Abstract

Supply chains are getting more and more extended on a geographical scale. They comprise a variety of companies, countries, employee nationalities and modes of transport. Creating sustainability is an important and major challenge in order to make this globalization trend long-lasting. How individual companies can modify their way of performing transports to achieve sustainability within this area is discussed in this article. It is not enough to solely optimize the transports, several other aspects, such as inventory and handling activities, are affected and have to be taken into consideration. Economical control measures will be used by the members of the EU as tools to reach environmentally related goals, connected to the environmental sustainability of the supply chain. Analyses show that these economical control measures will affect transport costs in a way that makes environmentally friendly transports the most cost efficient, enabling simultaneous optimization of the environmental performance and the transport costs.
Introduction
The global warming and the greenhouse effect are hot topics all over the world. Some dread the disastrous consequences this may have within a near future, while some consider the worry to be exaggerated. Nevertheless, the transport industry has been identified to be a big contributor to emission of the greenhouse gas carbon dioxide. Consequently, a lot of focus is directed to this sector in order to reach the environmentally related goals concerning diminishing of the emission of greenhouse gases. Taxes and fees are used as tools to steer transportation towards a more sustainable performance. Sustainability creates economical, social and environmental durability and the supply chain has to be well designed in order to achieve sustainability in all of these areas.

In order to investigate how the software company Syncron might adjust their supply chain optimization tool to gain sustainability, one of their customers - Lantmännen Maskin - has been studied. Different suggestions on how to adapt the supply chain to make it more sustainable has been applied to Lantmännens Maskin's outbound logistics of spare parts. The aim with this study was to discover general methods of improving the supply of goods, which can be used when optimizing the design of supply chains using Syncron's software.

The studied supply chain only comprises Swedish geographical areas, which is why existing and future taxes and fees in Sweden have been high-lighted. This article summarizes the realization and results from the thesis introduced to conduct this investigation.

Method
The authors’ initial knowledge in the area of environmental sustainable supply chains was limited and the project begun with a mapping of present and future environmental regulations in order to create an initial framework. This gave a useful understanding of the subject and served as basis when gathering empirical information. The case study at Lantmännen Maskin was performed and material on which to conduct an analysis was gathered. The analysis ends in conclusions and recommendations to concerned parties. Worth remembering is that every supply chain is unique and comparison between different supply chains has to be done with great caution.

Both quantitative and qualitative data were used in the thesis. Data was collected from primary sources such as, email correspondence with authorities, interviews and a questionnaire, while secondary data was mainly gathered from government publications and other literature. The credibility of a study is very important and one of the actions taken to enhance it is the choice of interviewing several persons at Lantmännen Maskin in order to obtain different points of views.

The Transport Industry
The emission of CO$_2$ made in the transport industry amounts to 28 percent of all CO$_2$ emissions in the EU. 84 percent of the emission made in the industry comes from road transports and 13 percent comes from the aviation sector. Forecasts reaching for 2020 are predicting an increase of freight transports by 21 percent. With these numbers in mind the importance of actively addressing the environmental aspects connected to the transport industry, in order to lower the emission of greenhouse gases, can easily be understood.

To deal with environmental problems due to transport related emissions and to be able to reach the environmental goals that have been set within the EU, shifts in means of transportation will be necessary. Road and air transports will have to be reallocated to rail and water without losing too much in efficiency and speed. Combinations of different means of transport must also become more common. One approach that creates incentives for shifts in means of transportation and aims to help the fulfillment of different environmental goals is the introduction of various economic control measures. The focus is on the road and aviation sectors, since these are the transport modes that emit the most CO$_2$. A possible introduction of a kilometer tax on the roads in Sweden, fuel prices for trucks and the inclusion of the aviation sector in the EU Emission Trading System (EU ETS) are the aspects that will have the largest impact on the transport industry in the near future.
The objectives when introducing a kilometer tax system are to decrease the amount of road transports, the costs for maintaining the road network and the emissions of greenhouse gases. The tax system would concern heavy trucks and they would then have to pay somewhere between 1-10 SEK per kilometer that they drive on the road network.

The fuel price for trucks mainly consists of equal parts of the fuel tax and the diesel’s purchase price. Changes in either of these will affect the total transport price noticeable. It is not very likely though that both components rise to the skies at the same time, since governments are aware of the fuel's important role in almost all industry activities.

The thing that distinguishes the EU ETS from other economical control measures is the steering towards a total combined emission level. All aviation traffic within the EU and flights with only takeoff or landing within the EU will be included in the EU ETS in 2012. The inclusion of the aviation sector in the existing EU ETS will not render too many new and extra administrational costs since the system is already in use today.

