MONIKA GÁBRIEL, ZOLTÁN SZEGEDI,
GÁBOR NICK, FERENC PONGRÁCZ

Utilization of Green Supply Chain Techniques in the Hungarian Automotive Industry

Dr. Monika Gábriel, PhD: Szent István University (gabriel.monika@gtk.szie.hu)

Prof. Dr. Zoltán Szegedi: Széchenyi István University (szegedi.zoltan@sze.hu)

Gábor Nick: Institute of Computer Science and Controll of the Hungarian Academy of Sciences (nick.gabor@sztaki.mta.hu)

Ferenc Pongrácz: Széchenyi István University, RGDI (ferenc.pongracz@hu.ibm.com)

Abstract

Automotive industry is a dominant sector of the Hungarian economy in terms of export, contribution to GDP and employment. The industry is going through radical changes, and environmental issues are getting increasingly important. This study aims to present the green supply chain management practice of the Hungarian automotive sector. In our empirical research, automotive manufacturer and supplier companies were questioned about their green supply chain management activities.

The results show the popularity of the different green techniques in the fields of product design, purchasing, manufacturing and logistics along the external supply chain. Green design is the less often applied field, since its techniques require large investments and the return is slow compared to the other green activities. The area of green purchasing has a large toolkit, and we've found big differences in the application rate of the individual techniques. The most popular green purchasing techniques are administrative ones, i.e. requiring certain documents from the supplier. Green manufacturing has a high average popularity, since it provides quick and tangible rewards to the company. The most popular techniques in green logistics aim the reduction of the environmental impact of packaging and the increasing efficiency of transportation. We have also found that investment recovery that aims to the increased efficiency of operations - by using less input to the same output - is quite popular, with a remarkable progress potential.

Keywords: supply chain, green supply chain management, automotive industry, Hungary

1 INTRODUCTION

Environmental issues are becoming increasingly important, especially in industries with great environmental impact. The automotive industry is one of these, and in addition, its customers are increasingly environment conscious. The automotive industry is also a good choice for researching supply chain management topics thanks to its outstanding level of supply chain management (SCM) practice.

Green supply chain management (GSCM) is integrating environmental thinking into supply chain management including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of life management of the product after its useful life (*Srivastava 2008*). The aim of this paper is to analyze the green supply chain management practice of Hungarian automotive sector. The article is focused around the question: What kind of techniques are used by Hungarian automotive companies and how developed the separate fields of GSCM are?

2 AUTOMOTIVE INDUSTRY TRENDS

2.1 GENERAL TRENDS

According to Mary Barra, the Chief Executive Officer of General Motors „Car industry is going to go through more changes in the next 10 years, than it had in the last 50 years". Barra emphasizes the following technological trends (*Barra 2016*):

- Electro mobility: Combustion engine cars are a thing of the past
- Connected Car: Cars "communicate with each other" – Continuous, automated data collection and mobile communication
- Autonomous car: Self-driving cars
- Car sharing: Instead of owning vehicles, emergence of as a service based business model.

A study published by McKinsey names the same key trends and lists some additional details behind each of them creating a range between high- and low-disruption scenarios of the Automotive revolution.

Table 1.Overview of the high-disruption vs. the low-disruption scenario

	High	Low
Diverse mobility		
City policies discouraging private vehicles	Intensified	Steady
New, on-demand business models	Prevalent	Limited
Modal shift away from car ownership to shared mobility	Significant	Limited
Autonomous driving		
Regulatory challenges are overcome	Fast	Gradual
Development of safe and reliable technical solutions	Comprehensive	Incomplete
Consumer acceptance and willingness to pay	Enthusiastic	Limited
Electrification		
Battery prices continue to decline	Rapid	Protracted
Regulator-driven emission restrictions	Intensified	Gradual
Consumer demand for electrified powertrains	Widespread	Restrained
Connectivity		
Uptake of car connectivity globally	Vast majority	Partial
Consumers regularly using paid content	Mainstream	Limited

Source: Gao et al. (2016:4)

The study identifies eight so called perspectives, driving forces that will affect the players of the Automotive supply chain. These are as follows. *(Gao et al. 2016)*

Shifting markets and revenue pools

1. Driven by shared mobility, connectivity services, and feature upgrades, new business models could expand automotive revenue pools by ˜30 percent, adding up to ˜USD 1.5 trillion.
2. Despite a shift towards shared mobility, vehicle unit sales will continue to grow, but likely at a lower rate of ˜2 percent p.a.

