EnviroInfo 2013: Environmental Informatics and Renewable Energies

A quantitative study on transport time for sustainable road freight logistics

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Abstract

Referring to the Institute for Energy and Environmental Research (IFEU), road freight transport will increase by 80% between 2004 and 2025. In order to reduce the negative environmental effects freight transport needs to be arranged more sustainably in future. Although rail and water transport is less climate-damaging than road freight, companies hesitate to relocate road freight transport to more environmentally friendly modes because these are slower. But at the moment it is not proven to what extent the majority of customers actually require the fastest possible delivery for their orders. In case longer transport times are accepted in the market, rail and water logistics would be an attractive and sustainable alternative. In this contribution more than 5000 freight transport orders handled in continental Europe have been analyzed in terms of time constraints given by the customers. It can be concluded that there is a significant amount of road transport which could be handled in a slower and more sustainable way. To do so, it is crucial that future transport management systems are able to identify non time-critical orders and support a modal shift.

1. Introduction

The Institute for Energy and Environmental Research (IFEU) assumes in its emissions report of 2012 that road freight transport will increase by 80% between 2004 and 2025 (IFEU 2011, 45). As a consequence the consumption of fuel and the emission of greenhouse gases such as carbon dioxide (CO_2) will also increase. The European DIN standard 16258 lends itself to the measurement of greenhouse gases in freight logistics and has been tested successfully in case studies (Froese 2012, 267-272). This standard is designed to support the logistics sector, especially the road freight business and was published by DIN in March 2013 (DIN 2013). In order to reduce the negative environmental effects freight transport needs to be arranged more sustainably in future.

Regarding sustainable transport modes, it is considered proven that rail and water modes produce fewer emissions per output unit (ton kilometers) than road transport (McKinnon 2010, 44). Despite this known fact, companies hesitate to transfer road freight transport to more environmentally friendly modes. Due to several obstacles the use of sustainable transport modes has not been established so far. In interviews A. Geiger and M. Smith asked logistic managers for critical factors which hampered the shift to sustainable modes (Geiger et al 2012). The following hindrances were cited: the long transport time, the high costs and low transport reliability.

The central point of this paper is the transport time which will be analyzed empirically. The transport time is defined as the duration between the pickup of the goods and the delivery to the customer including waiting times. A. Geiger and M. Smith came to the final conclusion that investments in improved traffic infrastructure are necessary, e.g. to establish regional hubs, where transports can be shifted by logistics

from one transport mode to another. These infrastructure projects usually take several years before they are completed. Furthermore even a better modal infrastructure cannot change the fact that rail and water transport is inferior in comparison to road freight regarding transport time, i.e. truck transports are much faster than the ecologically friendly alternatives. The average speed of cross-border freight trains is about 18 kmph (Ende et al 2004), 15 kmph for an inland water vessel (Kerstgens 2007) and 50 kmph for truck traffic (Wannenwetsch 2010).

Taking into account that the transport time is considered an obstacle for the use of more sustainable transport modes, it seems worthwhile to investigate in a quantitative manner how time-critical road transports actually are in practice. To establish a basis for general understanding of the terminology used, two terms need to be defined. *Time-definite* means the transport has a given timeframe in which the goods have to be delivered to the customer. *Time-critical* means that a timeframe is given and that moreover the transport is urgent as the delivery schedule is tight considering of the transport distance.

The question in detail is:

Which proportion of truck transports is not urgent (time-critical) or has no fixed delivery date (time-definite) which would make them suitable for slower and more sustainable transport modes?

2. Literature research

A literature research in scientific journals of logistics and conference proceedings was done. Furthermore an analysis on the internet (Google Scholar) was made using the keywords “road transport”, “sustainability”, “carbon footprint”, “greenhouse gas emissions”, “green logistics and “service time”. The aim of this elaboration was to provide some logistical background and to underline the relevance of topics discussed in this contribution. Moreover, it was essential to ensure that the questions to be examined had not already been answered and published elsewhere.

