Road Transportation
Environmental sustainability vs. lead time and costs

Master Project in Logistics and Supply Chain Management

Authors: Forsberg Niclas
         Gudmundsson Erik

Tutor: Hultman Jens

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Abstract

The recession of the early 1990’s marked the starting point for a transformation of the Swedish transportation industry. Cost oriented production techniques by the industry’s customer increased demand on swiftness, reliability and flexibility in transportation services. This development has continued ever since which in turn has continuously increased the rates of harmful discharges of emissions.

The research is performed on the Swedish plastic industry and examines the relationship between environmental sustainability, lead time and cost when selecting road carrier for transportations. The main purpose is to examine to what extent environmental concerns are taken into account when deciding over distribution and furthermore, whether there exist potential and ambitions for improvements. Out of theories concerning transportation modal choice, four points of interest constitutes the basis for the empirical gathering; prioritization of selection determinants, environmental requirements in procurement of transportation services, use of rail freight and acceptable cost levels for implementing environmental sustainability.

The study shows that the market of the Swedish plastic industry is driven by price competition and constant pressure from international trade. Naturally, cost is considered to be the foremost selection determinant in terms of transportation modal choice, followed by reliability and lead time. Furthermore, the study shows that environment is of low priority in respect to the other selection determinants. Although the current market condition diminishes the possibilities for changes, there exists a general ambition to become more environmental within the distribution activities. A majority of the respondent firms could potentially accept levels of increased transportation costs which balance with the costs of guaranteeing environmental sustainability in road transportations.

In reference to increased environmental ambitions, three conclusions can be drawn. The relationship between environmental sustainability, lead time and cost allow for environmental improvements if lead time can be extended to the maximum conceivable limit of the market. Furthermore, the price competition of the market makes own initiatives impossible in terms of raising price for transportations; environmental sustainability in road transportation must therefore be preceded by demand for such. Finally, it can be concluded that environmental improvements cannot be achieved single handedly; costs must be evenly distributed among the suppliers, customers and haulers.
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1 Introduction

“Environmental sustainability - The quality of a policy or proposal of ensuring an impact on the environment that is positive or, if adverse, that is at least within the limits of acceptability.” (Herefordshire, 2007)

The recession of the early 1990’s marked the starting point for a transformation of the Swedish transportation industry. Besides forcing great numbers of haulers into bankruptcy, the weak economy initiated a change of business strategy among the industry’s customers. In order to survive on markets with diminishing demand, cost oriented solutions were necessary; producers and retailers started to concentrate production as well as minimizing inventory levels to cut down on transaction costs. These new strategies reflected in a change of demand patterns among transportation services. (Sveriges Åkeriföretag, 2007) Although the function of distribution had been an important determinant for many years, it was not until then its function were really recognized (Rushton, 2006) From only supplying simple point-to-point deliveries, transportation firms became treated as extensions of its customer’s production processes which increased demand on swiftness, reliability and flexibility. (Sveriges Åkeriföretag, 2007) With continuous globalization and improvements in communications and transportation, the competition over end customers has been growing fiercer ever since. Market demands continuously raise the requirements of products and services making time and cost important factors for success (Harrison & van Hoek, 2005). As transportation is generally the foremost expensive of all logistic activities and its determinants are just time and cost, the sector has stayed in focus and remains a subject of constant refinement (Frazelle, 2001).

The practical results of this development show clearly. Producers and retailers can now increase their competitiveness by offering shortened lead times on deliveries, higher quality of transportation and better customer service than 20 years ago. From the haulers point of view, the market continuously grows and the opportunity for fruitful business is out there; as long as entry barriers can be handled, good money can be made. Although improvements can be measured from a corporate or consumer standpoint, the recent development is far from comforting while being viewed in an environmental perspective. Despite progress in a number of areas, transportation remains a burden to the environment and its continuous growth raises great concern in terms of environmental sustainability and global warming (European Environment Agency, 2007).

1.1 Problem & Background

As previously mentioned, Frazelle (2001) presents transportation as the foremost expensive of all logistic activities. But logistic costs are not the only transaction cost added to a product on its way from raw material to end consumer. From the very beginning of its refinement, labor, storage, packing, marketing, etc keeps adding to the total. By having such number of different costs affecting the end price, firms prioritize what cost to reduce according to the market standards of their product. As transportation costs do often constitute a small share of the total cost, localization of firms will be more dependent upon access to other resources. (European Environment Agency, 2007) For example clothes, a product that can easily be transported and demand great number of labor, are preferable produced in countries with low labor costs irrespective of their geographical location as the
cost of labor outnumber the transportation costs by far. This reasoning comes to the conclusion that the relative low cost transportation constitutes, makes its minimization a low priority. In practice, product distribution is then at most measured out of a lead time perspective rather than by its costs, resulting in continuous growth in demand for transportation services.

The growth in the transportation industry has clearly shown in statistics. Since 1992, volume of freight transports has increased by 42% (European Environment Agency, 2007). A majority of this increase is ascribed to road transport which has not only grown by its own development but also gained share on the expense of rail and inland maritime shipping (Eurostat, 2007). These statistics point out two very significant concerns in terms of economic benefit and environmental sustainability.

Figure 1-1 Volume of freight transport relative to GDP (Eurostat, 2007)

As shown in figure 1-1, the percentage increase in Gross Domestic Product (GDP) relative to volume differs in favor for transportation (Eurostat, 2007). This fact raises concerns as most activities that constitute GDP have, in one way or the other, a transportation component within (European Environment Agency, 2007). With such reasoning, the two values should have a similar progress but with the present skewed development, the result is less economic benefit per distance transported.

Figure 1-2 Discharge pollution (EcoTransIT, 2007)  Figure 1-2 Share of transport (Eurostat, 2007)

The second issue concerns the previously mentioned changes of share between different transportation means. When comparing road, rail and inland maritime transportation in terms of pollution (figure 1-2), the statistics clearly show the ecological disadvantages by having the majority of transportation by trucks (EcoTransIT, 2007). And when these facts
are put on the context of the curve shown in figure 1-3, the equation is simple; the recent development continue to add stress to the environment.

1.2 Purpose and research questions

With the problem and background statements as the basis, the research examines the relationship between environmental sustainability, lead time and cost when selecting road carrier for transportations. The main purpose is to examine to what extent environmental concerns are taken into account when deciding over transportation provider and type of service.

In order to answer the purpose, the following research question will work as guidelines.

- How do customers of transportation consider environmental issues when deciding on road transportation?
- What is the relationship between environmental sustainability, lead time and costs within the carrier selection process?
- What are the potential for customers of transportation to pay a higher amount to ensure environmental sustainability in road transportation?

1.3 Structure of the research

The first chapter – Introduction – explains the problem, background and aim of the research including the principal structure and delimitations. Next chapter – Theoretical framework – discusses the theory behind transportation management and its consequences on the environment. The third chapter – Method – presents the structural overview in depth and explains the research methodology. In the fourth chapter – Empirical findings – the results of surveys and interviews are presented. In the following chapter – Analysis – the data will be analyzed in the light of transportation modal choice and environmental sustainability. The final chapter – Conclusion – discusses the research questions and purpose by the result of the analysis.

1.4 Delimitation

The research will be based upon conditions prevailing in the Swedish transportation industry if nothing else is mentioned.
2 Theoretical Framework

In terms of product distribution, the transportation system is defined as the physical link that connects all fixed points in a logistic supply chain. By connecting geographically dispersed operations, the function of transportation is to bridge the buyer-seller spatial gap. (Coyle, Bardi & Langley, 2003) As mentioned in the introduction, transportation is the principal linkage process and do often consume most of the resources allotted to the logistics function (Frazelle, 2001, Gattorna & Walters, 1996). Nevertheless, increased spending on transportation does not naturally lead to better customer satisfaction or increased sales as the demand patterns for transportation services is not exclusively a result of own characteristics but rather the result a of change or shift in underlying demand patterns of end products. For example, transportation as the mean of moving physical goods from a warehouse to a store, its demand is relative to the demand of the specific product being transported. (Cole, 2005)

2.1 Modeling transportation

The traditional starting point of modeling transportation is simple. There are basically four questions needs to be answer; origin and destination, how often to transport, what mode to use and what route to take. (Gomer-Ibanez, 1999) The challenge comes when these questions are brought down to find the most appropriate solution. Transportation is a broad and complex field which can be analyzed from a number of situations and perspectives. Thus, the selection of an adequate model is necessary to be able to draw correct conclusions.

According to Tarko (2003), the theoretical scope of transportation analysis consists of a paradigm divided into four main categories; demand-, network-, traffic- and performance modeling (figure 2-1). Demand oriented modeling is commonly used when the aim of the research is to predict future demand. Basically, such models use historical data to forecast trends by opportunities and threats and are being used on both corporate and governmental levels. Secondly, network models are used when analyzing certain transportation modes and their possibility for interactions. Such modeling highlights connectivity between different modes which allows for easier decision when implementing intermodal transportation in a region or for a firm. Traffic models aims to display the relationship between transportation demand and cost components. The last category, performance modeling, is overarching and contains elements from all of the previously mentioned approaches. Commonly, performance modeling is used to compare the characteristics of different transportation alternatives by focusing on the relationships of different terms, for example volume, time, cost, traffic density, emissions, market strategies etc.
2.2 Transportation Management

The main objective of transportation management is, according to Frazelle (2001), to “...link all pick-up and deliver-to points within the response time, requirements of the customer service policy and the limitations of the transportation infrastructure at the lowest possible cost”. Cost is the dominating label for every expense that can be associated with distribution and response time, commonly denoted lead time, is defined as “…the time between receipt of an order and dispatch for delivery or actual delivery” (Lowe, 2002). Furthermore, requirements of the customer service policy include the foremost important objective, satisfying customer demand on transportation.