Changes in mobility behavior

3. Consumer mobility behavior is changing, leading to up to one out of ten cars sold in 2030 potentially being a shared vehicle and the subsequent rise of a market for fit-for-purpose mobility solutions.
4. City type will replace country or region as the most relevant segmentation dimension that determines mobility behavior and, thus, the speed and scope of the automotive revolution.

Diffusion of advanced technology

5. Once technological and regulatory issues have been resolved, up to 15 percent of new cars sold in 2030 could be fully autonomous.
6. Electrified vehicles are becoming viable and competitive; however, the speed of their adoption will vary strongly at the local level.

New competition and cooperation

7. Within a more complex and diversified mobility industry landscape, incumbent players will be forced to simultaneously compete on multiple fronts and cooperate with competitors.
8. New market entrants are expected to initially target only specific, economically attractive segments and activities along the value chain before potentially exploring further fields.

A Deloitte study also indicates major automotive market shifts due to rapidly evolving costumer mobility preferences. According to the study the key drivers are as follows.

- Hyper-urbanization: Approximately 70% of the world population is expected to live in cities by 2050 (90% in North America). More collaborative approaches are emerging like car sharing, driverless cars and improved public transportation.
- Generational views: Beside the traditional vehicle ownership model new generations are showing interest toward alternative access to mobility alternatives that are offering higher flexibility, lower costs and green alternatives
- Connected technology: "Innovations in V2X connectivity, mobile phones, apps, and smart card technology are disrupting the automotive industry. Moreover, automotive consumers will increasingly expect customer experiences that go beyond the sales or service transaction and leverage technology to integrate with their connected lifestyle."
- Convergence of the private and public sectors: "The mass adoption and use of new transportation systems (e.g., public transportation, electric and driverless cars vehicles, supporting infrastructure, etc.) is going to require increased public-private collaborations."
- Sustainability and environmental concern: Emission and fuel efficiency regulations are important drivers of technology development in the area of alternative power trains like electric vehicles, plug.in hybrids and vehicles powered by natural gas. The challenge is even higher given the fact the for instance in the U.S. costumer interest in SUVs and trucks remain high. *(Deloitte 2014:4)*

2.2 ENVIRONMENTAL ISSUES

Environment protection is still low on the customer preference ranking when it comes to individual purchasing decisions. According to the above mentioned study out of seven typical selection criteria (eco-friendliness, low cost, convenience, practicality, luxury, technology, and driving experience) only luxury was less important to the observed customer group in case of both Y generation respondents and other generations as well. This result suggests that currently environment protection is more regulatory than customer demand issue from manufacturers perspective *(Deloitte 2014)*. Limited willingness to pay premium for more environment friendly vehicles was confirmed by multiple additional studies *(PwC 2007, European Commission 2017, Thiel et al. 2017)*.

Despite the fact, that only few customers are ready to pay extra fees for green technology it is widely promoted that transport and manufacturing are one of the key contributors to CO2 emission which creates pressure on the industry from regulatory perspective and also from the direction of public opinion. *(PwC 2007, European Commission 2017, The Society of Motor Manufacturers and Traders 2016)*

2.3 BUSINESS ISSUES

In 2016 worldwide sales reached a record high of 88 million cars and the profit margin of the sector also reached its highest level compared to the past 10 years. Nevertheless, there are other indicators, which say that the industry is in the underperformer segment (versus other segments represented by for instance the S&P 500 or Dow Jones Industrial Average). These indicators are the "shareholder return" and the "return on invested capital". According to a PwC study "These numbers almost outweigh the positive sales and earnings results. They paint a picture of a sector that is a less attractive or less lucrative place to invest than other industries." This low return on investment can also explain the high number of bankruptcies, or near liquidations within the industry. *(Parkin et al. 2017:4)*

3 POSITION OF HUNGARY WITHIN THE GLOBAL AUTOMOTIVE SUPPLY CHAIN

Hungary has been successful in terms of attracting foreign investments especially in the field of automotive manufacturing over the past 10 years. Despite its relatively small population, the country was among the top 20 in terms of the number of jobs created by foreign investment in 2015 (15th), 2014 (18th) and also in 2013 (16th). In terms of estimated jobs created per million inhabitants, the global positon of Hungary is even more remarkable with its global 5th rank in 2015, and 7th over the time period between 2010 and 2014. These investments come traditionally from Germany (followed by the US) and the key target sector of the investments is Automotive *(Spee and Denick 2016)*. As a result, automotive industry is playing a critically important role within the Hungarian economy in terms of export, contribution to GDP and employment. *(Rechnitzer et al. 2017, Deloitte 2016)*.

