Green Supply Chain Management

Case: Turkish Automotive Industry by practices, pressures and performance

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2014

Student thesis, Master degree (one year), 15 HE
Industrial Management
Master Programme in Management of Logistics and Innovation
Degree project for a Master of Science with major in Industrial engineering and management

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Abstract

Purpose - This study aims to research the current state of green supply chain management (GSCM) initiatives with focus on practices, performances and pressures in Turkish automotive industries.

Methodology - The first part of the study is based on current literature on GSCM in automotive industry. The second part of the study includes empirical data collection and the development of literature survey and questionnaire survey. In order to research Turkish automotive manufacturers and its green activities, five main automobile manufacturers have been selected and the survey questions about all steps in green activities have been included in the questionnaire.

Findings – The findings indicate that although Turkish automotive manufacturers have already begun to consider GSCM as an important activity they have not completely implemented the green supply chain management in their business. Hence, there is a lack of knowledge and experience of full green supply chain management implementation in the Turkish companies and they regard GSCM as increasing costs. The companies work with ISO 14001 certification and EMS but do not fully carry out ISO 14001 and EMS requirements. Cooperation with customers, green purchasing, and green design are still new concepts for Turkish automotive companies.

Research limitations/implications – Data were collected in 2011 and are limited to the five Turkish automotive company

Practical implications – Clear understanding of these GSCM practices, performances and pressures will support and help Turkish automotive manufacturers implement GSCM efficiently and effectively.

Originality/value – This paper finds out that which green activities are most problematic in the Turkish automotive sector and provides development of GSCM in Turkish automotive manufacturers. Moreover, it can be a model for future researchs.
**Keywords** Environmental Sustainability, Green Supply Chain Management, Turkish automotive industry.

**Paper type** Research paper
Acknowledgment

First, I wish to thank Kaisu Sammalisto for supervision, valuable suggestions and assistances to conduct this study. I also would like to thank to the Swedish government to give an opportunity to the foreign students and provide us with this wonderful environment. Furthermore, I would like to thank the authority of Gavle University for providing great facilities to complete this master programme. Also, I would like to thank the personnel of five case companies for their help to provide the opportunity of visits and contribution by their useful comments on the questionnaires. Without them, this study would have been impossible.

Finally, my thanks and appreciation go to my family, especially my wife Pelin Demirci. Specifically, her help lead me to persuade my study, and made this study producible.

I dedicate this work to my son Sarp Demirci, who is one and a half years old.
## Contents

1. Introduction.................................................................................. 1

   1.1 Objective of the Research .................................................. 3

2. Literature Review.......................................................................... 4

   2.1 Environmental Management Systems ................................... 4

   2.2 The Automotive Industry and the Environment .................... 5

   2.3 Sustainability in Automotive Industry .................................... 8

   2.4 Sustainable Supply Chain Management ................................. 9

   2.5 Green Supply Chain Management (GSCM) ............................. 11

   2.6 Performance Measurement for GSCM ................................. 12

   2.7 Traditional Supply Chain Management and GSCM ............... 13

   2.8 The Components of GSCM ............................................... 14

      2.8.1 Green Designing ...................................................... 15

      2.8.2 Green Purchasing ...................................................... 16

      2.8.3 Supplier Selection and Automotive Supply Chain Structure .... 17

      2.8.4 Green Manufacturing ............................................... 20

      2.8.5 Green Marketing and Distribution ................................ 21

      2.8.6 Green Recycling ....................................................... 22

3. Research Methods ...................................................................... 24

   3.1 Research Approach ............................................................ 24

      3.1.1 Qualitative Research ................................................ 24

   3.2 Data Collection ................................................................. 24

      3.2.1 Questionnaire Development ........................................ 26

   3.3 Validity ............................................................................ 27

   3.4 Reliability ........................................................................ 28
4. Case Study

4.1 Green Supply Chain Management in the Turkish automotive industry

4.2 Automotive Industry In Turkey

4.3 FordOtosan

4.3.1 Air Emissions in FordOtosan

4.3.2 Energy in FordOtosan

4.3.3 Wastewater Treatment and Water Usage in FordOtosan

4.3.4 Waste Management in FordOtosan

4.3.5 Products and Materials

4.4 Oyak-Renault

4.5 Askam

4.6 Temsa

4.7 Otokar

5. Survey Results and Analysis

6. Discussion

7. Conclusion

8. Suggestion

9. Limitations

References

Appendix
List of Figures

Figure 1: Environmental Impacts to Automotive Industry (Source: Poon, 2009, p.2 modified from Demirci, 2011) ...........................................................................................................6
Figure 2: SSCM (Source: Carter and Easton, 2011, p.48)..................................................................10
Figure 3: The components of GSCM (modified from Weiwei and Huiyu, 2010, p.13) .................................................................................................................................................................14
Figure 4: Supplier selection process (Weele, 2010 cited in Igrashi et.al, 2013, p.248) ..................18
Figure 5: Automotive Supply Chain Structure (Source: EDI for the Automotive Industry, web page 1, accessed 2011) ........................................................................................................................................20
Figure 6: Survey results for 5 different case companies, practice part .........................................40
Figure 7: GSCM Practices- Summarized Mean .................................................................................41
Figure 8: Survey results for 5 different case companies, performance part .................................43
Figure 9: GSCM Performance- Summarized Mean .........................................................................44
Figure 10: Survey results for 5 different case companies, pressure part .....................................46
Figure 11: GSCM Pressure- Summarized Mean .............................................................................47

List of Tables

Table 1: Automotive industries’ environmental aspects and impacts (Source: Nunes and Bennett, 2010, p. 403). .................................................................................................................7
Table 2: Differences between the GSCM and Traditional SCM (Source: Luthra et.al, 2011, p.235). ..............................................................................................................................................14
Table 3: Environmental variables for supplier selection and evaluation (Source: Bai and Sarkis 2010, cited in Vanelle et.al, 2011, p.340) ..........................................................19

List of Abbreviations

GSCM – Green Supply Chain Management
SSCM – Sustainable Supply Chain Management
EMS – Environmental Management System
1. Introduction

Today, environmental concern is becoming more and more significant. After the Industrial Revolution, the world is gradually becoming more polluted every passing day. Human beings not only contribute to pollute the present-day resources, but also affect and threaten the future generations’ access to vital resources. Although demand and awareness to protect the environment was not a mainstream movement in the past, it has becomes an important activity nowadays. Public attention is increasing attention to issues related to the natural environment and production and manufacturing processes are viewed as the most harming practices on the environment. Attention is paid to issues like waste generation, ecosystem disruption and depletion of natural sources (Beamon, 1999 referring to Fiksel, 1996). Traditional supply chain management cannot give a suitable response to current stakeholder needs due to its negative effects on environment but also because of high public awareness on environmental subjects in all areas that are difficult to reach. This makes sustainability and the green ecological approach to be an alternative way to administer public requests to manage the use of resources in supply chain.

Sustainable supply chain management (SSCM) is defined as “the management of material and information flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development” (Seuring et.al., 2008, p.1700). The dimensions are economic, social and environmental responsibilities. Many studies have been carried out within the SSCM research field, which indicates a growing interest to further research this area (Seuring et.al, 2008).

Still, there is need for further studies to strictly focus on the environmental dimension of SSCM and evaluate the impact of large industry, e.g. automotive industry, on the environment. Environmental dimension of SSCM, green supply chain management (GSCM), which this paper focuses on, have been the dominant
aspect of SSMC since corporate and academic interest has recently risen significantly. In other words, it has become an inevitable aspect of concern in every area of business activities (Hsu and Hu, 2008).

Consumers’ requirements and governmental regulations put pressure on manufacturers to produce environment-friendly products. The green applications and environment-friendly products are noticed to lead to create a green chain and new concept of GSCM. Hsu and Hu (2008) briefly define GSCM as “green supply chain management has emerged as a proactive approach for improving environmental performance of processes and products in accordance with the requirements of environmental regulations” (p.205). Another important factor that makes several companies willingly implement GSCM is the importance of their reputation. Polluting the environment can damage the company’s image in the public opinion, which indirectly affect its sales and profitability (Seuring and Muller, 2008).

In brief, GSCM is an approach to improve performance of the process and products regarding to the environmental needs and rules. In addition to this, GSCM covers all steps of product’s life cycle. It can be observed from production, design, distribution, procurement steps to the use of products by the end users and products disposal at the end of its life cycle (Diabat and Govindan, 2011).

Companies start to view GSCM as a strategic analysis tool (LMI, 2005). This increasing interest proves that all producers have to be sensitive for the environment, which includes air, water and soil pollutions. These lead to global warming phenomenon, which currently becomes one the most challenging issues that needs several international treaties and cooperation to overcome.

At the same time, both profitability and environmental sensitivity factors has to be considered significantly. As it follows, this paper researches the implementation of GSCM in the automotive industry, which has a major impact on economy and employment factors in the developing countries. This topic has been investigated in a very limited manner before, and this paper tries to contribute the literature by its
findings on how Turkish automotive industry has implemented GSCM in their system. For this sake, three aspects of GSCM, practices, performances and pressures, are considered and the author tries to evaluate their utilization in Turkish automotive industry.

Among the large industries, auto industry can be considered as a major concern in the green context. Auto industry is a large and growing industry in a lot of countries in the world. Especially, there is a large amount of interest in auto industry in developing countries, which have plenty of cheap labor forces available and also enjoy logistical advantages and specific location benefits. Turkey, which this study has concentrated on, and countries like China and India are among these countries. Note that, automotive sector is the third largest and one of the most innovative sectors with important contributions to employment in Turkey (Etkin et al., 2000), (Brusati, 2011). This briefly portray why Turkish auto industry is very important on the country’s economy.

Tendencies in design phase to create a green design as a result of less gas consumption or using unleaded gasoline and exhaust less negative impact on environment are the main known activities in order to be more environment-friendly practices in automotive industry. In addition to this, automotive export potentials cannot be underestimated and this makes GSCM inevitable. Therefore, it is significant to analyze automotive sector in Turkey to properly see how the main automobile factories implement and utilize green GSCM in their supply chain management.

