ACTIONS FOR MORE SUSTAINABLE FREIGHT TRANSPORT – A COMPARISON BETWEEN THEORY AND PRACTICE

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ABSTRACT

To cope with the negative impacts from the transport sector there is a need for actions striving toward a sustainable development. To understand the complex area of sustainability and to avoid creating one problem by solving another, a holistic view needs to be taken. The purpose of this article is to compare the theory and practice in the field of future sustainable actions in the logistics system. Actions appearance in the literature and its implementation today and importance for the future are investigated among practitioners in the logistics system. Results from both a literature review and interviews provide an aggregated picture of the situation today, highlighting differences among actors, the relationship between actions and its contribution to the four principles of sustainability. This article argues that in order to contribute to all principles of sustainability not only one type of action is enough; a reduction of transport, traffic and emissions from the vehicles is needed in conjunction with governmental actions.

Key words

Actions, Freight transport, Future, Holistic view, Logistics, Sustainability

INTRODUCTION

Today there is an increased focus on environmental impacts from logistics in the political as well as the societal debate due to the large amount of greenhouse gas emissions that arise from transportation and contribute to climate change. The trends are clear; there is an increased share of road transport in Europe as well as longer transport distances in a steadily growing international market. The transport sector alone is today the largest sector still increasing its share of greenhouse gas emissions in society (EC 2009). Looking into the

societal goals, e.g., reducing greenhouse gas emissions by 20 % by 2020 (EC 2009), it is obvious that there is a large gap between societal goals and current trends.

Focus on climate change issues is forecast to increase among actors in the future. Piecyk and McKinnon (2009) forecast that climate change concerns are about to rise among companies involved in road freight transport operations, forecasting that 80 % of companies are likely to see their activities affected by climate change concerns to a significant or large extent by 2020.

Even if most research in the issue of sustainability is focusing on one problem at a time, e.g., greenhouse gases, it is important to understand the complex area of sustainability and to avoid creating one problem by solving another. Therefore, a holistic view, a large enough system perspective, needs to be taken (Holmberg and Robért 2000). Sustainability is most commonly defined as combining economic development with environmental concerns as well as social responsibility, also called the triple bottom line (Norman and MacDonald 2004), and origins from the well known Brundtland definition (Brundtland 1987). One difficulty in the issue of sustainability is how to simultaneously strive toward economic benefits, a reduced environmental impact and social responsibility. Traditionally, the logistics sector is driven by cost efficiency measures, increased service level and less tied-up capital, which also has influenced the unsustainable freight transport trends.

> *"It is unlikely that environmental-related goals and objectives take precedence over primary operational performance criteria such as cost, quality and delivery"* (Vachon and Klassen 2008).

Short-term economic development is in most instances in society of first priority. In order to help decision makers in companies and organizations to include ecological considerations into their product development and business strategies, there are different tools and methods to be used. Examples of tools are Environmental Management Systems (EMS), Eco-Efficiency, the Factor X Concept, Ecological Footprint and Life Cycle Assessment (LCA). Usage areas of different tools have been compared by Robèrt, Schmidt-Bleek et al. (2002) who shows the importance of selecting and designing tools that are relevant, not only for monitoring activities, but for the strategic sustainability purpose. In order to define a direction of the strategic planning it is a prerequisite to have a clear view of the goal (Robèrt, Schmidt-Bleek et al. 2002). By using four socio-ecological principles as an overall goal, a plan for sustainability can be identified that are avoiding "dead-ends" in the future and thus includes favorable outcomes and activities that are to be further measured by different tools (Holmberg and Robért 2000; Robèrt 2000; Robèrt, Schmidt-Bleek et al. 2002). Businesses and organizations have successfully been using these principles together with backcasting planning for finding creative solutions in their strategies (Holmberg and Robért 2000). The use of this framework can systematic manage sustainable freight transport strategies in an, up till now, unexplored way. In this article the principles will be used as a basis for discussing how different set of actions striving for a smaller impact on environment from freight transportation correlate to sustainability.

The four system conditions developed by Holmberg and Robèrt (2000) define a sustainable society from an ecological and social perspective. The first three system conditions states that the nature is not subject to systematically:

1) increasing concentrations of substances extracted from the earth's crust

2) increasing concentrations of substances produced by society
3) impoverished by over-harvesting or other forms of ecosystem manipulation

These three system conditions are about the ecological sustainability as a restriction for a sustainable society; the fourth principle takes the societal dimension and states that in a sustainable society:

4) resources are used fairly and efficiently in order to meet basic human needs worldwide

In the discussion of how to reduce the environmental impact of freight transport in logistics research, there are many examples of new solutions and theories about the complex relationship in between cause and effect (Ang-Olson and Schroeer 2002; Drewes Nielsen, Homann Jespersen et al. 2003; McKinnon 2003; Léonardi and Baumgartner 2004; Richardson 2005; Aronsson and Huge Brodin 2006; Kohn and Brodin 2008; McKinnon and Piecyk 2009). As mentioned by, e.g., Kohn and Brodin as well as McKinnon, there are examples of actions leading to smaller environmental impact as well as economic benefits by using, e.g., better route planning or educate in Eco-driving. (McKinnon 2003; Kohn and Brodin 2008). Still, the implementation of this kind of action has shown to be poor. Studied from a transport operator's perspective, Léonardi and Baumgartner (2004), show that to a large extent, the measures aimed at improving transport efficiency have been poorly implemented. But not only transport operator can take action; freight forwarders, transport buyers as well as authorities may act by themselves or in collaborations in order to reduce the environmental impact from freight transportation. In order to link the knowledge in theory to implementations in practice it is important to investigate the view from all the main practitioners in the logistics system. There is a gap of knowledge about how the practitioners in the logistics system views actions for reducing environmental impact from freight transport; what actions are actually implemented today among different practitioners and what actions are seen as important for reducing environmental impact from freight transport in the future.

The purpose of this article is to compare theory and practice in the field of future sustainable actions in the logistics system from a holistic view in order to define actions for more sustainable freight transport. The study undertaken in this article reviews actions discussed in the literature that aims for a smaller environmental impact from freight transport. Furthermore, the degree of implementation as well as identifying the importance of actions identified in literature is investigated among practitioners. Differences and similarities between literature and practitioners are highlighted as well as between groups of actors. The relations between actions are discussed as well as its contribution to sustainability by assessing the contribution to the four socio-ecological principles for sustainability . The study focuses upon road transport, and its interface to other transport modes. Both long distance transport and distribution are covered.

