



# **Supply Chain Management**

## **Postgraduate Course**

Postgraduate Dissertation

Supply Chain Strategies:

Green Supply Chain Management in the German Manufacturing Sector: Practices, challenges in the implementation and benefits on the organization's performance

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Patras, Greece, January 2024

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## Abstract

With the increasing global environmental concerns, businesses find themselves under pressure to create a product and organise their supply chain, in a way that it will be both sustainable and efficient. The quest for sustainability and efficiency, alongside the increasing environmental awareness of the public, has resulted in ideas like the Green Supply Chain Management (GSCM) concept to be more popular. GSCM principles aim to reduce pollution and waste, while not compromising the financial sustainability and operational efficiency and bring several benefits on the overall corporate performance. However, transforming a conventional supply chain to a green one, may be proven to be challenging, as the costs to implement it are high and the massive changes may bring disruptions. This dissertation, takes the German manufacturing sector, which is one of the most significant in the country's economy with the aim to investigate in-depth the GSCM concept. That includes the practices that the companies in Germany have implemented. Then the challenges that they may face in order to implement it. Finally, it is examined the impact on the firm's performance, alongside the potential benefits on it. Regarding the challenges it is shown that main issue is the financial costs. From the findings, it is revealed also, the impact on the environmental performance is positive, as reduction of pollution, resources used and waste is achieved. Similarly, GSCM practices seem to contribute to the operational improvement, as it increases the quality of the product and the efficiency. Financial performance seems to be also positive, as the costs savings achieved and the increased profitability, seem to outweigh the high initial costs. Finally, in the end of the research, the implications and limitations, alongside some ideas for future research are presented.

Keywords: Green Supply Chain Management, Challenges, Performance, Financial, Operational, Environmental, Manufacturing, Germany

## Στρατηγικές εφοδιαστικής αλυσίδας:

# Βιομηχανικός Τομέας της Γερμανίας: Πράσινη Διαχείριση της Εφοδιαστικής Αλυσίδας: πρακτικές, προκλήσεις στην εφαρμογή και οφέλη στην απόδοση του οργανισμού

Δημήτριος Στουπάκης

## Περίληψη

Με τις αυξανόμενες παγκόσμιες περιβαλλοντικές ανησυχίες, οι επιχειρήσεις πιέζονται να δημιουργήσουν ένα προϊόν και να οργανώσουν την αλυσίδα εφοδιασμού τους με τρόπο που να είναι βιώσιμος και αποτελεσματικός. Η επιδίωξη της βιωσιμότητας και της αποδοτικότητας, παράλληλα με την αυξανόμενη περιβαλλοντική ευαισθητοποίηση του κοινού, έχει ως αποτέλεσμα ιδέες όπως η έννοια της Πράσινης Διαχείρισης της Εφοδιαστικής Αλυσίδας (Green Supply Chain Management - GSCM) να γίνονται όλο και πιο δημοφιλείς. Οι αρχές της GSCM αποσκοπούν στη μείωση της ρύπανσης και των αποβλήτων, χωρίς να διακυβεύεται η οικονομική βιωσιμότητα και η επιχειρησιακή αποδοτικότητα και επιφέρουν διάφορα οφέλη στη συνολική εταιρική απόδοση. Ωστόσο, η μετατροπή μιας συμβατικής αλυσίδας εφοδιασμού σε πράσινη μπορεί να αποδειχθεί σημαντική πρόκληση, καθώς το κόστος εφαρμογής της είναι υψηλό και οι μαζικές αλλαγές μπορεί να επιφέρουν αναταραχές. Η παρούσα διατριβή, εξετάζει τον γερμανικό κατασκευαστικό τομέα, ο οποίος είναι ένας από τους σημαντικότερους στην οικονομία της χώρας, με σκοπό να διερευνήσει σε βάθος την έννοια της GSCM. Αυτό περιλαμβάνει τις πρακτικές που έχουν εφαρμόσει οι εταιρείες στη Γερμανία. Στη συνέχεια, τις προκλήσεις που μπορεί να αντιμετωπίσουν προκειμένου να την εφαρμόσουν. Τέλος, εξετάζεται ο αντίκτυπος στην απόδοση της επιχείρησης, παράλληλα με τα πιθανά οφέλη σε αυτήν. Όσον αφορά τις προκλήσεις, αποδεικνύεται ότι το κύριο ζήτημα είναι το οικονομικό κόστος. Από τα ευρήματα προκύπτει επίσης ότι ο αντίκτυπος στις περιβαλλοντικές επιδόσεις είναι θετικός, καθώς επιτυγχάνεται μείωση της ρύπανσης, των χρησιμοποιούμενων πόρων και των αποβλήτων. Παρομοίως, οι πρακτικές GSCM φαίνεται να συμβάλλουν στη λειτουργία, καθώς αυξάνουν την ποιότητα του προϊόντος και την αποδοτικότητα. Οι οικονομικές επιδόσεις φαίνεται να είναι επίσης θετικές, καθώς η εξοικονόμηση κόστους που επιτυγχάνεται και η αυξημένη κερδοφορία, αντισταθμίζουν το υψηλό αρχικό κόστος. Στο τέλος της έρευνας, παρουσιάζονται οι συνέπειες και οι περιορισμοί, καθώς και ορισμένες ιδέες για μελλοντική έρευνα.

Λέξεις-κλειδιά: Διαχείριση πράσινης εφοδιαστικής αλυσίδας, Προκλήσεις, Απόδοση, Οικονομική, Λειτουργική, Περιβαλλοντική, Βιομηχανία, Γερμανία

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## List of abbreviations

<b>Term</b>	<b>Abbreviation</b>
Customer Collaboration	CC
Eco-Design	ED
Content Analysis	CA
Green Distribution	GD
Green Manufacturing	GM
Green Procurement	GP
Green Supply Chain Management	GSCM
Green Supply Chain Management Practices	GSCMP
Internal Environmental Management	IEM
Investment Recovery	IR
Reverse Logistics	RL
Supply Chain	SC
Thematic Analysis	TA

## Chapter 1: Introduction

### 1.1 Research Background

Without a doubt, supply chain management (SCM) plays a vital role in all organizations trying to be competitive and successful in this fast-paced business world (Gunasekaran et al., 2004). When operating correctly, it ensures the frictionless collaboration of all the stakeholders involved in a product and its value. The main ways to achieve the so-much needed competitive advantage, and SCM contributes heavily on that, include cost reduction, improvements in efficiency, customer satisfaction, risk management and sustainability. Those points are crucial for the success of an organization (Baah et al., 2021) However, this hunt for advantage against the competition has led to some negative effects, that are visible in today's world. Currently the environmental degradation is a fact and it is not exaggerated to say, that manufacturing industries when they are not complying with certain laws and regulations harm the quality of life of people and animals, not only now, but also for generations to come (Tan et al., 2002).