Although the concept of green supply chain management and environmental awareness in companies is increasingly significantly, they still presume that GSCM will create an enhancing effect on the cost (Büyükozkan and Vardaroğlu, 2008).

1.1 Objective of the Research

As mentioned above, the overall aim of this research is to survey and evaluate GSCM activities and utilization by practices, performances and pressures in
To reach the aim, five Turkish automotive manufacturers (Ford-Otosan, Oyak-Renault, Askam, Temsa and Otokar, which are the giants within the Turkish automotive industry) have been selected and a questionnaire survey about all steps in green manufacturing and activities in these factories have filled out by their appropriate authorities. The results of this survey indicate which green activities are problematic in this sector and also give an overview of GSCM utilization in these main manufacturers.

Three parts are studied to evaluate the related GSCM activities. First, GSCM practices are investigated, and then GSCM performance is measured. Finally, GSCM drivers/pressures are explored.

All in one, in the thesis we have tried to find a proper respond for the following question: How do Turkish (main) automotive manufacturers implement and work with GSCM?

In brief, the results of this research show that Turkish automobile manufacturers have been already started to implement GSCM in their three dimensions, practices, performances and drivers of GSCM to some extent. However, there are a lot of related cases and regulations that need to be utilized for a successful and complete GSCM implementation.

The outline of thesis is as follows: The second chapter discusses the literature review. Research methodology will be reviewed in Chapter 3. In Chapter 4, cases of this study will be examined and finally, analysis and survey results will be presented in Chapter 6.

2. Literature Review

2.1 Environmental Management Systems

Many countries, particularly developed countries, have begun to create Environmental Management Systems (EMS) for aiming in EMSs and sustainable
development (Pun et. al, 2002). ISO (1996a) defines EMS: “An EMS is an integral part of an overall management system that includes organizational structure, planning, activities, responsibilities, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining environmental policy” (cited Pun et. al, 2002, p. 690).

In brief, EMS is management of an organization’s environmental programs, which is managing the impacts of the organization’s activities on the environment. EMS supplies a structured approach to plan and implement environment protection measures.

Since legal regulations according to national and regional conditions differ from each other, different environmental standards and entities may have been developed in different countries. This complexity has started to build a variety of barriers to trade. In order to overcome these differences between countries, the standardized EMS has been created. These standardized EMSs are as follow:

1) BS 7750, which is originated from British Standards Institute.
2) EMAS: Eco-Management and Audit Scheme, which is formed from European Union standards.
3) ISO14000, which is formed from International Standards Organization.

2.2 The Automotive Industry and the Environment

The automobile industry has definitely ease human’s life and made many contributions to the people’s daily life. Furthermore, as an economic phenomenon, it has significantly influenced the world’s economy. However, auto industry has also affected the nature and ecosystem. Note that, total world auto production reached 80.1 million units in 2011 (Blain, 2012). If the production goes at this rate, there will be approximately two billions cars on the road (Nunes & Bennett, 2010), which means more pollution, more negative impacts on environment, more energy consumption, and greater spend on world’s resources. Shortages in the energy and resources make
automotive manufacturers more sensitive. Thus, the environmental sensitiveness will impact the automotive industry in regarding such topics:

![Figure 1: Environmental Impacts to Automotive Industry (Source: Poon, 2009, p.2 modified from Demirci, 2011).](image)

To summarize, environmental aspects and impacts of the automotive industry on environment are summarized in Table 1.

---

**Market/Business**
- Globalisation
- Fierce Competition
- Co-competition
- Over Capacity

**Environment**
- Regulation & Standards
- Resources & Energy shortage
- Green Manufacturing

**Technology**
- Hybrid & Electric Alternative Energy
- Virtual Design
- Platform Sharing
- Drive-by-Wire

**Customer**
- More needs and demand (comfort, low price, new design, economic, safety)
- Build-to-order
- Changing buying behaviour

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6
Table 1: Automotive industries’ environmental aspects and impacts (Source: Nunes and Bennett, 2010, p. 403).

<table>
<thead>
<tr>
<th>Activities</th>
<th>Environmental aspects</th>
<th>Environmental impacts</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>Land use</td>
<td>Depletion of natural resources</td>
<td>Local, regional,</td>
</tr>
<tr>
<td>Buildings construction and operations</td>
<td>Energy, water and material consumption</td>
<td>Pollution</td>
<td>global</td>
</tr>
<tr>
<td>Manufacturing processes</td>
<td>Emissions of harmful substances Energy, water and material consumption</td>
<td>Depletion of natural resources and Pollution</td>
<td>Local, regional and global</td>
</tr>
<tr>
<td>Logistics</td>
<td>Shipping</td>
<td>Pollution of sea and air, traffic congestion</td>
<td>Local, regional and global</td>
</tr>
<tr>
<td>Job offers</td>
<td>Employment</td>
<td>Increased welfare</td>
<td>Local and regional</td>
</tr>
<tr>
<td>Economic contribution</td>
<td>Trade of goods and services, spin-offs</td>
<td>Flow of capital, people’s needs met</td>
<td>Local, regional and global</td>
</tr>
<tr>
<td>Use</td>
<td>Roads, parking spaces, bridges, etc.</td>
<td>Depletion of natural resources</td>
<td>Local, regional</td>
</tr>
<tr>
<td>Infra-structure</td>
<td>Air emissions</td>
<td>Air pollution</td>
<td>Local, regional and global</td>
</tr>
<tr>
<td>Fuel combustion</td>
<td>Mobility</td>
<td>Location transfer of people and goods</td>
<td>Regional</td>
</tr>
<tr>
<td>Mobility</td>
<td>Mobility of people and goods</td>
<td>Congestion and accidents</td>
<td>Local</td>
</tr>
<tr>
<td>End of life</td>
<td>Energy consumption</td>
<td>Depletion of natural resources</td>
<td>Regional</td>
</tr>
<tr>
<td>Collection, dismantling, reusing, remanufacturing and recycling</td>
<td>Avoidance of irresponsible Disposal Re-use of materials</td>
<td>Conversation of natural resources</td>
<td>Regional</td>
</tr>
<tr>
<td>End-of-life disposal</td>
<td>Landfill disposal</td>
<td>Depletion of natural resources and soil contamination</td>
<td>Regional</td>
</tr>
</tbody>
</table>

According to Table 1 and Mildenberger and Khare (2000), the main and significant global impacts start after production phase of vehicles. Nevertheless, before
production, during production steps and also final disposal of vehicles also cause serious environmental problems (Nunes and Bennett, 2010). Furthermore, the use of automobiles consumes huge amount of fossil fuels, which consequently leads to serious air pollution problem, due to the many harmful substances that the automobiles directly exhausts to the air. These emissions are Carbon Dioxide, Carbon Monoxide, Nitrogen Oxides, Sulphur Oxides, Ozone, Aldehyde compounds, particular material and Hydrocarbon particles (Nunes and Bennett, 2010). These dangerous compounds are known to be one of the main reasons of global warming issue. In addition to this, enormous water and energy consumption, solid waste generation and organic compound emissions are other hazardous environmental impacts that are created in the production phase. (Nunes and Bennett, 2010).

2.3 Sustainability in Automotive Industry

Recent nuclear disaster in Japan and huge oil leakage from the drilling tower in the Gulf of Mexico are good examples of potential environmental hazards that can be initiated by industries. Moreover, unstable political systems in the oil-producer countries) such as Libya, Iraq, Venezuela and etc. makes sustainable energies as attractive alternative sources of required energy for the industry. Automotive industries have been facing tremendous challenges regarding environmental issues for a long time. Since 1980, despite the automotive manufacturers have been following positive attitudes towards reducing environmental impacts of their production process, they still have not only problems with environment, but also have faced lack of sustainable supply chain (Orsato and Wells, 2007, p.991). One of the good example from Toyota is that lean production techniques in Toyota Production System eliminates waste from all activities and processes, but nevertheless, how end-of-life vehicles are eliminated and recycled again with an effective way are still waiting to be answered (Orsato and Wells, 2007, p.991).

Despite the accepted idea in the market that hybrid and electric cars are uneconomic,
their implementations are good news for the sustainability in the supply chain. In addition to this, Zah et.al (2007) indicated that using natural fibers instead of glass fibers may have economic, social and environmental improvement potentials for the automotive industry (Zah et.al, 2007). This will contribute not only economic benefits due to its low life cycle cost but also bring social benefits because of its high-added value into the automotive industry (Zah et.al, 2007).

On the other hand, companies are becoming more and more internationalist (Koplin et.al, 2007). Internationalization and globalization have caused working with different suppliers. Nevertheless, this makes it hard to eliminate materials whether it is harmful to the environment/social or not (Koplin et. al, 2007). Internationalization makes companies focus on long supply chain. This leads to waste of inventory cost and bullwhip effect, and higher total cost. Lack of supplier support and sharing cost in research and development practices will lead to the unsustainable supply chain. These are some of the problems that automotive manufacturers face in the world. However, there are social, economic and environmental problems that sustainable supply chain management deals with. Environment is the leading focus dimension of sustainable supply chain and it is pointed out more frequently on the media. That is why GSCM, which is the environmental side of the SSCM, is the main focus of this paper.

On the other hand, focusing on the environment dimension solely will not bring the sustainability in supply chain by itself. Economic and social sides are also inevitable. Thus, companies have to investigate social and economic aspects too.

### 2.4 Sustainable Supply Chain Management

Industrialization and changes in the business environment have led to the development of supply chain networks, which has become a crucial issue in nowadays business world. Increased globalization and outsourcing in industries have led industries focus and compete on a supply chain and its management. Several trends in supply chain have observed so far. Hopkins (2010) states “In the 1980s, it
was just-in-time production; in the 1990s, it was supply chain collaboration and the outsourcing of logistics activities; and in the 2000s, it was application of the internet, according to supply chain thinker, David Simchi-Levi” (cited in Xia et.al 2011, p.496). Today, the desired trend is to ensure sustainability within supply chain. Seuring et.al (2008, p.1545) defined the sustainable supply chain management as “the management of material and information flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e. economic, environmental and social, and stakeholder requirements into account”. These dimensions, as mentioned earlier, are economic, environmental and social. These dimensions are illustrated graphically in Figure 2.

