

ITS APPLICATIONS FOR HIGHER PRODUCTIVITY OF ROAD FREIGHT TRANSPORT



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Abstract

Recent years have shown ever increasing road freight volumes and it is forecast that the increase is likely to continue. At the same time investment in the road infrastructure is declining, which puts more stress on existing infrastructure that will have to handle the increasing road traffic volumes. This paper investigates how increasing the productivity of the road freight vehicles could be a part of the solution. And how the use of ITS technologies, including vehicle tracking, route planning and geo-fencing, could ensure political acceptability of these vehicles and minimise costly infrastructure upgrades. Some of the approaches that could be used to proceed with increasing weights and dimensions of road freight vehicles to improve their productivity are outlined.

Keywords: ITS, road freight transport, high productivity vehicles

1. Introduction

Recent years have shown ever increasing road freight volumes and it is forecast that the increase is likely to continue. At the same time the investment in the inland transport infrastructure is declining in the recent years¹, meaning that in most cases the existing infrastructure will have to handle the increased road freight volumes.

A cost-efficient solution to this emerging infrastructure supply and demand imbalance should be sought, and a part of the solution could be to increase the productivity of the road freight vehicles. A previous report of the International Transport Forum / OECD (2011) “Moving Freight with Better Trucks” investigates technical approaches that could be followed for increasing the dimensions and weight of road freight vehicles, whilst keeping or even improving their technical performance characteristics.

From the government perspective, the increase of the regulated weight and size limits in road freight may appear like a simple and cheap solution, but the impacts on the infrastructure of larger and heavier vehicles need to be considered. These impacts may not be uniform, with specific parts of the network being particularly vulnerable. Specific Intelligent Transport Systems (ITS) technologies, including vehicle tracking and route planning, can ensure that larger and heavier vehicles are confined to geo-fenced areas of the network, where their impact is minimal.

2. Research approach

This paper is based on the work carried out by the ITF/OECD on the topic of higher efficiency road freight transport and related ITS technology since the publication of the ITF’s report “Moving Freight with Better Trucks”. Particularly relevant work streams in this context are follow-on work for that report, analysing examples of successful implementation cases to identify common characteristics, factors or conditions that have contributed to their success, and policy research into ITS-based solutions for data-driven governance schemes.

In this context ITS measures have been crucial to enable the review and relaxing of the existing weight and dimension limitations in different locations around the world for specific vehicles or vehicle types. Desk research was used for investigating the cases with the aim of learning from successful ones in the past where ITS measures have been used for enabling the increase of weight and size limits. This allows producing guidelines for developing successful transport policies by investigating the underlying issues for market and impact, ITS and governance frameworks, and road safety implications.

¹ International Transport Forum / OECD (2017)

3. Discussion

3.1 Market and impact

Impact of HCVs

The distinguishing characteristic of High Capacity Vehicles (HCV) from the business perspective is that they are able to transport a larger weight or/ and volume of cargo in one trip than a normal vehicle would². For a haulier, when using these vehicles, the challenge is to optimize the use of loading capacity in transport operations so that the largest amount of cargo could be transported.

In practice, depending on the cargo type the loading capacity of the vehicle will be limited either by the weight of the transported freight, or by the volume of it. For example, in transport of steel the whole allowed volume of the freight vehicle will not be fully utilized, because the weight and axle load limitation will be reached. Similarly, the transport of plastic foam products will be limited by the volume of the volume of trailer, but not the maximum allowed weight or the axle loads. Densities of some commodities are listed in Table 1.

Table 1 – Density of common commodities (kg/dm³ = t/m³)

Commodity	Density t/m³
Water, Milk, Beer, etc.	1
Fuel, Oil, Ethanol, etc.	0.6 – 0.8
Earth	1.3 – 2.0
Concrete	2.2
Bricks	1.9
Alloy	2.7
Steel	7.9
Wood (dry)	0.5 – 0.9
Rubber	1.2
Beer boxes with 20 empty bottles (0.3mx0.3mx0.4m), 10 kg	0.3
Beer boxes with 20 filled bottles (same size, but 20 kg)	0.6
Refrigerators (white goods)	0.13
Nine passenger cars,1.5 t each, on a 100m ³ transporter	0.135
Single dispatched items (parcels)	0.15
Plastic foam	0.04

Source: International Transport Forum / OECD (2011)

The increase of weight limits and maximum axle loads for HCVs will mostly have an impact on the transport of types of cargo that are weight limited, like steel. Similarly, the increase in the maximum allowed dimensions of the vehicle will mostly impact the cargo types that are volumetrically limited. With increased vehicle size the main benefits for the haulier include: more efficient use of the vehicle, reduction of fuel consumption per unit of transported cargo³,

² A summary of the weight and dimension limitations of the vehicles is regularly assembled by the ITF for the ECMT countries and published on ITF website, <https://www.itf-oecd.org/weights-and-dimensions>.