To be able to take the right decisions when structuring the distribution of products and materials, transportation managers must consider a wide range of factors. Many of the considerations are quite obvious ones, but the problem lies within the many different aspects that need to be acknowledged Rushton, (2006). Although theorist uses different groupings of these determination factors, their results are somewhat similar; it ultimately points towards one decision point; a trade off analysis implied by Frazelle’s (2001) definition where quality of distribution stands in contrast with costs and the main objective being to satisfy customer and at the same time do it to the lowest possible cost. By using a performance modeling approach, Gattorna and Walters (1996) try to explain the factors influencing transport managers’ decision by grouping the considerations into three sets based according to Slater’s (1990) reasoning (see figure 2-2); operational factors which include customer, product, market and company characteristics; transportation mode which concern for example load size, costs, accessibility of different transportation means; and finally channel strategy, which denotes identification and interfaces of available channels.
Company characteristics refers to the own firm’s marketing, operational and financial strategies. Marketing strategies is considered to be one of the cornerstones as it determines the service level that will be offered to the customers. Dependent on market demand, customization of transport might be necessary or on the contrary, only standard quality levels are the most appropriate approach. Furthermore, financial objectives are a determinant as well, since level of performance contrast costs in a trade off perspective. Operating strategies influences the choice in terms of possibilities to control resources. Furthermore, Gattorna and Walters (1996) and Slater’s (1990) argues that market structure is an important determinant, significantly in terms of highly competitive markets as service level of deliveries could become one of the key determinants of which suppliers a customer chooses to work with. In addition, product characteristics needs to be considered, which might seem obvious but still, special product requirements of the transportation could become a needle’s eye for efficient performance. The fourth factor, customer characteristics, goes to some extent hand in hand with the marketing strategy as it concerns what service level being demanded among customers; special demands from customer groups must be met in order to stay competitive. Finally, environmental issues in the context of government infrastructure policy and transportation technology must be taken into account.

The second set of consideration, transportation mode, concerns the specific characteristics of different means of transportation. It is considered to be of great importance and influence on transportation management, and is further discussed in chapter 2.3.1.1.

The third set of factors, denoted channel strategy, refers to what options the firm has to reach their customers (Gattorna & Walters, 1996) and is considered to have a great influence on the long run performance of the firm (Carlos & Bakr, 2002). Channel strategy re-
fers to a set of trade off concepts; horizontal, vertical and lateral tradeoffs. Horizontal tradeoffs refer to choices between different transportation modes which could be used to perform the same task, for example comparisons between rail and road transportation. The key is to find the most appropriate transportation mode to meet the demands of the operational factors. Vertical tradeoffs concern the utilization of transportation resources. In other words, evaluations of where in the logistics functions the transportation supply the greatest benefit. The third trade off discussed concerns lateral tradeoffs where the cost for the transportation is compared with other business processes. For example, it could be preferable to produce in countries with low labor costs irrespective of their geographical location if the savings in labor outnumber the increased transportation costs.

Similar to Gattorna and Walters (1996), Rushton (2006) concludes a set of general factors that directly affect the very foundation of distribution (see figure 2-3). These issues are presented as operational factors, transport mode characteristics, consignment factors, and cost and service requirements.

![Figure 2-3 Transportation Modal Choice (Rushton, 2006)](image)

Operational factors are constituted by external operations, customer characteristics, product characteristics as well as a collective sub category denoted logistics components.

The operational factors are in its context pretty similar to the environmental factors of Gattorna and Walters (1996) and Slater’s (1990). Within external operations, Rushton (2006) discusses the impact of all the factors shaping a firm’s environment. He argues that government infrastructure policy and transportation technology are focal determinants and extends the discussion by acknowledging cultural and economical factors of geographical regions, even the effects of differences in climate. Rushton (2006) highlight the fact that these factors, external to direct distribution, must be known in order to move further into the decision process, especially when developing distribution in international contexts. The second sub category of the operational factors is customer characteristics and is defined about the same as the corresponding category of Gattorna and Walters (1996) and Slater’s (1990). Rushton’s (2006) addendum consists of service level requirements which by the
previous theorists were included in marketing strategies of company’s characteristics. Just as the former sub category, product characteristics have a corresponding category by the previous theorists. The physical nature of the product is an important factor when deciding over modal choice as volume to weight and value to weight is naturally crucial determinants. The collective category, logistics component, deals with resources and opportunities for the firm by basically including the horizontal-, vertical- and lateral tradeoffs mentioned within choices of channel strategy.

The second overarching category is denoted transportation mode and just as in Gattorna and Walters (1996) and Slater's (1990), it concerns different transportation modes' characteristics and will be discussed in Chapter 2.3.1.1. Under consignment factors, Rushton (2006) further discuss loading, routing and possibilities for efficient transit out of the characteristics of all possible transport assignments that could influence the practical use of the final choice of transport solution, a discussion corresponding with the possibilities for a firm to control resources within distribution. The final category, cost and service requirements, concerns the ultimate challenge for the transportation manager; the familiar cost-benefit tradeoff between level of service and the cost of distribution. With the basis of the previous category summarized in a specific service level, Rushton (2006) argues that in theory, the size of load to be moved and the distance to be travelled will determine the final decision choice of mode in relation to the cost.

### 2.3 Carrier selection

The carrier selection process is an important function in the procurement of transportation services as the final choice will directly determine the quality of the distribution (Bardi, Coyle & Novack, 1999).

![Figure 2-4 The Carrier Selection Decision (Coyle et Al, 2003)](image)

The process contains three principal steps as shown in figure 2-4. First of all, the transportation manager needs to decide on a specific mode according to a number of selection determinants. Further on, the manager must examine costs in relation to service levels and decide on possible outsourcing of the distribution; which in case leads to the final selection of what transportation provider to contract. (Coyle et Al, 2003) According to Bardi, Coyle & Novack (1999), there are a number of factors that needs to be examined in order to find the most appropriate solution.
2.3.1 Step 1 - Selection determinants

As mentioned earlier, the transportation modal choice is dependent on a wide range of variables in complex relationships. In order for a transportation manager to be able to take decisions, all these factors need to be accessible and easy to grasp. Irrespective of initial grouping, it is a necessity to break down the overarching factors from the performance models into more hands-on decision points, decisions points that eventually will lead to the cost-benefit tradeoff.

For most companies the general factor when thinking of carrier attributes is the cost and lead time aspect. Thought, a lot of research has been done in the subject and the above attributes is competing with other important concerns when considering choice of carrier. Early research by Saleh & Das (1974) states the reliability, stability in service, the image of the company, and the handling capabilities as the most important factors. Jerman et al (1979) declared in their research the six most important attributes for carrier selection from 26 different variables. These six attributes were price and privileges, earlier performance, the image of the carrier, the cooperation concerning rate adjustments, routing abilities, and competence of needs. The attributes were conducted from ratings by both carrier and shippers. For the carrier organization it is a focal point to know the dimension of the carrier selection process, and the value of having the perceptive in customer demand. To be able to compete in the transportation market the carrier organization needs to go beyond the perceptive in customer demand and define the potential customer segments and choose correct strategic option (Coulter, Darden, Coulter & Brown, 1989). One of the most crucial determinants for customers of transportation is the time and speed attribute, on account of the customer demand in today’s market. By reducing the time of freight transport to meet with the demand from customers, the most energy and polluting mode is often preferred since the lead time of the route is minimized (Rodrigue, Slack, and Comtois, 2001). Businesses today have turned into a more time limit process as of the market demand, and the result have been an increase in more polluting modes as air freight and road transportation is selected. Other factors why customers of transportation is selecting road and air freight is by the reason of the reliability when it comes to on time delivery and the safety of the goods (Rodrigue et al, 2001).

Presently, six decision points dominates the selection process; transport cost, transit time, reliability, accessibility, capability and safety. Transportation cost is, as previously mentioned, all the costs that can be associated with the transportation; for example distribution rates, loading and unloading, damaged goods, etc. In early carrier selections, simple cost comparisons were the predominant factor for every decision made but after the recent recognition of transportation as an extension of production processes and sometimes tools for competitive advantage, cost analysis is leaning towards evaluating alternative options through trade off comparisons; in other words weighting unit of costs in relation to unit of perceived value. (Coyle et Al, 2003) The second factor in the consideration is lead time for the transportation, also commonly denoted transit time. As previously mentioned, lead time is the total time that elapses from a transportation order dispatch until the goods are delivered. The lead time factor is closely related to reliability which in turn refers to the consistency of transit times; in other words if promises and time schedule are kept by the hauler. In addition to costs, lead time and reliability, accessibility and capability determines if a hauler can practically perform transportation. Capability refers to the physical equipment and facilities needed for a particular good. Accessibility is, as formerly mentioned, the ability to provide transportation over the desired route. The final factor in the selection concerns safety and security; to have the goods arrive at the destination in the same condi-
tion as they were while being loaded at the origin. Although insurances can secure capital in case of damages, it cannot cover opportunity costs for lost business or forgone productivity, etc. (Coyle et Al, 2003)

<table>
<thead>
<tr>
<th>Selection Determinants</th>
<th>User Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport Cost</td>
<td>Landed costs</td>
</tr>
<tr>
<td>Transit Time</td>
<td>Inventory, stock-out costs, marketing</td>
</tr>
<tr>
<td>Reliability</td>
<td>Inventory, stock-out costs, marketing</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Transit time, freight costs</td>
</tr>
<tr>
<td>Capability</td>
<td>Meet physical/ marketing needs</td>
</tr>
<tr>
<td>Security/Safety</td>
<td>Inventory, stock-out costs</td>
</tr>
</tbody>
</table>

Figure 2-5 Carrier Selection Determinants (Coyle et Al, 2003)

Which one of these selection determinants companies should focus upon is dependent on the business activity in question. For example, importers of expensive furniture will probably prioritize security and safety over short transit time, just as transportation cost is the focal point of firms involved in international trade with low-valuable goods.

2.3.1.1 Transportation modes

Transportation is generally divided into four major modes; road, rail, sea and air freight. (Coyle et Al, 2003) In addition to these principal categories, containerization (Rushton, 2006) and the use of pipeline (Coyle et Al, 2003) are also commonly discussed as a fifth and sixth mode. While examine statistics and comparisons between different modes, transportation distance together with the mode’s practical benefit usually determines what option to be put in the context of the other. In other words, when comparing domestic transportation modes in Sweden, air and sea freight, containerization and pipelines are irrelevant.