Figure 2: SSCM (Source: Carter and Easton, 2011, p.48).

Carter and Easton (2011) clarifies these dimensions and sustainability rising prominence with these words; “There are a number of drivers for this rising prominence of sustainability, including supply and demand characteristics
surrounding energy consumption, an increased understanding of the science relating to climate change, and greater transparency concerning both the environmental and the social actions of organizations” (Carter and Easton, 2011, p.46).

Webster (2006) defines this importance with these words “With a decisively important impact on operational efficiency, supply chain management of the auto industry becomes one of the core elements for the survival or success of the very industry” (cited in Xia et.al 2011, p.496).

2.5 Green Supply Chain Management (GSCM)

Recently, many researches and studies have been conducted on GSCM concept in the literature. The history of the greening the supply chain is inspired from the research on reverse logistics studies in 1990s (McKinnon et.al, 2010). The idea of GSCM was first emerged in the research named “environmentally responsible manufacturing” by the Michigan State University in 1996 (Wang and Luo, 2010). Later on, Van Hoek (1999) realized the relation between environmental study in logistics and the reverse logistics, which then was extended to the study whole chain (McKinnon, 2010). Hsu and Hu (2008) defined GSCM: “GSCM is as an approach for improving performance of the processes and products according to the requirements of the environmental regulations” (cited in Luthra et.al, 2014, p.23). Hervani et.al (2005) explains GSCM as “GSCM is the summation of Green Purchasing, Green Manufacturing/Materials Management, Green Distribution/Marketing and Reverse Logistics” (cited in Luthra et.al, 2014, p.23). Briefly, GSCM includes traditional supply chain management applications integrating environmental criteria (Gilbert, 2000).

Although the GSCM concept was introduced in 1990s, it still is a new concept in the underdeveloped or developing countries such as China, Turkey, India, and etc. Therefore, it is crucial to analyze examples of implementations of GSCM in these countries to see how successful these countries are in utilization of GSCM in their main industries. In this study, we analyze the automobile manufactures in Turkey.
2.6 Performance Measurement for GSCM

GSCM Performance measurement is a very difficult task for enterprises. Measuring the environmental performance between enterprises is much more difficult than measuring one of them (Hervani et. al, 2005). Lack of systems, non-standardized data, and weak technological integration, along with cultural and organizational differences are the reasons that makes it difficult to measure environmental performance of the organizations (Hervani et. al, 2005). Regulations, competitiveness and marketing are the main forced reasons that make performance measurement necessity for green supply chain management (Hervani et. al, 2005).

The main aims of performance measurement for green supply chain management are internal control and analysis and external reporting (Hervani et. al, 2005). This external reporting, control and analysis activities are necessary for better business managing and making continuous improvement in the business. Evaluation of environmental performance is achieved via Environmental Performance Evaluation (EPE), which is defined as “an internal process and management tool designed to provide management with reliable and verifiable information on an ongoing basis to determine whether an organization’s environmental performance is meeting the criteria set by the management of the organization” (Jasch, 1999, p.79). Moreover, Simpson et. al. (2007) stated that challenges of green supply chain as “customer has significant potential to force improvements to its suppliers’ environmental management practices, introduce environmentally sound technologies, and collaborate with suppliers to share knowledge and jointly develop more sustainable products and processes. From the customer’s perspective this may require a more hierarchical approach to the issue of supplier greening – that is, expecting that some suppliers will be more or less responsive than others. From a supplier’s perspective this may present both advantages and difficulties in their attempts to meet a new and possibly under-developed set of environmental performance requirements. From a government perspective this may require a more collaborative approach to working with
organizations as the challenge to meet the goals of global sustainability increases” (p.29).

2.7 Traditional Supply Chain Management and GSCM

As discussed, environmental issues have become more significant in all companies and have caused supply chain methods to change. Therefore, traditional supply chain management is not valid anymore in the competitive market (Luthra et al., 2011). Moreover, legislative pressures and consumer demands are also reasons for GSCM (Luthra et al., 2011).

Traditional supply chain management focuses on economy as an objective. On the other hand, in addition to economy as a goal, GSCM pays more attention to ecology, as mentioned in previous sections. Traditional supply chain does not pay attention to human toxicological effects, while green supply chain management is green and ecologically optimized (Luthra et al., 2011). Only managing of production and distribution from raw material to the final destination, which is the traditional supply chain management, is not enough anymore. Traditional supply chain management is not concentrated on hazardous effects to the environment during production and distribution. The main concern is to monitor and control the final products. The summary of these two types of supply chain management are given in Table 2.
Table 2: Differences between the GSCM and Traditional SCM (Source: Luthra et. al, 2011, p.235).

<table>
<thead>
<tr>
<th>No</th>
<th>Characteristics</th>
<th>GSCM</th>
<th>Traditional-SCM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Objectives</td>
<td>Economic &amp; Environmental</td>
<td>Economic</td>
</tr>
<tr>
<td></td>
<td>friendly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Environmental Impacts</td>
<td>Low Environmental Impacts</td>
<td>High Environmental Impacts</td>
</tr>
<tr>
<td>3</td>
<td>Cost</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>4</td>
<td>Flexibility</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>5</td>
<td>Speed</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>6</td>
<td>Supplier Selection criteria</td>
<td>Environmental Friendly</td>
<td>Price</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Long Term Relationship</td>
<td>Short Term Relationship</td>
</tr>
</tbody>
</table>

2.8 The Components of GSCM

According to the Hervani et al. (2005), GSCM contains green purchasing, green manufacturing/materials management, green distribution/marketing and reverse logistics. GSCM should contain six parts in the whole chain from designing to final process recycling (Cao, Y., 2007), which can be listed as green manufacturing, green purchasing, green designing, green marketing and distribution, and green recycling. This is illustrated in Figure 3.

Figure 3: The components of GSCM (modified from Weiwei and Huiyu, 2010, p.13).
These components are defined and debated in the following subsections.

**2.8.1 Green Designing**

Green design is an increasing importance in the industry today. It is just one of many environmental topics that producers and manufacturers are expected to aim for. The reasons and factors that force producers for green design are: government’s environmental legislation, company image, public impression and consumer demand, and increasing waste disposal cost (Dowie, 1994). According to the Chen and Sheu (2009), design changes caused decrease on the costs of processing wastes and recycling. Design for environment (DfE) or another called eco-design aims to think product’s life cycle for more environment-friendly products. The main aim is to eliminate hazardous environmental impact utterly through sensitive design (McLennan, 2004). According to the waste hierarchy, the three Rs, reduce, reuse and recycle should be applied in the design stage. If the design extracts the maximum benefits from products, automobile in this case, the automotive manufacturers can generate the minimum amount of waste. Energy and resource efficiency are significant in the green design (Wiaderski, 2005). Green design includes two types; modular and loop design (Huiyi and Weiwei, 2010). In modular design, products are divided into smaller parts and then are used in different needs to drive multiple functionalities. Modularity in design provides decrease in cost and makes design flexible. In addition to this benefit, it contributes to augmentation, exclusion, ease of change and reusable modules. In augmentation, it adds a new solution by plugging in a new module. When buying a new car, paying extra money for upgrading the car’s engine with more powerful engine without any necessity to change other parts of the car is a recent example for modular design in cars or modularity in car design. Loop design or design for recycling, as the name implies, is the design for recovering and recycling. Rising raw material cost and pressures from governmental or non-governmental organizations push manufacturers to come up with
environment-friendly or easily recyclable products.

2.8.2 Green Purchasing

Green purchasing or environmentally preferable purchasing is very crucial in nowadays procurement activities (Igarashi et.al, 2013). Min and Galle (2001) defined green purchasing as “an environmentally-conscious purchasing practice that reduces sources of waste and promotes recycling and reclamation of purchased materials without adversely affecting performance requirements of such material” (Min and Galle, 2001, p.1222-1223). While, price, delivery and quality was the main criteria for the supplier selection until 1990s (Igarashi et.al, 2013), in today’s world, purchasing activities without thinking about environment is not possible. Green purchasing requires environmental criteria in supplier selection and this lead to green supplier selection method (Noci, 1997 cited in Igarashi et.al, 2013, p.247). Supplier selection is not only important decision for providing the right products on a competitive price level, but also a good way to developing the environmental performance (Igarashi et.al, 2013). According to Walton et.al (1998) “A firm's environmental efforts will not likely succeed without integrating the company's environmental goals with its purchasing activities” (Walton et al., 1998 cited in Igarashi et.al, 2013, p.247). Green purchasing does not only provide benefit to the environment, but also helps the organizations’ brand image, customer satisfaction, risk reduction and cost minimization. Green purchasing can help organizations’ competitiveness in the economic and social area (Green Purchasing Guide, 2011). Brand image benefits can be observed in the public,which directly affects the sales. Influence customer as making green purchasing will return to the organizations as customer retention benefit. Therefore, delivering green products will reflect customer values and this lead to increase brand image, improve customer relations and gain an edge over competitors in the market (Green Purchasing Guide, 2011). Organizations can reduce their risk with green purchasing. Hazardous chemicals or dangerous chemicals accidents may happen. For instance, oil spill in the Gulf of
Mexico caused BP Company to lose million dollars in lawsuits. It also made a non-sensitive environment image of the company in the public and customers’ mind. Thus, it is possible to offset environmental and economic risks with environmentally preferable purchasing. Green purchasing’s cost reduction benefit is also important. Organizations exist for gaining money and they exist as long as they make profit. There are indications that green purchasing may be observed costly in the short term, but it is more profitable in the long run. A green product uses energy, gives out less waste and its lifecycle lasts longer. Thus, green purchasing is capable of cost reduction. Operation maintenance, energy and water usage, higher durability and environmental convenience are also examples for the cost reduction (Green Purchasing Guide, 2011). It is crucial to note that organizations must have green supplier criteria for deciding the right suppliers to make green purchasing for implementation of green supply chain management (Igarashi et.al, 2013).

