreasing
- globalization of the supply chain (the parts of source from abroad)
- traders to reduce stocks (they order more often and less).

3. ANALYSIS OF DATA RELATED TO FREIGHT TRANSPORT PUBLISHED ON THE WEBSITE OF THE CENTRAL STATISTICAL OFFICE

The data of Hungary for 2019 have already been uploaded to the website of the Central Statistical Office [KSH, 2020], in the article we present the proportion of road freight transport for all types of freight transport. The data refer to rail, road, water, and pipeline transport, air freight is not shown separately, as there was no data on it.
As the Figure 1 shows, road freight transport, measured by the weight of transported goods, accounted for 65% of total freight movements.

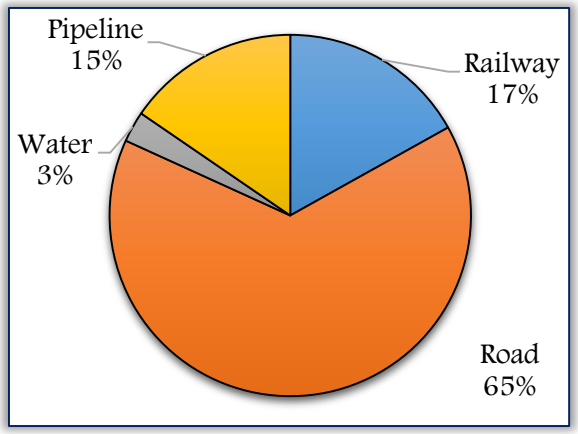

Figure 1. Distribution of way of transport, based on the weight of transported goods
Source: Editing by the author based on CSO data

Table 1. Distribution of way of transport, based on the weight of transported goods (thousand tonne).
Source: Editing by the author based on CSO data

2019	Mass of transported goods in Hungary (thousand tonne)				
	Railway	Road	Water	Pipeline	Altogether
Internal freight transport	14 573	166 231	122	19 230	200 155
International freight transport	38 106	35 958	8 470	28 895	111 429
Summary	52 678	202 189	8 592	48 125	311 584

Table 2. Distribution of the way of transport per tonne-kilometre
Source: Editing by the author based on CSO data

2019	Tonne-kilometre in Hungary (million)				
	Railway	Road	Water	Pipeline	Altogether
Internal freight transport	1 735	13 546	5	2 420	17 705
International freight transport	8 952	23 287	2 115	6 480	40 834
Summary	10 687	36 832	2 120	8 901	58 540

It is shown in the Figure 2 below that road freight transport accounted for only 63% of total freight traffic per tonne-kilometre. The reason for this is that rail and water transport are more suitable for transporting heavier goods than road freight transport. Which goods that can be moved in one heavy weight are transported on these means of transport.
The Table 3 below summarizes internal and international data related to road freight transport, from 2015 to 2019, broken down into year.
Analyzing the data, compared to 2015, in 2019 the following changes took place in road freight transport:

- the weight of internally transported goods increased by 4.88% and the value of freight tonne-kilometres increased by 30.68%
- in the case of internationally transported goods, the weight of goods decreased by 10.67% and the value of tonne-kilometres decreased by 30.68%
- it means in totally the weight of the transported goods are increased by 1.73% and the value of freight tonne-kilometres decreased by 3.96%.

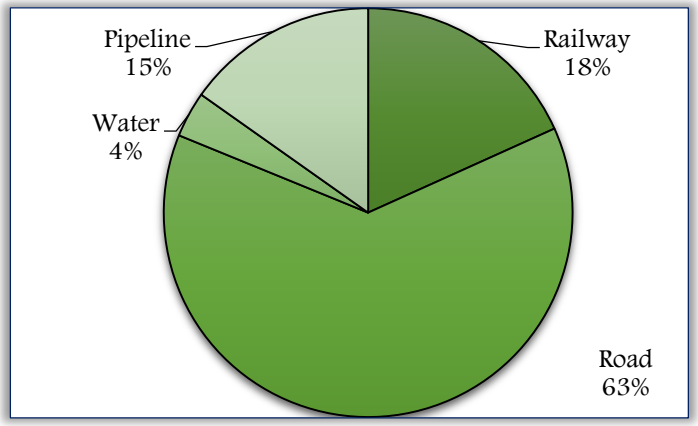

Figure 2. Distribution of transported goods by tonne-kilometre
Source: Editing by the author based on CSO data

Table 3. All road transport between 2015-2019 Source: Editing by the author based on CSO data

All road freight transport						
Period	Internal freight transport (Hungary)		International freight transport		All freight transport	
	Mass of transported goods (thousand tonne)	Tonne-kilometre (million)	Mass of transported goods (thousand tonne)	Tonne-kilometre (million)	Mass of transported goods (thousand tonne)	Tonne-kilometre (million)
2015	158 490	10 366	40 253	27 986	198 743	38 352
2016	156 663	11 856	41 099	28 151	197 762	40 006
2017	147 048	12 156	41 211	27 531	188 259	39 687
2018	169 601	13 193	37 068	24 755	206 669	37 948
2019	166 231	13 546	35 958	23 287	202 189	36 832
Change compared to 2015 data (percentage)	4,88	30,68	-10,67	-16,79	1,73	-3,96

4. EMISSIONS FROM TRANSPORT

The harmful effects of transport on the environmental we mean air pollution, noise and vibration loads, soil and water pollution and waste generated from transport vehicles [Széchenyi István University Department of Transport, Science of Transport Note].