Road freight is the dominant transportation mode (Eurostat, 2007) and denotes all types of carriage performed on road networks, from the smallest pickup truck to semitrailers (Coyle et Al, 2003). The advantage of road transport services are commonly summarized by accessibility and short transit times. Accessibility refers to the fact that a sophisticated network of roads and highways allows this mode to provide transportation services irrespective of geographical location of origin or destination. By not being dependent on access to tracks, waterways or airports, road freight becomes the foremost accessible mode of domestic transportation. Short transit time is the result of a set of factors decreasing lead time on deliveries in respect to other transportation modes. As of its own power unit, trucks can be operated independently. Furthermore, routes can easily be optimized by shortest travelling distance as well as rescheduled according to changing conditions. Consolidation and the use of terminals do also provide flexibility which allows more efficiency in a time perspectives. (Coyle et Al, 2003) In addition to accessibility and time, road transportation is advantageous in terms of goods handling. Packing costs can be kept to a minimum as the likelihood of damage is not as great as in the other modes of distribution. (Rushton, 2006) The disadvantages on the other hand, come out of pollution, reliability and carrying capacity. As detailed in chapter 2.6, pollution is a great concern for this mode (EcoTransIT, 2007). Furthermore, the reliability can be questioned as the influence of weather conditions and traffic cannot be fully estimated in advance. In terms of carrying capacity, the limited size of
trucks as well as legislations constrains shipments to relative small volumes. This in turn creates a high cost per ton-mile ratio in comparison with other modes, a fact that can prove really disadvantageous when capacity utilization is low. (Coyle et Al, 2003)

Rail transportation finds its foremost advantages in low cost per ton-mile ratio (Rushton, 2006) and low levels of pollution (EcoTransIT, 2007). As carrying capacity is relatively good, rail transportation is the number one choice in heavy and bulky freights over longer distances (Coyle et Al, 2003). Rail freight does also have few limitations to what types of goods it can transport as a result of its large volume capabilities and strong power units. (Rushton, 2007) Disadvantages of rail transportation are principally found in transit times and accessibility. Bounded to its tracks, rail freight cannot provide origin and delivery services as trucks. For a customer situated far from railheads, deliveries by trains must then be solved by double handling with road freight. (Coyle et Al, 2003) Furthermore, tracks limit flexibility in terms of route deviations as schedules of passenger trains are in most cases prioritized. Railroad freight is also problematic in an international freight perspective due to different track sizes and other physical standards. (Rushton, 2007)

| Accessibility | X |
| Transit Times | X |
| Cost/Tone | X |
| Reliability | X |
| Environment | X |

Figure 2-6 Comparison Road and Rail Freight

As in figure 2-6, the most preferable choice of mode can be shown out of a simple comparison by advantages and disadvantages. But the selection of mode is not that simple. In some cases, transit time can be lower for rail transports as well as the cost per ton can increase when double handling with trucks are necessary. As of this, generalizations can be misleading which means that every comparison must be put in the context of a specific transportation.

2.3.2 Step 2 & 3 - Selecting transportation provider

When the mode has been decided upon, the next step is basically to find the most appropriate transportation provider through quotations and comparisons; the final choice will be the one offering most in benefit per cost reference to the expected customer service level.

2.4 Performance measures

Among others, Gattorna and Walters (1996) highlights the importance of performance measures for continuous evaluation of current and possible transportation alternatives. Their suggestion is based upon measures grouped by three criteria according to figure 2-7.
2.5 Greener Transportation

“Growing freight traffic volume also means environmental responsibility for businesses” (EcoTransIT, 2007)

In today’s business, companies are facing a change in responsibility towards the environment. Since there have been a huge increase in freight transport during the last decades, there have been a rise in awareness of environmental impacts from the distribution industry (EcoTransIT, 2007). This increase has led to a demand for organizational action to enable a sustainable development in the transportation sector. With the demand of greener alternatives, a rise in services is offered by third parties. This offering can concern alternative transportation, new engine technologies, or other innovative solutions for protecting the eco-system. For describing the solutions which can be adapted in organization, we decided to define some of the best practices in the transportation industry and describe the environmental impacts that emerge from road freight.

2.5.1 Best practices

Waters (2006) declare that seven percent of the GDP in Western Europe is represented by the transport sector. The energy that is consumed by transportation is estimated to be one-third of the entire energy consumed by the European Union. Out of that energy consumption, 85 percent can be ascribed to road transportation. The environmental effects from road transportation are shown in figure 2-8.
<table>
<thead>
<tr>
<th>Emission</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>Global warming</td>
</tr>
<tr>
<td>Oxides of nitrogen</td>
<td>Smog and ozone formation</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>Toxic</td>
</tr>
<tr>
<td>Sulfur dioxide</td>
<td>Acid rain</td>
</tr>
<tr>
<td>Changeable organic compounds</td>
<td>Chemical smog</td>
</tr>
<tr>
<td>Particulate matter</td>
<td>Breathing problems</td>
</tr>
</tbody>
</table>

Figure 2-8 Emissions and their effects (Rushton, 2006)

With large amounts of emission being discharged from road transportation, there have been extensive efforts in finding alternative options for road freight transports (Rushton, 2006). One effort for sustainable development is fuel improvements. Rushton (2006) describe new technologies such as high pressure injection systems, computerized engine management systems, and reduced sulfur content in diesel as new inventions to limit emission discharges.

When it comes to best practices in the transportation industry, there are several transportation providers with innovative ideas in how they can work for decreasing the environmental impact from road freight. The article Road transport best industry practices (2003) describe several corporations which are working on sustainable development in the transport provider industry. Some examples are:

- **Alternative fuel**
  The transportation provider have means of transportations which drive on less environmental harmful fuel, as bio gas or other new technologies in engine performance that is more beneficial for the surroundings and the eco-system.

- **Eco-driving**
  Educational courses for the drivers of road freight, when it comes to driving more fuel efficiently and considerately.

- **Environmental Management Systems**
  Environmental management systems is a way of running corporations processes toward more environmental operations. Example of this is the certification ISO 14001 standard which is a non-mandatory alternative for sustainable development. There are also tools that can present information on the impacts of their distribution, and search for substitutes of transports (EcoTransIT, 2007)

- **Early morning - distribution system**
  For the deliveries to be as effective as possible, the system control early morning deliveries to stay away from traffic jams and to optimize the use of the carrier which will minimize the emissions.

- **Vehicle utilization and avoidance of empty trips**
  Optimize the logistics processes and operations within the company, for utilize the cargo and increase the proportion of returning goods.
2.5.2 Environmental management

When it comes to best practices, a concept many organizations are adapting to is environmental management. Environmental management, defined as “…ensuring that environmental concerns are included in all stages of development, so that development is sustainable and does not exceed the carrying capacity of the environment” (Saroof, 2007), is a rather new field of research which has experienced its most apparent development during the recent decades. With its efforts to understand the structure and function of the environment, the role of the field is to conform and coordinate human behavior to prevent further damage to the Earth (Barrow, 1999). In today’s businesses, environmental thinking is as important as the quality or services the organization offering. If companies ignore environmental issues as in pollution or other damages, it can result in a public rejection of their products or services (Morris, 2004). There is also an increase in legislation pressure and therefore has the demand of structuring the organization environmentally increased, to meet the demand from both customers and different legislations. To avoid these problems, many corporations implement environmental management systems that control companies’ processes towards more environmental operations. When corporations implement an environmental management system, they minimize the risk of incidents from their operations that concerns the environment (Morris, 2004). For organizations to follow these performance there have been quality- and environmental management standards named International Organization for Standardization (ISO). ISO 9000 is for quality management and ISO 14000 is for environmental management. The international standard of an environmental management system is called ISO 14001, which is a non mandatory standard where there is a third party controlling that the organizations follow up the environmental demands which the legislations or specific country are requesting. The demand for ISO 14001 is different in each corporation. It is up to the organization itself to set the level of ambition in their environmental performance (Almgren & Brorson, 2006). However, to get the certification there are certain levels you have to accomplish to be accepted as an ISO certificated organization.

![Environmental standard ISO 14001 (Almgren et al, 2006)](image)

Corporation’s responsibility is to identify their environmental influence and act on it by improvements in the organizational operations. The positive result of implementing an ISO certification, other than improvements against the environment, is to confirm to customers and other stakeholders their dedication to environmental issues (DHL, 2007). Figure 2-9 illustrates the implementation cycle of the environmental management system ISO 14001. The environmental management system consists of 5 elements with specific demands that
need to be fulfilled (Almgren & Brorson, 2006). Those elements and operations are shown in figure 2-10.

<table>
<thead>
<tr>
<th>Environmental Policy</th>
<th>• Today’s policy statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning</td>
<td>• Environmental aspects</td>
</tr>
<tr>
<td></td>
<td>• Rules &amp; demands</td>
</tr>
<tr>
<td></td>
<td>• Environmental Goals</td>
</tr>
<tr>
<td>Implementation &amp; Application</td>
<td>• Resources, responsibility, roles, competence, awareness</td>
</tr>
<tr>
<td></td>
<td>• Documentation, communication</td>
</tr>
<tr>
<td></td>
<td>• Organizational governance, preparedness</td>
</tr>
<tr>
<td>Follow-up</td>
<td>• Measurements and surveillance</td>
</tr>
<tr>
<td></td>
<td>• Evaluation of requirements</td>
</tr>
<tr>
<td></td>
<td>• Deflections, measures, corrections</td>
</tr>
<tr>
<td>Management Review</td>
<td>• Decisions</td>
</tr>
<tr>
<td></td>
<td>• Changes</td>
</tr>
</tbody>
</table>

Figure 2-10 The 5 elements of EMS (Almgren et al, 2006)

The implementation cycle consist of these elements which are looped for continuously improvements of the company’s operations. ISO 14001 can be seen as an internal factor to improve your own direction toward the environment within the organization. Although, in many cases as an external motive to confirm outside stakeholders their standpoint on today’s issues towards the environment. The interest of improve your operations against the environment has increased during the past decades. Especially with the ongoing discussion of global warming and the harmful emissions that comes from freight transports. In terms of transportation, environmental management is basically to follow up all the business processes that contain transportation elements according to the concept of environmental sustainabilty and improve to certain extend.