METHODOLOGY

In order to identify an action list for reducing environmental impact from freight transport, literature was reviewed. Thereafter, a qualitative interviews series was made in order to find out what actions were implemented today among practitioners in the logistics system, and what actions were seen as important for reducing the environmental impact from each actor's perspective.

The literature review includes scientific articles, policy documents and reports. Using scientific data base research, covering Scientific, Technical and Social Sciences literature, articles were identified from sorting out abstracts of interest from different sets of search terms. As a complement, policy documents were search for by the governmental websites on national as well as European level. Reports by respected research organizations are also included in the literature review. From the literature, a categorization of actions was made and listed according to a set of categories. The action list was reviewed by a number of researchers in the field in order to validate that most known important areas were included. Thereafter, the action list was revised and a few more actions included. The action list was used in the interviews in the second part of the study.

Semi-structured interviews were conducted with respondents from four practitioner groups identified as being part of the main actors in the Swedish logistics system: transport operators, freight forwarders, transport buyers and authorities. The transport operators were medium sized trucking terminals operating on a regional level; the freight forwarders were third party logistics providers operating at an international level and the transport buyers were large international companies having their bases in Sweden. The authorities were both on national and city levels. The number of interviews in each actor group as well as the respondents' position is summarized in table 1. Two researchers conducted the interviews, lasting about 1 to 2 hours each. The interviews were recorded and later transcribed.

***Table 1** - Summary of the respondents in the interviews.*

Type of actor	**Position in the organization**	**Number of respondents**
Transport operator	Environmental manager (2) and Chief Executive Officer (1)	3
Freight forwarder	Operational manager (1), Environmental manager (1) and Logistics expert (1)	3
Transport buyer	Logistical manager (2) and Environmental manager in the logistical organization (1)	3
Authority	Freight transport responsible at Ministry of Enterprise, Energy and Communications (1), Governmental Agency for Innovation Systems (1), City Authority (1)	3

The interviews included two parts. The main section contained a discussion about specific questions that were raised by the researchers. The questions covered the same areas for all actor groups, although they were slightly adjusted in order to fit the different actors. The final and second part of the interviews included an assessment of the action list developed from literature in order to identify to what extent each action was important in order to reduce the environmental impact from freight transport for each respondent's organization or company. Furthermore, actions that were not included in the list yet were identified. Each action was assessed according to a seven scale ranking, where 1 represented minor importance, and 7 extremely important. Since there are limited numbers of empirical data the assessment should only be used for seeing patterns and as input for creating a hypothesis together with the interviews.

In order to analyze to what extent actions are leading toward sustainability, the potential effects from the actions identified as most important were analyzed in accordance with the four principles of sustainability (Holmberg and Robért 2000).

This study is a first step in a research project aiming at investigating what logistics strategies are leading toward sustainability. The study is explorative in its nature, creating hypotheses rather than testing them. The study gives a first indication about trends and pattern among four actor groups in the logistics system. In order to test these results, this study will be complemented with a quantitative survey in future research where a large number of companies and organization will be included in the sample. This planned survey will provide a more general picture over how Swedish practitioners are acting for reducing environmental impact from freight transport, and identify differences among actor groups.

The result of this study are used as input for future research aiming at facilitating potential choices of sustainability actions within the freight transport and logistics system; how to understand the interaction between different sets of actions and how to identify actions aiming at sustainability.

ACTION IDENTIFICATION

Literature describes numerous ways to reduce environmental impacts from road freight transport. Factors affecting the environmental impact from freight transport have been studied by several researchers, resulting in analytical frameworks showing up in the relationship between cause and effect (Drewes Nielsen, Homann Jespersen et al. 2003; Richardson 2005; Piecyk and McKinnon 2009). The relationship between different factors and their effects shows a complex picture in the logistics system and many ways of choosing and combining variables in order to illustrate relations from different perspectives. E.g., Piecyk and McKinnon (2009) have constructed a framework mapping the complex relationship between CO_2-emissions and a series of logistical parameters identifying structural, commercial, operational, functional, product-related and external factors.

Based on the research found, identified actions in the literature were divided according to different categories, showed in figure 1. Action aim is about three levels of reducing environmental impact from freight transport (Björklund 2005), action pre-conditions is about policies and regulations affecting different levels of action operations and action operations are about concrete actions that are reducing environmental impact in the three action aim levels. These three action categories; action aim, action pre-conditions and action operations will be further described below.

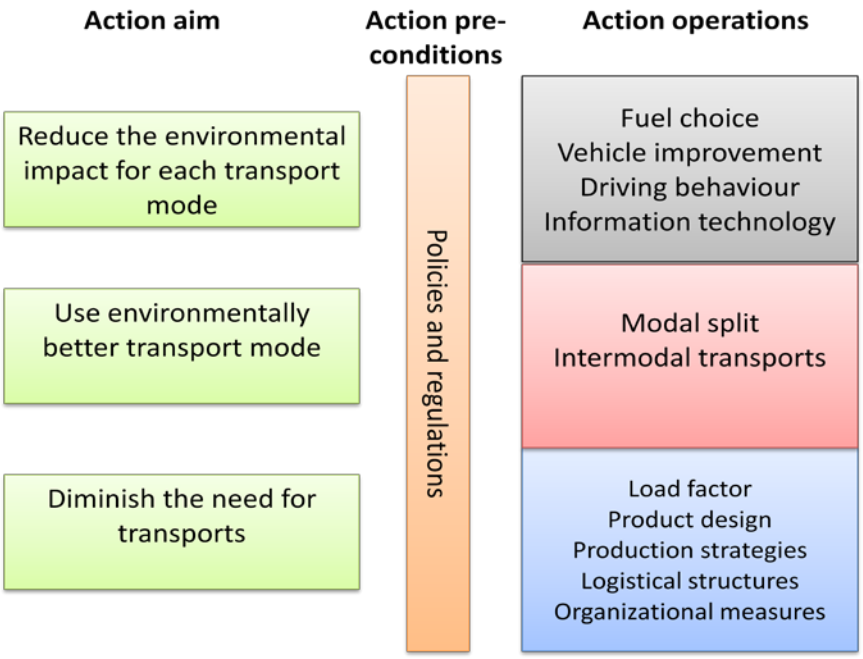

***Figure 1** - Type of actions included in this study*

Action aim

To reduce the environmental impact for each transport mode is for road transport about efficiency measures in each vehicle, such as using an alternative fuel to diesel or using less fuel due to more efficient driving.