Characteristically, in 2020 the manufacturing and construction sector is responsible for 13,1% of the worldwide greenhouse gas emissions (Statista, 2023). Manufacturing industries harm heavily the environment through the irresponsible tactic to dispose defective products or unnecessary materials, that ends up polluting the land, the water and the air (Min & Kim, 2012). It harms though the companies themselves, as wasting materials and not trying to involve them in the value creation, spending irresponsibly resources, while not ensuring the sustainability of them and having unnecessary processes only have negative impact. Any action that does not add value to the product, shall be considered as a waste (Sundar et al., 2014).

The topic of Green Supply Chain Management (GSCM) has become more and more relevant the last decades, due to environmental crisis. It is believed that GSCM can be part of the answer to both of the problems (Dubey et al., 2017). That means not only the environmental sustainability, but also the sustainability of the company itself. If the various organizations, manage to implement an overall sustainable approach, they can maximize their effectiveness (Abualigah et al., 2023). This is possible through reducing not needed processes and materials, recycling or reusing those that they can. This would lead to produce less waste, thus less violating of the environment. Except that, it translates to significantly less expenses. At the same time, there are also certain cost benefits that derive from these conditions that are related to the increased health and safety conditions (Brown et al., 2000). A company shall have less expenses and more productivity if its employees face less work accidents. All of the above, can bringing value to the product that before seemed to be not possible (Carter & Rogers, 2008). GSCM brings a potential to solve two major problems at the same time.

Even though implementing practices of GSCM may turn out to be really beneficial for the industry and the world, it has been proven to be quite challenging as well. As it is an established industry with centuries of tradition, the companies are not always eager to change and subsequently risk unwanted results that may bring delays to their production, thus their profits (Wright et al., 1993). In addition to that, as the pressure to change is high, all the departments

involved in such a process need to be fully on board and that can bring inconsistencies (Mathiyazhagan et al., 2015). Currently the market is highly competitive and the upper management of the corporations do not feel ready to risk a lot. Additionally, they may have lack of deep knowledge over this subject (Zaabi et al., 2013).

Altering the approach used on the supply chain can have a significant impact on the performance of company, as it affects the whole life-cycle of a product. According to Zhu and Sarkis (2004) and Zhu et al. (2005) GSCM can be initially at least divided in two groups, that are the internal and external practices. The internal includes mainly the internal operations of a firm. Those refer primary to the eco-design, the green logistics, recycling and re-manufacturing (Li et al., 2022). On the other hand, there are also the external ones, that refer to purchasing, customer cooperation and investment recovery, supplier selection and in general have to do with practices that the collaboration with other stakeholders is a necessity (Zhu et. al. 2013). In this thesis, the performance is divided into three main categories that are the financial, the operational and the environmental performance. All those practices found in the GSCM principles can affect significantly those performance points and is something that is addressed in this research.

All in all, it is certain that is required further research on how GSCM practices can be implemented better to benefit both the environmental and the companies' sustainability, while overcoming the various barriers that exist. Having in mind also, the new studies that shed light over the subject and the new technologies emerging, it is safe to conclude that sustainability is a matter of continuous improvement, rather than a one-off change.

## 1.2 Aim and Objectives

The primary aim of this research is to ‘‘explore the benefits and challenges of implementing a GSCM approach in the manufacturing sector and the impact of it on the organization’s performance’’. The objective is to be conducted in a way, that is takes into consideration both the environmental and the corporal sustainability. Analysing the situation in depth, can bring a clearer overview and underline the importance of having sustainability in the corporal agenda.

The research objectives of this study are:

1. To define the concept of GSCM
2. To examine the various GSCM practices.
3. To identify challenges that German Manufacturing companies face to implement them.
4. To examine the impact of the GSCM practices, and if they are beneficial, on the organization’s performance.

### 1.3 Structure of this research

This research consists of six main chapters, which can be found in table 1.1. The first chapter constitutes the introduction in the topic of Green Supply Chain Management, highlighting the current problems observed in the environmental and businesses sustainability. Furthermore, it indicates why GSCM shall be considered as a part of the solution. Then, it provides also the aim and research objectives.

The second chapter is the literature review, which aims to elaborate more in the concept of GSCM. It shall be analysed in-depth all those practices, alongside the benefits and barriers that they bring in the manufacturing companies. In addition to that, here would be analysed how GSCM impacts the performance of a firm according to the literature. This will provide valuable insights on the topic.

The third chapter is the research methodology, that outlines the philosophy and method used.

The fourth chapter is the data analysis of the findings.

The fifth chapter is the summary of the research, based not only from the data acquired, but also the findings of the literature review. By paralleling those two sets of findings, valuable information can be gathered around how similar or different they are.

Finally, the 6<sup>th</sup> of this Thesis, include the conclusion, recommendations, future work and limitations.

<i>Chapter 1: Introduction</i>	<ul style="list-style-type: none"> <li>• Research Background</li> <li>• Aim and Objectives</li> <li>• Structure of the research</li> </ul>
<i>Chapter 2: Literature Review</i>	<ul style="list-style-type: none"> <li>• Definition of Green Supply Chain Management</li> <li>• Practices of GSCM</li> <li>• Challenges of implementing GSCM practices</li> <li>• Impact and benefits of the GSCM practices on the company's performance</li> <li>• Conceptual framework of the literature review</li> </ul>
<i>Chapter 3: Research Methodology</i>	<ul style="list-style-type: none"> <li>• Method used for this research</li> </ul>
<i>Chapter 4: Data Analysis</i>	<ul style="list-style-type: none"> <li>• Analysis of the dataset</li> </ul>
<i>Chapter 5: Examination of Research findings</i>	<ul style="list-style-type: none"> <li>• Summary</li> <li>• Discussions</li> </ul>
<i>Chapter 6: Conclusions</i>	<ul style="list-style-type: none"> <li>• Conclusion</li> <li>• Future work</li> <li>• Limitations</li> </ul>

Table 1.1: Structure of this research (Source: Author)

## Chapter 2: Literature Review

### 2.1 Purpose of the Literature Review

The main purpose of this chapter is to examine the already existing literature and to seek answers to the initial research objectives. Initially, in this chapter, are defined the concept of Green Supply Chain Management and its practices applied in the industrial manufacturing sector. After establishing the basic terms, it moves on examining the benefits and challenges met of implementing such an approach within an organization's Supply Chain. Afterwards, it is discussed more specifically how the GSCM practices influence and impact the performance of a firm on a financial, operational and environmental level. In the later part of the chapter, all of the above findings are synthesised in a conceptual framework alongside the objectives of this dissertation.