³ Woodrooffe (2017)

reduction labour expenses per unit of cargo. This also has a positive externality of lower pollution and greenhouse gas emissions associated with the transportation of the cargo.

The impacts of introduction of HCVs will differ depending on implementation case, the geographical environment, the operational pattern of the company, the type and density of the cargo, and other factors. The main result in most cases will be the increased efficiency of operations per unit of transported cargo. Improving the asset and labour utilisation and energy efficiency of road freight transport will improve its competitiveness, making it difficult for alternative, lower-carbon modes to increase their share of the freight market.

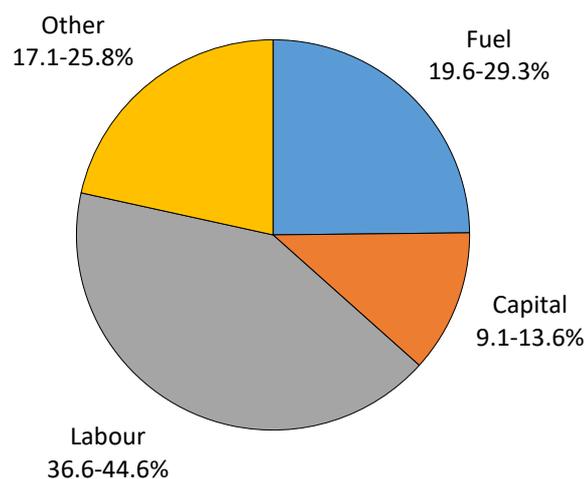


Figure 1 - Road haulier cost structure in European countries, min-max range in %

Data source: Panteia (2018) for Austria, Belgium, Denmark, France, Germany, Great Britain, Italy, the Netherlands, Norway, Spain and Sweden.

The labour, capital and fuel costs are the three major cost components of road hauliers, see Figure 1, and the use of HCVs can be a way for reducing those and improve the road transport cost efficiency. The mode shift impacts that the increases of road transport efficiency and consequent cost reductions bring seem to have been overestimated in the prior research, de Jong (2017). Different mode choice is only one possible reaction to price change.

Other possible reactions of the shippers include changes in: fuel efficiency, transport efficiency, transport demand and different commodity demand. In an example from Sweden it has been shown that increases in road tonne-km are mainly driven by other factors than increased road transport efficiency due to use of HCVs, Vierth (2017).

Potential applications

Universal increase of weights and dimensions of vehicles is neither needed nor desirable, and sometimes even not possible due to existing infrastructure limitations. However, in specific circumstances relaxing existing regulations for some types of activities or geographical areas can bring considerable advantages for hauliers, shippers and society as a whole.

An attractive situation for use of HCVs could be in cases where large volumes of either volume- or weight-limited cargo need to be transported on specific routes within a limited road network, and where the existing infrastructure requires no or minimal investment for allowing those vehicles on the roads, and also where alternative transport modes may be either unavailable or cost more in transportation of the specific cargo type. In this case a higher economic efficiency could be reached, having the positive social benefit from reduced number of vehicles, lower emissions and less vehicles on the roads.

Other potential applications for HCVs are where the cargo is volumetrically limited, like in the transport of low density cargo. Also, sometimes the use of HCVs is justified in cases where the competitiveness of the industry that is served is low, e.g. mining, and it serves the purpose of preserving employment in that industry. This is the case in far North Western Australia, where due to low iron ore and other commodity pricing the local operations were impacted, which brought the need to seek more efficient ways of transporting raw materials to the Utah port, Koniditsiotis (2018a).

Modal shift policies

To alleviate the pressure of freight traffic flows on the road infrastructure the transport policies on national and supranational level have promoted mode shift away from road, usually to rail or inland waterways, for decades. In the European Union (EU), for example, the most recent mode shift goals can be found in the 2011 EU White Paper on Transport, which aims at shifting 30% of road flows above 300 km to rail and inland waterways by 2030 and 50% by 2050. But statistics show that in the EU the mode shift policies have not been effective, with impacts being much lower than the research results suggest⁴.