2.8.3 Supplier Selection and Automotive Supply Chain Structure

Supplier selection is very significant and crucial in the purchasing activities. Igarashi et.al (2013) asserts that supplier selection is not only important decision for providing the right products on a competitive price level, but also a good way to developing the environmental performance. Supplier selection has to be considered to make green purchasing acceptable with respect to the environmental awareness in the selection process. Choosing the best environment-friendly supplier is very substantial to establish green purchasing. Igrashi et.al (2013) put its importance into these words: “Selecting a supplier can be regarded as an important decision, not only in the sense of providing the purchasing organization with the right materials, products or solutions at a competitive cost level, but also in the sense of improving its environmental performance, e.g., through avoiding hazardous materials or considering alternative solutions that require less materials and/or energy” (Igarashi et.al, 2013, p.247). This proves that supplier selection is not only important for providing the right products on a competitive price, but also a way to enhance the
environmental performance. Products that indicates energy saving and eco-friendly features are not enough for the green purchasing. To carry out green purchasing, whole process of purchasing activities should be eco-friendly, e.g., using recycled papers or even electronic sources in the transactions instead of using papers. Moreover, making better relationships with suppliers will result in decrease in the inventory levels, low costs and better accuracy (Luthra et.al, 2011). Supplier selection criteria cover quality, quantity, services and responsiveness. Green supplier selection criteria should cover more than these, especially in the automotive industry because many raw materials and parts (including steel, Aluminum, Iron, Lead, plastic natural rubber, synthetic rubber, Copper, Zinc, and etc.) are used in the automotive industry, which can directly affect the environment. Supplier selection process is presented in Figure 4.

![Supplier selection process diagram](image)

**Figure 4:** Supplier selection process (Weele, 2010 cited in Igarashi et.al, 2013, p.248)

Supplier selection begins with identifying the needs. Then formulation of criteria for potential suppliers is agreed, and then contact with the potential supplier with call for tenders is made. After evaluation of the supplier’s qualification, final selection is made. Evaluation of supplier performance might be used for later use and this can help improvement of supplier performance (Igarashi et.al, 2013). Vanalle et.al (2011) defined supplier selection and evaluation process according to environmental variables, which are given in Table 3.

<table>
<thead>
<tr>
<th>Category</th>
<th>Factors</th>
<th>Sub-factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental practices</td>
<td>Pollution control</td>
<td>Remediation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End of process controls</td>
</tr>
<tr>
<td></td>
<td>Pollution prevention</td>
<td>Product adaptation</td>
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<tr>
<td></td>
<td></td>
<td>Process adaptation</td>
</tr>
<tr>
<td></td>
<td>Environmental</td>
<td>Establishment of environmental policy and</td>
</tr>
<tr>
<td></td>
<td>management system</td>
<td>commitment</td>
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<tr>
<td></td>
<td></td>
<td>Identification of environmental aspects</td>
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<td>Environmental objective planning</td>
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<td></td>
<td>Environmental responsibility assignment</td>
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<td></td>
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<td>Evaluation of environmental activities</td>
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<td>Environmental performance</td>
<td>Resource consumption</td>
<td>Energy consumption</td>
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<td></td>
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<td>Raw material consumption</td>
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<td></td>
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<td>Water consumption</td>
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<tr>
<td></td>
<td>Pollutant reduction</td>
<td>Pollutant agent production</td>
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<tr>
<td></td>
<td></td>
<td>Toxic product production</td>
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<tr>
<td></td>
<td></td>
<td>Waste production</td>
</tr>
</tbody>
</table>

In the automotive industry, there is a tiered supply chain structure. Original equipment manufacturer (OEM) is the auto manufacturers, which pick up parts, assemble and then sell product. General Motors, Toyota, Ford, Renault are examples of OEM companies. Suppliers are categorized based on their importance in the automotive supply chain. Domestic and global tier1, tier2, and tier3 suppliers are the main suppliers for the automotive industry. Tier 1 suppliers are the most important and vital suppliers, which supply large components, sub-systems or systems that are important, the parts that are directly put on the automotive. These kinds of suppliers produce their parts, specifically for one of the original equipment manufacturer. Tier2 suppliers are the suppliers that supply parts or components to the Tier1 suppliers. The same structure is valid for the Tier3, which provide parts for Tier2 suppliers. Raw materials suppliers are also providers for the OEM. Third party logistics (3PL) providers are also suppliers that distribute vehicles to the distribution...
hubs and then reached to the dealers.

The relationship between the suppliers and the manufacturer is briefly presented in Figure 5.

![Automotive Supply Chain Structure](image)

**Figure 5**: Automotive Supply Chain Structure (Source: EDI for the Automotive Industry, web page 1, accessed 2011).

### 2.8.4 Green Manufacturing

Green manufacturing or environmentally conscious manufacturing is a way of manufacturing that minimizes waste and pollution. In green manufacturing, all environmental impacts are considered in all stages of production. Melnyk and Smith (1996) defined the green manufacturing as “a type of modern manufacturing mode, the goal of which is to minimize the environmental impact during the product life cycle including manufacturing, use, disposal and so on through design and manufacturing” (cited in Li et.al, 2010, p.149).

The green manufacturing mainly aims at reducing energy consumption and waste emission (Li et.al, 2010). Implementation of green manufacturing decreases energy costs. Recycling the materials, identifying the wastes, and purchasing from green suppliers are simple ways for green manufacturing implementation. In the long run,
enterprises realize that they compensate their green investment cost. The experts believe that, manufacturers should use three life cycles to design the products. First, design for re-use. Second, develop a product that can be interchangeable with other products. Finally, instead of creating a new product, updating the product or releasing the new product additions should be considered from manufacturers.

2.8.5 Green Marketing and Distribution

There is a common belief that green marketing means advertising of products with environment-friendly characteristics in the business. The terms like ozone friendly, environmentally safe, environmentally friendly, hazardous-material-free or recyclable are related to green marketing. However green marketing is wider than these concepts. Green marketing strategies are used as an additional promotion from companies instead of analyzing products and their impact on the environment (De Craecker & De Wulf 2009). Green marketing should incorporate from product modification to changes to the manufacturing, distribution changes, packaging changes and to the advertising changes (Polonsky, 1994). According to the public opinion polls, when all things equal, consumers prefer to choose green products with respect to product that less friendly to the environment (Ginsberg and Bloom, 2004). On the other hand, when consumers have to make trade-off between product specifications or thinking the environment, product specifications and appeal are always win (Ginsberg and Bloom, 2004). However, most consumers do not desire to buy green products. Electric car production with its poor sale is a good example. Higher electric car price, its short battery life and cost are the factors that consumers do not sacrifice from their budget (Ginsberg and Bloom, 2004).

Distribution of products causes substantial problems for enterprises. Logistical cost is the main indicator that affects competitiveness in the market. The environmental impacts of distribution and transportation are crucial topic for sustainability. Carbon dioxide emissions and other greenhouse gas emissions are increasing. Global warming, air pollution, greenhouse effect, and oil spills are the considerable
problems for transportation. Green transportation or distribution implies to any transport system that gives out less harmful impact on the environment. That transport also incorporates non-motorized transport. These types of transports include cycling and walking. Using green vehicles, car sharing services and urban transportation services also lead to environmentally sustainable, economically efficient and socially sustainable transportation. With the latest marketing innovation, car shipping services are also good example to lower the impact of transportation on the environment (Ginsberg and Bloom, 2004).
Note that for automotive manufacturers, transportation of products is the main indirect cost. Green transport is principally should incorporates centralized distribution with a reasonable route planning (Christopher, 2005). Also using shipping logistics instead of using road transportation of vehicles are good examples for lowering the negative impact on the environment. Using optimized route planning in the transportation and effectively managing distribution systems are the activities that can be implement in the green distribution. In addition to this, using recyclable or reusable materials in the transportation will lower the environmental impact of transportation.
Green packaging is also part of green distribution. Packaging features will impact the distribution of materials; size, shape, horizontal or vertical packaging.

2.8.6 Green Recycling

Reuse or recycling of products has recently been significant since environmental concern is increased. Green recycling or reverse logistics means reusing the products and materials in a green way. The Council of Supply Chain Management Professionals (2005) has described reverse logistics as “a specialized segment of logistics focusing on the movement and management of products and resources after the sale and after delivery to the customer. It includes product returns for repair or credit” (cited in Chaves and Alcantara, 2006, p.3).
Reverse logistics contains all activities, which are performed in the logistics but the
difference is that they implement in the reverse way (Hawks, 2006). Hawks (2006) also points out that “reverse logistics is more than reusing containers and recycling packaging materials. Redesigning packaging to use less material, or reducing the energy and pollution from transportation are important activities, but they might be secondary to the real importance of overall reverse logistics” (p.1). To this end, the main activities that are taken place in reverse logistics are as follow:

- **Collection**: take back the products from user end.
- **Reverse logistics**: reaching the products from the end point of consumption to the point of starting.
- **Recycle**: reuse of products, repair, renovate, reproduce, and recycle or disposal of products with the lowest impact on the environment.

If goods are being sent backwards or reverse, it cannot be mentioning about that this activity is an example for reverse logistics (Hawks, 2006). Excess and seasonal inventory, restock, recalls, salvage and returned goods which are damaged are also responsibility of reverse logistics (Hawks, 2006).

Although technology brings much easiness into human life, products have become more complex and their life cycles have become shorter. This causes increase in the amount of waste in the industries (Mildenberger and Khare, 2000). This is more crucial to face in the automobile and automotive industry, which is the most resource-intensive sector in the whole industrial systems (Mildenberger and Khare, 2000).

