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Energy efficiency of road freight hauliers—A Nordic comparison

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HIGHLIGHTS

- Energy efficiency index proved to be a very useful tool for comparing the hauliers.
- Shipper's interest in hauliers' performance improves the level of energy efficiency.
- Fuel monitoring practices are fairly similar in the four countries.
- Level of implementation of energy efficiency actions is similar in the four countries.

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ABSTRACT

In order to promote policy targets for decarbonising road freight, it is important to gain knowledge on the current energy efficiency practices of hauliers in various countries. This research aimed to provide such knowledge to enable international comparison of the energy efficiency practices of road freight hauliers. This was achieved by replicating the Finnish haulier survey in Denmark, Norway and Sweden. Energy efficiency index was developed to provide a simple metric for international comparison. The EEI covers various aspects of energy efficiency to provide a comprehensive outlook into the issue. The monitoring practices are fairly similar in all four countries, with typical monitoring done manually when filling the tank and data kept on a computer. Tonne-kilometre data is rarely monitored, but some other performance measures may be used. Current level of implementation of various energy efficiency actions is rather similar between the four countries. The simple and inexpensive actions, like choosing the lorry according to the cargo and idling avoidance, are most widely implemented. The energy efficiency index developed in this research proved to be a very useful tool for comparing the hauliers in the four countries.

1. Introduction

There is a wide variety of measures for decarbonising road freight transport. Road freight hauliers always work in inter-company cooperation with the shippers. Shippers have their own requirements and needs regarding the freight transport operations and their decisions enable or disable opportunities to decarbonise road freight operations. However, the hauliers also have possibilities to decarbonise their operations regardless of shippers decisions. Primarily, the hauliers have control over the loading of the lorry, technical specifications of the lorry, type of fuel used and practices of monitoring fuel consumption.

A decarbonisation model by Heriot-Watt University and Freight Transport Association presents 36 decarbonisation measures which may be applied by logistics companies (FTA, 2012). International Energy Agency presents 26 policy measures and analyses the complex outcomes of these measures (International Energy Agency (IEA), 2009). British Freight best practice programme's Fuel Ready Reckoner presents 28 decarbonisation measures for fleet management and analyses their interrelations as well as ease and cost of implementation (DfT, 2010). Léonardi et al. (2006) list 76 decarbonisation measures affecting various indicators of the decarbonisation framework. These examples highlight that road freight hauliers have many ways to change their operations towards more sustainable direction. However, information on the level of implementation of these measures is scarce.

Tacken et al. (2011) interviewed 10 large German LSPs about their measures and AECOM (2010) did a survey among British

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hauliers on their monitoring practices. Liimatainen et al. (2012) presented the results of a Finnish haulier survey exploring their fuel monitoring practices and level of implementation of energy efficiency measures. This research aims to add more countries to this list to enable international comparison of the energy efficiency practices of road freight hauliers. This is achieved by replicating the Finnish haulier survey (Liimatainen et al., 2012) in Denmark, Norway and Sweden.

2. Literature on opportunities for decarbonizing road freight

2.1. Average load on laden trips

Increasing the average load on laden trips increases the fuel consumption on l/100 km basis, but decreases the mileage required to perform the same haulage (tkm) and thus improves the energy efficiency (tkm/kWh) and decreases the total CO_2 emissions. Average load may be disaggregated further to maximum payload weight and vehicle utilisation rate. This disaggregation may be helpful as the largest lorries are not suitable for every operation, e.g. in urban areas, and hence the changes in the average load may be caused by necessary changes in average maximum payload weight of the fleet.

Opportunities for decarbonising road freight transport through increasing average load on laden trips are numerous, but mainly constrained by the inter-functional relationships between transport and other business activities (McKinnon, 2008). Increasing the transport cost through fuel taxation or road user charging may be used as policy measures to increase the importance of vehicle utilisation. Other policy measures include allowing larger lorries and relaxing access restrictions, as well as promoting better vehicle loading through awareness campaigns and benchmarking information (International Energy Agency (IEA), 2009).