We narrowe down the analysis to emissions, analysis of effects on noise and soil pollution, waste formation and road network load is not part of the study. When we talk about emission, we also examine the extent of carbon dioxide emissions, because it is the most harmful substance emitted into the atmosphere in terms of global warming.

The extent of air pollution from road vehicles also depends on the number and composition of the vehicle fleet, and the distribution of the area (spatial distribution) and traffic continuity (time distribution).

Reducing greenhouse gas emissions: EU objectives and actions, it can be read in this article which published in 2018 [European Parliament, 2018], transport is the most significant source of greenhouse gas emissions. Based on information published on the page of the European Commission under the Paris Convention [The Commission calls for a climate neutral Europe by 2050, 2018], CO_2 emissions must be reduced to 60% of 1990 levels by 2050 and the increasing of emissions from transport must be stopped.

According to the European Parliament, transport is responsible for 30% of CO_2 emissions, which 72 per cent related to road transport, the prevention and emission reduction measures should be targeted primarily in this area. In addition to tightening emission rules, improving fuel quality and the development of the road network these would be the most important task (establishment of a bypass and relief road network).

5. CHANGE IN SPECIFIC CO_2 EMISSIONS

Data published by Deutsche Bahn [Inclusion of CO_2 equivalents also for specific emissions, 2017] on the change in specific CO_2 emissions per mode between 2014-2016. Based on this data, the conclusion is that in 2016 the CO_2 equivalent of all ways of transport decreased compared to the 2014 values.

Table 4. Specific CO_2 equivalent of transport ways (g / tkm) in Germany in 2016
Source: Editing by the author based on Deutsche Bahn data

Specific CO_2 equivalent of transport ways (g / tkm) in Germany			
Way of transport	2014	2015	2016
Road freight transport	112,0	92,3	97,4
Rail freight transport	22,4	21,9	20,8
Water freight transport	9,4	8,6	6,9
Air freight transport	789,0	773,0	757,0

As the table shows, that road freight transport emits 76.6 g less CO_2 per tonne per kilometer than rail freight transport.
Taking into account the data in Table 3, about 10% of road freight traffic could be diverted to rail freight transport, it would emit 282,000 less tonnes of carbon dioxide in freight transport only in Hungary.

6. EMITTED CO_2 BY TRANSPORT SUB-SECTOR IN HUNGARY IN 2019

Figure 2 shows that road freight accounts for 63% of the goods transported per tonne-kilometer, which represents 36,832 million tonne-kilometre of freight (Table 3).
Based on the data in Figure 2 and Tables 3 and 4 the value of CO_2 emissions per freight sub-sector is shown in Table 5.

Table 5. Emitted CO_2 by freight sub-sector in Hungary in 2019.
Source: Editing by the author based on CSO and Deutsche Bahn data

Emitted CO_2 by transport freight sub-sector in Hungary in 2019			
Way of transport	Specific CO_2 equivalent of ways of transport (g / tkm)	Freight tonne-kilometers (million)	CO_2 emitted (tonnes)
Road freight transport	97,4	36 832	3 587 437
Rail freight transport	20,8	10 523	218 878
Water freight transport	6,9	2 338	16 132
Summary			3 822 447

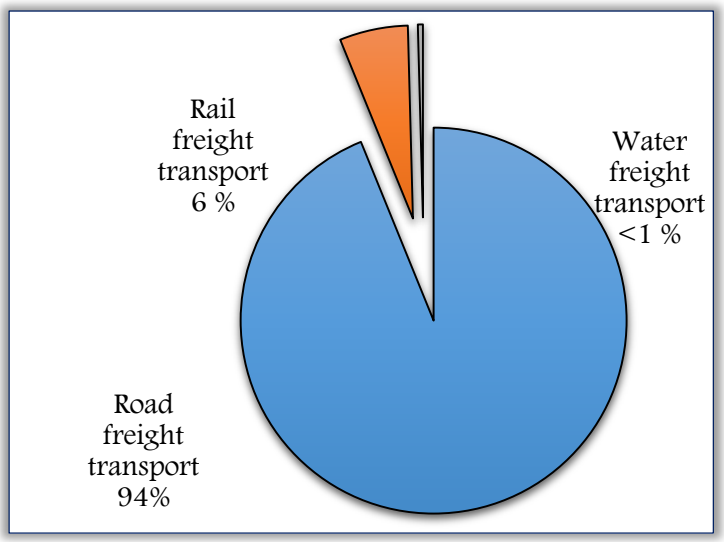

Figure 3. Emitted CO_2 by transport freight sub-sector in Hungary in 2019.
Source: Editing by the author based on CSO and Deutsche Bahn data

Road transport is almost exclusively responsible for the amount of CO_2 emitted by freight transport.