On the last years, automotive companies, which are located in the Europe and US have created a partnership to establish a recycling infrastructure (Mildenberger and Khare, 2000). In this system, the manufacturers can handle end-of-life vehicles better. The demand for this life-cycle awareness and its management is growing in the world, especially in the automobile industry. The European directive 2000/53/EC, End of Life of Vehicle has been released. The directive intends to reduce the waste, which is arising from end-of-life-vehicles (Millet et.al, 2012). The automotive manufacturer must obey that vehicles are on the market rely the reuse
and recovery objectives of 85% in mass (Millet et.al, 2012).

3. Research Methods

Case study based on questionnaires, which has been used in this study, is vastly employed as a research strategy (Ninlawan et al., 2010; Zhu et al., 2007; Kumar et al., 2012). In this study, case companies include automobile manufacturer (FordOtosan and Oyak-Renault), bus manufacturer (Temsa, Otokar), commercial and armored trucks (Otokar, FordOtosan and Askam), and van manufacturer (Askam). In overall research, qualitative analyses have been used. In the conclusion and suggestion parts, qualitative questions’ answers, which are based on a five-point Likert-scale, are converted to the numerical mean values and then evaluated.

3.1 Research Approach

3.1.1 Qualitative Research

Qualitative research analyzes written documents, data from observations and open-ended interviews and it includes suggestions and researches “how” questions and it generally is a method in the social sciences (Patton, 2005). Literature review, comments and observations from the questionnaires have been used as qualitative data. We focus on how Turkish automotive companies implement GSCM, and we collect our data through questionnaires. Qualitative data has been used in the survey part, and qualitative questionnaires are sent to the case study companies and then fulfilled data have been analyzed.

3.2 Data Collection

Primary data, secondary data, questionnaires and observations have been used in this research. The data directly collected from five Turkish automotive manufacturers are thesis’s primary data. Automotive companies’ activity and annual report are used as a secondary data. Questionnaires, which have been sent to the automotive
companies, are used as a questionnaire data. These questionnaires are gathered in appendix part (Appendix A, B, C and D). The types of automotive manufacturers are in the thesis: automobile manufacturer (FordOtosan and OyakRenault), bus manufacturer (Temsa, Otokar), commercial and armored trucks (Otokar, FordOtosan and Askam) and van manufacturer (Askam). Instead of choosing one type of manufacturer, many types of automotive manufacturers are selected for a better evaluation of GSCM. Random sampling is used in the overall thesis. Five case companies are selected and companies are not only sampled from automobile companies, but also sampled from bus, van, commercial and armored trucks companies.

The questionnaires for GSCM practices, performance and pressures have been modified from three scientific articles (Ninlawan et al., 2010; Zhu et.al, 2007; Kumar et.al, 2012).

Note that, the regulation abbreviation in the questions in the regulatory part is described as:

**Regulations-REACH:** Regulations that European Union legislated in 2007 for regulations on chemicals and their safety use (Geraghty, 2008). Shortly, the regulation strives for regulation, evaluation, authorization and restriction of chemical substances (Geraghty, 2008).

**Regulations- EUP Eco Design:** It stands for Design for Energy-Using Products and the EU’s policy makers put this legislation and it was adopted in 2005 (Eup Eco Design, 2012). The directive restraints the design of energy-using products and makes these products’ design more environmentally friendly (EU, 2005).

**Regulations-EWC:** EWC stands for the capital letters of European Waste Catalogue. The directive seeks to manage the waste and classifies waste materials.
3.2.1 Questionnaire Development

Empirical data are used in this study. Questionnaires have been sent to the five Turkish automotive manufacturers to obtain the empirical data. The questionnaires are responded to by the managers from human resource department. Human resources department divided questionnaires into the groups and sent to the related departments and then questionnaires had been sent back to the author. The questionnaire was considered from three scientific articles and then reformed again (Ninlawan et al., 2010; Zhu et.al, 2007; Kumar et.al, 2012). The questions have been adapted into the automotive sector and contain four parts with the general information questions. These parts include general information, GSCM practices, GSCM performance and GSCM pressures, respectively. In the general information section, companies’ general information is presented, which includes number of employees, companies’ corporation model and questions about whether there is an EMS and also an ISO certification or not. In the second part, the GSCM practices are presented. The GSCM practices part contains five subsections. These are internal environmental management practices, green purchasing practices, eco-design practices, cooperation with customers and investment recovery. In the internal environmental management practices subsection, questions are replied using a five-point Likert-type dimensions (e.g. 1= not considering it, 2=planning to consider it, 3=considering it currently, 4=carrying out some degree and 5=carrying it out fully). The question are in this part were developed on industrial expert inputs (Zhu et.al, 2007). In the third part of questionnaires’ questions, which is green supply chain performance, questions are answered using a five-point Likert-type dimensions (1=not at all, 2=a little bit, 3=to some degree, relatively significant and 5=significant). The questions in this section were developed from authors who focus on the environmental, financial and operational performance topics (Zhu et.al, 2007). The last part of the questionnaires are answered using a five-point Likert-type dimension (1=not at all important, 2=not important, 3=not thinking about it, 4=important and 5=extremely important). In the last part, GSCM pressures are
presented. The part is divided into three categories. Finally, one example is given and explained how questions has to be filled. Questionnaires are separated from the excel sheet in each section. The results are charted with the “Radar with Markers” which suits in a five-point Likert-scale. In the “Radar with Markers” chart, values are displayed relative to a center point. Maximum and minimum points are from 1 to 5. This chart is used in this study because the data and categories are not directly comparable with other case. The questionnaires are explicitly illustrated in Appendix A, B, C and D part. In the results part, survey results are presented by companies and its all mean values. The mean values are calculated by summing up each question’s point from the same part between them and by dividing each question to the number of case companies.

3.3 Validity

Validity in research represents acceptable research from the research community (Biggam, 2011). Research strategies and data collection techniques and all about empirical study are related to the validity of the research (Biggam, 2011). Research strategy that is suitable to the collection and analysis of data represents valid research (Biggam, 2011).

In the thesis, we focus on only five Turkish automotive companies’ green supply chain management. Therefore, case study with using questionnaires is used as a research strategy, which is suitable with collection and analysis of data. The primary data was obtained from the automotive manufacturer’s different departments. The fulfilled excel questionnaire data is obtained from the Human Resources Department-Training Team Leader in FordOtosan, Supply Chain Department-Logistics Performance Manager in Oyak-Renault, Production Department-Production Director in Askam, Human Resources Department-Human Resources Manager in Temsa and Production Department-Process Engineer in Otokar. Therefore, all the data is reliable and trustable.

Green practices, green performance of the company and pressures that force
manufacturers for green activities are ranked according to the five-point Likert-type. The data that are used and quoted from the internet and the database and books in the thesis, are valid and referred to the expert authors. These data are cited by using APA reference style and added to the reference part. Finally, the research is valid and appropriate in terms of data collection and analysis method. The analysis and questionnaires for practices, performance and pressures of the GSCM method is based on three similar scientific articles (Ninlawan et al., 2010; Zhu et.al, 2007; Kumar et.al., 2012).

3.4 Reliability

Reliable research stands for the trust of the research and the study could be valid but it can be unreliable (Biggam, 2011). Therefore, research strategy has to be appropriate to the research and data collection techniques have to be relevant. The thesis was carried out with analysis and it was based on theories of GSCM. As it was mentioned earlier, the questionnaires are based on three valid scientific articles and can be integrated into the automotive industry’s GSCM activities. The data collection and sampling is also randomly selected from the different kind of automotive manufacturers. Valid strategies and techniques have been employed and suits with the thesis objectives. The results of the thesis represent Turkish automotive manufacturer’s general overview on GSCM.

4. Case Study

In this section, five case companies are introduced in more details and their GSCM activities are explained. In the following section, their performance in implementing GSCM is analyzed via questionnaire-based research methods and the results are discussed.
4.1 Green Supply Chain Management in the Turkish automotive industry

The automotive production becomes desirable for several developing countries due to the low tax rates, lower labor costs and environmental regulations (Yilmaz and Ustaoglu, 2013). One of the favorite countries for internationalization and setting up international industrial plants, especially in automotive industry, is Turkey. The chairman of the Turkey Automotive Industry Association (OSD) Onen clarifies the opportunities and addresses why Turkey is chosen with these words: “Turkey is one of the most significant candidates in globalization process due to its workforce potential, automotive culture and high quality tradition. Additionally, there are also other factors that provide advantage to us like flexible working hours, capability of efficient use of facilities, suppliers that are self-improved, experienced and capable of high technology and co-design skills, high quality manufacturing, improved energy and communication infrastructure and higher workforce efficiency” (Onen, 2010, p. 24).

Note that these set up plants also bring many environmental problems to the country. Increased sensitivity on environmental protection in the world have also caused Turkish automotive supply chain managers to think and carry out green supply chain management practices for developing their environmental performance together with economic performance. In this study, we concentrate on evaluation of their success toward implementation of GSCM practices in their manufacturing systems.

4.2 Automotive Industry In Turkey

As a modern history of automotive sector in Turkey, car manufacturing began in 1996 with “Anadol” fiberglass car powered by a foreign-made engine. However, before that, the Otosan factory was established to produce under-license Ford Motor Company models in Turkey in 1959. In 1961, Turkey produced its first indigenously designed and produced car in Eskisehir, which was named “Devrim”.
Custom Union agreement between Turkey and EU is signed at the end of 1995 and a free trade area was established between EU and Turkey. This advantage accelerated the shift of production facilities to Turkey by many automotive manufacturers (Yilmaz and Ustaoglu, 2013).

In 2013, Turkey produced 633,604 cars and 491,930 commercial vehicles, totally 1,125,534 motor vehicles listed as the 7th largest producer in Europe and 17th largest producer in the world (OICA Production Statistics, 2013). Totally, 893,124 new vehicles are sold in 2013 with 664,655 passenger cars and 228,469 commercial vehicles.