Elsewhere in the world the share of road transport has also been growing steadily with some exceptions, e.g. in the US, where the volumes of road freight have reduced slightly. The share of rail stays relatively high in CIS countries, where primary products demand cheap transportation over large distances, which gives rail uncontested advantage.

Although the total freight transport costs are important in mode choice decision making, other factors than price, including time sensitivity of the goods, reliability and flexibility are important. It is also important that much of the freight market is non-contestable amongst modes, which means that a small part of the whole market is subject to road-rail or road-inland waterway competition. Therefore additional mode shifts will be difficult, unless more aggressive and/ or costly policies are employed.

Regulatory accommodation is crucial for adoption of HCVs, because without relaxing existing vehicle size, weight and axle load limitations the operation of such larger and heavier vehicles is impossible. Policymakers at the different levels of government are the drivers for policy change, e.g. the minister of transport, who would have to see how HCVs could contribute to achieving their transport policy goals.

⁴ A review of price elasticities can be found in Significance and CE Delft (2010), *Price sensitivity of European road freight transport – towards a better understanding of existing results*, report 9012-1 for Transport & Environment, Significance and CE Delft, The Hague and Delft.

Stringent enforcement thanks to technological developments, like use of GPS tracking systems and automated weighing and vehicle measuring technologies, can help overcoming the obstacles. They can reliably ensure that the weight and dimension limitations are not exceeded, and that the vehicles are staying within the designated geographical areas where their operation is allowed. The operations can also be limited to specific stretches of roads that are suitable for HCV operation.

Suitability of the road infrastructure must be evaluated when designing the rules for HCVs. Infrastructure characteristics, e.g. radius of the roundabouts or maximum load capacity of the bridges that need to be crossed, can be a limiting factor. Therefore often it may be wiser to limit the implementation areas to specific routes or geographical areas where niche transport markets would benefit from efficiency increases.

3.2 ITS and governance frameworks

Regulatory requirements

Legislators around the world have created a legislative environment for regulating the road freight transport industry. Also, due to the international nature of road transport in parts of the world with smaller countries and relatively open international road freight markets, the most important rules and regulations in the field are supranational. National regulations are more important in larger countries with significant domestic freight markets and low levels of openness for foreign operators. Rules and regulations, both national and supranational, must be enforced to deter offenders from repeated infringements and to promote responsible behaviour of drivers and road freight operators.

Types of regulation

Three key types of regulations are governing road freight transport:

- **Vehicle condition rules:** relate to the technical condition that the vehicle must meet to be able to perform freight transport operations in the market.
- **Market-based rules:** are those that apply to road haulage operators and regulate their access to the road transport market or its specific segments. They could be rather general and specify what provisions the haulier has to fulfil to obtain a licence and be able to operate in the market, or specific.
- **Driver-based rules:** are those that apply to access to the profession and the actions of the driver when at work, resting or in the state of availability to perform their duties. They include social rules, but also relate to actions that the driver might take when driving, including those regulated by the traffic code.

Enforcement practices

The cost-efficient enforcement of road haulage rules and regulations among different countries or regulatory regimes is complicated due to the lack of alignment, harmonisation and application. The enforcement of road haulage rules for regulating road-based freight transport is carried out via:

- **On-the-spot roadside checks:** are carried out either at the roadside or at dedicated sites where authorities check vehicle condition rules, market-based rules and driver-based rules. In order to carry out these controls, countries must assign a competent

authority and enable that authority to legally carry out enforcement actions. In many cases the police are assigned this role but due to the complexity of some rules and requirements for special equipment, it could also be another dedicated entity.

- **Checks on company premises:** allow enforcement of specific legislation, e.g. the company registration or some of the driver-based social legislation. In on-premise checks, control officers visit the company and physically check the records and documents that the company is required to hold either in paper or digital form. Such checks, like the roadside ones, are slow and quite expensive and cannot be performed on a regular basis in every company.

ITS-based opportunities

Various applications of new technologies can contribute to a more efficient as well as a more flexible regulatory framework for road-based freight transport. These technologies include various in-vehicle systems and road-side/ infrastructure systems. These and other technologies produce data that opens new possibilities for lighter but more comprehensive and widespread enforcement actions. This previously unavailable data also may make real-time enforcement a possibility and lead to an overhaul of regulations towards more data-driven approaches.