7. EU EMISSIONS TARGETS

The European Union's goal is to reduce CO_2 emissions by 2050 the emission level has to reach the 60 percent of the 1990 levels of emission. There is no specific limit on transport-related CO_2 emissions, but we would like to use this proportionality in our present study.
According to the data of the Central Statistical Office [KSH, 2018], 3,868 thousand tonnes of CO_2 were emitted by freight transport and storage in 1990. If we want to reduce this to 60% in that case by 2050 it should be reduced to 2 321 thousand tonnes. According to 2017 data, the amount of emission was 4,231 thousand tonnes, which means statistically this is a strong growth instead of decline. The CO_2 emission must be reduced by 1910 thousand tonnes by 2050.
How can we achieve this reduction?

1) As we have previously calculated, if 10% of road freight traffic could be diverted to rail freight transport, it would emit 282 thousand tonnes less CO_2 in freight transport only in Hungary. This is 15% of the total mitigation task.
2) Continuous tightening of the Euro-norm system [European Standards 2020] has significantly reduced vehicle engine emissions from year by year, which is constantly having an impact on the fleet rejuvenates.
3) Developments from railway technology and the reduction of specific emissions from energy production also have a significant impact on CO_2 reduction.
4) By increasing stocks and moving them in larger bulk, a hectic logistics system requiring immediate deliveries, these could be avoided.

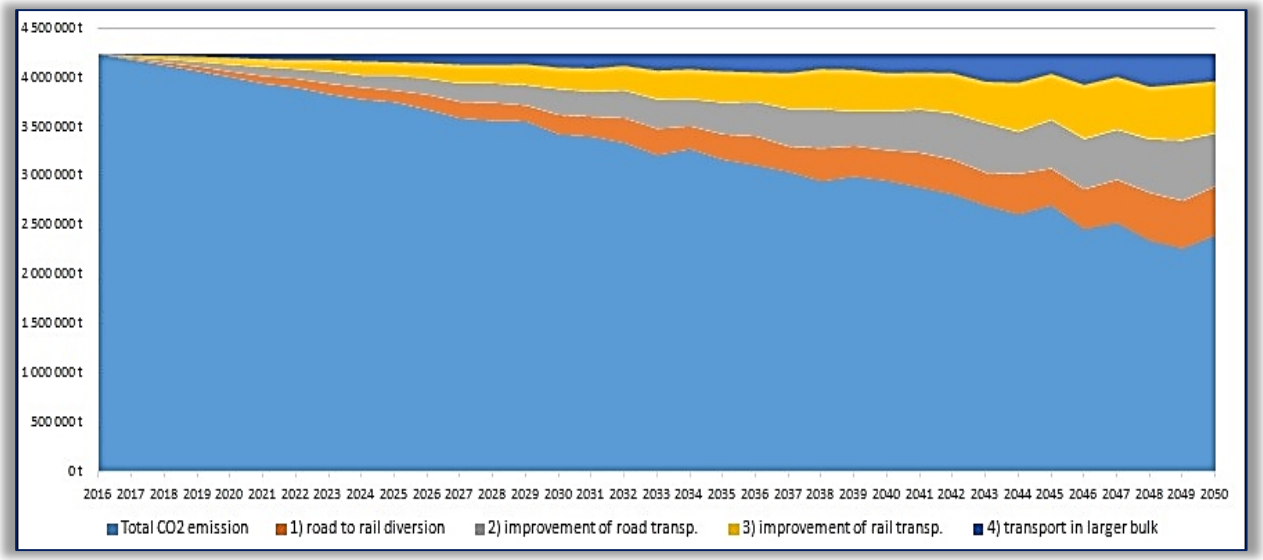

Figure 4. Summaries of the effects of CO2 reduction activities

In our view, the plans formulated by the European Union can be implemented by summarizing the effects of the above-mentioned trends.

8. CONCLUSION

They are looking for solutions to reduce pollution in all areas of science, therefore emissions from transport are given priority. However, it should not be forgotten that a significant part of road transport is related to the movement of goods, so special attention should be paid to reducing and optimizing freight transport.

As the EU aims to reduce CO_2 emissions to 60% by 2050 compared to 1990 levels, significant action is also needed on freight transport.

In our examination, we described the possibilities of reducing harmful substances emitted during the movement of goods through calculations. By shifting road freight to rail, a significant reduction in CO_2 emissions can be achieved, but we also explored further options to reducing potential CO_2 emissions from freight transport.

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