To use an environmentally better transport mode is primarily about the choice of transport mode; changing into an environmentally better alternatives than road, such as rail or sea. To diminish the need for transports is, for example, about reducing transports by logistical and organizational changes so that, e.g., an increased load factor can be obtained in the vehicles, leading to fewer vehicles in traffic due to a better coordinated transport flow. It is also about localization of industries and the choice of suppliers so that an effective transport flow can be obtained.

Environmental impacts from freight transport discussed in literature are related to exhaust emissions from the engine (e.g., CO_2, NO_x, SO_x and particles), congestion, accidents, noise, land use. A large focus today is on reducing CO_2 emissions. When reducing CO_2 emissions other environmental impacts will most commonly decrease. For example, by decreasing fuel consumption by a better driving pattern, all emissions from the combustion of fuels will be decreased (e.g., CO_2, NO_x, SO_x, particles, etc.). Still, the traffic level will remain the same, hence not contributing to reducing accidents or congestion levels. Actions taken in order to increase the load factor in the vehicle may lead to a reduction in the number of trucks on the road, hence contributing to fewer accidents and congestion and at the same time fewer emissions from the combustion of fossil fuels. It is important to be aware of what kinds of environmental impacts are reduced by the different types of actions. In figure 2, the three levels of reducing environmental impacts from freight transport are related to indicators affecting environmental impact: transport, traffic and emission reduction. Moreover, the violation from the freight transport sector of the four principles of sustainability is included in

the figure. In the analysis chapter, a deeper discussion about how identified actions of importance are related to sustainability will take place.

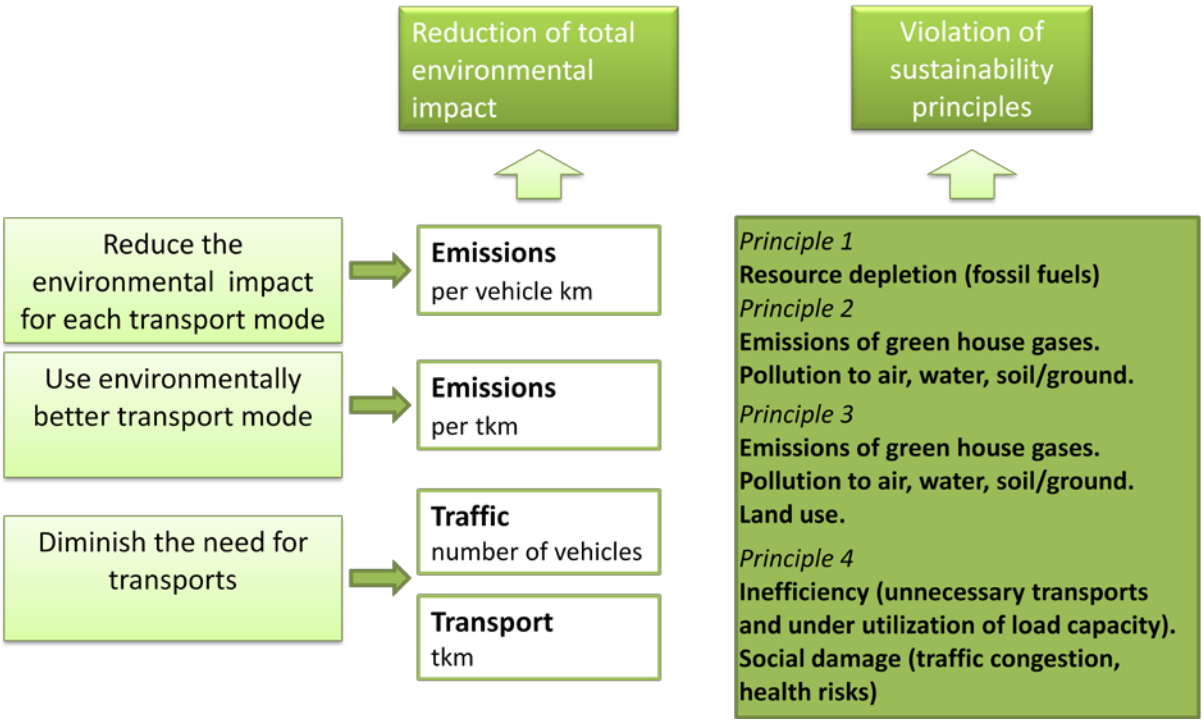

Figure 2 – *To decrease the violation of the 4 sustainability principles by reducing environmental impact from freight transport*

The actions included in this study are a summary of actions that are most frequently discussed in literature. There are of course a wide range of additional actions on different detailed levels that can be taken that are not handled here, where the main categorizations are covering actions on a general level.

Action pre-conditions

There are several pre-conditions affecting the action operations, e.g., available techniques on the market, resource availability, market factors and policies and regulations. In this study actions concerning policies and regulations on a national governmental level is included in the discussion.

Policies and regulations

Policies and regulations could have a great influence in the development of the transport sector; there are several examples of incentive schemes or regulations that have affected the freight transport market. Three different kinds of measures are mostly discussed in literature: economic, administrative and investments.

Economic measures include, e.g., road charges, incentives schemes and taxes. Within research there are positive examples of how road charges have positively affected the traffic situation; both in urban areas (Baradaran and Firth 2008) and for highway traffic (McKinnon 2006).

Research also show positive examples that increased taxes on fossil fuels would reduce the environmental impact, such as CO_2 emissions (STEM 2007). Of course this is not an easy task to implement, having industries' and companies' competitiveness in mind in an international market, leading to the importance of harmonization of taxes and rules among countries.