### 2.2 Green Supply Chain Management

Green supply chain management, constitutes a part within what is characterized as sustainable supply chain management, as it mainly focuses on the environmental side, and secondary to the financial, leaving out the social responsibility most of the times. It is fundamentally though connected to the principles of sustainability.

According to Srivastava (2007, p. 54-55), GSCM is defined as:

*'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'.*

Other definition states that GSCM relates more to the green purchasing part of the operations or that it covers the whole flow of materials in the integrated green supply chains connecting suppliers, manufacturers and clients (Lee and Klassen, 2008). In the literature analysis of Ahi and Searcy (2013), there are documented 22 different definitions for GSCM. The point that most of them align, is that GSCM as a concept addresses environmental and economic issues, while it has a vital role in the coordinating of the flows of the materials within the supply chain (Laari, 2016). In other words, it could be said that GSCM uses environmentally friendly practices and principles within the supply chain with the goal of minimizing the ecological footprint of an organization, while maintaining or even improving the performance and efficiency. It is characterized as an innovative concept, as it requires creativity to move towards this direction. The situation that has been shaped environmentally and risk-management wise, has led the researchers, to explore new ways to build more secure organizations through developing the sustainability across the processes (Ates & Bititci, 2011).

## 2.3 Manufacturing sector in Germany

The manufacturing sector in Germany refers mainly to the wide range of industries that are engaged in the production of various physical goods, machinery, chemicals, pharmaceuticals, automobiles, electronics or equipment. It is without a doubt, one of the most important sectors in the German economy as in 2022, it contributed around 23,5% to the country's GDP. At the same time, more than 7 million people are employed in this sector, highlighting even more the importance of it for the country. (Statista Search Department, 2023)

German manufacturing has a great reputation, mostly renown for the exceptional quality and their leadership in innovation across the world, developing new technologies and changing the global manufacturing scenery over the years (Goicoechea et al., 2012). A significant contributor in this success, is the supply chains that the firms have developed in this industry. After years of developing efficiency and flexibility, they are integrated both in the European and global markets (Merschmann & Thonemann, 2011).

Even though the manufacturing sector in Germany is advanced, the impact on the environment is still massive. According to the German Federal Environment Agency (Umweltbundesamt) the processes involved in the sector, cause around 22% of the country's total greenhouse gas emissions. The country's total was 746 million tons of greenhouse gases, with manufacturing being accountable for 164 of them (Wilke, n.d.). Although, worth noticing is in figure 2.1, that year after year, the number of the emissions steadily decreases, while the gross value-added increases. This happens as a result of the switch to more efficient production processes, resource efficient products (Wilke, n.d.) and the existing legislation that enforces the sector to have a more sustainable approach in manufacturing, packaging and waste management (BMWK - Federal Ministry for Economics Affairs and Climate Action, n.d.).

The German manufacturing sector could be summarized as a field that encompasses diverse industries and is defined as the engine of the country's economy. It defines in such extent the German economy, that any changes happening there, can have an immediate impact in the whole country's quality of life. This refers not only to the financial aspect of the matter, but to the environmental as well.

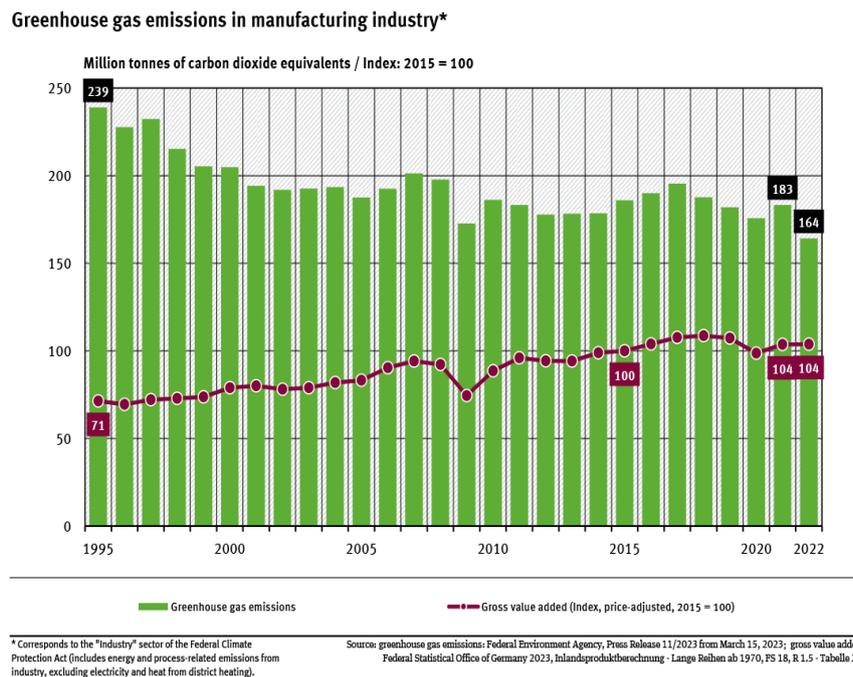


Figure 2.1: GHG emissions in the German manufacturing industry (Source: Federal Statistical Office of Germany)

## 2.4 Green Supply Chain Practices

As Green Supply Chain Management Practices (GSCMP) are defined all the actions and processes implemented into the supply chain, with the goal of achieving sustainable development. The sustainable development, that is consisted of different concepts used, can contribute to the profitability, while reducing the business risks (Hasan, 2013) According to the various research, GSCM can be implemented, using many different practices, that have a different impact on each business field that they are used. In the manufacturing sector, is commonly accepted practices that start from the early stages of designing a product, all the way to reverse logistics. Those practices are widely classified as internal or external (Rao & Holt 2005; Yang et al. 2013; Zhu et al. 2013).

### 2.4.1 Internal Green Supply Chain Practices

Internal are classified those that can be implemented solely within the organization and external refer to those activities that external stakeholders are necessary, such as suppliers and customers.

### **2.4.1.1 Internal Environmental Management**

This is considered to be the first step, and absolutely necessary towards sustainable development. As IEM is described as the commitment of the upper-level management of an organization by setting sustainability goals, and support it actively with their decisions and leadership to achieve them (Feng et al., 2018). Subsequently, it will be possible then to adopt certifications, such as ISO 14001, used as a proof to the stakeholders involved, that the commitment to environmental management is actual and GSCM is implemented as a long-term strategy for the company's future (Nishitani, 2009). Likewise, other concepts certifications like ISO 9001, that are related with quality management, can be achieved following the same path (Psomas et al., 2011). Additionally, training of the involved staff, regarding GSCM principles and practices, shall bring valuable knowledge, that is obligatory when moving to a such direction as an organization (Sarkis et al., 2011).