2.6 Emissions from transportation

The state of the environment has lately changed into a worldwide environmental, social and economic challenge. With continuous increase in greenhouse gases, in particular Carbon dioxide (CO2), Methane (CH4) and water vapor, the radiant energy exchange between the atmosphere and the space is gradually deteriorating. Naturally, transportation is one of the main factors contributing to this negative development (Schneider, 2002). In the theoretical scope of general transport emission analysis, theorists argue that research that aims to improve the state of the environment should follow of a three step program; identification, inventory and control of emission sources (NAPS, 2000). As well as for studies on national and global levels, the same structure is commonly used on corporate levels. For a better understanding of how road transportation in the supply chain has an effect on the environment and for describing how greener services can give results in sustainable development, we have selected a framework for identifying emission sources by Kam, Christopherson and Smyrnios (2006). The framework is shown in figure 2-11.
The framework is analyzed from a company’s perspective taking into account their standard operations. The company is surrounded by different impacts such as political influences, technologies, characteristics of the organization, etcetera. From the surrounding impacts, the output is determined with different transportation issues that affect the state of the environment. To give an example, a standard corporation faces a huge amount of pressure towards them when it comes to environmental issues. Initially it can be different transport regulations within the European Union and/or other political institutes which determine new policies in the industry, or regulations considering the emission discharges or other transportation issues which need to be eliminated. Secondly, they also have a pressure from customers and the market of using specific technology and other services that focus on sustainable development of the environment. Furthermore, there is an internal organizational characteristic in every corporation, which determines how they work for sustainable development. It can be internal strategies as environmental management system for being seen as an eco-driven organization, or which channel strategy they use for reaching their customers and so on. All these impacts from the surroundings have an influence on how the corporations output will be managed when it comes to environmental discharges. As can been seen in the framework, the directly output which concerns environmental issues can be emission discharges from large trucks or discharges from the transportation provider. The organization itself can have unnecessary operations or processes that concern transportation and the environment. The specific energy source, especially concerning the distribution process with the usage of diesel and petrol. Finally, the road infrastructure when it comes to specific industry, location, or channel distribution that is used. It is a major factor how the harmful discharges can vary for each organization when it comes to the infrastructure. The example above is an operation flow that is very simple, though with heavy emissions from transportation resulting in large effects on the environment.
The framework gives the organization a general view of the sources of emissions and discharges. The importance regarding such analyzing is to take a broad view and see where and what kind of discharges the organization is contributing with. Kam et al. enlighten their framework to inform companies that they must operate with three different factors: new technologies in the industry, external influences, and internal policy directives. For example of this, new technologies in road transportation that are friendlier to the environment, work with the goals from the governmental regulations with their environmental policies, and internal directives as working with environmental standardizations as ISO certification or other internal operations for contribute to a sustainable development.

When analyzing the extent of transportation emissions, or to make “inventory” according to NAPS (2000), the basis is constituted by the following formula:

\[ \text{Total emissions} = \text{Emission rate} \times \text{Vehicle activity} \]

As shown, the total outlet of harmful emission is the result of two variables; emission rate and vehicle activity. Emission rate denotes the emissions produced by one transportation unit. The second variable denotes vehicle activity which is defined by distance transported and is naturally the result of geographical location of origins and destinations, capacity and service requirements. Accordingly, by reducing the distance transported, total emissions will decrease.

As previously discussed and shown in figure 1-2, the emission rates vary between transportation modes (Caceres & Richards, 2007).

<table>
<thead>
<tr>
<th>Primary Energy</th>
<th>Road</th>
<th>Road Euro 2</th>
<th>Road Euro 3</th>
<th>Road Euro 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>resource consumption</td>
<td>7.465,533</td>
<td>41.177,038</td>
<td>42.683,791</td>
<td>41.403,277</td>
</tr>
<tr>
<td>Carbon Dioxide greenhouse-gas, global warming</td>
<td>0.03</td>
<td>3.043</td>
<td>3.155</td>
<td>3.06</td>
</tr>
<tr>
<td>Nitrogen Oxide acidification, human toxicity, summer smog</td>
<td>0.322</td>
<td>32.959</td>
<td>23.978</td>
<td>15.161</td>
</tr>
<tr>
<td>Non Methan Hydro Carbons summer smog / human toxicity</td>
<td>0.016</td>
<td>1.739</td>
<td>1.696</td>
<td>1.929</td>
</tr>
<tr>
<td>Dust (incl. Particles) human toxicity, greenhouse effects</td>
<td>0.005</td>
<td>0.506</td>
<td>0.563</td>
<td>0.154</td>
</tr>
<tr>
<td>Particles</td>
<td>0.005</td>
<td>0.457</td>
<td>0.512</td>
<td>0.105</td>
</tr>
<tr>
<td>Sulfur Dioxide acidification, eco- and human toxicity</td>
<td>0.017</td>
<td>1.74</td>
<td>1.804</td>
<td>1.75</td>
</tr>
<tr>
<td>Distances</td>
<td>458,145</td>
<td>465,313</td>
<td>465,313</td>
<td>465,313</td>
</tr>
</tbody>
</table>

Figure 2-12 Emissions by transportation mode (EcoTransIT, 2007)

As an example of this difference, the figure 2-12 shows an estimation of emission from road and rail transportation on the distance between Stockholm and Gothenburg, carrying a cargo weight of 100 tons. Road transportation is presented by emission classification of Euro 2-4, and without detailing these classification refers to environmental legislations which are intended to continuously increase the environmental standard on trucks. The calculation clearly shows the ecological differences between the two modes.
The last point of the analysis program of NAPS (2000) concerns control of emission sources. On a corporate level, theorists propose a number of measures to achieve control but irrespective of approach, progress towards decreasing emissions and environmental sustainability do eventually come down to a familiar situation, the choice between benefit and costs. In practical terms, transportation managers must decide whether the firm can afford to be environmentally friendly.

2.7 Basis for empirical gathering

As previously mentioned, the research aims to examine the relationship between environmental sustainability, lead time and cost when selecting transportation mode; a study that is performed with emphasize on environmental issues. Out of the theoretical framework, four points of interest has been selected; prioritization of selection determinants, environmental requirements in procurement of transportation services, use of rail freight and finally, acceptable cost levels for implementing environmental sustainability. These four points constitute the basis for the first round of empirical gathering, the survey found in Appendix 1.
3  Method

3.1 Outline of the research method

The approach of the research has been to initially pinpoint the factors that determine a manager’s choice of transportation mode and discuss these modes’ impact on the environment. Furthermore, a population of approximately 300 respondent firms was picked out of a predetermined industry. These firms received a survey with the purpose to provide the authors with a median of the industry’s view on the subject at matter, which came out in form of a respondent rate of 50 corporations. In addition, six follow up interviews were held with companies having predetermined environmental requirements to achieve additional more in depth information. Finally, the answers were summarized and analyzed in the context of the transportation mode selection determinants.

3.2 Research approach

The two research approaches that can be used in doing studies are either the inductive approach or the deductive approach.

The inductive approach deals with the way of new discoveries that can be created to theories. The researcher sees patterns in the world and from that collects the empirical findings, then builds categories that will be standpoints in the creation of new theories. Compared to the deductive approach (see figure 3-1) where it goes from a theory to a hypothesis, collecting data, the findings, test of the hypothesis, and from that build theories (Bryman and Bell, 2007). You build theories from the data that is collected, and see relations that can be generalized into conclusions. The deductive approach is often called the way of proof.

Our research approach was based on the deductive approach, with today’s theories in road transportation and the environment impact. And with the beliefs and values from our respondents we will try to build new knowledge in how an organization sees the environmental aspect in carrier selection. To generalize the knowledge into how organizations in the future can work for a sustainable development in road transportation.

Figure 3-1 Example of the process of deduction (Bryman and Bell, 2007)

3.3 Research method

3.3.1 Qualitative research

We have chosen to use a qualitative study as our research method. A qualitative study is based on people’s opinions, ideas, apprehensions, values and behavior etcetera. Compared to quantitative studies where they study different phenomenon and how often they occur. We have chosen the qualitative research method since we want to achieve a wider view and a better understanding of the issue from people’s opinions and beliefs, and not as quantitative research describing measurements in occurrence. Qualitative research is not often testing theories, it rather generates them. However, there are examples of research where qualitative methods are used for test theories (Bryman and Bell, 2007). Since the use of surveys
in our study, the purpose is not to measure a quantitative analyze from the survey, instead with the purpose of in which order carrier selection attributes is selected and the carrier mode which is preferred. We wanted to achieve a ranking of important factors in carrier selection, and agreed on the best way of conduct as many answers as possible in our limited timeframe was to conduct a questionnaire and focus on sending it out to several respondents. Since the survey did not completely answer the research questions that were determined we decided to add interviews for gathering additional answers to our research questions for fulfilling the purpose of the study.

3.4 Data collection

Our data collection will distinguish between the transportation firm and the customer firms. We have collected information from the transportation firms in the terms of greener alternatives when it comes to road transportation, and from the customer of transportation services we have put our focus on the carrier selection process when it comes to environmental options. The main reason for differentiate the empirical methods, collection of data in terms of surveys/interview or secondary data, is that we did not need the same information from the transportation firms which was needed from the customers of transportation since it was their opinion we needed to gather for analyzing the subject.

We expected the information from the transportation firms to be more of a descriptive approach of today’s options in environmental services. And the expected information from the customers of transportation service to be more of their own opinions and their position concerning the importance of environmental solutions when selecting carrier. We also conducted data from earlier studies as literature and journals about environmental issues and customer behavior considering carrier selection. To gather the right relevance of today’s environmental issues in road transportation, recently environment reports from the European Union was used, as information on different regulations controlling how transportations can be sustainable towards the environment, and the development of sustainable alternatives corporations can provide to best meet the demand that is changing in today’s businesses, as when companies going toward a more outward approach in how they want to be seen. Plus that we focused on journals and other research that has been made in the subject for achieving more reliable information in the carrier selection process.

3.4.1 Primary data

3.4.1.1 Respondent selection

To gather the right information in our empirical findings, we needed to select a neutral industry where different limitation where excluded in the carrier selection process. We could not choose an industry where there was a huge demand in a particular attribute in carrier selection. Example as the food industry where there is a high demand in time since the food need to be kept fresh and cold. So the industry we selected where the production/manufacturing of plastic goods. The main reason for deciding on the plastic industry was given that the goods are of a low value and do not have specific demand on fragile goods or any demand of time for the product to be staying fresh during carrier time. However, with the plastic industry determined it was giving us a delimitation of certain attributes from other industries considering carrier selection. Though, the limited attributes would not affect the purpose of the research.

It is huge importances to get the right respondents when considering survey and interview selection. Our respondents must have used transportation in their daily business and have used carrier selection as a factor in previously operations. That the respondents must have
used carrier selection earlier is a factor that we believed most of the respondent had. Though, to be certain we clearly declared this issue when we sent out the surveys and interviews to the respondents.

3.4.1.2 Population description

After the selection of industry we searched for the whole population of manufacturing firms of plastic goods from the “Plastic industry association” and from “Eniro Gula sidorna”, which were appropriated 500 in Sweden. Since the limited timeframe and to get as many answers compared to the population, we sent out our survey to roughly 300 corporations. This resulted in a respond rate of 50 units, which determine a sample size of 50 units out of a population of 500 corporations.