Thus, it is clear that the automotive industry contributes to employment and plays a crucial role to Turkish’s economic growth. On contrary to this positive effect, recent heavy taxes on gasoline prices and automotives have caused loss of jobs and unemployment in Turkish automotive industry. This problem cannot be solved by decreasing the gasoline prices in the sustainable environment. Hence, alternative energy sources can be used in order to mitigate the problem and create a sustainable supply chain in automotive industry in Turkey.

4.3 FordOtosan

Established in 1959, Otosan stands for “Otomobil Sanayi” (Automotive Industry), it is a joint venture with Ford Motor Company. Koç Holding and Ford Motor Company started their partnership in 1977 with license agreement to produce automotives under Ford brand. Then their partnership continues ownership. Ford assumes 11% ownership in Otosan and now their share in partnership is equal to 41% each (FordOtosan, 2012). FordOtosan produces automobiles, trucks, commercial trucks and vans. FordOtosan produced commercial vans under Ford Transit and Ford Connect and heavy commercial truck under Ford Cargo brand name. FordOtosan produced their automobiles and commercial vans in Kocaeli, Gölcük factory. Their commercial and heavy commercial trucks are produced in Eskişehir, İnönü plant in Turkey. FordOtosan’s environment policy includes (FordOtosan, 2012)
• Meet and even exceed the requirements of relevant environmental legislation.
• Work continuously to improve the EMS.
• Minimize waste, prevent pollution at source and reduce the negative impacts on the environment.
• Protect the environment, and spread this principle to the world.
• Determine the risks related to the environment and reduce them for emergency situations.
• By fulfilling the occupational health and safety codes prevent the negative effects that may affect the environment.
• Giving training to employees and contractors to develop awareness on the environment protection.

FordOtosan, activities and products have to identify the environmental factors, which define the objectives, goals and programs that are established to create the ISO 14001 Environmental Management System. Its manufacturing, products, services and activities covering the ISO 14001 Environmental EMS, has been certified for the first time in 1998 (FordOtosan, 2012). The main goals and objectives for this significant environmental impact are: (FordOtosan, 2012)

• Air and water pollution, noise, leaks and spills are to be reduced and prevented as much as possible.
• Reduce waste by employing recycling and reusing approaches.
• Develop natural resources such as energy and water conservation methods.
• Ensure efficient use of energy and materials.
• Control environmental hazards arising from the activities of contractors.
• Minimize the effects of environmental factors and control for the future of new products, processes and activities.

4.3.1 Air Emissions in FordOtosan

FordOtosan "sustainable development", as a principle of the company, ensures that
all processes from design stage are selected to use the newest and most environment-friendly technologies. Water-based paint used in the dyeing process is the best and recent example of this embodiment. Water-based paint is used in the dyeing processes to reduce the volatile organic compounds in the air. This application is the first of the European Ford Factories in the automotive sector. Water-based paint and the use of incinerator, as well as with the use of natural gas as a combustion source for heating and process reduces emissions to the minimum levels. The results of periodic measurements made in FordOtosan facilities demonstrated that they have been well below legal limits. In addition, the cooling and fire extinguishing systems that have less hazardous potentials on ozone were employed, and the gases, which have usage limitations, are not used in the process (FordOtosan, 2012).

4.3.2 Energy in FordOtosan

FordOtosan has an Energy Committee that monitors the energy saving policies. Periodic meetings with the Energy Committee, which processes and / or efforts to reduce energy use in facilities projects for this purpose, can be arranged. Energy saving methods, which are implemented in the Kocaeli Plant, are:

- Using photocells and reduction system for energy saving in the environmental lighting system.
- Human and vehicle access doors are insulated and closed automatically with a high energy recovery
- Using self-transformer spot welding gun which enables 50% less energy-consuming in the welding workshop.
- Energy savings of up to 30% by the automation system.
- Reuse of the energy obtained from incinerator to use oven heating.
- The use of the points of use for water preheating provided from the waste heat from compressors.
- Using the economizer to give the water to the boiler for the energy recovery.
• Establishment solar water heating system in the social facilities.
• The application of air curtain in the automatic doors for energy saving.

4.3.3 Wastewater Treatment and Water Usage in FordOtosan
Wastewater treatment and water usage is significant in FordOtosan. All domestic and industrial wastewater is treated on-site wastewater treatment plants. Wastewater, which is treated by treatment plants, is controlled by analyzing both laboratories and accredited institutions. Significant gains in process water consumptions to protect natural resource and conservation work are done. However, using well water in the facilities instead of filtering the service water is negative impression to the company for sensitiveness to the environment.

4.3.4 Waste Management in FordOtosan
The environmental impacts of hazardous wastes are stored based on REACH regulation and European Waste Catalogue directive and disposed carefully. In addition to this, FordOtosan works to decrease the waste of raw material and increase the recycling of waste mass, and therefore considerable gains has been achieved in reduction of hazardous waste. The most recent study on this subject was on Kocaeli Plant wastewater treatment plant. For instance, in this wastewater treatment study, both reduction of the amount of sewage sludge, as well as increasing the calorific value of waste has been used as an additional fuel in cement factories.

4.3.5 Products and Materials
FordOtosan aims to create the useful product’s life and this life aims to reduce the negative environmental impact. For this reason, FordOtosan has done the following green activities:
• Transit vehicles produced in Kocaeli Plant is more than 85% recycling rate.
• Even though there is not a currently legal requirement in the production of
Cargo truck, there is more than 90% recycling rate in the Cargo truck manufactured FordOtosan İnönü Factory.

- Materials that are used in the production and in the facilities, are governed by the Ford Restricted Material Management Standard.
- There are no ozone-depleting halon gases in the fire and cooling systems.
- All Ford dealers and services are informed about the environmental hazards in order to reduce the environmental impacts that may occur during the use of the product.

Other green activities are analyzed in more details in the questionnaires.

4.4 Oyak-Renault

Oyak-Renault is a Turkish automotive manufacturing company. Renault, Oyak and Yapı Kredi Bank were established as a partnership in 1969 and Oyak-Renault Car Plants became operational after two years. Oyak group is an armed forces pension fund. Today, the Oyak-Renault company is the largest subsidiary outside Western Europe in the worldwide of Renault’s partners. The Oyak-Renault group is the leader production and exportation in the Turkish Automotive Industry (Renault, 2012). Oyak-Renault produced automobiles in Bursa, Turkey. The Oyak-Renault, produce and export of Renault’s passenger cars and the mechanical parts of the production. The Renault group worldwide is one of 38 production centers with the body, assembly and mechanical frame with the logistics centers (Renault, 2012). The annual engine production capacity is 450 000 and 360 000 automobiles (Renault, 2012). Oyak-Renault, still produce Symbol, Clio III model versions 3 and 5 door hatchback, and the Grand Tour, Fluence and Megane HB models are produced with the automobile engine and mechanical parts and exported to the world (Renault, 2012). Recently, Oyak-Renault has started to produce electric Fluence model and exported it to the world. This zero emission electric vehicles, is a solution for offering a sustainable transport, which will decrease the environmental impact of automobiles.
Renault is aware of the importance of the problem of global warming that is why Oyak-Renault trying to reduce CO2 emissions over the entire life cycle models to reduce the ecological traces of the car on earth (Oyak-Renault, 2012). Renault in 2007 launched the Renault eco2, the environmental strategy, in which, the vehicles are more efficient and economic (Renault, 2012). Renault’s eco2 vehicles meet the demand of green production, green recycling and decreased CO2 emissions. Eco2 symbol means that the vehicles have been manufactured in a Renault factory that has been certified by ISO 14001. As certified in accordance with ISO14001, it guarantees manufacturing process has the reduced the impact on the environment. It means for Renault, less energy, less water, few chemicals and producing less waste. Recycling in Renault is inevitable for the eco2 vehicles. Any model in Renault eco2 was designed to have the maximum number of recycled plastic parts. To get the Renault eco2 signature, at least 7% of the vehicle’s plastic content has to be made of plastic recovered from end-of-life products (Renault, 2012).

Now, nearly 10% of plastic materials come from recycling. In 2015, Renault expects that this number goes up to 20%. Any Clio eco2 model emits 115 g/km of CO2. This means emitting less CO2 and less fuel consumption. From recycling viewpoint, at the end of any Renault eco2’s life, such as Clio eco2 model, 95% of its parts will be reused to make another Clio (Renault, 2012).

According to the Renault’s data, Renault has decreased energy consumption in the manufacturing process by 25% since 1996 (Renault, 2012). According to the Renault’s website data, total reductions over the last 10 years are listed as below;

- 25% (kW/vehicle) energy consumption
- 57% (kg/vehicle) water consumption
- 65% (kg/vehicle) waste production
- 44% (kg/j/vehicle) liquid wastes
- 68% atmospheric emissions
4.5 Askam

Askam Truck was established in 1962 as a joint venture 60% Chrysler International S.A. share. The company started production in 1964. The companies’ truck serves a wide range of applications in the industry. In 2002, the name was changed from Chrysler Kamyon (Chrysler Truck) to Askam Kamyon (Askam, 2012).

In 1978, the Chrysler International S.A. transferred their share to the local partners of Tatko, Farmers, Ruşensad and the company has continued to produce with Chrysler International Manufacturing, Patent, Licensing and Sales Agreement (Askam, 2012). In addition to Chrysler licensed trucks, the company made a license agreement with the Japanese Hino Motors for producing small Hino trucks in 1991 (Askam, 2012).

Askam Truck, continued technical cooperation with the world famous manufacturers Eaton, ZF, Dana Spicer, Perkins Engines, Deutz AG, MAN Steyr and Jellinghaus Gmbh, and maintained their experience of production and manufacturing engineering (Askam, 2012).

Following the merger of Daimler-Benz and Chrysler, the company started to use Askam Truck Manufacturing and Trade Incorporated Company name and the company present its products to the market under Desoto and Fargo brand names (Askam, 2012).