The automotive sector is not only a dominant sector in Hungary, but at the same time, it is highly concentrated as well. The two key players are Audi Hungaria Motor Kft., with its seat in Győr, and Mercedes-Benz Manufacturing Hungary Kft. operating in Kecskemét. In 2015, Audi Hungaria was the seventh largest company in the region in terms of revenue, with EUR 8.3 billion, while Mercedes was the 23rd in the regional ranking, with EUR 3.4 billion. In 2015, Audi Hungaria employed over 12,000 employees directly, while Mercedes had more than 3,700 employees. *(Coface 2016)*

The main motivation of bringing production functions of the automotive supply chain to Hungary is relatively low labor cost, more accurately good value for money available labor force. *(Rechnitzer et al. 2017, Deloitte 2016)*.

"Stan Shih, Acer's founder introduced the concept called Smiling curve around 1992. In a graph where the vertical axis represents value-added and the horizontal axis the sequential steps in the production value chain, from research and development through manufacturing to marketing activity the resulting curve appears like a smile. This is an easy to remember visualization of the observation, that the beginning and end of the value chain brings considerably higher added value than in the middle of it.

Compared to the nineties, nowadays the smile is becoming wider and increasingly half-sided. It is becoming wider, because on one hand, technological developments and even more sophisticated management methods are resulting in higher cost efficiency and on the other hand, potential locations of production plants are in furious competition for investments. Meanwhile, due to the opportunities created by cloud computing and digitalization, a long list of software-based innovators are transforming whole industries including Automotive.

The smile is becoming half-sided because in the area of social media the traditional marketing tools are proven to be less effective. Consumers are way more informed that they used to be ten or even five years ago, do not accept marketing messages without criticism and rather value design and experienced product/service quality." *(Nick and Pongrácz 2016:67)*

While Hungary is among the countries with the highest industrial contribution versus total GDP, the readiness for new technologies and methods represented by the so-called Industry 4.0 initiative are relatively low, compared to the European competitors. *(Berger 2014)*

4 GREEN SUPPLY CHAIN MANAGEMENT FIELDS AND METHODS – LITERATURE REVIEW

One of the main directions of green supply chain management research is the clarification of its fields of application, and the investigation of the applied management methods and techniques. Regarding this topic, it is important to make a distinction between fields and principles, where fields are the green equivalents of supply chain activities within the company, with a defined set of methods and techniques *(Gábriel 2013)*. The most important ones are general management methods that do not belong to any field of SCM. These are: cooperation with the other members of the supply chain (Dakov and Novkov 2008, Hsu and Hu 2008, Zhu et al. 2008, Eltayeb et al. 2011, Chan et al. 2012, Lin 2013); recycling *(Dakov and Novkov 2008, Hsu and Hu 2008, Lin 2013);* life cycle management (Hsu and Hu 2008); management commitment *(Hsu and Hu 2008, Zhu et al. 2008)* and investment recovery *(Zhu et al. 2008, Chan et al. 2012)*.

When thinking of greening the supply chain, all parts must be taken into account since processes are related and modification in one part of the supply chain can significantly change other parts. GSCM fields are organized parallel to traditional supply chain processes – from the design of the product down to the delivery to the customer.

4.1 GREEN DESIGN

The aim of green design (or eco-design) is the minimization of a product's environmental impact during its whole life cycle without compromising other essential product criteria, such as performance and cost *(Eltayeb et al. 2011)*. In other words, green design means the design of products or services with certain environmental consciousness. The most often cited green design techniques are:

- design of new products for reduced consumption of hazardous materials *(Zhu et al. 2008, Eltayeb et al. 2011, Lin 2011);*
- design of new products for reuse, recycling or remanufacturing *(Zhu et al. 2008, Wooi and Zailani 2010, Eltayeb et al. 2011);*
- design of new products for resource efficiency – including reduced energy consumption, reduced material usage, use of renewable energy and reduction of waste output *(Zhu et al. 2008, Wooi and Zailani 2010, Eltayeb et al. 2011, Lin 2011)*.