3.4.1.3 Sample selection

Our sample size consists of 10 % of all the manufacturing corporations in the plastic industry. These 50 corporations were our main target for achieving the result from ranking the carrier attributes with our focus on the environmental impact in the selection. However, since we needed more detailed in depth information from the carrier selection process for organization, we added interviews from the sample size of 50. The main reason for conducting additional information about the road carrier selection was to get more in depth information of the environmental aspect of it, and to be able to get additional answers if new question would appear during the study. As later described, our survey answered if the organization had predetermined environmental requirements which was our standpoint for doing follow up interviews. This, since the selection of the interview respondents had to be environmental driven considering their freight transportation. So our interview sample was 12 companies with predetermined environmental requirements, and the respondent rate from these 12 companies resulted in 6 interview answers.

3.4.1.4 Survey

For us to achieve most answers with the limited time frame, we decided to send out our survey by e-mail to the 300 respondents that were selected. The reason of choosing e-mail was since it is easier to get hold of the right people, with the responsibility of transportation, and the possibility of a quick reply for the respondent and us.

When we sent out the survey, we started by declare the purpose and the research question we had of our study, so that the respondent could get an idea in the problem area. Our survey design was of a descriptive sort, describing attitude and values (O’Leary, 2004) from the customer standpoint consider transportation selection. As described earlier, the respondents were producer of plastic goods, using transportation in their daily operations. The survey was designed short and easy to answer for the respondents, and was sent out to 300 corporations for gathering as high sample size as possible, for achieving a higher validity in the research and a better reliability in our analysis later. The answer from the survey was from closed question, where the customers’ was ranking their most important priority when selecting transportation, stated if their corporation had predetermined environmental requirements, if they were using rail transportation as an option, plus that they answered the extended price in percentage they can allow themselves when selecting environmental options in transportation services. The survey questions and design can be viewed in appendix 1.
3.4.1.5 Interview

Since we needed more additional information considering the carrier selection subject, we decided to send out mail interviews with more in-depth questions to a certain respondent rate. The reason for doing mail interviews was the flexibility for the respondent to analyze our question during some time, and that we could put more effort in the question we sent out for a better reliability and validity in the study. By sending out mail interview we can also cover a wider geographic area since the respondents is covered all around Sweden. We sent out the interview questions to corporation with predetermined environmental requirements, which we earlier determined during the survey questionnaire. The reason was to identify their predetermined requirements and do interviews from that point of view.

The interview design that we used was in-depth questions. The reason for using in-depth question is for achieving a discussion with a more opened opinion towards the subject from the respondents (Jacobsen, 1993). Since we had many different interview respondents', we chose to send out the question in an interview guide so the replies will be from the same preferences. The interview guide can be shown in appendix 2.

The selection of the interview respondents was from the answer from the survey, were we had 12 companies using predetermined environmental requirements. From those 12 respondents, we achieved answers from six of them.

All the answer from the primary data is described in the empirical finding chapter, and is from customers of transportation services.

3.4.2 Secondary data

“Secondary analysis is the analysis of data by researchers who will probably not have been involved in the collection of those data…” (Bryman and Bell, 2007)

The main secondary data we used is from the transportation companies, were we selected the two largest transportation corporations in Sweden which is DHL and Schenker Logistics. Our purpose was to examine the environmental solutions different road carrier had, and what option the customer have when ordering transportation services. Other secondary data we used is theories described in the theoretical framework, where we explain earlier studies in transportation, from its impact on the environment and different carrier selection theories. This is described generally for giving us a wider understanding in the subject and to give the reader an understanding of our reflections to analyze upon later on.

The secondary data from the transportation companies is described in the empirical finding chapter.

3.5 Method for data analysis

To analyze the data we gathered, we have used the information from our theoretical framework for helping us analyze our data findings from today’s transportation services, the information from the surveys and interviews we have conducted. With our theoretical framework we have stated today’s environmental issues, factors in carrier selection in transportation, different approaches in how corporations today work towards more environmental sustainability, regulations that constrain firms to environmental choices, and alternatives how transportation can result in a decrease of damages to our environment.

What we would like to accomplish with our data analysis is to compare the information in the theoretical framework with the result from the empirical findings and see if there is a
connection or gap between customer’s intentions toward a more environmental friendly transportation. And if there is a change in how customers and transportation firm reflects on their business to be more environment friendly, both negative and positive to their business value. Is there a prospect that customer of transportation services think in environmental sustainability when it comes to choice of carrier selection and the environmental factor?

3.6 Validity

The validity of a research is the truthfulness of the conclusion that is created from the study (Bryman and Bell, 2007). From our study it means, the importance that we use the right questions and attributes in our questionnaire and interviews so we measure the right concept of our research.

As mentioned earlier, our empirical findings were from both surveys and from interviews. With that we have assured that we examined and analyzed our questionnaire to the extent that we got the right answers that responded to our research questions. And from the interviews, which have been as a continually respondent which has answered new or additional questions that came up during the study, we have analyzed the questions in advance so they could be applicable to the purpose of the research.

3.7 Reliability

To make sure a research have reliability, the result of the study must be repeatable. Meaning it can be applied in other conditions and can be highly consistent (Bryman and Bell, 2007). When we examined the carrier selection of the respondent industry, we only study a small sample of a huge population.

However, since the carrier selection of road transportation occur in a huge amount of organizations. We believed that the result from our research is consistent with other industries, even if our choice of industry is very neutral and have not such demand in time and security. Since the material they carry is not so fragile and time demanded as mentioned earlier. Though, our research is focusing on the environmental aspect in carrier selection so the consistent can be applied in our study and can be repeatable in other industries or studies as well.

3.8 Method criticism

As the gathering of empirical data was performed by interviews and surveys on a large sample group of companies, where the return of answers were 50 out of 300, the method decreases the study’s validity. The problem is known as key informant bias (Maxwell, 1996) and is explained as the problem of few respondents providing most of the information. Although measures have been taken to increase the response rate by sending out short surveys and interviews, this fact remains and must be acknowledged while evaluating the conclusions. Furthermore, discussing environmental issues with corporations, one must be aware that answers do not necessarily reflect the practical truth. Since environment in many cases concern corporate responsibility, marketing and trademarks, the answers could also include ambitions and in some cases wishes. Nevertheless, with the purpose of the study being to enlighten the relationship between environmental sustainability, lead time and cost and furthermore examine whether there are possibilities for implementing greener alternatives within transportation, we believe that the answers hold enough validity to support conclusion in terms of market trends.
4 Empirical findings

4.1 The plastic industry

The Swedish plastic industry contains approximately 600 companies which employs about 18,000 persons and shows an annual turnover of 13.2 billion SEK (Nordfors, 2005). The main output of the industry is a wide variety of plastic products, everything from large industry goods to small custom made details. In particular, four factors shapes the business environment of the plastic industry; the relationship with the customers, legislations, international trade and access to raw materials. (Nordfors, 2007)

In terms of customer relationship, the majority of the companies within the industry are subcontractors, often to large multinational manufacturers. Only a minority of the companies produces and sells toward retailers or end consumers. With continuous implementation of on-demand production techniques as well as other means of improving cost and production efficiency among the manufacturing customers, the subcontractors is under constant pressure for improvements, especially in terms of lowering costs. Furthermore, the industry is the subject of international competition as well as outsourcing since production techniques and raw materials can be accessed in low cost countries. The strength of the Swedish domestic industry is known to be quality, competence and flexibility. Due to the excessive use of chemicals in the production process, legislation put pressure on the industry as well as prices on raw materials, in particular oil which constitute one of the basic ingredients when creating plastic bulk. (Nordfors, 2007)

4.2 Survey

The surveys main objective is to get a ranking of the different attributes customers observe as most important when selecting road carrier for distribution of goods and furthermore, provide an implication of the industry’s view on increased costs to attain environmental sustainability.

4.2.1 Selection determinants

Out of the selection process discussed in the theoretical framework, the first survey question Choice of provider and transportation service requests a prioritization of the selection determinants.

1. Choice of provider and transportation service

   The list contains the most common factors which determine choice of provider and service. Prioritize these factors from your transportation needs.

   (1=Highest priority, 7=Lowest priority)

   - Cost (Cost, weight alternative volume/km)
   - Lead-time (Time demand on deliveries)
   - Reliability (The delivery follows out as plan)
   - Environment (Environmental standards)
   - Availability (Responsetime)
   - Capacity (Bulky/ freight/ fragile)
   - Security (Damage goods / thefts)

   The result of the prioritization clearly shows cost how the selection determinants are valued. Cost is considered by most of the respondents to be the leading factor followed by re-
liability and lead time. Although Figure 4-1 only reveals first priority, the second to seventh level found in Appendix 3 further proves these factors’ importance. Many respondents commented that the price competition on the market makes costs very important but still, they have to rely on the transport provider to keep their promises as customers do not accept failures, especially when it comes to delivery dates.

![Figure 4-1 First priority - Selection determinant](image1)

As shown in Figure 4-2, the environment attribute had a low priority with most respondents ranking it as number 5 when it comes to selection determinants.

![Figure 4-2 Priority of environment as selection determinant](image2)

As shown in Figure 4-2, the environment attribute had a low priority with most respondents ranking it as number 5 when it comes to selection determinants.

### 4.2.2 Procurement and environment

The second question in the survey concerned **Predetermined environmental requirements for procurement of transportation services** and were put to indicate the level of consciousness.

1. **Predetermined environmental requirements for procurement of transportation services**
   Have your company predetermined environmental requirements when purchasing transportation services?
   - [ ] Yes
   - [ ] No

When it comes to predetermined environmental requirements in the procurement process, the result shows that 24% have a standard in the organization and 76% has no predetermined requirements (See Figure 4-3). Some respondents commented that although they did
not have any environmental standards within their procurement processes, some of their customer could have special demands in accordance with their respective certificates.

Figure 4-3 Predetermined environmental requirements

4.2.3 Transportation by rail

The question Transportation mode requests to what extent rail transportation is used among the respondents distribution.

3. Transportation mode
   Do your company use rail transportation? If "yes" state share:
   
   % of total volume is transported by rail

The answers provided by the respondents’ shows an expected result, rail as transportation mode is uncommon (See Figure 4-4). Several respondents did also comment that they only purchase a transportation service based upon three criteria, volume, price and time. As explained, they were only interested in whether the goods arrived in time, in other words that the providers kept their promises; which transportation mode that was used is meant to be irrelevant for their businesses.

Figure 4-4 Companies usage of rail transportation

4.2.4 Sustainable development

The fourth and last question of the survey, denoted Sustainable development, concerns the tradeoff between costs and environmental sustainability. The purpose is to find the percen-
tage level of increase in transportation costs that could be acceptable to guarantee environmental sustainability.