Administrative measures include regulations that affect the transport system. One example is the regulation of euro-class emission standards that have shown success in reducing local pollution (e.g. NOx and particles). Other measures discussed by researchers that have the potential of reducing environmental impact form freight transport are the increase of vehicle length and weight regulations (McKinnon 2005) and regulations concerning lower speed restrictions (Ang-Olson and Schroeer 2002; Johansson and Nilsson 2004). In city distribution the relaxation of night delivery restrictions would have an effect on the local environment (McKinnon 2007).

Investments in infrastructure: road, rail and sea will affect the availability and efficiency in the system. Swedish studies show that an increase in investments for rail would reduce emissions (CO_2) considerably (Banverket 2007).

Economic measures	**Administrative measures**	**Investments**
Road charges – city Road charges – highway Taxes upon fossile fuels Incentives schemes for renewable fuels	Increase the amount of night deliveries – less restrictions Lower speed restrictions Allowance of longer/heavier vehicles	Infrastructure investmens - rail Infrastructure investments – road

Figure 3 – *Summary of policies and regulations identified for reducing the environmental impact from freight transport.*

Action operation

This section includes motivation of each specific actions included in the categories from figure 1. The actions are presented according to the three levels of reducing environmental impact; reduce the environmental impact from each transport mode, use environmentally better transport mode, diminish the need for transports.

Reduce the environmental impact for each transport mode

Fuel choice, vehicle improvement and driving behavior
Due to the combustion of fossil fuels, the greatest emissions today from the vehicles by road are greenhouse gases. In order to reduce these emissions, research on possible alternative fuels instead of fossil fuels for use in road transport is steadily growing and includes many options, such as choice of resource base (e.g., biomass, crops, waste), choice of energy carrier and choice of techniques in the engine. There are different premises on distribution and long-haul heavy transports, having more options on the distribution side due to its lighter vehicles and shorter distances. Hedenius (2007) mentions the following alternatives to fossil

fuels: hydrogen, fuel cells and bio fuels. In order to increase the efficiency in the engine, hybrid and plug-in hybrids are other alternatives having potential to decrease the efficiency by 34 % in city center and 7 % long haul (Muster 2000).

Since 1980 fuel efficiency has increased by 20 % (Chapman 2007). The efficiency in the engine and the design of the vehicles will have a considerable effect upon the fuel use, hence also on emissions (e.g., CO_2, NO_x, So_x, particles). Ang-Olson and Schroeer (2002) are providing the potentials to increase the energy efficiency of trucks by, e.g., improving aerodynamics and driver training; reducing speed and idling have the potential of fuel savings between 4.3 - 8 % (Ang-Olson and Schroeer 2002).

Information technology
Furthermore, in order to use the vehicles more efficiently, information technology has been shown to be useful in order to optimize routes (Léonardi and Baumgartner 2004; Baumgartner, Léonardi et al. 2008). Information technology can also be used in order to provide better planning of transports from production to warehouses in a manufacturing company. Increased visibility through information support systems may lead to using the distribution systems more effectively (Aronsson and Huge Brodin 2006).

The actions identified in literature to reduce the environmental impact from vehicles by road are summarized in figure 4.

Fuel choice	**Vehicle improvement**	**Information technology**
Alternative fuels	Truck hybrids	Route optimization
Driving behavior	More efficient engine	Support system for better planning and vizaualization of transports
Eco-driving	Better aerodynamic design on the vehicle	

Figure 4 – *Summary of action operations identified for reducing the environmental impact from vehicles by road.*

Use an environmentally better transport mode

Modal split
To use an environmentally better transport mode than road is one of the main alternatives that is pointed out as a more sustainable direction for the future (Caïd, Crist et al. 2002; Blinge and Svensson 2005; Chapman 2007).

Both sea and rail transport are identified to have less of an environmental impact than road. Rail transport in general has the smallest environmental impacts of the four most common transport modes, the second best is sea, thereafter road, and the least environmentally friendly is air cargo (Caïd, Crist et al. 2002; Blinge and Svensson 2005; Chapman 2007).

Intermodal transport
Using sea or rail most often requires a combination with road transport, or a combination between all modes, i.e., intermodal transport. Research has taken up how to handle the shift of

loading units between transport modes in a more efficient way due to shortened lead time and cost (Bontekoning and Priemus 2004).

The actions identified for using an environmentally better transport mode is summarized in figure 5.

Modal split	**Intermodal transport**
Shift to more sea transports Shift to more rail transports	More intermodal transports at a general level Better technique for shifting loading units between transport modes

Figure 5 – *Summary of action operations identified for using environmentally better transport mode than road*

Diminish the need for transports

There are several factors determining the need for road transports. As shown in figure 2, it is primarily about two aspects – to reduce the traffic and/or to reduce transport work. Reducing the traffic is about reducing the number of vehicles on the road by sending the same amount of goods in fewer vehicles. Reducing transport work is about reducing the distance or reducing the amount of goods to be sent.

Load factor
Increasing the load factor in the trucks is an action correlating with many other actions, and is of course central in order to reduce the traffic (McKinnon 2003). Obviously, the very main idea of freight forwarders dealing with transport services is to group shipments from several customers, thus increasing the load factor in general and also the competitiveness and efficiency of themselves as an actor. In city distribution, possibilities for consolidation of goods between transport operators, freight forwarders and/or transport buyers have been tried out in many pilot projects. Still, there are many challenges in its implementation phase, e.g., to reach a successful partnership in between the organizations and companies to be involved, showing few implemented examples in reality although the potential for improvement is high (Blinge and Svensson 2005; Lindholm and Thalenius 2006).

Another possibility connected to increasing the load factor in vehicles is to reduce the empty running by trucks(McKinnon 2003; McKinnon and Ge 2006). Some of the empty running is due to imbalances in goods flow on a geographical basis that will be impossible to eliminate. Other factors, such as scheduling consignments or finding backloads, would lead to loading the return journey to a higher content (McKinnon 2003).

Product design
The product characteristic will also have an effect on the load factor in the vehicle (Blinge and Svensson 2005; Piecyk and McKinnon 2009). Dematerialization of products and packaging adapted to effective logistics could increase the possibility to increase the load factor considerably by reducing the weight and volume of goods.