The production range of Askam varies between 3.5 - 40 tons maximum laden weight for trucks and vans. Truck production of Askam serves a wide range of transportation in close to 160,000 vehicles in the construction sector (Avaroğlu, 2012). Askam Truck has gained the 'TS-EN-ISO 9001:2000 Quality Assurance Certificate' and got 'Laboratory Proficiency Certificate', which is accredited by the TSE (Turkish Standards Institute) (Avaroğlu, 2012).

4.6 Temsa

Temsa, manufacturer of buses and minibuses, is one of Turkey's leading automotive companies with its own brand in the segment of production and exports. Temsa is
also the distributor of Mitsubishi and Komatsu brands in Turkey as well. Temsa has a total production capacity of 10,750 vehicles, 3,250 buses and minibuses, 7,500 light trucks, including one shift per year in Adana Production Plant (Temsaglobal, 2012). Temsa’s Adana production facility produces intercity passenger and tourist buses as Safir brand name, midi-buses with Prestij brand name and city transportation buses are developed under the Avenue brand (Temsaglobal, 2012). In addition to this production, TS35 buses for America and Tourmalin and Safari buses for Europe market are also produced (Temsaglobal, 2012). Temsa is awarded with a “Grand Award Midi Coach of the Year” with the production of MD 9 buses, which is produced in Adana Production Plant (Temsaglobal, 2012). Temsa established Adana Supplier Industry Center in order to develop effective business processes in 2004 (Temsa annual report, 2011). This Supplier Industry Center consists of eight suppliers, which only supplies spare parts to the Temsa. Temsa has also established one Supply Industry Center in the production facility. In this center, there are six suppliers that supply seat, luggage rack, composite parts and equipment parts to the Temsa. These two supply centers provide a significant added value to business processes.

Temsa has received ISO 14001 EMS Certificate and aims to minimize the environmental impacts that may occur in the production activities (Temsa annual report, 2011). The company studies show reduction in amount of waste, evaluation of waste water and natural energy resources for energy savings, prevention of environmental accidents, using eco-friendly raw materials, reducing carbon footprint from energy consumption and reducing cost of environmental management (Temsa annual report, 2011). The company supports the concept of environment-friendly production. The company started to use water-based paints and adhesives for expanding the use of more environment-friendly raw material. In this way, the use of chemical substances is reduced and significant progress has been initiated (Temsa annual report, 2011). The environment and sustainability education is conducted every year for intervention and prevention of environmental accidents (Temsa
annual report, 2011). In addition to this, the environment and sustainability education is also conducted to the Temsa’s dealers and suppliers (Temsa annual report, 2011). Consequently, TEMSA’s TS EN ISO 14001:2004 EMS certification has been valid for years and maintains its certificate every year (Temsa annual report, 2011).

4.7 Otokar

Otokar was founded in 1963 and had operated under Koç Group. Since 1963, it has been supplying solutions to its customers both in military and commercial. The first intercity bus in Turkey was manufactured in Otokar (Otokar, 2013). The company is operated in Adapazarı with its 1200 employees in a 552,000m² manufacturing plant. Otokar operates in production of light commercial vehicle group segment. The company also serves range of a public transport service for the commercial market. Vans, buses and bus-type vehicles are the main groups of the transport service. The company has also trailer and semi-trailer production under the license of Fruehauf. However, Otokar has also been producing its semi-trailers under its own brand since 2006 (Otokar, 2013). On the other side, the company works with the Turkish Defense industry for supplying armored and land vehicles to the defense industry. Otokar manufactured Turkey’s first electric bus Doruk Electra to decrease the environmental impact (Otokar, 2013).

Social responsibility is significant in Otokar. Environmental quality and relationship with the community is crucial within their business. Otokar has an ISO 14001 certificate for reducing the negative impacts of manufacturing (Otokar, 2013). The company is awarded by many institutions for its efforts to face environmental problems such as Sector Environmental Prize by the Istanbul Chamber of Industry, Şahabettin Bilgisu Environment Prize by Kocaeli Chamber of Industry and also Akdeniz University Environment Prize (Otokar, 2013).
5. Survey Results and Analysis

A total of 5 questionnaires were collected from 5 case companies. The questions have been asked in a five-point Likert-scale, that is, 1= not considering it, 2= planning to consider it, 3= considering it currently, 4= carrying out to some degree, and 5= carrying it out fully. The findings are summarized below.

The questions were categorized into three different parts: GSCM’s practices, performance, and pressure. The results are presented in two ways. In the first one and in order to be able to compare between different companies, the points for each part (practices, performance, and pressure) and for each company is individually presented.

In the second presentation, the mean value of different question related to each three part (practices, performance, and pressure) is taken over all five case companies. This is done in order to take an overview on how Turkish automotive companies are dealing with GSCM.
GSCM Practices:

<table>
<thead>
<tr>
<th>GSCM Practices</th>
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<tbody>
<tr>
<td><strong>FordOtosan</strong></td>
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<td><strong>Oyak-Renault</strong></td>
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<td><strong>Askam</strong></td>
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*Figure 6: Survey results for 5 different case companies, practice part.*
In figure 6, the results for the questions related to GSCM’s practice for each case company is presented. As illustrated, giants of Turkish automotive manufacturers, to some extent, have implemented GSCM practices. Note that the highest point in all companies is related to question (1.6) and (1.7), which indicates ISO 14001 Certification and EMS existence. This means that ISO 14001 Certification has been obtained by the Turkish automotive manufacturers and EMS exists in their plants. Although the manufacturers have obtained ISO 14001 certification and EMS exists in their plants, according to the performance results, they do not carry out fully ISO 14001 certification requirements and EMS needs.

Cooperation with customers, which includes cooperation with customers for eco-design (4.1), cooperation with customers for cleaner production (4.2) and cooperation with customers for green packaging (4.3), has the lowest points in all companies. It is also observed that eco-labeling of products (1.8), cooperation with suppliers for environmental objectives (2.1), and environmental audit for suppliers’ internal management (2.2) also have lower points. This result indicates that cooperation with customers is in a weak form in the Turkish automotive industry. The evidence presented indicates that customer feedback is not greatly noticed in the production phase in Turkey.

**GSCM Practices-Summarized Mean:**

![GSCM Practices-Summarized Mean](image-url)
In figure 7, mean values of five parts of questionnaire over the five case companies are taken to give a snapshot on how Turkish automotive industry deals with green activities. As shown in Figure 7, internal environmental management practices have the highest mean value in the GSCM practices. Based on the evidence that all five case companies have quality environmental management, an EMS and ISO 1400, there is not a big difference that affects their total mean about this certification and its’ EMS between five companies. On the other hand, in spite of the fact that Otokar and FordOtosan are being managed from the same group (Koç), there are many differences between them. The main difference between these two companies is the internal environmental management practices. Eco-labeling of products in the subgroup of internal environmental management practices causes the gap between their mean values, since eco-labeling seems a new concept in Otokar. Although FordOtosan has large global customers, Otokar serves mainly to army forces and domestic market. Low market pressures and competitiveness in the domestic market makes them postpone eco-labeling of products in this company.

Furthermore, cooperation with customers is the lowest part in the GSCM practices. While, customer and supplier relationships are crucial to the successful coordination of supply chains and developments in the performance of suppliers’ capabilities (Simpson et.al, 2007), the results shows that Turkish automotive manufacturers are quite far away from the customer cooperation before and after production phases. On the other hand, green purchasing practices have the second lowest points in the summarized mean results. Price, delivery and quality are still the main criteria for the supplier selection in Turkish automotive industry.
## GSCM Performance:

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<td><strong>Askam</strong></td>
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*Figure 8*: Survey results for 5 different case companies, performance part.
In figure 8, the results for the questions related to GSCM’s performance part for each case company is given. Improvement and support organization’s environmental position (1.6) and increase in training cost (3.3) are among the highest point values for the GSCM performance in all five companies. This result indicates that Turkish automotive manufacturers strive for maintaining their environmental performance. The question (3.4), which indicates increase of costs for purchasing environment-friendly materials, has the lowest point values for different cases. This shows that green purchasing in Turkish automotive manufacturers is still a new concept and environment-friendly products are not the primary purpose in the purchasing phase. Green purchasing is being seen costly and therefore its activities cannot be developed well enough. Thus, the environmental requirement does not implement in the supplier selection process. Lack of governmental legislation about green purchasing is also another important factor that does not force manufacturers to make their purchasing green.

**GSCM Performance-Summarized Mean:**

In figure 9, mean values of three parts of questionnaire related to GSCM performance over the five companies are calculated. As can be seen, mean value of environmental performance is the highest mean value in the performance part.
Enforcement of ISO 14001 certification and EMS existence are the factors that affect directly to environmental performance mean.

On the other hand, mean value of negative economic performance is the lowest in the GSCM performance. Increase of costs for purchasing environment-friendly materials is the main reason in the subgroup that decreases the mean values of negative economic performance.
### GSCM Pressures:

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*Figure 10: Survey results for 5 different case companies, pressure part.*
In figure 10, the results for the questions related to GSCM’s pressure part for each company is shown. As presented, the value for the question related to governmental environmental regulations (2.1) has the highest points. That is due to the fact that automotive industries have constantly experienced pressures from government’s environmental regulations, and therefore Turkish government’s legislation for the environment is an effective pressure for them to implement GSCM. Export pressures (1.1), also has a higher value for different manufacturers. This can be explained via the companies’ strong foreign cooperation. Note that all five case companies are joint venture in some way. Therefore, they have to obey the EU directives to supply and sell their products in European Union countries.

**GSCM Pressure-Summarized Mean:**

![GSCM Pressure-Summarized Mean](image)

*Figure 11: GSCM Pressure- Summarized Mean*

In figure 11, mean values of three parts of questionnaire related to GSCM pressure for the five case companies are given. As shown, the mean value of market pressures is the highest value in the GSCM pressures part. Particularly, export pressures are the main reason for this part. Automotive companies in Turkey are mainly joint venture of global automotive giants. Therefore, export pressures and demand in the international market are the main pressures to forces Turkish automotive manufacturers to consider green activities in their supply chains.