Involved Parties
As mentioned above, Syncron provides supply chain optimization software for global supply chain planning, fulfillment and supply. At present, only tied-up capital and service level affect the outcome of the optimization, but Syncron suspects that the transportation cost will soon also be an important factor due to environmentally related economical control measures. For this reason, they are eager to learn about what parameters in the supply chain that has the largest impact on the transport cost.

Lantmännen Maskin uses Syncron's software product when placing stock orders for replenishment at their retailers and in their central warehouse. These retailers provide the agriculture sector with spare parts for, and services on machines such as tractors and threshing machines. A large customer is the internal workshop that performs service on agriculture machines. The central warehouse in Malmö supplies retailers all over Sweden with spare parts. On most occasions transportation is performed by truck, but when necessary, due to rush orders, air freight is used. Rush orders are order types that must be delivered one or two days after the order placement and they are normally placed when a shortage arises at the retailer. The internal demand, from the workshops, generates the majority of the rush orders.

If the purpose of the order only is to refill the inventory, a so called stock order is placed. Unlike rush orders, these orders have a lead time of six or seven days. Shipments are collected Monday through Friday and distributed Tuesday through Saturday.

Analysis
The analysis of Lantmännen Maskin's supply of spare parts to their retailers is mainly based on the matrix presented in Figure 1. The internal adaption methods that would affect Lantmännen Maskin the most were identified. The identification was based on the possibility of achieving the largest cost and emission saving within the distribution system. The identified methods are all aspects that Lantmännen Maskin may realize themselves, and which enhance the sustainability of the supply chain. A short description of the internal methods follows below:

- Delivery Frequency - A lower delivery frequency of the stock orders renders a lesser amount of shipments
- Order Types - Shifts from air to road transports for rush orders
- Article Classification - Increasing the number of stocking articles
- Virtual Supply - A retailer functions as a regional supplier for rush orders and a form of lateral transshipment is implemented into Syncron's software.

The horizontal top row, in Figure 1, shows the most important areas that are affected by modifications of the cost and emission drivers, i.e. implementations of the adaption methods. The ranking of the methods is made by evaluating its effect on the distribution system and a high overall ranking implies a large positive effect on the supply chain of spare parts. Both general numerical calculations and reasoning, and also to some extent evaluation of the total cost, have led to the ranking number placed in each column in the matrix.
The areas in focus are the transport cost and the environmental effect, since those are the ones that are the closest related to the sustainability concept. The other areas; service level, tied-up capital and lead time, are mere second hand reactions. This does not mean though, that they are negligible in any way in the effort of enhancing the sustainability of the supply chain.

By looking at the ranking, a decreased delivery frequency and an introduction of a logistical virtual supply solution are hence the methods that will have the most positive effect on Lantmännen Maskin, why these areas are of most interest.

Results and Conclusions

The mapping of present and future conditions within the transport industry indicate that stricter regulations related to environmental performance are to be expected. The probability for an introduction of a kilometer tax is significant and the cost consequences for transporters using trucks would be considerable. Calculations regarding Lantmännen Maskin's supply chain show that their costs for road transports would increase by 17 percent due to a 7 SEK kilometer tax. Another economical control measure is the fuel price, which is likely to increase either due to increased taxes, increased oil price or a combination of those. A realistic level of increase is 7 SEK per liter, which is equivalent to a doubling of either the current tax or the current purchase price on diesel. However, this would only cause a cost increase on Lantmännen Maskin's road transports in the size of 5 percent.

The introduction of the aviation sector in the EU ETS is decided to take place in 2012. This will lead to additional cost for airlines emitting more carbon dioxide than they have emission allowances for. This cost will be transferred to the transport buyer, but according to calculations, not be greater than a few percent, which can be explained by the fact that air freight already is very expensive. This statement is confirmed by the fact that Lantmännen Maskin could reduce their overall transport cost with about 48 percent if all air transports were eliminated.

By reducing the delivery frequency, savings on road transport costs in the size of 20 percent or more could be achieved. This would more than even out the cost increase due to a 7 SEK kilometer tax.

Another way to improve the coordination of demand and supply is by using an extended virtual supply solution. Supplying retailers with rush order from a regional supplier would not only reduce the number of air transports and hence lower the transportation cost, but also improve the environmental performance significantly. The consequences on the material flow for Lantmännen Maskin, with the starting point in the political environmental incentives are illustrated in Figure 2.
Recommendation

The above presented conclusions motivate certain recommendations to Syncron and Lantmännen Maskin. In order to enable extended coordination in the supply process, Syncron should be governing the rush order handling. Lantmännen Maskin should aim to decrease the air transports by implementing the virtual supply solution and by getting accurate forecasts from the workshops and thereby avoiding rush orders.

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