Production strategies
What kind of production strategy a manufacturing company has affects the transport pattern in several ways. Just-in-time principles may lead to more traffic but not an increase in transport work; hence, the vehicle utilization can be less efficient(Blinge and Svensson 2005; Piecyk and McKinnon 2009). The reason for this is the reduction in articles in stock, and an increase in the frequency of smaller consignments. These trends are putting more pressure on the logistics planning the transports, having to consolidate goods with other companies to a greater extent in order to be efficient.

Logistics structures
Logistics structures concern number, location and capacity of factories, warehouses and other facilities in the logistics system (Piecyk and McKinnon 2009). Logistics structures also include choice of suppliers. Still, there are few examples of how the final environmental impact will be affected from logistical structural changes. It has been argued in the literature that the increasing haul length has been the main reason for freight transport growth (McKinnon 2003) due to wider sourcing of suppliers, centralization of production, and the development of hub satellite systems. Going back to a more decentralized system would then have the potential to lead to less transport work and possibly a smaller environmental impact. On the other hand, using a centralized distribution system will lead to more goods consolidated to one point, from the production unit to the central warehouse, giving other possibilities for reducing the environmental impact from actions such as increased possibilities for using another transport mode (Kohn and Brodin 2008).

Also, the number of nodes and links in the supply chain can affect the transport pattern. According to McKinnon (2007), reducing nodes and links in the supply chain may streamline the supply chain, achieving a higher degree of vertical integration in a certain manufacturing or distribution site and less transport work. Still, this is very site dependent and there is little information regarding how these changes will affect the total environmental impact (McKinnon 2007).

A wider sourcing has been identified as one of the main factors for increasing haul length as mentioned above. Returning to more localized sourcing by choosing more regional suppliers is discussed by several researchers as one action that would reduce the transport work (Blinge and Svensson 2005; Chapman 2007; McKinnon 2007).

Organizational measures
Lammgård (2007) identifies measures of an organizational nature that could affect the environmental impact of freight transport to a certain extent. Often, the level of ambition in the organization regarding environmental issues is related to their environmental work within the organization; thus, an increased quality of the environmental work can increase the level of ambition among the purchasing organization. To put environmental demands on the freight transport operators or freight forwarder when purchasing transports will put pressure on these actors to place environmental issues higher on the agenda. Additionally, many actions need the participation of different actors, though co-operation initiatives are of importance in order to implement actions toward a less environmental impact of freight transport. Organizational measures will raise the awareness about environmental issues in organizations and will indirectly raise the possibilities toward implementation of concrete actions giving smaller environmental impact.

In figure 6, the actions identified for diminishing the need for freight transports are summarized.

Load factor	**Product design**	**Production strategies**
Increase the fill rate at a general level Consolidate with other operators/companies goods Reduce empty running	Reduce the material use in products Packaging adapted for efficient logistics	Reduce the use of JIT strategies Reduce frequency and larger quantities in one order Have more flexible time restrictions for pick up/delivery of goods.
Logistical structures	**Organizational measures**	
Reduce the number of nodes and links in the supply chain Centralized distributions system Decentralized distribution system Choosing more regional suppliers	Increased quality on the environmental work within the organization Increased co-operation between organizations Increased focus on demands upon suppliers, contract design, and conditions for delivery etc.	

Figure 6 – *Summary of action operations identified for diminishing the need for more freight transport*

ACTIONS IN PRACTICE

The interview series provides the study with input about the actors' views on actions aiming to reduce the environmental impact from freight transport. The results contain two parts: examples of actions implemented today, and examples of actions identified as important in order to reduce the environmental impact from the organization's freight transport from each actor's perspective.

Actions implemented today

The practitioners involved in this study are in different ways working with freight transport and environmental issues solely or together. The pattern that can be seen is that transport operators as well as freight forwarders are focusing on actions concerning fuel choice, vehicle improvement, driving behavior, and the use of information technology. There are examples of using alternative vehicles in both distribution and long haul transports, but still to a limited extent. Transport buyers do have a more diverse agenda due to different industries and stages of development in the company. A common aspect is that they include environmental demands when purchasing transports. It can also be seen a trend towards more participation in forums in which different actor groups are collaborating and discussing environmental issues.

Transport operator

Eco-driving education is performed by the drivers of all transport operators included in the study. In line with this the respondents had been implementing or were on the way to implement tools or systems for follow-up the fuel savings from an education in eco-driving. These tools are also important in order to be able to report the actual fuel consumption and emission savings back to their customers, who require reports to a higher extent today than

before. Tools for route optimization and planning were also introduced at the transport operators' activities.

Two of the transport operators worked with environmental issues more actively than the other respondent. By being part of test pools in cooperation with a trucking industry, new techniques for alternative fuels had been tested historically on their routes, although there were not any tests going on at the moment. One transport operator planned for new tests to start within 2010. Also, in order to meet one large customer's requirement, one transport operator started up an intermodal solution in cooperation with a rail freight company. The other two transport operator's did not use intermodal transport due to their regional market and short transport distances.

Freight forwarder

The freight forwarders are pointing out that their main business idea is to consolidate goods flow. Therefore, to increase fill rate is essential for their efficiency and business. Freight forwarders included in this study are today putting demands on their transport operators in areas such as education in eco-driving and type of euro-class to be used. Regarding the distribution systems in city centers, the respondents point out that they are as efficient as they can be in a logistics perspective today. Of course, the use of renewable fuels would reduce the impact on the environment, but they have not yet been possible to implement to a large extent.

One of the freight forwarders offers the customers green transports from bio gas vehicles, but mentions that not many customers are prepared to pay more for a green option. Another freight forwarder is using bio fuel pick up cars in two city centers in Sweden. Also, tests are made for using RME fuel.

In order to increase the efficiency of the production system there are examples from one freight forwarder where the implementation of hand units in the transport operator's vehicles is going on. This leads to information flow in real time and direct communication with the vehicles.

Both freight forwarders actively participate in collaborations between actors, initiatives and forums aiming for discussing issues related to less environmental impact from freight transport.

Transport buyers

The transport buyers included in this study were large international companies, where two of them have had a fast growing rate lately. Some differences were seen between the different companies.

Company one focused on improvements of their logistics systems, in terms of cost, service and tied-up capital. They were aiming for reducing warehouses and going lean. In terms of environmental work they were putting environmental demands on the transports according to QIII (Q3 2008)and hope to gain more information about the current system through better information from the freight forwarders (road).