4. Sustainable development
The concept “sustainable development” means that the discharges from the transport sector should be balanced with the reinvestments to the environment, meaning the total influence on the nature is equal to zero. If the transport provider should guarantee the demand for sustainable development, the cost for the distribution will increase. How big increase in percentages of the transport cost is your company willing to pay for guarantee a sustainable development?

0 - 1%
1 - 2%
2 - 3%
3 - 4%
4 - 5%
5 - 10%
10%<

Concerning the extra cost respondents can accept to pay the carrier for guaranteeing environmental sustainability in the transportation of the goods, the answers were optimistic. The answers show (See Figure 4-5) that more than 70% are willing to pay 3-10% increase on the cost for transportation to support more environmental transportation; only three respondents rejected such an increase.

4.3 Follow up interviews
As a follow up on the survey, interviews were conducted in order to obtain additional information and standpoints. The interview concerned five point of interest; transport procurement, competition, customer demands and environment.

4.3.1 Transportation Procurement
Five follow up question were asked concerning transportation procurement;

1. Describe your process of transportation procurement.
2. How are your environmental requirements designed?
3. Are the transportation companies able to meet your demands?
4. Do the transportation providers market their environmental alternatives?
5. In which parts should the transportation providers improve their services?

In summary, the procurement process shows basically one common approach. The respondents contact a number of known transportation providers with a specification of the distribution in question and requests quotations. These quotations are later evaluated and decisions are taken. Transportation is often purchased on year basis, in some cases in periods reaching over several years. A common practice in the industry is cooperation between the manufacturer and the customer in the procurement process. As explained by a respondent, both parties requests quotations from a number of firms and the one that arranges the best agreement will be responsible for the transportation between the two.

The existence of environmental requirements varied a lot by the respondents. Some answered that the transportation providers were given instructions by the quotation according to predetermined quality certificates while other did not have any outspoken requirements and referred back to the providers as being responsible for such issues. The ones with environmental requirements included in the procurement process showed no common approach rather than individually designed demands. Concerning environmental requirements, all respondents answered that the transportation providers could answer demands but in terms of marketing their greener alternatives, they fail; a majority of the respondent’s states that environmental transportation is seldom to never discussed within the procurement process. When it comes to possible improvements within transportation services, the key issue is denoted costs. Although lead time was mentioned, the majority holds cost as the foremost factor.

4.3.2 Competition

In terms of competition within the plastic industry, three questions were asked;

1. What are the main outlines of the domestic competition?
2. How does international competition affect the business?
3. How would an increase in price affect competition?

Several respondents concluded that the competition on the market is very hard and the fact that being a subcontractor means to blindly follows the demand of the client. The foremost tool for competition is cost. Although quality remains an important matter, it was seen more of a prerequisite to even be able to do business. In terms of international competition, one of the respondent summarized the situation; “The competition within the industry is unyielding with substantial affect from South-East Asia. The only thing that has been discussed the past five years has been cost reductions. Increase in price is excluded”. All of the respondents showed similar answers proving that competition from countries with low labor costs do have a large influence on how the domestic businesses are carried out, in particular pricing. Naturally, the answered to the third question, whether an increase in price would affect the situation, were answered that it would be devastating for the business.

4.3.3 Customer demands

Concerning lead time, two questions were asked;

1. What are the outlines of customer demands when it comes to lead time from order point to delivery?
2. How would an increase in lead time affect customer relations?
The respondents answer proved to vary a lot dependent on the product they were producing. The answers stretched from “Just in Time” to several weeks. In terms of transportation lead time, the standard was explained to be three days for domestic distribution. The common denominator is that lead time for transportation is not a crucial determinant, the time of delivery is. As reasoned by one of the respondents, “To keep promises is more important than lead time when it comes to customer relationships. As our customers have promises to fulfill towards their customers, a delivery failure by us will echo throughout the chain which means problems”. The overall way of thinking is that lead time within own production is the ruling factor, transportation lead time is considered to be secondary. In terms of increases in lead time, the answered varied as well. Some respondents argued that an increase is not acceptable among their customers and such an occurrence would probably lead to extensive loss of sales while other meant that extension in lead time could be a possibility. Furthermore, the respondents’ comments did also concern improvements in planning the production and distribution processes. Some uphold that with better planning in combination with adjustments of order points lead time could be stretched without interrupting the customers’ business processes.

4.3.4 Environment

The environmental issues were followed up further by two questions:

1. Have any of your customers ever requested environmental consideration in transportation?

2. Suppose you choose to apply environmental sustainability in your distribution which leads to an increase in price of 5%. What would be the reaction by your customers?

In the case of customer requesting environmental considerations, the majority answered no. Some of the respondents have been asked indirect while discussing environmental certifications with customers but not in practice. As explained by a respondent, “Questions from customers concerning environmental do mainly concern our production processes and waste disposal rather than emissions from distribution”. A price increase as a result of granting environmental sustainability was in general rejected by every respondent. Such an increase was explained to result in great losses of sales and further open up the domestic market for international competition. Although the definitive answer, some commented that there would be no problem as long as such increase goes hand in hand with the customers’ environmental quality standard, an own initiative of that character would be impossible.

4.4 Environmental progress by transportation providers

To enlighten the different options that the customers of road transportation have in choosing more environmental alternatives, we decided to state how the biggest transportation firms in Sweden work towards sustainable development and shortly describe what the alternatives they offer. The two companies we have chosen to examine are Schenker Logistics and DHL since their positions as market leaders tend to set standards for the transportation industry as whole.

4.4.1 Schenker Logistics

Schenker Logistics presents their environmental ambitions with the statement, "a goal is to become the most environmentally sustainable logistics provider in Sweden". With its outspoken strategic goal to increase capacity and meet the market demand of increased overall geographical
coverage, the principal challenge is to find the balance between growth and reduction of environmental impact. The main goal for road freight is to increase efficiency of the transports 50% per ton and kilometer by the year 2020 by continuously improving the activity in seven areas; eco driving, speed limits, vehicle renewal, intermodal transportations, longer vehicles, capacity utilization, and efficient city logistics (Schenker, 2007).

Presently, 50% of Schenker’s drivers have been trained in eco-driving. The result of such courses is a decrease of fuel consumption on an average between 4-10%. Within a five year period, the goal is to have all drivers certified in eco driving which would lead to a potential reduction of 5% in domestic fuel consumption. Speed limits refer to lowering the average speed. According to own studies, Schenker claims that by lowering the average speed by 2km/h would save approximately 1,7 million liters of diesel every year and only result in a minor loss of transportation lead time. Furthermore, by continuously renew the fleet of trucks; the advantages of technological progress can help to further reduce fuel consumption and pollution. In a five year period, this renewal is said to lower the pollution of carbon dioxide with 10%. Vehicle renewal is also planned to work towards options in renewable fuels. Intermodal freight refers to transportation which uses more than one mode of carriers. For long distance transports, beyond 450km, a combination of rail and road transports is argued to be the foremost efficient solution in terms of environmental sustainability. Presently, 10% of all the carriage is intermodal but the aim is the further develop the sector by 20%. The fifth area of improvements concerns length of trucks. By using longer trucks with greater capacity, fewer trucks are needed to perform the same work. Although due to legislation, the maximum length/weight allowed are 32meters/ 60tons, capacity per truck would still increase by 50 m3 resulting in a decrease of fuel consumption by 15%. In a practical context, this would decrease the number of trucks per day from 35 to 25 on the distance between Stockholm and Gothenburg. Capacity utilization could also increase further by developing the dispatch and route planning systems. By advance computerized planning systems, route optimization would increase overall efficiency. City logistics refers to the much small transportation that is carried out within the city limits of metropolitans. By an extended use of terminals and planning systems, Schenker argues that fuel consumption could be decreased by a couple of percent. (Schenker, 2007)

In terms of transportation services, Schenker do not offer any special environmental alternative, efforts towards decreasing emissions are instead distributed over all services according to the formerly mentioned areas of improvements. (Schenker, 2007)

### 4.4.2 DHL

In the context of sustainable development, DHL claims to use its influence to make industries, especially the transport sector and firms within the logistic area, proactive in issues concerning higher environmental performance. The environmental ambition is also summarized with a slogan; “Our goal is to operate with minimum impact on the environment” (Deutsche Post, 2007). Naturally, DHL needs to overcome the same obstacles as Schenker in order to fulfill its objective. With a continually increasing emission volume of approximately 830,000 tones of CO2 per year (2004), DHL is trying to minimize these discharges by investing in modern vehicles with alternative fuels as well as taking full advantage of their operations with the help of an environmental management system (Deutsche Post, 2007). Their environmental management system, ISO 14001, is presented as the core to identify, improve and follow up environmental issues in strategy and operations. DHL has an official agreement to follow under United Nations Global Compact, which is a framework for companies to follow, to support their strategies and operations with different principles as
human rights, labor and environment. The environment principle focuses on corporations’ ability to use environmental friendly technologies and to be innovative in the environment area (UN global compact, 2007)

The main activities for DHL concerning the environment are to...

… reduce CO₂ plus other discharges from transport modes
… reduce local air pollution from vehicles and constructions
… decrease noise from transportation mode
… decrease waste from our constructions and increase recycling
… reduce energy consumption
… neutralize today’s discharges to achieve a zero influence on green house gas discharge, by invest in projects for renewable energy sources
… increase the product line like “Green Ton”, where transportation is done by bio fuel, which reduce the carbon dioxide discharge

The last point of the list, Green Ton, is marketed as an important step towards environmental progress in transportation. The practical meaning of the service is that the transports are carried out with trucks driven on alternative biogas fuels, fuels that generate 60-80% less emission than regular diesel. As shown in figure 4-6, the development of Green Tone has been extremely successful for DHL and more customers are purchasing the service. From 2002 to 2004 has the Green Tone service increased from approximately 400 thousand to 1700 thousand green tone (See Figure 4-6) (DHL, 2007).

![Figure 4-6 Development of Green Tone (DHL, 2007)](image)

### 4.4.3 Environmental sustainability guaranteed

Presently, neither Schenker nor DHL offer any road transportation services that guarantee total environmental sustainability. Although alternative fuels prove to be more environmental friendly than ordinary ones, emission is still discharged and must be accounted for. A solution to such unaccounted discharges has been found by DHL within the segment of air transportation.