### **2.4.1.2 Eco-Design and green packaging**

Eco-Design is the environmental management approach through the whole development and processes around the manufacturing of a product. Of course, the goal is to reduce the negative impact on the environment, without though reducing the performance and quality of it. (Van Weenen, 1995, Johansson, 2002).

Overall, it could be said, that ED is a holistic practice, as it covers many different aspects that are vital in the processes. It starts with the product design itself, and the relevant decisions made around it. Using the ED tactic, when a product is being designed, it means that the choice of materials and resources that will be used, serve the purpose of sustainable development within the whole life-cycle of it (J. Li & Sarkis, 2021). The goal of the practice is to lead to less resource requirements, both around materials and energy, for the product to be manufactured. It is also considered a key element of ED, to produce a good, that has a great quality and later has no high complexity in order to be suitable for recycling or remanufacturing (Pigosso et al., 2013). Zhu, Sarkis and Lai (2008) mention also that in the designing stages could be avoided the use of dangerous material in the product.

To the ED belongs also the packaging of the product, once it is a finished good. Many companies now, under the pressure of the legislations and customers' demands, realised that it is required a different approach on that matter too (Molina-Besch & Pålsson, 2015). It is a rather difficult task as it needs to sustain the quality standards. Green packaging, as observed in the literature, includes the combination of less packaging material used, substituting plastic or toxic packaging, with more of biodegradable materials, being safer for the environment and the human (Wandosell et al., 2021).

### **2.4.1.3 Green Manufacturing**

Green manufacturing (GM), or green production, has as a goal to reduce the ecological negative impact by using all efficient machinery and the new available technologies (Dheeraj & Vishal, 2012). This kind of production process could not only have less environmental impact, but to contribute also to higher efficiency. Efficiency that increases, because of the energy saving tactic and reduction of material used, hence lower costs (Amemba et al., 2013).

The stopping of conventional manufacturing of the product and moving to the green manufacturing may require that the production means shall be reviewed and redesigned appropriately. A significant part of the energy used in order to produce, comes from the machinery used (Sangode & Tjprc, 2019). In addition to that, equally important is to review if all the operations are actually needed or add actually value to the product. If not, then this shall be eliminated, as it only produces waste (Sundar et al., 2014). These actions put together, can reduce significantly the energy consumption and emissions that a firm produces during these processes.

## **2.4.2 External Green Supply Chain Practices**

Into this category, belong all those practices, that a firm cannot implement on their own. For these practices, it is obligatory the collaboration and communication with external stakeholders. As external stakeholders, are referred in this case, suppliers, partners or customers that based on their behaviour or demands can affect the supply chain.

### **2.4.2.1 Green Procurement**

The procurement department within a supply chain has a decisive role in the selection of the materials and components that will be used (Tassabehji & Moorhouse, 2008). Especially in the industrial manufacturing industry, the final product is most of the times high in complexity, because of the number of components required and the increasing competition, that keeps adding pressure to evolve the product (Wiendahl & Scholtissek, 1994). In the case of green procurement (GP) they need to purchase materials that are characterized as eco-friendly, meaning that can be recycled and have reusability (Sarkis, 2003). As it is understandable, the components used define to a high degree how environmentally an end-product will be.

Furthermore, the raw material bought, is directly connected to its supplier. It is a GP task to control the potential suppliers, whether they comply with certain regulations and if their supplies can qualify as eco-friendly (Amemba et al., 2013). Other than that, there are more criteria, such as product quality, risks and supplier capabilities, as all of those will have an impact later on the processes of the firm and the end-product (Lintukangas et al., 2016). Furthermore, they need to give guidelines to the suppliers that they need to follow, audits that need to successfully pass or technology and information sharing with them (Murray, 2000). The collaboration with the selected suppliers is necessary and may involve joint participation in

various environmental programs, information sharing or even investments, depending on the capabilities of the organizations (Zhu, 2009). Overall, one of the ultimate goals of GP would be to build a transparent and long-term relationship with the suppliers, that can guarantee the green sustainability of the product. As the main focus of GP, is to minimize the environmental impact through the whole supply chain and sustainable development, it can be critical in the success or failure of the ‘green’ transformation of a company (Salam, 2008).

#### **2.4.2.2 Investment Recovery**

Investment recovery (IR) is considered to be one of the most common practices of GSCM in the literature (Foo et al., 2018; Çankaya & Sezen, 2019). Basically, it is the practice of a firm to sell any excessive and unused material or stock, with the goal of minimizing the losses, of material that is now outdated and in any other case, it would be a waste. In that way, an organization is able to recover the highest possible value of those already purchased products (Susanty et al., 2019). Another aspect of IR for manufacturers is the asset lifecycle management and utilization. Here is included the proper acquisition, maintenance or disposal of assets, alongside the reducing of storage requirements (Lee et al., 2014). Facing these issues heedlessly would consequently have a negative impact on the financial and sustainable situation, bringing uncertainty internally and externally among the stakeholders.

All of these, contribute to the popular belief that investment recovery is a critical practice for a successful implementation of GSCM (Zsidisin & Hendrick, 1998). Having a different approach in the way that the obsolete products and assets are treated, enable also the ‘back-end’ of the supply chain to add competitive advantage (Zhu et. al, 2008)

#### **2.4.2.3 Customer Collaboration**

Customer Collaboration (CC) is a practice that affects the supply chain transformation. CC within GSCM context, is defined as the eco-collaboration between customers and a firm with the goal to exchange information and knowledge about each other processes with the goal of environmental and quality improvements (Shah & Siddiqui, 2019).

Implementing a steady collaboration between the manufacturer and its customer’s base can have an overall impact on how successful the processes are. Starting an environmental campaign, can lead to raise environmental awareness to the customers, highlighting to them the importance to recycle or return an end-of-life product for remanufacturing (Ardakani et al., 2022). Such moves, improve the reverse logistics practice as well, as the CC is a necessary aspect for it, in order to reach its full potential. The customers can help to reduce waste that the firms manufacture and at the same time, be the key that allows them, to have access to the defective or EOL products (Ardakani et al., 2022).

Furthermore, having regular active feedback rounds with them, provides valuable input from the early stages of designing a product, all the way to the final packaging. In general, having also external input, besides the internal evaluations, can result to improvements of the processes (Laari et al., 2016). Nonetheless, customers have proven to be as a driver for organizations to

reassess and change their ways for a cleaner production (Azevedo et al., 2011). In that way, CC targets to involve the customer in the green processes, making them environmental partners (Vachon & Klassen, 2008).