Company two had just insourced their distribution center leading to cost savings and better control of goods flow. Through focus on better packaging and higher fill rates in their loading units they have increased their efficiency lately; by developing their own reusable boxes and exchanging disposable pasteboard boxes. Their focus is now on reducing plastic in the packaging of their products. This company also put environmental demands on their freight forwarders (sea and road). They had historically also worked hard to reduce their amount of transports by air.

Company three was a transport heavy industry, purchasing transport mostly by rail and sea. They had been part of several projects aiming for reducing their environmental impact: developing more efficient ships, measuring electricity use on rail, testing alternative fuels locally and testing to use longer vehicles by road. Furthermore, this company also put environmental demands on their suppliers of freight transport according to QIII (Q3 2008).

All transport buyers are actively participating in collaborative forums having sustainable transports in focus including different types of actors.

Authorities

On a national level there is a focus on co-operative actions. A logistical forum includes representatives from industries, freight forwarders, transport operators, researchers and politicians and serves as the link between national businesses and the government. The logistical forum creates actively working groups within different focus areas. Furthermore, a large initiative called “green corridors” is going on serving as a platform for research, new ideas and showing existing ongoing projects, best practices, in the area of three transport corridors throughout Sweden.

On a local level, naturally, city distribution is of importance, showing a range of initiatives aiming at consolidating goods flow. Introducing e-business within elderly care and working for planning the orders for the activities within the council so that delivery is less frequent are other examples. Efforts to increase the environmental demands upon the freight transports in the purchasing process have been made.

The logistical research founded by the national government has lately been having a large research initiative regarding sustainable freight transports. There is more focus today on higher co-operations between academics and society and in the near future the research will take a wider view integrating freight- and passenger transportation.

Actions evaluation

In the interviews, a discussion concerning what actions are important in order to reduce the environmental impact from freight transport in the future from each actor’s perspective was taken. The respondents were asked to rank the level of importance of each action on a scale ranging from 1 to 7, where 1 represented minor importance, and 7 extremely important.

In general, cost-efficient actions concerning increase in load factor are seen as very important for all actor groups, such as consolidation with other operators and companies goods, adapt packaging and to allow longer vehicles. Also to increase the use of alternative fuels are seen

as very important in order to reduce the environmental impact from freight transport from most actors' perspectives.

Transport operator

Extremely important for reducing the transport operator's environmental impact is to use alternative fuels. The interviewees showed a great interest in this issue, and mentioned also the difficulties when testing alternatives. New techniques can be less reliable, leading to higher costs for service and especially reduced quality for the customers in terms of longer lead times etc. In order to increase the use of alternative fuels, incentive schemes are identified as important.

The transport operators also valued the importance of using more intermodal transports in order to reduce the environmental impacts. Still, the result shows little use of intermodal transports from the respondents today. Also because of acting on a regional level, and mostly short transport distances, the use for rail seemed limited by the transport operators themselves.

There are several actions identified that are concerned with other actors' activities. All respondents thought the issue of reducing frequency and larger quantities in one order as well as having more flexible time restrictions for the pick-up and delivery of goods was very important for reducing the environmental impact from freight transport.

Freight Forwarder

In general, policies and regulations are seen as very important within this actor group. The highest point of importance is the allowance of longer vehicles followed by increasing the amount of night deliveries by fewer restrictions.

Also, the freight forwarders recognized the importance of having more flexible time restrictions for pickup and delivery. In the interviews the freight forwarders pointed out that they were affected by the customers' pressure toward later pick-up and earlier deliveries, hindering a flexible planning and more efficient distribution.

Moreover, the use of alternative fuels as well as education in terms of Eco-driving is ranked as very important.

Transport buyers

Two actions that are identified as extremely important in order to reduce the environmental impacts from the freight transports are to use more efficient engines and to increase the fill rate generally, especially by consolidating goods from companies and operators. Today this is seen by purchasing transports primarily from freight forwarders.

The transport buyers also agree upon the importance of adapting packaging for efficient logistics and increasing the co-operation in between organizations. These are also areas where the respondents showed examples from their work today.

Among policies and regulations, allowance of longer vehicles was rated as most important for the transport buyers.

Authorities

To increase co-operation between organizations are identified as very important from the authorities' viewpoint. This is also an area where much work is done today. Also, to increase the consolidation of goods are very important, especially in city logistics. This is an action shown to be difficult to implement, even if there is examples of taken initiatives from the city authorities.

ANALYSIS

Table 2 summarizes the actions identified from the interviews as most important for reducing the environmental impact from freight transport. Actions that most interviewees agreed upon being very important are included in this list. There can, naturally, be seen different attitudes among actors, where some examples will be discussed below.

Table 2 – *Actions identified as most important for the respondents and their contribution to the four principles of sustainability*

Action operation	Specific action of importance	Implemented by practitioners	Sustainability			
			Principle 1	Principle 2	Principle 3	Principle 4
Fuel choice	Alternative fuels	test	yes	yes	yes	no
Driving behavior	Eco-driving	yes	yes	yes	Yes	no
Load factor	Consolidate with other operators/companies goods	yes	indirect	indirect	indirect	yes
Product design	Packaging adapted for efficient logistics	yes	indirect	indirect	indirect	Yes
Production strategies	Have more flexible time restrictions for pick up/delivery of goods	no	indirect	indirect	indirect	Indirect
Organizational actions	Increased co-operation between organizations	yes	indirect	indirect	indirect	Indirect
Policies and regulations	Allowance of longer vehicles (road)	no	indirect	indirect	indirect	Yes
	Incentive schemes for renewable fuels	no	indirect	indirect	indirect	Indirect

A summary of the level of implementation are also included in the table (*yes* means to a major extent, *no* means there is no such examples in the interviews and *test* means that there have been tests performed). Furthermore, the potential contribution to the sustainability principles from each of these actions is summarized (*yes* means to a major extent, *no* means that there is no contribution and *indirect* means that the action have a potential to contribute to sustainability).

The relation between these actions as well as other actions from the literature review is discussed in two subsections in this chapter, *fuel choice and driving behavior* and *load factor*. Some future perspectives are taken and a discussion is made about its contribution to sustainability.