The combination of conventional and novel data sources, the innovative use of data sets and data sources beyond its originally intended purpose, advanced (both real-time and historical) data analytics, and new business models enable new tailored services to enter the road-freight and logistics market. In addition recent developments including vastly improved digital connectivity including ubiquitous use of mobile devices, coupled with mobile internet access, have helped speed up these processes.

A shift to data-driven policy and regulation, enabled by these developments, holds the promise of offering policy makers and regulators a superior tool for detecting non-compliance to rules and ensuring that transport services contribute to fulfilling pre-defined policy objectives. In addition, the same systems and technologies may also revolutionise the road freight industry, enabling more efficient transport solutions based on platforms matching supply and demand, creating more flexible conditions for drivers through vastly reduced driving tasks, or even full automation of vehicles.

Discussion

ITS technologies and big data in transport and with it the opportunity for more data-driven policy making holds the promise of enabling more targeted and flexible regulatory framework and more efficient enforcement mechanisms based on quantifiable policy indicators. For this a two-step evolutionary approach can be envisioned, with as a first step an improved enforcement regime using currently underutilised data sources and contents, and eventually a completely new framework.

This new framework would involve the move towards a fully data-driven policy-making approach. For this quantifiable policy indicators would have to be defined together with mandated or incentives-based voluntary access to commercial or proprietary data sources combined with data contents already in the public domain and potentially some other data as well. Given the use of this data for regulatory purposes, a high level of trust, reliability, consistency, and continuity is required for the data sets to be used.

Whilst clear potentials can be identified, a number of specific challenges need to be overcome. No level playing field exists internationally in terms of technology readiness, policy approaches, and economic development. This will require the use of a two-tier system allowing a minimum level of functionalities or even a specific separate system for some users. Also additional issues may arise due to the innovative characteristic, requiring different roles and responsibilities of the stakeholders involved.

3.3 Road safety implications

Country overview

The path to Vision Zero and other road safety initiatives are high on the political agenda due to the substantial socio-economic impacts of the injuries and life loss caused by the accidents. The safety of HCVs due to their increased size and weight is one of the major concerns, and often used as the main argument by the opponents to stop any related initiatives. See below for the situation in selected countries:

- **Sweden:** The permitted maximum length of vehicle combinations is 25.25m, in comparison with most other countries of the EU, where the upper limit is 18.75m. A study on Sweden that focussed on determining whether longer truck combinations (18.76 – 25.25m) have a higher associated of accidents per vehicle km travelled in the 10 year period of 2003-2012, Bálint et al. (2014), showed that combinations that exceed the EU length limit of 18.75m were involved in less fatal or severe crashes per billion VKT than regular EU combinations.
- **Australia:** Accident rates for high capacity vehicles are considerably smaller than those of conventional trucks. The comparatively good results should be considered in the context of road infrastructure and enforcement conditions that these vehicles are used in, which are usually much safer roads with lower traffic volumes often away from densely populated areas, as well as under the Australian Intelligent Access Program, which ensures significant levels of route, weight and speed compliance, Koniditsiotis (2018b).
- **Canada:** Long combination vehicles operate under special permit system. In the provinces of Manitoba, Saskatchewan, and Alberta long combination vehicles consist of a tractor and two or three semitrailers or trailers exceeding the basic length limitation of 25 meters specified by provincial truck size regulatory schemes. The three types of vehicles are Rocky Mountain doubles, Turnpike doubles and triple trailer combinations. If counted together from the accident rate perspective the three high capacity vehicle types had the best safety record of all vehicles during 1999-2005 in the province of Alberta.
- **South Africa:** The Smart Truck or Performance-Based Standards Pilot project was introduced in 2007 as a subset of the Road Transport Management System, to increase heavy vehicle safety and road transportation efficiency. The project has shown a reduction in the crash rate of 35.4% vs the RTMS-certified baseline fleet, Steenkamp et al. (2017).