#### **2.4.2.4 Green Distribution**

Manufacturing companies have to move massive amounts of supplies and products across their supply chain. This includes, transport of goods from the suppliers, intercompany transportation all the way to deliver the final product to the end-customer. This is proven to harm the environment through the increasing greenhouse gas emissions. Green Distribution (GD) as a practice is the implementation of environmentally friendly transportation and logistics practices with the aim to reduce the eco-footprint impact in the distribution of the goods (Ghobakhloo et al., 2013). This can be achieved, by having effective planning and warehousing, by delivering directly to the user site, thus avoiding unnecessary transportations and finally use of eco-friendly vehicles and fuels (Ninlawan et al., 2010). In addition to that, it is also vital to be more effective, that the shipper, whether is the manufacturer in that case or the supplier involved, will minimize packaging size. Creating loading patterns can increase the space utilization, both in the warehousing and the transportation (Carter and Ellram, 1998).

#### **2.4.2.5 Reverse Logistics**

Reverse Logistics (RL) share common principles with IR, as it is also characterized, as a concept that ‘closes the loop’ (Zhu et al., 2008). As the classic logistics and supply chain approach usually refers to the outbound chain of moving products from the manufacturer to the end-customer, RL focuses on the other way around (Govindan et al., 2015). RL is a key practice for GSCM, as it revolves around the recycling and remanufacturing concept (Mishra et al., 2022). The main activities included in this practice, have to do with the return management. Having a product returned, assists a manufacturer to be able to recycle their own products, thus minimizing the environmental impact. Through RL, it can be evaluated the reason of the returns and the defective products, eventually leading to process and quality improvements (Jayasinghe et al., 2019). In the literature, it is a concept that has been researched multiple times, as it is one of those that can have immediate financial and environmental impact (Shaik & Abdul-Kader, 2012).

<b>GSCM Practice</b>	<b>Feature</b>	<b>Reference</b>
<b>Internal Environmental Management</b>	Top management of an organization commits to promote actively a sustainability strategy in its internal operations. It shall also motivate the staff to get a deeper knowledge around the GSCM concept.	(Feng et al., 2018)  (Sarkis et al., 2011)
<b>Eco-Design and packaging</b>	Integrating eco-friendly principles into the design and development of the product and the processes. It is required to take into consideration factors, such as material selection, resources efficiency, recyclability and quality.	(Van Weenen, 1995)  (Johansson, 2002)
<b>Green Manufacturing</b>	Use of practices, technologies and processes during the manufacturing of the product, that minimizes the environmental impact.	(Tassabehji & Moorhouse, 2008) (Sarkis, 2003) (Lintukangas et al., 2016)
<b>Green Procurement</b>	Procurement of goods, services and partnering with suppliers with a focus on environmental considerations, while not compromising the quality of the end-product.	(Tassabehji & Moorhouse, 2008) (Sarkis, 2003) (Lintukangas et al., 2016)
<b>Investment Recovery</b>	Optimize the value of assets and resources management, with the goal of recapturing value, while promoting the reuse, remanufacture and recycle approach.	(Susanty et al., 2019) (Lee et al., 2014) (Zhu et. al, 2008) (Zsidisin & Hendrick, 1998)
<b>Customer Collaboration</b>	Involving customer, through information and knowledge exchange, making them environmental partners in this effort to promote a green sustainability strategy.	(Shah & Siddiqui, 2019) (Ardakani et al., 2022) (Laari et al., 2016) (Vachon & Klassen, 2008)
<b>Green Distribution</b>	Implementation of environmentally friendly transportation and logistics practices with the aim to reduce the eco-footprint impact in the distribution of the goods.	(Ninlawan et al., 2010) (Carter and Ellram, 1998)
<b>Reverse Logistics</b>	Management of the returns, with the goal of recycling, remanufacturing or disposing the used products in an eco-friendly way. It impacts financially, environmentally and operationally the organization.	(Zhu et al., 2008) (Akdoğan & Çoşkun, 2012) (Jayasinghe et al., 2019) (Shaik & Abdul-Kader, 2012)

*Table 2.1: GSCM practices and features (source: Author)*



*Figure 2.2: GSCM internal & external practices (source: Author)*

## 2.5 Challenges in the implementation of GSCM

Sustainability is a concept that has become relevant mainly the last two decades and has raised some controversy around it (Seuring et al., 2008). This is caused, by the multifaceted and complexed challenges, that are primary related to financial, processes and stakeholder factors. In previous researches, Mathiyazhagan et al. (2013) analysed 28 barriers, Govindan et al. (2014) identified 47 barriers and finally Dube & Gawande (2016) pointed out the 14 more influential barriers, based on their research.

Crucial is reported to be the commitment from the side of upper management. One common barrier is, that the top management of an organization is not showing interest in changing to a ‘greener’ approach, not wanting to disrupt the current status of the supply chain, risking unwanted results (Sarkis, 2012). This is directly related to the fear of failure that such a change may hide, as sometimes it valued for them the economic interests over the environmental considerations (Revell & Rutherford, 2003). A possible failed or poor implementation of GSCM practices, would prove to be costly for the firm. A product that has reduced quality or problematic processes, will result to loss of the competitive advantage, causing significant monetary losses, thus risking the sustainability of the organization (Dube & Gawande, 2016).

An important aspect in the barriers found in the literature, is the financial dimension. It would require a courageous decision to shift to GSCM approach, as the cost implications shall not be underestimated (Zailani, 2009). In order to implement the GSCM practices, such as eco-design,

manufacturing or distribution, would definitely require a high investment cost (Dube & Gawande, 2016). Similarly, according to Hosseini (2007), it is observed that one challenge is the resistance to adopt new green technologies. Organizations found to be hesitant to invest in machinery and equipment (Luthra et al., 2011), even though GSCM has innovative characteristics and innovation is directly connected with the technology advancements (Digalwar & Metri, 2004).

There is also the human resource challenge, as the lack of training in GSCM, leads to not acquiring deeper knowledge over the subject, making it harder for them to accept the changes and move as a unit towards that direction (Menon & Ravi, 2021). If the employees do not understand the principles that the company tries to implement, they would be more resistant to change, hence it would be harmful for the performance of the supply chain (Muduli et al., 2020). Technical expertise is one of the most necessary skills in order to implement GSCM, and if the staff do not possess them, alongside the limited knowledge over the principles, would result that this effort will be a failure (Bowen et al., 2009). GSCM demands that the responsible staff is well aware of the alternatives and has the expertise to not drop the end-product's quality (Dube & Gawande, 2016).