Fuel choice and driving behavior

Alternative fuels are identified as very important in order to reduce the environmental impact from freight transports, especially from the perspective of the transport operators and freight forwarders. Today alternatives to diesel are used to a limited extent. The reasons for this are several; there is not one single satisfactory technology on the market, the techniques are not sufficiently tested, the vehicles cost more than conventional vehicles, there is a lack of availability of alternative fuels and little knowledge about the actual environmental effect in a life cycle perspective. It is very important to set the potential outcomes from alternatives in relation to the whole system. The hope for alternative fuels is large, which was also seen in the interviews.

"In the future we will have a better alternative than fossil fuels,
which will solve the problems that we have today"
– Swedish transport operator.

But the reality is different; studies show that biofuels are in best case going to cover one fifth of today's fossil fuel use in the transport sector in the future (VIEWLS 2005).

As long as there is a win-win situation between reducing the environmental impact from freight transports and cost savings, there will be incentives to act. Eco-driving is a good example which brings you cost-savings quickly. Still, the improvement is limited; once you have improved your driving it cannot continue indefinitely. In the future, new technologies in the vehicles choice of driving pattern might not be under as much influence of the driver as it is now.

Fuel choice, driving behaviour and sustainability

How the use of alternative fuels is affecting the impact on sustainability is a complex issue where many variables affect the impact on sustainability. Firstly, this action will reduce the amount of fossil fuels used, hence contributing to fulfilling principle one. But, dependent upon what kind of alternative and the choice of resource base (e.g., crops, biomass, garbage), the amount of energy content in the resource to be used, amount of land needed for growing resources to be used in the fuels, the efficiency in the production process, the level of competition with other user areas for the specific resource, etc. is showing different impacts on sustainability for principles 2-4. It is important to increase the awareness about the "mission impossible" to find one solution taking the place of fossil fuels on a global level. Regional solutions in combination with other actions need to be found and take place.

Using fewer resources (i.e., fossil fuels) for the same amount of transports will contribute to a smaller impact on the first three principles hence being more sustainable.

Important to highlight is that the actions mentioned above, aiming for alternative fuel choices and better driving behavior, will not contribute to other social sustainability issues regarding less traffic congestion and inefficient vehicle use.

Load factor

In the above list of actions the majorities relate to increasing load factor in the vehicles, or are facilitating an increased load factor. Other studies confirm the importance of improving efficiency in the transport system through, e.g., increased load factor, which in most cases also implies an improved economy (Blinge 2005).

The load factor can be considerably affected by the package design and is identified as an important action from the actors. Examples of initiatives taken in this area have been shown from transport buyers in the interviews. Gustafsson et al. gives examples where adapted packaging saved 21% of fuel use from transports in one company (Gustafsson, Jönsson et al. 2004). Important to highlight is that an adapted packaging does not provide a smaller environmental impact from the freight transports itself. Only if being able to consolidate a larger goods flow, this action can make a significant difference on load factor.

Having more flexible time restrictions for pick-up and delivery will make the transport operator and freight forwarder plan the transport more efficiently and have the potential to increase the load factor. The interviews show that the importance of change in production strategies are least concerned by the transport buyer. On the other hand, interviews show that the frequency of consignments, having larger quantities in one order and having more flexible time restrictions for pick-up and delivery is very important for the transport operators and freight forwarders. The transport operators as well as freight forwarders had registered that the trends of having tighter and tighter time windows for pick-up and delivery gives the operator less time to plan the logistics in an efficient way. Influencing the transport buyers to be more flexible is a challenge since this change can be seen as affecting the service level negatively. This is a typical example of where an increased co-operation between freight forwarder and transport buyer can bridge these knowledge barriers and typically increase the understanding of each other's situation contributing to a smaller environmental impact in total.

Co-operation between organizations can be a prerequisite in order to reach a more efficient system finding other solutions than only an actor can implement. A closer co-operation can lead to more understanding of each other's activities and systems. The interviews showed great interest in collaborative actions and that a majority was participating in formed groups within their own branch or cross disciplinary. The Deutche Post (DHL 2009) identifies that it will be important for logistics companies to cooperate with competitors in order to consolidate more transport volumes in the future.

The interviews as well as the questionnaire showed a great interest from a majority of the respondents for allowing longer vehicles by road. Allowing longer vehicles is a regulation that has a direct effect upon load factor, potentially leading to less traffic, and a reduction of emissions/tkm. It is, however, important to look upon this kind of action in a wider perspective in order to see how this affects other areas in society. Changes in regulation regarding vehicle length can potentially have an effect upon transport price as well as choice of transport mode. Studies show that adapting Swedish vehicle standards to European shorter vehicle standards would lead to socioeconomic disadvantages, such as more traffic, congestion and accidents and in conjunction with other actions lead to more goods by rail (Vierth 2008). Allowing longer vehicles can lead to the opposite, potentially socio economic

benefits, reduced transport price and consequently, also, potentially movement from rail to road.

Increased load factor and sustainability

Increasing the load factor in the vehicle can reduce the amount of vehicles used, using smaller amount of fossil fuels in total, and emits fewer emissions on a general level. This is reducing the level of impact on the first three principles of sustainability. Also, recourses are used more fairly and efficiently, reducing traffic levels, and thus contributing to meet principle 4 in a better way. When consolidating goods, the transport distance can increase due to changes of routes for picking up additional goods. The break-even for when an efficiency gain is made depends on, e.g., savings in number of vehicles to be used, changes in length of haul and changes in goods volume to be transported. In order to meet the principles of sustainability it is very important to increase these kinds of efficiency gains, but it is important to see the system as a whole in order to understand how much environmental impact is reduced. In addition the use and combustion of fossil fuels are still contradicting the first three principles of sustainability showing the need for other actions as well.