4.2 GREEN PURCHASING

The interpretation of green purchasing in the literature is quite uniform. Researchers have similar ideas about the aim and the methodology of green purchasing. The basic idea is decreasing the environmental impact caused by resources used in the products. This can be stated by the selection of appropriate materials and/or suppliers. Methods and techniques include:

- demanding supplier certifications, environmental management systems (ISO14000, OHSAS18000, RoHS) *(Zhu et al. 2008, Ninlawan et al. 2010, Eltayeb et al. 2011, Vörösmarty 2015);*
- supplier environmental auditing *(Zhu et al. 2008, Hsu and Hu 2008, Ninlawan et al. 2010, Eltayeb et al. 2011, Vörösmarty 2015);*
- setting environmental requirements for purchased items *(Garcia Martinez et al. 2006, Chien and Shih 2007, Zhu et al. 2008, Hsu and Hu 2008, Ninlawan et al. 2010, Eltayeb et al. 2011, Chan et al. 2012, Chen et al. 2012, Vörösmarty 2015);*
- demanding environmental information on the purchased item, such as test results, bill of materials, environmental questionnaires and product labelling *(Dakov and Novkov 2008, Hsu and Hu 2008, Eltayeb et al. 2011)*
- finding a more environment-friendly alternative source of input *(Chien and Shih 2007, Ninlawan et al. 2010, Lin 2013, Chen et al. 2012, Vörösmarty 2015)*
- professional and financial support to the supplier to reach environmental objectives *(Dakov and Novkov 2008, Zhu et al. 2008, Eltayeb et al. 2011)*
- evaluation of second-tier suppliers *(Zhu et al. 2008)*
- paperless purchasing processes *(Ninlawan et al. 2010)*.

4.3 GREEN MANUFACTURING

The green manufacturing process shall use inputs with low environmental impact, work with high efficiency and generate the minimal amount of waste and pollution. The methodology of green manufacturing includes:

- decreasing resource utilization *(Srivastava 2008, Chen et al. 2012);*
- hazardous substance control *(Ninlawan et al. 2010, Chen et al. 2012);*
- decreasing energy utilization by energy-efficient technologies and increasing the ratio of green energy *(Ninlawan et al. 2010, Chen et al. 2012);*
- integration of different forms of material reuse into the manufacturing process – disassembly, refurbishment, remanufacturing or recycling *(Srivastava 2008, Ninlawan et al. 2010, Chen et al. 2012)*.

4.4 GREEN LOGISTICS

According to Ninlawan et al. *(2010)* and Chan et al. *(2012)* green distribution consists of green packaging and green transportation. Green packaging involves downsizing of packages, use of „green" packaging materials, cooperating vendors

to standardize packaging, minimizing material uses and time to unpack, adopting returnable package methods, promotion of recycling and reuse programs. Green transportation means deliveries directly to the user's site, usage of alternative fuel vehicles, distribution in great batches and change to modal shift. In my opinion, the concept of logistics involves both packaging and transportation, so I will refer to green packaging and green transportation as green logistics activities.

I also include reverse logistics in the field of green logistics. Two interpretations of reverse logistics can be found in literature. One group of researchers *(e.g. Srivastava 2008, Eltayeb et al. 2011)* view certain types of reuse activities (such as disassembly, refurbishment, remanufacturing and recycling) as part of manufacturing or as a separate set of activities. The other group *(e.g. Beamon 1999, Ninlawan et al. 2010, Lin 2013)* view them as part of reverse logistics. Although both views have arguments, if we interpret conceptions correctly, only real logistics activities should be considered as part of reverse logistics, which are collecting, inspection and sorting, pre-processing and location decisions and network design *(Srivastava 2008)*.

4.5 INVESTMENT RECOVERY

Investment recovery aims the increased efficiency of operations by using less input to the same output. Investment recovery has a positive effect not only on economic performance but also on environmental performance by reducing the amount of waste, material consumption and the disposal of end-of-life equipment *(Zhu et al. 2008, Chan et al. 2012)*. The most often mentioned techniques are:

- sale of excess inventories/material;
- sale of scrap;
- sale of excess equipment.