To summarize the results of this research it can be said that, without doubt, time plays an important role in logistics. The Seven-Rights-Definition also lists time as one of the crucial requirements. Referring to *Plowman*, logistics means to make sure the availability of the right goods, in the right amount, in the right condition, at the right place, for the right customer, the right costs and at the right *time* (Plowman 1964). Other authors also emphasize time as an important service dimension, e.g. *Koether (*Koether 2004, 21*)*. *Rodrigue*, *Slack* and *Comtois* subscribe to this view and declare that time is often crucial and that speed requires less sustainable transport modes. Additionally they indicate that there is a paradox in logistics that the more efficient transports are, the more freight will be transported (Rodrigue et al 2001).

Lahl explicitly underlines the need for a sustainable modal shift when he says “(the) Essential core of economically, ecologically and socially oriented transport politics is to create prerequisites for a shift of freight transport from trucks to railway and water transports” (Lahl 2005, 267).

Clausen, Schneider and Dobers had set up a matrix in order to assess the possibilities for reducing greenhouse gases, such as CO_2, in logistics. Referring to this matrix, the shift of transport mode from road to rail only requires low investments and offers a high potential of greenhouse gas reduction (Clausen et al 2011). In other words, shifting to a more sustainable transport mode is considered as an easy win.

3. Study

To survey the time in road freight, more than 5000 transport orders (shipments) handled between November 2012 and January 2013 in continental Europe were analyzed in terms of time constraints. International shipments between different countries were included as well as national ones (domestic business). The countries involved were Austria, Bulgaria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and Switzerland.

The analysis focused on the following questions:

a. What lead times are logistics providers facing when they are processing transport orders for their customers?

b. What is the percentage of time-definite and time-critical transport orders?

c. What percentage of transports could be considered for a slower and more sustainable transport mode but still be in compliance with the time restrictions given by the customer?

During the raw data preparation the transport orders were extracted from the data warehouse for analysis, sorted and checked to see if the records were complete, i.e. that all key information such as delivery dates, addresses and weight were included. Duplicates were deleted (data cleansing). In order to ensure a wide spread of transport orders were selected in terms of distances and timing, a frequency count was done (table 1). It shows which are the main truck routes within this data extract whereby Germany was not the only country of origin, but the main one.

To country	FR	BE	AT	CH	NL	PL	ES	IT	DK	SE	Other
From Germany (DE)	852	396	308	315	349	275	268	226	151	139	610

Table 1
Frequency of routes origin to destination countries

Additionally a frequency counting regarding distances (kilometers) was done (table 2). It indicates the distribution of distances per range. Most of the transports had to be carried between 500 and 1000 kilometers (range <=1000). The average of distance per transport is 846.6 kilometers.

Range	<= 500	<=1000	<=1500	<=2000	<=2500	>2500	*Sum*
Distances in kilometers	1449	2208	669	480	207	55	*5068*

Table 2
Frequency of transport distances

A further step was the calculation of the available processing time in days for shipment handling. Afterwards all distances between starting point (origin) and end point (destination) of shipments were calculated by route planning software *map&guide* (PTV Group) and added to the extract. Based on the enhanced data, the time buffer (available transport time minus necessary transport time) is known.

4. Results

The correlation coefficient -0,003 indicates that there is no relationship between distance (kilometers) and buffer (number of days). Also no relation between transport weight (kilograms) and buffer could be proven (correlation coefficient +0,007). The latter might surprise: smaller shipments are often under more time pressure in case they are subsequent deliveries or spare parts.

It would appear that 2057 (40.6%) transport orders did not have any delivery date requested by the customer. 231 (4.6%) transports had a delivery date, which were only entered into the transport management system as free text. This is not machine readable and thus not taken into consideration as time-critical by operators. 2488 (49.1%) transports did have in fact a fixed delivery date/time: i.e. the customer defined a deadline for service fulfilment. To validate shipment timing, as stated before, all shipments were analyzed by logistic routing calculation software. It turned out that 420 transports had at least a 3 day buffer, so only the remaining 2068 (40.8%) were critical in terms of time. Even with the express orders some had a sufficient buffer, as a result only 253 (5.0%) of them were really time-critical. The overview below summarizes the results (table 3).