- **Netherlands:** During the 4-year HCVs trials there were 54 accidents reported. The conducted analysis attributed no direct causality between specific vehicle characteristics and the causes of the examined, Rijkswaterstaat (2011). There did appear to be indirect links in relation to specific weather conditions and driver behaviour, but there was no conclusive data.
- **Germany:** In the 5-year trial of HCVs there were 13 accidents involving HCVs reported with just one personal injury. The analysis of these accidents, similarly to that in the Dutch study, does not suggest that HCVs have any adverse impact on road safety. Although the data basis is small, the analysis of the accident situation in the field trial did not suggest that the deployment of HCVs could have any adverse impact on road safety, Irzik (2017).
- **Denmark:** In 2009 and 2010 during the 2-year evaluation period of HCVs only 4 accidents involving HCVs were registered during 37 million vehicle km driven. This results in significantly lower accident frequency for EMS high capacity vehicles. If HCVs had the same accident rate as ordinary trucks, 16 accidents would have taken place. It must be noted that the road network that the EMS vehicles are allowed to operate on is a different one, therefore proper comparison cannot be done based on this data, Vejdirektoratet (2011).

Discussion

The reported accident rates in all countries are lower for HCVs than conventional vehicles, but one should not rush with conclusions that the safer operation is due to the characteristics of the vehicles alone, as there seem to be several reasons affecting vehicle safety. The certified high capacity vehicles are often equipped with additional safety systems, which conventional vehicles do not have. These technological improvements could lead to lower accident count and lower severity of the accidents.

Also, additional enforcement and monitoring equipment is sometimes required to be installed on board. This leads to high capacity vehicles having higher compliance rates with the existing regulations and ensure safer everyday operation. HCVs tend to be more expensive than regular vehicles and the companies that start using them tend to assign their best drivers, those with best performance, to those vehicles. In some cases the drivers of HCVs are required to follow additional training to obtain qualification to drive these vehicles.

In most cases the road networks that HCVs are allowed to use are limited to specific geographical areas or specific limited routes. Therefore the road networks they use are not the same that conventional road freight vehicles use and they could even be adapted specifically for HCVs. If HCVs are limited to “safer” roads outside rural areas with less traffic, fewer possibilities of interactions with other road users are possible. It means that the statistics that were cited above are not always comparable with those of the conventional trucks.

The higher efficiency of HCVs means that the same amount of transportation can be performed with a lower number of vehicle kilometres. This reduces the exposure and inevitably the absolute number of accidents, which is a benefit to the society. The contributing factors to safety of HCVs are a developed regulatory framework that is backed up with

appropriate enforcement. Existing ITS technology has been used for enforcement successfully; driver training and adapted infrastructure design is important as well.

4. Conclusions

It is important to appropriately respond to the economic and environmental pressures that road transport is experiencing, especially because action on these issues is in line with transport policies of most of the countries. Although the emerging technologies for road transport like electrification and power supply from the infrastructure are coming closer to practical implementation, they only address a part of the problem and implementation will take time. In this context relaxing the size and/or weight restrictions for road freight vehicles is a relatively instant and low-cost solution, which has been validated in numerous places around the world.

The benefits of HCVs are on two fronts. On one, for road hauliers and shippers of the goods there are economic benefits that come from the savings that the greater efficiency of these vehicles allows to achieve. And on the other, there are the societal benefits of safer road transport operations with lower accident rates due to fewer safer trucks on the roads for the same transport volume, and the environmental benefits from lower greenhouse gas emissions and pollution per ton kilometre of goods transported.

The HCV adoption in most countries is not happening despite clear benefits of their use. The successful implementation cases where ITS amongst other measures have been used to enable the increased size and/or weight of the road freight vehicles have shown factors that help the adoption or hinder it.

In the introduction of HCVs the support and collaboration from the industry, both the transport companies and the shippers, helps introduction. Having a public figure that acts as an opinion leader or an influencer is beneficial. The public opinion is emotional and the opinion leader can translate the knowledge of the impacts to be perceivable by the general public. This could help overcoming the lobby efforts of competing modes, which have been aimed at creating false public perceptions despite evidence that modal shifts away from other modes are minimal with introduction of HCVs and safety impacts are positive.

Limiting the use of HCVs to specific geographical areas or specific roads can help implementation for two main reasons: the readiness of the infrastructure and lower opposition from competing modes. The infrastructure is not always adapted to the technical performance of heavier and longer vehicles. It is hard to transform the whole network, but specific roads may already be usable, or require minimal changes, which is easy to achieve. In specific geographical areas road transport is the only mode of transport; therefore no/ lower opposition against localised implementation from competing modes of transport can be expected.

It is crucial to respond to the economic and environmental challenges road transport is facing, and using larger and heavier vehicles to increase efficiency of road transport is a way that ensures a win-win outcomes for both the industry and society.

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