5 MATERIALS AND METHODS

5.1 RESEARCH OBJECTIVES AND METHODS

The aim of this study is to present a picture of the GSCM fields and techniques applied in the Hungarian automotive industry. The research is based on a questionnaire prepared for investigating the GSCM practice of respondents. In the questionnaire, we surveyed the areas such as:

- Green design (3 techniques)
- Green purchasing (10 techniques)
- Green manufacturing (4 techniques)
- Green logistics (5 techniques)
- Investment recovery (3 techniques)

Respondents were asked to choose the most appropriate answer from the five options below:

1.	*We don't use it and we don't plan to*
2.	*We don't use it but we plan to*
3.	*Under launch/implementation*
4.	*We use it for less than 1 year*
5.	*We use it for more than 1 year.*

The answering options are more detailed than simply Yes or No in order to get a clearer picture on the development of GSCM fields. With this scale future applications and implementations in progress are also possible to be measured.

5.2 SAMPLE OF THE RESEARCH

The subjects of the primary research were automotive manufacturers operating in Hungary and their suppliers. The research questionnaire was sent to 350 companies belonging to the target group between July 2014 and November 2015. We got 75 questionnaires back, out of which 72 were properly filled and appropriate for statistical processing. This accounts for a 20.5% response rate.

66.7% of the respondent companies are Hungarian, while 33.3% are of foreign majority ownership. Regarding number of employees, the sample companies include small, medium and large enterprises: 22 companies (30.6%) employ 50 persons or fewer, 25 companies (34.7%) have a staff of between 51 and 250 employees, and 25 companies (34.7%) are large enterprises with over 250 employees.

Respondents represent the whole supply chain from OEM to Tier4 suppliers. The sample is composed of 4 OEMs, 12 Tier1, 15 Tier2 and 41 Tier3-4 suppliers.

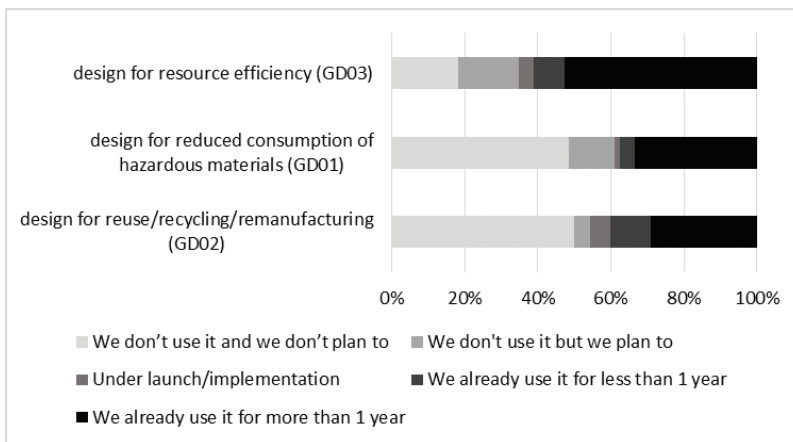
6 RESULTS AND DISCUSSION

We calculated the frequencies of the different answers on the application of each GSCM technique. Figures 1-5 show the results grouped by GSCM field. The techniques are ranked by their frequency.

6.1 FREQUENCY OF APPLICATION – GREEN DESIGN

The techniques of green design are the less common in the sample – only 46% of the respondent companies use it (for more or less than 1 year). The reason for the relatively low level of application can be that green design does not result quick wins. The positive effect appear years after the launch of GD projects. Companies have to take the costs and the risk that makes GD less attractive. Otherwise, there is a reasonable progress potential, shown by answers *„I don't use it but I plan to"* and *„Under launch/implementation"*.