DISCUSSION

Efficient transports and induced transport demand

Efficiency gains in the transport system, such as higher load factor or less fuel consumption, has been argued to be of most importance for the practitioners and also economically beneficial. As a consequence, the costs for operating the transport may go down, also resulting in a possible transport price reduction as well as an increased quality of the transport. This may lead to an induced transport demand. The phenomenon can be resembled with the rebound effect, that efficiency gains aiming for reducing resource use in the system get offset by other systemic or behavioural responses leading to little or no gains in total (Ruzzenenti and Basosi 2008). In traffic planning it is well known that solving capacity problems in traffic by, e.g., improved roads will increase traffic (Smidfelt Rosqvist and Hagson 2009). Ruzzenenti and Basosi (2008) has evaluated the efficiency gains in the transport system and its relation to globalisation, concluding that the large fuel efficiency gains in the last decades was very likely to be one of the driving forces for the events of outsourcing and globalization and the increased transport demand. In the case of allowing longer vehicles by road, the relative attractiveness between the choices of transport modes, i.e., road and rail, get changed in favor for road transport, which could theoretically lead to an induced demand for more road transport (Smidfelt Rosqvist and Hagson 2009). Therefore, it is important to be aware about this phenomenon, and in order to only increase the efficiency and not also the transport demand, policies and regulations, such as taxes, could be necessary to implement in order to offset an increased demand in the transport system as a whole.

Changing logistical structures – not important for reducing environmental impact from freight transport?

It was no homogen view from the practitioners on how important changes in logistical structures were in order to reduce the environmental impact from freight transport. Transport

buyers show examples of logistical structural changes that were made to save costs, but having unknown effect on environmental impact. There is a lack in knowledge about how these types of actions affect the outcome in terms of environmental impact. This has also been discussed in literature showing different viewpoints in this issue (McKinnon 2003; Kohn and Brodin 2008). Within the logistical system it is a balance in between cost savings from other parts in the supply chain, such as large scale benefits from centralization of production in low cost countries, and the potential reduction of the environmental impact from transports. All interviews confirm earlier statements that saving pure costs is of utmost importance from a company perspective, and as long as the transport price is such a small share of the total product value, other efficiency measures in the supply chain will take precedence over the transport related issues on the strategic level of decisions concerning logistic structures. Hence, an even lower transport price would not make these issues of more importance; rather, the opposite.

The practitioners participating in this study were questioning if global production, markets and the dependency of long distance transports were actually able to continue indefinitely. A majority of the respondents were foreseeing more localized markets, i.e., closer distances between production and market in a desirable future scenario. Piecyk and McKinnon's (2009) study agree upon these kinds of changes, foreseeing a possible increase in local sourcing until 2020. Still, in order to reach such a development, increased transport prices were seen as a must by the interviewees - where governmental involvement in market factors were seen as one possibility for raised transport cost. Earlier studies show, though, that the transport price needs to more than double to have an effect on the choice of logistical structures in companies (McKinnon and Woodburn 1996).

Transport growth

To argue that there is a need for reducing transport growth is somewhat controversial and can be seen as contradictory to economic development. The importance of trade for industries' and countries' economic development is not questioned. But, when taking a longer time perspective, it is difficult to understand how society's environmental targets can be met without a reduction in transport volumes at the same time as being more efficient. Several researchers show by scenario analysis that radical changes need to take place. Piecyk and McKinnon (2009) find that if a business as usual scenario is to come true, the road freight sector will be far away from the governmental goal of reducing the CO_2 –emissions by 80%, thus intensified actions are needed by government and businesses. Åkerman and Höjer (2006) further state *"It does not seem possible to reach the target level for sustainable greenhouse gas emissions… only by relying on technology. Improved technology in conjunction with renewable fuels is important, but transport volume growth also has to be curbed."*

In order to bridge the gap between today's unsustainable trends and a sustainable future, actions need to be taken on all levels to reduce transport, traffic as well as emissions in all actors' environments. By increasing knowledge about how organizations' logistics and production strategies affect the outcome in terms of environmental impact from transports a larger step can be taken toward sustainability. This may be done through increased understanding and co-operation in between actor's environment, having a longer time perspective and a more holistic way of thinking.

CONCLUSIONS

This study compares actions suggested in academic literature to reduce the environmental impact from freight transport sector with the views of different practitioners. The results show that:

- **There is a gap of awareness and a difference in opinions between practitioners and between practitioners and the academia on how important and relevant the suggested actions are for reducing the environmental impact.**
  Increasing the use of alternative fuels and an improvement of load factor are seen as important by all practitioners; while logistics structures affecting transport growth is not in focus when reducing environmental impact. Although logistical structures are not identified as important today, clearly there is a growing awareness about these issues among the practitioners. A positive trend can be seen towards more collaborative projects concerning sustainable transports where the actors, including authorities, are participating.
  Transport buyers include environmental demands when purchasing transports as an efficient action. Furthermore, transport buyers do not generally reflect on their logistic strategies and demands on e.g., lead time and the precision on pick-up and delivery time, affecting the freight forwarders possibilities to plan routs and consolidate goods. Transport operators as well as freight forwarders are focusing upon actions concerning vehicle improvements, fuel choice, driving behavior, and use of information technology. There is a belief from the practitioner's side in this study that there will be technical solutions on the environmental problem in the future. Although technical development has been impressive have the transport growth over time generated more emissions than has been saved through technical advances. Alternative fuels are especially seen as a possible reality in the near future although most literature shows that only a small share of the present consumption of fossil fuel is realistic to substitute.

- **There is a need for methodologies that takes a holistic system approach on sustainability and logistics.**
  Actions taken in one end of the logistic system can affect the other end in a contra productive way unless other actions, e.g., in the regulatory system are implemented simultaneously. Notice should be taken upon the rebound effects of more efficient transport systems, which is argued to be important for the induced demand for transport.
  Most actions suggested in academic research focus on one issue, e.g., greenhouse gases, and not a necessary holistic view. In order to fulfill all principles of sustainability not only one type of action is enough. Both a reduction of transport, traffic and emissions from the vehicles are needed in conjunction with governmental actions. It is important to have a holistic view when discussing sustainability; having a longer time perspective as well as observing other effects in the system as a whole.

Due to the fact that transport costs are low in comparison to other costs in the supply chain the incentive to reduce the transport work is not prioritized in the companies' strategies. At the same time it is clear that the logistic structures have a strong influence on the demand of transport services. If reduction of transport work is an efficient and desirable way to reduce

the environmental impact from the freight transport sector must the price on transport be increased or regulatory instruments introduced to a higher extent than today.

There is need for further research about what criteria can be set on upcoming actions in the logistic system that will contribute to a sustainable development. This is the first step in research aiming at developing a method of how to identify bridging logistics strategies towards sustainability.

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