A different challenge is the market competition and uncertainty that is observed in today's world. Due to the fast-changing scenery in the global market, organizations are more hesitant to make dramatic changes, that may harm the competitive advantage and lower the profits (Chien & Shih, 2007). The pressure added by the competition, can play a critical role, as it is quite often observed, that companies are influenced and defined by the actions of their business competitors (Walker et al., 2008).

Customer awareness around sustainability and its benefits, shall not be taken for granted, as for a portion of them, the most important criteria is the final price (Gong et al., 2019). A company trying to implement such green strategies, may not find the necessary demand for its products, if the public awareness is low or if they do not do the proper marketing to highlight the benefits to the environment, hence to raise the consciousness over this matter (Sreejith, 2012).

Another barrier are the various regulations and policies applied by the respective governments, that do not support or give enough benefits to the organizations that implement GSCM (Zailani, 2009). External challenge are also the suppliers (Wycherley, 1999). An organization is heavily dependent on its suppliers and their approach, indirectly can define their end-product. It is a demanding task to find the commitment from their side, as they would need to change a lot in their own processes. They need to be persuaded that it lies within their best interests to do it (Bai & Şatır, 2020). Moreover, for a successful GSCM implementation, it is required a certain level of relationship among the supply chain stakeholders, that includes understanding, extended information sharing and trust (Walker et al., 2008).

Those barriers may not have the same influence or significance for every market, as each industry has also different characteristics (Dube & Gawande, 2016). It is important though to identify them and develop a strategy that faces the potential problem effectively. That is the way, to reap the benefits that GSCM has to offer and capture the competitive advantage (Meythi & Martusa, 2013). The challenges are synopsised in the figure below.

*Table 2.4: Challenges to implement GSCM (source: Author)*

<b>Challenge</b>	<b>Description</b>	<b>References</b>
Poor commitment from upper management	Top management is not interested in moving to an implementation of GSCM.	(Sarkis, 2012) (Luthra et al., 2011)
Financial costs	The financial costs to implement GSCM are usually high, as there are many investments needed to be done in order to alter the processes.	(Dube & Gawande, 2016) (Zailani, 2009) (Sreejith, 2012)
Resistance to adopt new technologies	The unwillingness to invest in new green and efficient machinery or equipment	(Hosseini, 2007) (Luthra et al., 2011) (Digalwar & Metri, 2004)
Fear of failure	The fear that an unsuccessful implementation would be harmful for the financial sustainability of the organization.	(Dube & Gawande, 2016) (Revell & Rutherford, 2003)
Lack of training in GSCM	It is the lack of educating the employees regarding the GSCM principles and its importance.	(Menon & Ravi, 2021) (Muduli et al., 2020)
Lack of technical expertise	It is the lack of knowledge on how to design product and processes that use the GSCM principles.	(Bowen et al., 2009) (Dube & Gawande, 2016)
Uncertainty in the market	The market is not considered stable enough, so many organizations hesitate to invest or change.	(Chien & Shih, 2007) (Walker et al., 2008)
Low customers awareness	Customers either do not know enough about the benefits of green products or do not show enough demand.	(Gong et al., 2019) (Sreejith, 2012)
Lack of governmental support	Governments do not give enough benefits or motivation to the firms that implement GSCM.	(Zailani, 2009)
Poor supplier commitment	Supplier are not committed enough from their side, to implement GSCM in their materials and processes or gain certifications.	(Wycherley, 1999) (Bai & Şatır, 2020)
Poor stakeholder communication	The communication quality and information sharing across the stakeholders is low and non-transparent.	(Walker et al., 2008)

*Table 2.4: Challenges to implement GSCM (source: Author)*

## 2.6 Impact of GSCM practices on the organization's performance

The importance and the usefulness of the practices can be measured against the impact that they have on the organization. GSCM as examined primary focuses on the environmental and financial performance. However, based on the literature as well, when examining GSCM and performance, it has to be added the third dimension that is the operational one (Younis et al., 2016). When implemented GSCM alters significantly the processes, so it shall be taken into consideration this side as well. In this chapter, the target is to examine how the various GSCM practices affect the performance of a firm on those three levels.

### 2.6.1 Impact and benefits on the environmental performance

Delving deeper into GSCM and its practices, it could be highlighted that the more direct effect that it has, is on the environmental performance. Most of those practices address this issue, as they revolve around the substitution of the conservative ways of manufacturing, distributing and processing a product, with an eco-friendly approach. Younis et. al. (2016) defines the positive environmental performance of a corporate as the capability of an organization to reduce the negative ecological footprint by lessening emissions, waste, use of hazardous materials and reducing the number of environmental accidents. These practices can contribute to build more resilient organizations and adaptable to the changes, while seeking continuous improvement in the processes and new opportunities in the markets (Semana et al., 2019).

GSCM practices are quite often examined the literature and identified as a mechanism that has a positive impact on the environmental performance of a firm (Green et al., 2012; Zailani et al., 2012; Zhu et al., 2008). First of all, putting GSCM into practice, enabling IEM that needs to be done by the top management and requires its total commitment, can alter the whole approach and change of the conservative and proven to be harmful for the environment processes, especially in the manufacturing sector (Uddin, 2021). By working towards this direction, and using Eco-Design and green manufacturing, the waste and emissions can significantly be reduced (Fianko et al., 2021). A product that is being designed with an eco-friendly approach, could require less resources, hence less material. It could be said, that ED sets the ground for enabling recycling, remanufacturing and reuse of the end-product. Subsequently, this would lead to less waste and an overall improvement in the environmental performance (Alcaráz et al., 2022).

Furthermore, green packaging can have also a direct positive impact on the environmental performance. The conventional packaging includes mainly plastic, with the statistics showing that this kind of plastic bags have a very short 'use life' and only one third of it is recycled (Plastic Waste and Recycling in the EU: Facts and Figures | News | European Parliament, n.d.). Green packaging is mentioned to be beneficial, as it optimizes the material used, is practical to handle and minimizes the waste produced (Molina-Besch & Pålsson, 2015).

One more aspect of the environmental impact of the GSCM practices on the environmental performance is found in the implementation of green distribution and transportation (Saada, 2021). Freight transportation when a non-environmentally friendly fuel, such as diesel or petrol

is used, induces GHG emissions (Abbasi & Nilsson, 2012). Switching to a model that uses eco-friendly fuel (e.g., electricity) or mean of transportation (Rizet et al., 2018) and plans the shipping in an effective way (e.g., in batches) can reduce the GHG emissions and the pollution of the oceans. Alternatively, collaborative transportation, between various companies that implement GSCM, can reduce emissions as well, as it maximizes the capacity used and avoids empty trips (Guajardo, 2018).