Figure 1. Application rate of green design techniques



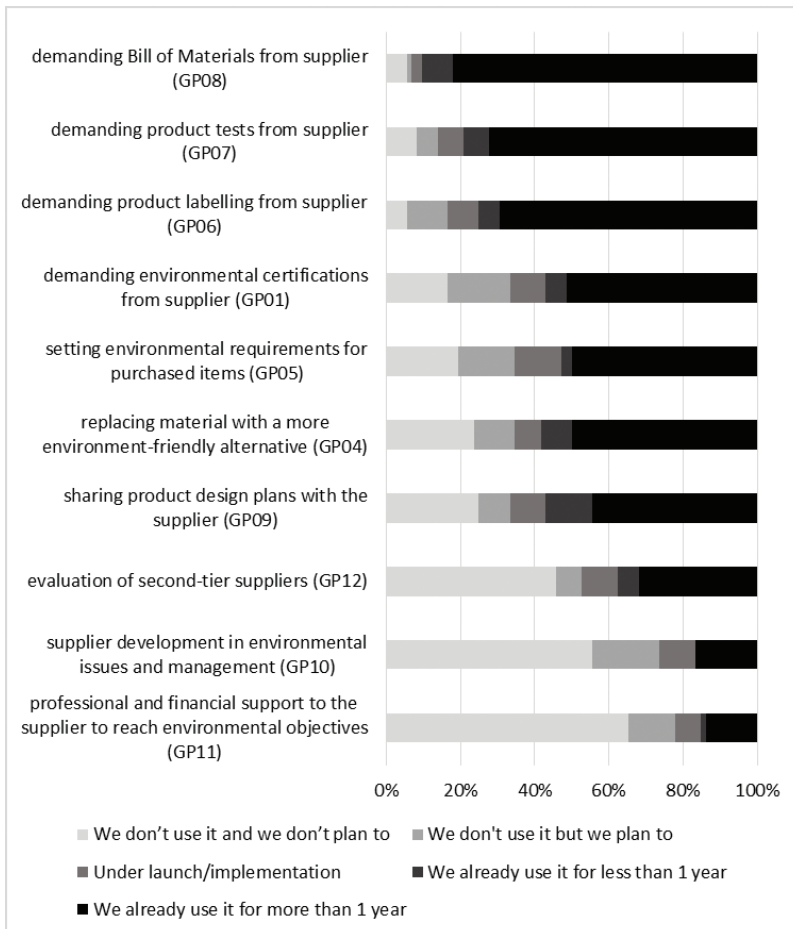
Source: own research

As shown in Figure 1, the most frequently used technique is the design for resource efficiency, which addresses the reduction of material and energy consumption, the use of renewable energy and the reduction of waste. This method not only helps to reduce environmental impact but at the same time it means cost reduction at the same time. The other two methods with no cost reduction possibilities are less popular, their rate of application is around 40%.

6.2 FREQUENCY OF APPLICATION – GREEN PURCHASING

Green purchasing has a large toolkit, and the popularity of the individual techniques is very different. The average application rate is 54%.

Figure 2. Application rate of green purchasing techniques



Source: own research

The application rates of green purchasing techniques are shown in Figure 2. Some of the techniques are "administrative" ones, which require certain documents or certificates from the supplier (techniques GP01, GP06, GP07, and GP08). The application of these techniques does not require big effort from the buyer company, so these are the most popular ones. The least strict methods

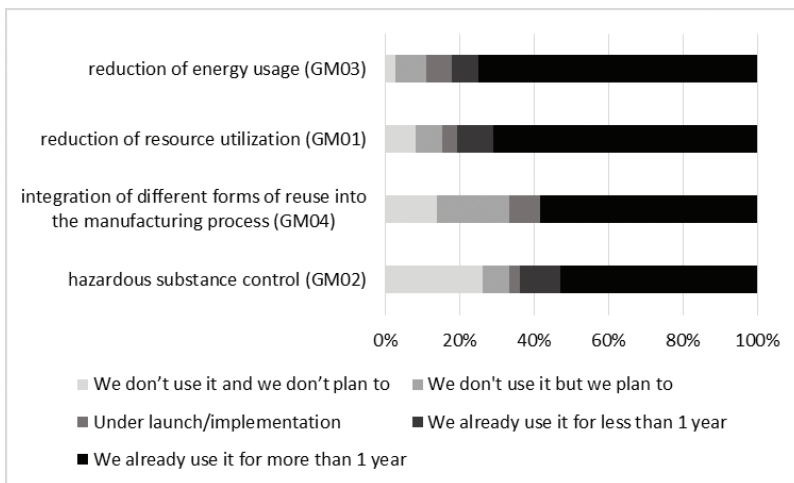
(GP06-07-08) are applied by more than 75% of the respondents, for more than one year, and in case of GP01 there is a big progress under way. Only a small part of the companies (6-17%) do not use or plan these techniques.

Setting environmental requirements for purchased items (GP05) and replacing material with a more environment-friendly alternative (GP04) are more time-consuming, applied by half of the companies for more than 1 year. The progress potential is also relevant here. Sharing product design plans with the supplier (GP09), that requires high level of trust, shows similar patterns.

The least popular techniques aim the development or support of the supplier (GP10, GP11). These methods are very costly and require specific investment to the supplier. This can be the reason for the low application rate by not exceeding 20%. Evaluation of second-tier suppliers (GP12) is also not popular.