The mean value of competition in the subgroup of green supply chain pressures is
the lowest summarized mean in the group. This is because of the domestic market that Turkish automotive competitors hold.

6. Discussion

Environmental hazards initiated by industrial activities have become a major concern for the future of mankind. Among different industries, automotive industry is one of the most environmental-affecting industries due to its large scale and enormous consumption and waste. As discussed in previous sections, there is large amount of interest for automotive industry in developing countries. Turkish automotive industry is a fine example, which creates lots of job opportunities and wealth for the country. However, this comes at the price of negative impact on the ecosystem.

In this study, we have selected five Turkish case companies, the giants, and we have evaluated their green supply chain activities based on three major implications (GSCM practices, performances and pressures). In our analysis, the fulfillment of the companies has been separately calculated for these three different parts.

The major objective of this study is to evaluate and understand how Turkish automotive manufacturers implement and work with GSCM.

Considering the GSCM practices part, our survey results indicates that five case companies have already obtained ISO 14001 certification and EMS. This is due to the fact that after the 2000s, the Turkish government increased help to the industries to decrease their environmental impact and from 2006, The Turkish government has begun to supply fifty percent of the money needed for ISO 14001 certification (Yontar, 2008).

On contrary, it is seen that cooperation with customers is not considered well enough in the industry. Simpson et.al (2007) believes that customer and supplier relationships are very important to the successful coordination of supply chains and developments in the performance of suppliers’ capabilities.

Noting the GSCM performance part, it has been found out that environmental
performance under GSCM performance is in a better state in Turkish automotive giants. Enforcement of ISO 14001 certification and EMS existence are the factors that affect directly to environmental performance mean.

On the other hand, negative economic performance is the weak section in the GSCM performance. Lack of green purchasing activities based on environment-friendly materials, green design activities cross-functional cooperation for environmental improvements, eco-labeling of products, cooperation with suppliers for environmental objectives are the reasons that affect the results of green supply chain performance.

In the GSCM pressure part, it has been seen that the market pressures has the best score among other subcomponents. This can be explained via export pressures in Turkish automotive companies. As discussed in Section 4, it is known that the case companies are mainly in a joint-venture structure. Therefore, export pressures and demand in the international market drive the main pressures on the Turkish automotive manufacturers to consider green considerations in their supply chain.

Competition in the subcomponents of green supply chain pressures is the weakest one according to the study’s results. In contrast to international market, the green competition of the case companies in the domestic market is not desirably high. This is because of the situation in the domestic market that is greatly being held by these five companies.

In addition to these findings, several other remarkable observations have been made based on the points received for separate questions in the questionnaire. For instance, green design is also nominal in the Turkish manufacturing industry. Dowie (1994) claims that government’s environmental legislation, company image, public impression and consumer demand, and increasing waste disposal cost are the main factors that pushes producer for green design. Green design causes decrease on the costs of processing wastes and recycling (Chen and Sheu, 2009). Design-for-environment directly affects the increase in the positive economic performance with the product life cycle extension.
When it comes to the differences between case companies, FordOtosan and Oyak-Renault have the best performance among all manufactures. This is because of the fact that both companies are joint venture of global companies and its attitudes towards environment caused to decrease the environmental impact.

7. Conclusion

This paper is based on a questionnaire survey filled by appropriate authorities representing five Turkish automotive manufacturers. Based on the findings of this study, it is observed that these Turkish automotive manufacturers have not completely implemented the GSCM.

The study have concentrated on three aspects, GSCM practice, performance and pressures, each of which includes several subcomponents. It is seen that case companies were very successful in implementing and working with some of these subcomponents, while they failed to utilize the other subcomponents. For instance, all companies have obtained ISO 14001 certification and EMS. On the other hand, it seems that cooperation with customers, green purchasing and green design a still a new concept for Turkish companies and they have not implement the related systems yet. While Turkish automotive manufacturers are more responsive to the customers’ environmental performance requirements, cooperation with customers is weak in the Turkish automotive manufacturer industry. Therefore, cross-functional cooperation and cooperation with customers are also inevitable to implement green supply chain management effectively and efficiently.

In addition to this weakness, green design is very weak in the industry. However, green design leads to decrease on the cost of processing wastes and recycling (Chen and Sheu, 2009), government’s environmental legislation, company image, public impression and consumer demand, and increasing waste disposal cost is the reason that lead manufacturers green design (Dowie, 1994). Therefore, increasing consumer demand and government’s pressures can increase green design activities in the industry.
Results show that companies still think that fully implementation and utilization of GSCM has an enhancing effect on their cost.

Furthermore, export market and government pressures are the pressures that lead Turkish automotive manufacturers to implement GSCM. Companies not only have to focus on carrying out a task of government regulations, but also take as a goal to decrease the environmental effects.

Finally, as Simpson (2007) points out “the customer’s environmental performance requirements can have a positive influence on a supplier’s strategic level of commitment toward its environmental responsibilities” (p.43). If Turkish market and customer request more green products, then it will shape positively environmental responsibility of manufacturers.

All in one, as pointed out in the previous sections, it is concluded that GSCM includes various aspect and Turkish automotive industry has been successfully implement some of these aspects. However, it fails to fully implement and work with GSCM needs.

8. Suggestion

The study results indicate that some components of GSCM have not been utilized well enough, e.g., green purchasing and green design activities. To improve this situation, manufactures have to understand that the extra cost for performing green purchasing and design is a long-term investment. Cross-functional cooperation and cooperation with customers should be strongly concerned to achieve effective and efficiency in GSCM. Beside this, commitment of GSCM can be spread to the whole employees in the supply chain. Collaboration between all stakeholders in automotive industry should be reviewed and consolidated. The EU legislative pressure in the industry is a good way of improving the green performance in the organization. Obeying the directive “EUP Eco Design” will result in extension of lifetime of product and recovery of product (Ninlawan et.al, 2010). This will also affect the green recycling positively. Regulations “REACH”, which aims to regulate the
chemicals and their safety use will directly influence to the GSCM performance. If the Turkish automotive industry obeys these directives, environmental performance and reduction of air emission, solid wastes, waste water, and hazardous materials will be significantly low. All in one, some suggestions to the Turkish automotive industry can be listed as below:

- Environment-friendly products should be encouraged and purchased more from the suppliers. Green products should be the first constraint with the detailed supplier selection criteria in the purchasing activity.
- Cross-functional cooperation and cooperation with customers should be spread to the whole automotive industry.
- Green design, green purchasing activities should be promoted.
- Encourage employee and skilled labors for reverse logistics management.
- Government support policies can be reviewed again, and Turkish government shall raise help the manufacturers for green activities, including ISO 14001 certification help, encouragement with tax returns for green purchasing, green design and etc.
- Top management commitment for towards GSCM should also be reflected on the employers.

9. Limitations

The conduct of this dissertation study is limited to the Turkish automotive industry. The sample space only includes five Turkish automotive manufacturers. The respondents of the questionnaires are not randomly selected and the questionnaires are fulfilled by the companies’ representative managers. The results and suggestions are not generalized into the whole Turkish automotive industry and they do not indicate any model. These five case companies and its suppliers only supply the goods for automotive industry. Therefore, the analysis should be evaluated with respect to this condition.
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Noci, G. (1997). Designing ‘green’vendor rating systems for the assessment of a


Appendix

A. General Information

1.1 Your company is
   - state-owned
   - joint venture
   - foreign direct investment enterprise
   - private sector

1.2 Number of employees

1.3 Does your enterprise have environmental management system?

1.4 Does your enterprise have ISO 14001 certification?

B. GSCM Practices

1.0 Internal Environmental Management Practices

1.1 Commitment of GSCM from senior managers

1.2 Support for GSCM from mid-level managers

1.3 Cross-functional cooperation for environmental improvements

1.4 Total Quality environmental management

1.5 Environmental compliance and auditing programs

1.6 ISO14001 certification

1.7 Environmental Management Systems exist

1.8 Eco-labeling of Products

1.9 Support of environment regulations

2.0 Green Purchasing practices

2.1 Cooperation with suppliers for environmental objectives

2.2 Environmental audit for suppliers' internal management

2.3 Suppliers' ISO14001 certification

2.4 Second-tier supplier environmentally friendly practice evaluation

3.0 Eco-design practices
3.1 Design of products for reduced consumption of material/energy
3.2 Design of products for reuse, recycle, recovery of material, component parts
3.3 Design of products to avoid or reduce use of hazardous of products and/or their manufacturing process

4.0 Cooperation with customers
4.1 Cooperation with customer for eco-design
4.2 Cooperation with customers for cleaner production
4.3 Cooperation with customers for green packaging

5.0 Investment Recovery
5.1 Investment recovery (sale) of excess inventories/materials
5.2 Sale of scrap and used materials
5.3 Sale of excess capital equipment

C. GSCM Performance

1.0 Environmental Performance
1.1 Reduction of air emission
1.2 Reduction of solid wastes
1.3 Reduction of waste water
1.4 Reducing harmful/hazardous materials
1.5 Decrease in the environmental accidents
1.6 Improve and support organization's environmental position

2.0 Positive Economic Performance
2.1 Decrease of cost for materials purchasing
2.2 Decrease of cost for energy use/consumption
2.3 Decrease of fee for waste discharge
2.4 Decrease of fee for waste treatment
2.5 Decrease of fine for environmental accidents
3.0 Negative Economic Performance
3.1 Increase of investment
3.2 Increase of operational cost
3.3 Increase of training cost
3.4 Increase of costs for purchasing environmentally friendly materials

D. GSCM Pressure

1.0 Market
1.1 Export pressures

2.0 Regulatory
2.1 Governmental environmental regulations
2.2 Regional/local environmental regulations
2.3 End of Life Vehicle Regulations
2.4 Regulations- REACH
2.5 Regulations- EUP Eco Design
2.6 Regulations-EWC

3.0 Competition
3.1 Competitors' green strategies
3.2 Industrial professional group activities