Policy measures can only guide companies to improve their vehicle utilisation, but better results are gained if companies realise the potential cost savings and implement measures such as:

- nominated day delivery system, which decreases the inefficiency caused by demand fluctuations (McKinnon and Edwards, 2010)
- more space efficient cargo handling equipment and packaging, which reduce the need for packaging without compromising the protection of goods from damages (McKinnon, 2008; FTA, 2012)
- double deck trailers, which allow stacking pallets or roll cages to better utilise the maximum payload weight (FTA, 2012)
- intra- and inter-company cooperation, which decreases the inefficiency caused by geographical imbalance of goods flows and lack of inter-functional coordination (McKinnon and Edwards, 2010; McKinnon, 2008; Léonardi et al., 2006)
- lightweight vehicles, which decrease the unladen weight of the vehicle and increase the maximum payload weight for transporting more high density goods (FTA, 2012).

2.2. Empty running

Most reasons for inefficiencies and decarbonisation measures mentioned for the average load on laden trips also apply for empty running, but empty running is even more dependent on the inter-company cooperation. The potential for increasing backloading and reducing empty running is not fully utilised quite simply because there is a lack of knowledge of available loads. Even if there is such knowledge, backloading may not be realised because outbound delivery is prioritised and there is an increased risk for delays with backloading. Also the vehicles or cargo handling equipment may not be suitable for the backloading products, or the driver's working hours limit the possibilities for backloading (McKinnon and Ge, 2006).

Inter-company cooperation through establishing a network of hauliers improves the sharing of knowledge on backloads. Also wider use of web-based tendering of freight transport services improves the level of knowledge. Increased visibility of freight operations and cooperative efforts for avoiding delays can be used to develop confidence between the shipper and haulier and thus make backloading more acceptable. Empty running also decreases when reverse logistics, such as recycling of packaging waste is deployed or when reuse of handling equipment or refurbishment of products increases. Transport policy may affect the empty running by increasing the cost of transport, relaxing the working time and cargo handling restrictions as well as by standardising cargo handling equipment (McKinnon and Ge, 2006; McKinnon and Edwards, 2010; International Energy Agency (IEA), 2009; Léonardi et al., 2006).

2.3. Average fuel consumption

In addition to the vehicle loading, the fuel consumption is determined by three main factors: traffic conditions, vehicle specifications and driver's behaviour (Léonardi and Baumgartner, 2004). Traffic conditions include road geometry, road roughness and traffic flow. Road geometry affects fuel consumption mostly in hilly terrain, but also winding roads may cause braking and acceleration which increases fuel consumption. Road roughness affects the rolling resistance and thus smooth pavements decrease the fuel consumption (Wang et al., 2012; Matthews et al., 2011). Traffic flow is affected by the number and behaviour of other road users and by the regulation of traffic flow, i.e. traffic lights, speed limits, etc. The effects of road geometry are minor compared to the effects of irregular traffic flow. The fuel consumption is lowest at average speed of around 70 km/h and the consumption increases by about 50% if the average speed reduces to 20 km/h and more than doubles with average speed of 10 km/h (JAMA, 2008). A Finnish research found that the fuel consumption of an 18 t delivery truck increased by about 33% from highway cycle to delivery cycle (Erkkilä et al., 2008). Hence, transport policy may decarbonise road freight transport by investing in road infrastructure, improving road traffic management, introducing road user charges and relaxing restrictions for night deliveries (International Energy Agency (IEA), 2009). Hauliers, on the other hand, may use a weighted objective function in vehicle routing where fuel consumption and other costs as well as vehicles are taken into account (Kara et al., 2007; Palmer, 2007; Quak and De Koster, 2009; Bektaş and Laporte, 2011; Xiao et al., 2012). This may also help to avoid congested roads and negotiate with their customers to reschedule the deliveries or relax the time constraints. These measures may result in fuel savings of around 6% (Léonardi et al., 2006; Palmer and Piecyk, 2010; FTA, 2012).

Vehicle specifications affect the fuel consumption in numerous ways. First, there are significant differences in the fuel consumption between the new lorries of different brands (Erkkilä et al., 2008). Unfortunately, there are no standards or tests for the fuel consumption of lorries in place in Europe, so no objective information is available for hauliers. Only Japan has introduced standards for lorries and significant reduction in fuel consumption is expected to be achieved (International Energy Agency (IEA), 2007a; McKinnon, 2010). Historically, the fuel consumption of lorries has improved by around 1% annually, but this development may have been disrupted because of the tightening limits for NO_x emissions (International Energy Agency (IEA), 2007a). However, there are several possibilities for improvements in truck engine