DHL is the first company to offer a carbon dioxide neutral express transportation by air. The transportation service is called GOGREEN and works like a normal transport, though with the difference that the aggregate carbon dioxide discharge for the transport is zero. The neutralization is achieved by calculating the total discharge of emissions for the route in terms of distance, volume and weight to later balance that result with a higher transportation cost which in turn is invested in ecological causes.; investments that is explained to balance the inevitable emissions of a transport. The added cost that DHL charge for GOGREEN is 2% on the standard transportation cost (DHL, 2007).
5 Analysis

5.1 Operational factors prevailing in the plastic industry

An overarching analysis of the operational factors influencing transportation modal choice could be performed either on Gattorna & Walters (1996) and Slater (1990) or Rushton (2006) approaches. Irrespective of choice, the points of interest concerns in particular two fields; product characteristics and market structure.

The characteristics of the products, different molded plastic details, results in one particular influence; competition is mainly based on price as everything from production techniques and raw materials are accessible worldwide and the plastic details are easily transported. With such characteristics, the production is not delimited to a specific location or region which makes the respondent firms constantly under pressure from international competition. The main feature that protects the domestic industry from outsourcing to low cost countries are basically demand of smaller batches of designed products and the possibility to offer shorter lead time. Common by these two factors is that they are both hard to pinpoint. As of its relative high level of customization, the wide variety of different product in the industry complicates the task to identify an average product. Furthermore, without an obvious average product, it is impossible to establish an accurate estimation of a median lead time. The second major influence concern market structure. As previously mentioned, the majority of the respondent firm’s are subcontractors to either large manufacturers or wholesalers. This situation plays a major role when determine the distribution of power between buyer and seller. By being subcontractors, the customers dictate the conditions that will prevail and the ones that cannot reach the demanded service level are exchanged. As explained by the interviewees, wholesalers are often easier to negotiate compromises with compared to manufacturers. One reason behind such statement refers to the logistic activity occurring after products have arrived to the customers’ whereabouts. Goods arriving at wholesalers are either stored in warehouses or directly transferred to their respective end customers. For manufacturers, which in this industry commonly uses on-demand approaches with low safety stocks on own inventories, goods arriving are directly put into production or stored on short-term basis. When put in the context of their respective business processes that generate profits, a shortage for a wholesaler means loss of sales while a shortage for a manufacturer means additional losses as whole production lines must be stopped. By being dictated and under constant pressure from price competition, the respondents have limited possibilities to change how business is being conducted. To summarize, the respondents compete with price on a market controlled by the customers. With small possibilities for dictating the rules of trade, changes in distribution are basically restricted to adjustments in lead time.

5.2 Transportation mode

A majority of the respondents do exclusively use road transportation by trucks. Only 6 out of 50 companies are using railroad transportation for part of their distribution. This is negative in an environmental perspective since the emission rates between the two vary a lot where rail road is better. So what are the reasons behind road transportation being the preferred mode? The reasons are not only found by the advantages by road transportation but also in the shortcomings of distributing by rail.
As of its low priority, the environmental factor can be excluded in the discussion as of its low priority as a selection determinant. None of the respondents commented that using rail transportation was the result of a conscious effort to be more environmental. Reliability on the other hand, scored high as a selection determinant which would imply that rail would be used to a greater extension than the survey proved. This situation is best explained by the fact that although transportation by rail is considered more reliable, the difference from road transportation is not significant enough to have any considerable effect.

Furthermore, the cost per ton ratio proves to be in favor for rail. Obviously, a train capacity is far greater than a truck but the problem comes by the railways accessibility. As trains are bounded to its tracks and the infrastructure is not as developed as the road network, the goods must often be loaded into trucks to be able to reach their final destinations which diminish the profits earned through the cost per ton ratio. Furthermore, rail road needs longer transportation distances to be effective, distances which few of the respondents have to their customers. The fifth point, transit times, do also in part concern co-loading. Road transportation is generally known to be faster and although lead time is not the foremost crucial determinant, it is still of such importance that it adds to the list of choosing trucks before trains. In addition to the reasoning above, it must also be mentioned that many respondents did also answer that they only buy the transportation service and they do not put any efforts into what mode is being used. This unawareness is understandable as many of the firms focus all their efforts on their core businesses.

5.3 Comments on selection determinants

Cost
As shown by the survey results, cost is the foremost factor influencing the choice of transportation provider. Figure 4-1 shows the first priority selection with the cost factor as the most preferable with a 48 % result. As of the previously mentioned reasoning, low margins and price competition forces the respondents to choose the transportation provider with the lowest cost per volume ratio. The cost factor is also selected in high priority as companies’ second and third choice. Considering an increase in cost, the interview respondents declared that with the competition in the market, a higher price for using environmentally services would probably result in deprivation of customers.

Lead Time
As explained by the respondents, lead time is important but is not ultimately decisive when it comes to choosing transportation provider. Although it is hard to derive or estimate an industry standard as the differentiation of products is extensive, lead time of the goods from attaining the order to distribution is rather weeks than days. The respondents had an
average lead time of 3 days for distributing the goods everywhere domestic. The importance of the distribution was not the time for it, the focal point were the time for delivery.

**Environmental Sustainability**

Environmental sustainability scored low as a selection determinant. Although a number of respondents claimed that they following environmental quality standards while purchasing distribution services, it is fair to say that this factor is of low priority. As many of the respondents explained, increased environmental sustainability results in greater costs, costs that cannot be justified. The extra cost for greener transportation services were the respondents approach both positive and negative. The majority could accept an increase in transportation cost for sustainable development. However, the respondents were not willing to adapt alone to such a change in transportation service without more demand from both end-customers and other stakeholders. When it comes to the transportation provider, the study has reviewed different services in best practices regarding environmental transportation. However, the majority of the respondents had no recall of the provider offering greener options within the procurement of transportation services.

**Reliability**

Reliability was by many respondents considered to be equal to customer service level and therefore of great importance. By purchasing reliable transports were goods are delivered on time and with no damages, the customers’ business processes are not interrupted. When the survey respondents prioritized the selection determinants, the reliability factor came second with 28% as number one priority.

**Capacity - Security/Safety - Accessibility**

All of these three factors were by many respondents seen as basic conditions for even purchasing the distribution service in the first place. Also to mention, since our study have limitations as the industry and the transportation mode we are examine, these different attributes is not the focal point for the respondents or for us to answering our research question. Since accessibility is one of the major advantages for road transportations, and security/safety is not prioritized for the plastic industry.

### 5.4 Environmental sustainability, lead time and cost

The respondents’ prioritizations of selection determinants do not only show the first and foremost choice when selecting a transport provider but also how prioritized environment is in the selection context. A prioritization by putting all the selection determinants together is impossible as there do not exist trade off situations in every possible combination of these relationships. For example could no company allow lower emission discharges on the expense of accessibility since customer still needs to be reached as well as a company cannot risk that the goods are damaged during transportation (security/safety) on the same basis. In addition, inability to reach destination (reliability) or choice a transport provider that cannot deliver due to physical needs (capacity) is impossible since all these parameters are considered to be basic requirements for even transporting goods. In terms of trade off for environmental sustainability, cost and lead time are the only possible antithesis. Nevertheless, the question points out the relationship between three and shows their prioritization to one another. By the very basis, the relationship (Figure 5-2) between environmental sustainability, lead time and cost is according to the triangular paradigm shown in figure 5-3. As increasing the level of environmental sustainability demand investments, cost is naturally the contrary factor. Furthermore, longer lead time on deliveries allow for better transpor-
tation planning which increase environmental sustainability. Finally, short lead time costs more as transportation planners have less options to work with.

![Figure 5-2 Relationship environmental sustainability, lead time and cost](image)

![Figure 5-3 Triangular paradigm](image)

When plotting the respondents’ answers within the paradigm by the first (•), second (◦) and third priority (³), the results show clearly, cost is the foremost selection determinant and any other improvement of transportation services would concern lead time. This shift is simply explained by the fact that, with the present situation on the market, the benefit customer perceive from improvements in lead time is far greater than the benefit of providing more environmental friendly transportation. As commented by several respondents, lack of customer demand creates no greater incentives to go green.

![Figure 5-4 Triangular paradigm – Priority](image)

The lead time aspect is interesting as it comes second to costs and could hold opportunities for improvements. As claimed by respondents, keeping agreements by delivering on the promised date is considered more important than providing short lead time on transportations. With this in mind, the respondents have the opportunity to extend the overall lead time from order point to delivery. By increasing lead time to the maximum conceivable
limit of the customers, benefits will not only come in shape of decreased transportation costs but also extended time for planning which can lead to improvements towards environmental sustainability.

5.5 Towards environmental sustainability

As global warming is frequently discussed in media and in politics, and there is a growing awareness of the negative effects of emissions caused by road transportation, one can reason that there is a growing willingness for both the individual as well as the corporation to take initiatives towards improvements in the area. As formerly presented, transportation providers have started to acknowledge the potential and starts to marketing green alternatives. In figure 2-6 we describe the framework by Kam et al which determine the road emission a company have on the state of the environment. As the framework concern both internal and external factors that can affect the environment, the company can use it to identify the different sources and try to minimize their impact and work for a more sustainable development.

Since the plastic industry is examined, model will be illustrated through a corporation from that industry segment (see figure 5-5). Hence, the corporation is a manufacturer of plastic goods (Company A), which offer their products to customers within 3 days service. They use one of the largest transport providers with their standard service without any environmental solutions which result in reducing the cost of transportation. From authority governance, the transport provider has regulations which need to be followed as euro standards etcetera. The governance controls the transportation industry, and that certain standard is followed with restricted emission discharges. When it comes to the outcome from transportation of their products the infrastructure of the road system is well functioned, the transport provider use large trucks with heavy emission discharges, the emission outcome comes from combustion of diesel and petrol, plus that the company have no returning freight coming back when delivered the goods. The operation flow of this illustration is very simple, though with heavy emissions from the transport operations which have a large effect on the state of the environment from only one manufacturing firm.

![Diagram of environmental impacts of freight transportation](image)

Figure 5-5 Environmental impacts of freight transportation (1) (Kam et al)
From the illustration above, calculation can be made to some extent on the emission discharges a corporation with the same environmental strategy would have. From the empirical data that is obtained, the corporation average on distributed tone was estimated to be 35000 tones. When it comes to the average distance the goods were distributed, 250 kilometers and more were selected. So if company A has an annual distribution weight of 35000 tones, and is transporting the goods from point A to B which is approximately 450 kilometers (from Stockholm to Gothenburg). The discharges of carbon dioxide from the transportation carrier would be 1000 tone of emissions for just transporting goods for company A. Since the example above did not have any returning freight, it can also be added a great number to this illustration.

If the manufacturing company instead had used a greener alternative for their freight service plus an environment management system the emission discharges would have decreased excessively. If comparing figure 5-5 with figure 5-6, the results show what changes a corporation can do to improve development of pollute emissions.