6.3 FREQUENCY OF APPLICATION – GREEN MANUFACTURING

Figure 3. Application rate of green manufacturing techniques



Source: own research

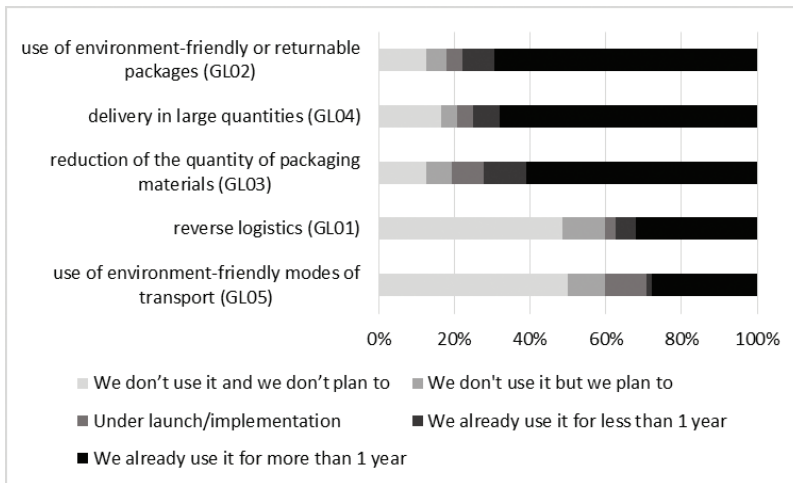
The frequency of the use of green manufacturing methods is high (see Figure 3.). The average application rate is 71%. Techniques aiming the reduction of material or energy usage have the highest application rate (GM01 and GM03, around 80%). Very few companies do not even plan to apply them (3-8%). The reason can be that both techniques have a positive side effect on the costs, and its realization is easy.

Integrating the different forms of reuse into the manufacturing process (GM04) is less popular but the number of planned and underway implementations is remarkable (19%).

6.4 FREQUENCY OF APPLICATION – GREEN LOGISTICS

As Figure 4 shows, green logistics techniques show big differences in the rate of application. The average rate is 58%. The most popular techniques aim the reduction of the environmental impact of packaging (GL02 and GL03) and the increasing efficiency of transportation (GL04). The application rate of these methods is between 72 and 78%, with a remarkable rate of recent introductions.

Figure 4. Application rate of logistics design techniques



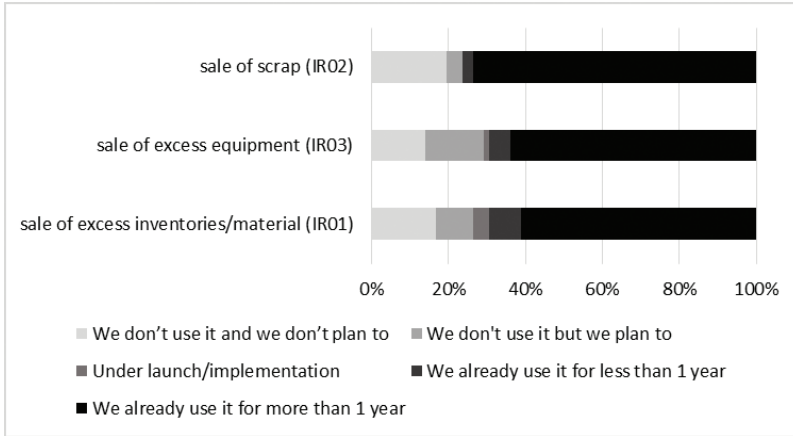
Source: own research

Reverse logistics (GL01) is applied by only one third of the companies and half of the remaining ones do not even plan its introduction. Environment-friendly modes of transport (GL05) are also less popular, but it is not only an environmental consideration: it depends also on the logistics characteristics of the product, on the distances and on the timing of deliveries.

6.5 FREQUENCY OF APPLICATION – INVESTMENT RECOVERY

The techniques of investment recovery and better equipment usage are quite popular; in average 72% of the respondents apply them. The application rates are shown in Figure 5.

Figure 5. Application rate of investment recovery techniques



Source: own research

Most companies sell the scrap material (IR02) but very few other companies plan to do so. Sales of excess equipment and material (IR01 and IR03) is performed by 70% of the sample companies and the potential progress is also high.

6.6 OBSERVATIONS ON POPULARITY AND PROGRESS OF GSCM TECHNIQUES

We prepared an overall popularity ranking of all involved GSCM techniques. The ranking is based on the rate of applications (technique is applied for more or less than 1 year). We did not include techniques under launch or implementation because in these cases the technique is not used in everyday operations, it is not part of company practice, and its effects cannot be measured.