Green Procurement is important, as it decides the suppliers and what is purchased. Handling this properly can be beneficial for the reduction of the ecological footprint of the product, as except the processes involved, it is consisted of the components required for its manufacturing (Ghosh, 2019). GSCM has as a requirement that suppliers are eco-friendly and collaborate for the goal of improving the environmental impact. Worth mentioning also, is that according to Preuss (2001) this could have a ‘green multiplier effect’ as these direct suppliers can be motivated to collaborate for their businesses with other suppliers that have implemented green strategies.

Moreover, impactful is the collaboration with the customers. The company can through initiatives persuade the customers to actively participate in their green processes, providing on one side improved demand for the product itself and on the other side reduced environmental impact (Ottman et al., 2006). Looking at the bigger picture, in order for the GSCM to be successful, it is a necessity to involve all the stakeholders internally and externally. Beneficial as well is the practice of reverse logistics as the company has the means to either recycle, reuse or do an eco-friendly waste management. The process of remanufacturing is estimated that it can preserve over 85% of the used energy and materials (Saruchera & Asante-Darko, 2021). GSCM has as a requirement, that waste shall properly be disposed, because through that way it can be achieved the minimization of accidents and exposure to hazardous materials.

In conclusion, it has been pointed out multiple times in the existing literature a positive relationship between GSCM and environmental performance of a firm. When all the practices are put in use, they can play a pivotal role to mitigate the environmental degradation and as mentioned above, is observed to facilitate innovations across all the processes involved in the production and distribution of a product.

### **2.6.2 Impact and benefits on the financial performance**

One of the most important aspects in the corporate performance is the financial one. It plays a decisive role in the sustainability, growth and competitiveness of it. Those points are important to be taken into consideration in any business and how the various strategies implemented are going to affect them. In this case, it shall be explored the impact and the benefits of it, on this aspect.

It is clear that some of the environmental practices, have to be implemented, regardless of the financial impact, as they are result of external pressures, such as regulations by the government (Zhu and Sarkis, 2013). GSCM approach though, might be implemented also for other reasons, as more and more firms can find benefits in competitiveness. It is a ‘doing well by doing good’

situation that is found extensively in the existing literature (Orlitzky et al., 2003; Falck & Heblich, 2007).

GSCM may be related more to the environmental performance, but it has also strong ties with the financial performance as well. By minimizing the waste, emissions and energy used, it can lead to better efficiency in production, combined with less operating costs (Rao & Holt, 2005). Cost reduction shall be one important objective for any manufacturing organization and GSCM practices aim towards that. Except the waste reduction, reduction of costs can be achieved also by green procurement, trying to obtain more sustainable materials for less of a price and that by having an environmentally friendly approach, costs related environmental accidents shall be decreased (Onyango et al., 2014). Costs performance can find also benefits in the phase of the designing of the product. Building a product that requires less materials, can have a direct impact in saving costs in the purchasing of them (Cicconi, 2020). Building strong supplier relations, with partners that share the same approach, can result also to lower costs and better agreements. Except that, this can add also to a better long-term cost management, as GSCM supports a long-term perspective (Holloos et al., 2012). Improved supplier relationship, for a sector like the manufacturing one may translate to better access to material and has the potential to be crucial for the economic performance (Holloos et al., 2012).

Furthermore, it should not be underestimated, the importance of resource efficiency in the economic performance. Being able to manage the returns better, having the option to refurbish, recycle or remanufacture leads to reclaiming some of the value of an already sold product (Saruchera & Asante-Darko, 2021). Through that, a product can have an ‘extended life’, bringing consequently additional profits, that otherwise would be considered as ‘lost’. That is supported by Gallo et al. (2012) that points out that enabling remanufacturing as a process, can lead to a cost reduction of 35%-40% with an average margin of 20%. Moreover, complying with rules and regulations, could also bring additional costs avoidance. GSCM helps to identify better risks, that in the economic performance translates to avoiding paying fines and penalties, that usually are quite high, alongside a significantly damaged reputation that decreases the sales (Laari et al., 2016).

It is often mentioned in studies and surveys, that customers and businesses currently tend to be more loyal and to prefer to buy products that are high in quality and eco-friendly (Chang & Fong, 2010). Opening new market opportunities, can translate into increased sales, hence increased growth, market share and profitability (Rao & Holt, 2005). Survey from McKinsey and Company in the US (2023), shows that 60% of the consumers are willing to pay more for sustainable packaging, while companies with ESG-related claims had 1.7% higher growth in retail sales between 2018-2022, in comparison with products that had not (Am et al., 2023). Likewise in Germany, surveys show that 73% of the consumers pay attention to the sustainability of the products and buy most of the times according to that factor as well (UmweltDialog, 2016). Similarly, statistics from the German Ministry of Environment, show that manufactured products that are green, thus qualify for the official state environmental label, gain larger market share year after year, with the goal of reaching 34% of the country’s share in 2030 (Wilke, 2021).

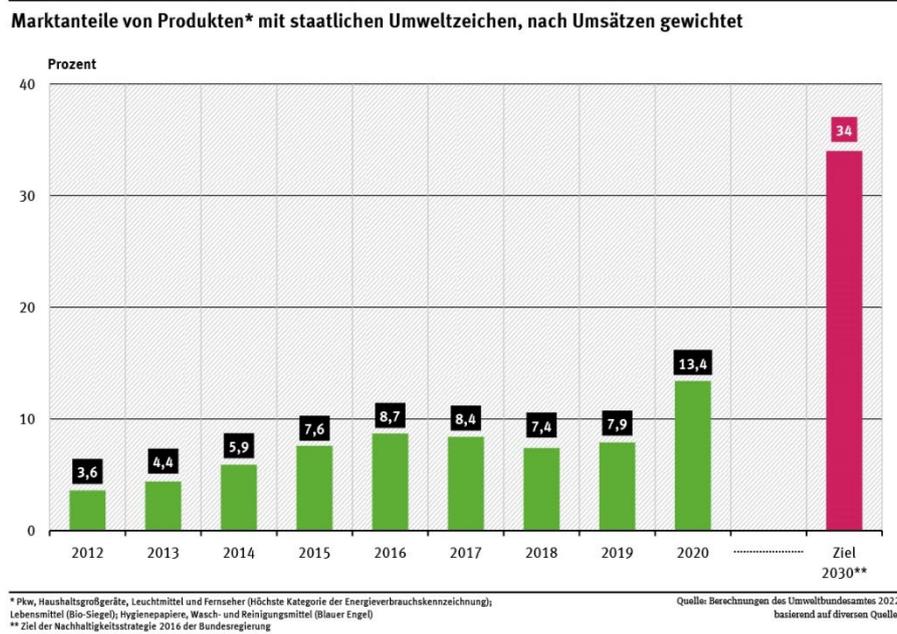


Figure 2.3: Market shares of products with the state's environmental label, based on the revenue (German Ministry of Environment, 2021)