No.	Time-definite	Number of shipments	Share	Time-critical shipments (buffer < 3 days)	Share
1	Shipment does not have any fixed delivery date/time at all.	2057	40,6 %	0	0 %
2	Shipment does have non machine readable delivery date/time.	231	4,6 %	0	0 %
3	Shipment does have standard delivery date/time.	2488	49,1 %	2068	40,8 %
4	Shipment does have express delivery date/time.	292	5,7 %	253	5,0 %
	SUM	*5068*	*100 %*	*2321*	*45,8 %*

Table 3
Overview of analysis results of transport time

Finally, based on these figures, it can be concluded that there is a significant number of road transports (2747, 54.2%) which are neither time-definite nor time-critical. Thus they could be handled in a more sustainable way. Apart from costs, the main criterion which is a deciding factor in the choice of which transport mode should be used is the transport time. At present Information Systems in logistics do not take this fact into account. Transport management systems are usually limited to only one mode (truck transports or railways) and continue in their old routine by merely supporting the order fulfilment without

doing any analysis on sustainability. It means a road transport management system can only plan and bill road transports, a rail transport management system only rail business, etc. As an important step ahead it is recommended that future transport management systems automatically sort out all orders which are neither time-critical nor time-defined and recommend an environment-friendly transport mode for these. As a result the operational user in logistics would be supported by suggestions on how to act more sustainably. The analysis done in this paper shows that there is sufficient potential in the transport market for sustainable transports while customer-given delivery dates could still be satisfied.

5. Outlook

In this context further research should be useful. How can operational employees be supported in deciding whether a transport needs to be booked for road transport or a more sustainable mode? How should the operational process and information flow be defined? Furthermore, besides time the authors M. Smith and A. Geiger defined two additional limiting factors - high transport costs and low reliability. These have not yet been analyzed quantitatively and also what influence these two factors have on sustainable logistics.

Bibliography

Deutsches Institute für Normung, DIN (2013). Methode zur Berechnung und Deklaration des Energieverbrauchs und der Treibhausgasemissionen bei Transportdienstleistungen, DIN EN 16258, Berlin

Ende, L., Kaiser, J. (2004): Wie weit ist die Liberalisierung der Schiene? WuW- Fachverlag der Verlagsgruppe Handelsblatt GmbH, Heft 01, S. 26 – 37

Froese, J. (2012): Standardized greenhouse gas emission calculation in medium sized road logistics. In: EnviroInfo 2012, Core Application Areas (Part 1), pp. 267-272, Dessau

Geiger, A., Schmied, M. (2012): Abbau von Hemmnissen im Verkehr zur Emissionsminderung, Umweltbundesamt, Dessau

IFEU (2011): Aktualisierung „Daten und Rechenmodell: Energieverbrauch und Schadstoffemissionen des motorisierten Verkehrs in Deutschland 1960-2013“ (TREMOD, Version 5.2) für die Emissionsberichtserstattung 2012 (Berichtsperiode 1990 – 2010), S. 45, Heidelberg

Clausen, U., Schneider, M., Dobers, K. (2011): Klimaschutz liefern - Logistikprozesse klimafreundlich gestalten, Kurzstudie 05.2011, Initiative “2° – Deutsche Unternehmer für Klimaschutz” und Fraunhofer IML, S. 19, Berlin

Kerstgens, H.(2007): Bahn und Schiff hängen LKW ab. Multimodale Containertransporte bieten schon auf kurze Distanzen spürbare Kostenvorteile

Koether, R. (2004): Taschenbuch der Logistik, Fachbuchverlag Leipzig, p. 21

Lahl, U. (2005): Der Container und die Globalisierung, in: Loske, R, Schaeffer R (Hrsg): Die Zukunft der Infrastrukturen. Intelligente Netzwerke für eine nachhaltige Entwicklung, S. 267ff, Magdeburg

McKinnon, A.(2010): Green Logistics, p. 44, London

Plowman, E.G. (1964): Lectures on elements of business logistics, Stanford University

Rodrigue, J.P., Slack, B., Comtois, C. (2001): Green Logistics (The Paradoxes of). In: The Handbook of Logistics and Supply-Chain Management, London

Wannenwetsch, H. (2010): Integrierte Materialwirtschaft und Logistik, Berlin