Eight techniques reached 75% application rate, these were the most popular techniques. Their ranking is shown on Table 2. These methods cannot be tied to one field of GSCM, they come from all fields except for green design. The green purchasing techniques that are in the top ten are all administrative ones, i.e. requiring documents (BOM, product tests and product labels) from the supplier that ensure its environmentally conscious operations. The two green manufacturing techniques provide not only environmental but also financial advantages to the company, which explains their attractiveness. Rationalization of packaging and transportation also provide economic benefits besides the environmental ones. In summary, companies are the most willing to apply a GSCM technique, if it

- is easy to implement and the costs are relatively low;
- provides quick wins;
- provides not only environmental but economic benefits.

Table 2. The 8 most popular GSCM techniques

	Technique	Application
GP08	Demanding bill of materials from supplier	90%
GM03	Reduction of energy usage through energy-efficient technologies	82%
GM01	Reduction of material usage in existing products	81%
GP07	Demanding product test results from supplier	79%
GL02	Use of environment-friendly or returnable packaging	78%
IR02	Sale of scrap	76%
GP06	Demanding product labelling from supplier	75%
GL04	Transportation in big quantities	75%

Source: own research

The least frequently used techniques can be tied rather to a certain field or type of GSCM activities. Techniques with the lowest application rate aim supplier development (professional and financial support – 15% and supplier development in environmental issues – 17%). We suppose that the low popularity is due to the large dedicated investment required to supplier development activity. These investments (mainly into infrastructure and human resources) are tied to that particular supplier, and in case of a break-up, these investments will be lost. Companies are willing to do such investments, when the risk of losing the supplier is low (such as in the case of a high-quality and stable customer-supplier relationship). In our survey, this applies only to a small part of suppliers, and that explains the low rate of its application.

Green design techniques are also not popular (GD01 – 38% and GD02 – 40%). The return on such investments is slow – the time of return depends on time-to-market, which is significantly longer than the return time of other (e.g. the administrative) GSCM techniques. Other infrequent techniques were the environment-friendly ways of transportation (GL05 – 29%), the collection of used products for reuse (GL01 – 38%) and the evaluation of second-tier suppliers (GP12 – 38%).

We also ranked the GSCM techniques based on their development potential. It is important because it refers to the estimated penetration of these techniques in the near future. We evaluated progress potential by the rate of companies that answered, *„I don't use it but I plan to" „I have it under launch/implementation"* or *„I already use it for less than 1 year".* Nine methods show a development rate greater than 25%, these are shown in Table 3.

Table 3. The nine most intensively developing GSCM techniques

	Technique	Progress
GP01	Demanding environmental certifications from supplier	32%
GP05	Setting environmental requirements for purchased items	31%
GP09	Sharing product design plans with the supplier	31%
GD03	Design of new products for resource efficiency	29%
GP10	Environmental education of the supplier	28%
GM04	Integrating the different forms of reuse into the manufacturing process	28%
GP04	Replacing material with a more environment-friendly alternative	26%
GL03	Reduction of packaging materials	26%
GP06	Demanding product labelling from supplier	25%

Source: own research

The majority of these techniques belong to the field of green purchasing, showing the importance of supplier management and cooperation.

7 SUMMARY

The analysis of the answers of the questionnaire gave us a picture about the green supply chain management situation in the Hungarian automotive sector. The results show big differences among the "popularity" of GSCM fields, and also among the different techniques of the same field.

Green design is the least intensively applied field of GSCM, since it has only a long-term effect but requires great investment from a company. Only large companies can afford it, mainly OEMs and Tier1 suppliers.

Green purchasing is the most popular field, with the largest toolset and the biggest growth potential. The large number of companies planning or implementing green purchasing techniques show the importance of this trend. The most popular techniques demand different documents and other proofs from the supplier on the environmental characteristics of the given product or process. The larger investment a given technique requires, the less frequently is its usage.

The most popular green manufacturing methods aim towards resource efficient production, and have not only environmental but also economic benefits. In green logistics, the focus is mainly on packaging. "Greening" of transportation and reverse logistics is not widely used yet.

Finally, with this study we have also intended to create a basis for further research, such as using the same questionnaire for international comparison (of the automotive industry) or, for inter-sectoral comparison of green practices.

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