![Diagram showing environmental impacts of freight transportation](image)

Figure 5-6 Environmental impacts of freight transportation (2) (Kam et al)

The company has the same circumstances as earlier, though with more environmental operations within the corporation strategy. The same pressure from governmental regulations, unchanged transport provider despite the fact of usage of a more environmentally service, with the effect of environmentally deliveries within 3 days to their customers. The outcomes from this strategy are that the transport provider drive large trucks with new engine technologies with bio fuels, and the company have implemented an environmental management system as ISO 14001 that control the operations in the organization, resulting in no empty trips for the drivers and the large trucks contain returning freight of wastes for recycling.

The emission discharges from the example in figure 5-6 can be calculated on the same basis as earlier. If the company uses a provider with large trucks driving on bio fuels, as DHL’s service Green Tone which have a 60-80 % decrease in carbon dioxide discharges. The total emission discharges would then be between 200 and 400 tones, plus add the returning freight which also has a huge impact in environmental issues. The lead time of delivered
goods would sustain the same, and the only down effect for Company A by using environmentally services would be the cost of the service.

By analyzing the cost aspect of freight transportation we can see (figure 5-7) that the current cost level for standard transportation service is lower than the environmentally services that exist. Example is DHL where the customer must accept an increase in cost for the result of environmental sustainability in their road transportation.

![Figure 5-7 Current cost level compared to today's environmental services](image1)

From the survey conducted, one can see that 86 percentages of the respondents were willing to pay 2 percentages extra on the cost for transportation in support of environmentally alternatives, and 70 percentages could accept an increase of 3 % and more. Figure 5-8 shows that the majority of customer acceptance from the questionnaire when it comes to the increase in cost for sustainable development.

![Figure 5-8 Customer acceptance for environmentally services](image2)

Since there are environmental solutions in road transportation, and there exist potential for a customer acceptance when it comes to an increase in the cost for the services. The result should be that every customer of road transportation should use these options when selecting services. However, from the respondents there were also the results of 76 percentages with no predetermined environmental requirements. So an implementation of such initiative as greener transportation for corporations has not yet been successful.

DHL have their environmental service in air transportation called Go Green. As described earlier, an extended cost of 2 % for the transportation service would secure environmental sustainability from reinvestments in the eco-system. The question is if this service could be applicable in road transportation. From the respondents, a customer acceptance to an increase in price is positive. The issue would then be who can take on the cost for sustainable
development in road transportation, the corporation who buy the transportation service or will the end-customer be affected with a higher price for the goods?

Although firms are willing to pay an extra amount to ensure environmental sustainability, the respondents state that they cannot accept to take care of the whole cost by themselves they need to be helped by a growing demand of such services. Today, the ones that will most likely take the cost for ensuring environmental sustainability in transportation is the end customers, the corporation will only increase the price for their product to the end consumer. This reasoning implies that the situation needs a change in consumers’ patterns. If consumers start to appreciate that their goods are delivered from the suppliers with green alternatives and that they can afford an increase in overall prices, then there are great possibilities for improvements. This thinking is not too surprisingly, of course, all the respondents are, with a few exceptions willing to work towards an improvement in transportation. The great question is who is going to take the cost for such development. The respondents stated that they are not in power to make decisions towards more environmental friendly operations in road transportation, this since the end customers are not ready to take care of the cost and expenses of such initiative. As of the present market condition in the plastic industry, international trade results in low marginal for domestic producers. This situation makes it almost impossible to raise prices without losing customers.

But although customer demand is low, there are changes in best practices that the different transportation providers are offering. With new technologies invented the provider gives the customers a choice of getting the benefits of road transportation with their reliability and fast transportation, though with a focus on the environment. There is a possibility of a new element in the carrier selection determinant, which is the environmental aspect of the carrier. However, there is a need for change in the patterns of the supply chain for environment services within the distribution of products. The demand for environmentally services in road transportation is needed in every part of the chain, even if the end customers must accept the increase in price.
6 Conclusions

Overall, the respondents’ answers prove an unambiguous and fundamental reason why the progress towards environmental sustainability in transportation is slow; trucks is the most efficient transportation mean with the present standard of distribution, cost is the dominating selection criteria and there exist no particular end consumer demand for green alternatives.

By the very basis, the relationship between environmental sustainability, lead time and cost is according to the triangular paradigm shown in figure 6-1. As increasing the level of environmental sustainability demand investments, cost is naturally the contrary factor (1). Furthermore, longer lead time on deliveries allow for better transportation planning which increase environmental sustainability (2). Finally, short lead time costs more as transportation planners have less options to work with (3).

When putting these three trade-offs in the context of the respondent’s ranking of selection determinants (Appendix 3), the visualization (Figure 6-1) shows clearly that a considerable majority of the respondents are positioned within the cost corner of the paradigm (1). By the respondents’ prioritization, it can furthermore be concluded that an increased transportation budget will be spend on lead time rather than improving the environment (2), a simply choice as lead time is considered to produce greater customer benefit with the present market situation. Besides this situation, the respondents’ answers show, in particular, two points of interest. First, the respondents reasoning behind lead time and environmental sustainability show that adjustments can be performed between the two in order to achieve environmental improvements. Secondly, cost is the principal decision factor of all and its importance overshadows both efforts towards environmental sustainability as well as improvements in lead time.

As keeping agreements by delivering on the promised date is considered more important than providing short lead time on transportations, manufacturers can extend the overall lead time (production and transportation) from order point to delivery. By increasing lead time to the maximum conceivable limit of the market, benefits will not only come in shape of decreased transportation costs but also extended time for planning which can lead to improvements towards environmental sustainability.

- Increase lead time from order point to delivery to the maximum conceivable limit of the market.
As of the current market situation within the respondent’s industry, there is no apparent end consumer demand for extended environmental alternatives which make manufacturers see the function of transportation only as a tool for product distribution, not for competition. As an increase in price as a result of guaranteeing environmental sustainability would mean loss of sales, a change must be triggered with consumer demands; as of now, the perceived customer value of low transportation cost is explained to be greater than initiatives towards green alternatives. In accordance with the customers’ reasoning, cost is considered to be the foremost important internal selection determinant of all. Just as transportation is not prioritized in reference to other business processes, any greater incentives of change other than cost reductions do not exist. Profits are invested to gain efficiency in other value adding process rather than to finance improvements in transportations. This reasoning explains why environmental concerns have a low priority within the selection process of a transportation provider and leads to the following conclusion:

- **Initiatives for improvements which will raise price must follow an increase in demand among end consumers. Increase prior demand will result in loss of sales.**

![Triangular paradigm - Shift towards environmental sustainability](image)

Although the market lack of hands-on demand for environmental transportation, the study shows that there is an overall interest in green distribution among the manufacturers. With increased cost as the foremost obstacle for developing environmental sustainability, there are not only a need for incentives to change end customer demand, the cost of going green must be evenly distributed among the suppliers, producers and customers. Although one could argue that the income of downstream members in the value chain originates from end consumers’ investments, part of their profits must be set aside to bear the increased costs.

- **Costs of going green must be evenly distributed among suppliers, producers and customers.**

To summarize, the development of environmental sustainability in transportation basically depends upon a change in demand patterns of end consumers. As proved in air transportation, environmental sustainability can already be guaranteed by balancing unavoidable emission discharges with investments in environmental improving activities (Figure 6-3).
With a growing awareness of the environment, quality standards and ISO certifications along with other means of corporate responsibility, we believe that increased marketing efforts of green alternatives can initiate such a change.
7 Suggestion for further research

The study has shown that the majority of the respondent manufacturers are interested in improving the environmental quality of distribution. Suggested research is to follow up on the interest among the industry’s end-customers, and furthermore investigate how a change towards environmental sustainability could be initiated.
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Appendix 1 – Survey

Cost, lead-time, and environment within road transportation

1. Choice of provider and transportation service
   The list contains the most common factors of transportation when it comes to choice of provider and service. Prioritize these factors from your transportation needs.
   (1=Highest priority, 7=Lowest priority)

   - [ ] Cost (Cost, weight alternative volume/km)
   - [ ] Lead-time (Time demand on deliveries)
   - [ ] Reliability (The delivery follows out as plan)
   - [ ] Environment (Environmental standards)
   - [ ] Availability (Response time)
   - [ ] Capacity (Bulky/ freight/ fragile)
   - [ ] Security (Damage goods / thefts)

2. Predetermined environmental requirements
   Have your company predetermined environmental requirements when purchasing transportation services?

   - [ ] Yes
   - [ ] No

3. Transportation mode
   Do your company use rail transportation? If “yes” state share:

   [ ] % of total volume is transported by rail

4. Sustainable development
   The concept “sustainable development” means that the discharges from the transport sector should be balanced with the reinvestments to the environment, meaning the total influence on the nature is equal to zero. If the transport provider should guarantee the demand for sustainable development, the cost for the distribution will increase. How big increase in percentages of the transport cost is your company willing to pay for guarantee a sustainable development?

   - [ ] 0-1%
   - [ ] 1-2%
   - [ ] 2-3%
   - [ ] 3-4%
   - [ ] 4-5%
   - [ ] 5-10%
   - [ ] 10% <
Appendix 2 – Interview

Central questions
1. How many employees in the corporation? _______ Employees
2. What is your approximately freight volume each year? _______ Tone
3. In what distance do you freight the majority of your goods? (If possible, state approximately share on each distance)
   _______ 0-100km
   _______ 100-250km
   _______ 250-500km
   _______ 500+km

Procurement
4. Describe your process of transportation procurement?
5. How are your environmental requirements designed?
6. Are the transportation companies able to meet your demands?
7. Do the transportation providers market their environmental alternatives?
8. In which parts should the transportation providers improve their services?

Competition
9. What are the main outlines of the domestic competition?
10a. How does international competition affect the business?
10b. How would an increase in price affect competition?

Customer demands
11. What are the outlines of customer demands when it comes to lead time from order point to delivery?
12. How would an increase in lead time affect customer relations?

Environment
13. Have any of your customers ever requested environmental consideration in transportation?
14. Suppose you choose to apply environmental sustainability in your distribution which leads to an increase in price of 5%. What would be the reaction by your customers?
Appendix 3 – Priority selection determinant

<table>
<thead>
<tr>
<th>Priority</th>
<th>Cost</th>
<th>Reliability</th>
<th>Leadtime</th>
<th>Environment</th>
<th>Accessibility</th>
<th>Capacity</th>
<th>Security</th>
</tr>
</thead>
<tbody>
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Priority of capacity as selection determinant

Priority of security as selection determinant