Based on that, according to Klassen and McLaughlin (1996), greening the supply chain, can be the key to expand a firm's markets or overtaking competitors that do not have the same strategy. The access to new markets and the increased price for a product, can bring a higher profit margin for the firm, hence be beneficial for the economic performance (Klassen & McLaughlin, 1996). Also, by enabling the customer collaboration would help to identify better the needs and the concerns of the consumers, hence building a more valuable product that will increase demand, thus outperforming the competition (Hong et al, 2013). Being able to increase the customer satisfaction and the public image of the firm can add economic benefits to the supply chain (Zhu et al, 2013).

There is though, a concern in some studies that unlike the environmental improvements, that should be definitely expected, in the financial performance there cannot be the same certainty that all the GSCM practices turn out to be beneficial for the company (Green et al., 2012). Characteristically, moving to a green inbound process may reduce the pollution, but has no obvious financial benefits for the company (Rao & Holt, 2005). This concern also, derives from the fact that in order to implement GSCM it requires a significant investment, at least initially, increase the operational costs (Khan et al., 2021).

In conclusion, the vast majority of the findings in the literature point out that directly or indirectly the implementation of GSCM practices across the supply chain would bring economic benefits (Rao & Holt, 2005; Zhu et al., 2013; Yang et al., 2013). Kurapatskie and Darnall (2012) point out that a company that uses high-order sustainability activities, such as re-designing and changing existing products and processes can lead to gain competitive advantage, that translates to higher financial pay-offs as well. Similarly, if a firm uses only low-order sustainability activities, like trying just to improve an existing process or product, can still achieve a better financial performance, but slightly worse in comparison with the higher-order

ones. This happens, because these kinds of activities are easier to be replicated by their competitors, hence then losing the so-much needed competitive advantage.

### **2.6.3 Impact and benefits on the operational performance**

One of the distinctive characteristics of GSCM is that unlike other sustainability strategies, it relates a lot with the operational performance of an organization. In the literature, it is observed though, that most of the times, it is examined more the relationship between GSCM and either the financial or the environmental performance. However, in the observed literature, can be found the statement that manufacturing companies that implement GSCM practices, can achieve better results in their operational performance (S. a. R. Khan & Dong, 2017; Green et al., 2012).

Operational performance is referring to the strategic dimension that a firm selects to operate in (Yu et al., 2014). Similarly, in the manufacturing dimension, the capabilities that should be prioritized to be developed revolve around effectivity (Yu et al., 2014). Generally, the points that relate to effectivity and competitive advantage on the operational level could be broken down to four major points according to the literature. Those would be quality, time, cost and flexibility (Narasimhan & Das, 2001).

First of all, regarding the internal GSCM practices, according to Sroufe (2009) IEM, ED and green manufacturing show that the more one company enables these activities, the more positive is the relationship to the performance. Moreover, ED and green manufacturing are observed to contribute significantly to the efficiency and the quality of the end-product. This happens due to the fact, that the detailed designing phase and the selection of the right equipment and machinery, has the potential to lead to a better-quality product, that subsequently will produce less waste (Sroufe, 2009). Porter and Van Der Linde (1995) mention that pollution translates to inefficiency on an operational level, as the unnecessary waste do not add value to the product and is a sign that available resources have not been properly used. In addition to the effectivity though, they add that eliminating waste has a beneficial impact also on costs and quality, as similar to defects, pollution also can highlight flaws on the product and the processes.

In the same way, GD is mentioned to have positive impact on lead times, effectivity and flexibility, because of the better capacity utilization that is achieved through that practice (Lai & Wong, 2012). Similarly, CC is supporting the positive relationship, as designing and adjusting the end-product, while taking into consideration the consumer's feedback, can increase the customer's satisfaction and will eventually translate to a reduced reject rate (Vachon & Klassen, 2008). In like manner, close collaboration with suppliers can lead to innovation and further development of the existing processes, that will reduce costs and increase the effectivity (Geffen & Rothenberg, 2000). Furthermore, Klassen and Whybark (1999) point out that integration of environmental technologies across the supply chain relate to a positive impact on quality and costs. On top of that, firms that implement reverse logistics and remanufacturing shall expect reduced costs, better quality, improved delivery and flexibility in the operations (Saruchera & Asante-Darko, 2021). The time needed for a product to be remanufactured, rather than being manufactured from the start, is significantly less. This process, benefits both the time of producing, but subsequently the delivery time as well (Saruchera & Asante-Darko, 2021).

There can be found though in the literature, result that state that the impact of the GSCM practices will not be necessarily beneficial for the operational performance. González-Benito and González-Benito (2005) presenting the findings of their research, point out that in the cases of companies with increased volume of production, seems that green practices have a negative impact on the operational objectives. Additionally, operational performance might be negatively affected by the supply chain disruptions caused during the transition towards a greener approach (Handfield et al., 2005). Harmful could be proven to be that in some cases, the options of potential suppliers are limited, thus this could hurt the flexibility of the firm (Svensson, 2007).

To sum up, operational performance seems to be positively impacted by GSCM according to the majority of the literature. The current data points out that even GSCM and environmental collaboration with suppliers is a relatively new concept, in comparison with the conventional ways of acting in a SC, leads to better results on the operational level, especially in terms of quality and customer satisfaction (Azevedo et al., 2011).

## **2.9 Research Gap, Research Questions and Conceptual Framework**

This part summarises the research gap according to the literature that was discussed in the previous section and shows the research questions with a conceptual framework.

Green supply chain management is a concept that was developed the last decades, as the ecological awareness in the world has risen, because of the increasing environmental problems (Herrmann et al., 2021). Zhu et al. (2012) have explored the GSCM internal and external practices and the impact of them on the corporate's performance, with an emphasis of how these practices act as a mediator between them and the company's performance. Similarly, Green et al. (2012) empirically assesses the impact of the GSCM on the firm's performance and the linkage between the manufacturers with the supply partners. There have been also a significant number of researches that focus on the GSCM practices and the impact on the performance in the manufacturing sector, in the context of a particular country, such as between others, China (Zhu & Sarkis, 2004), India (Mitra & Datta, 2013), Korea (Choi et al., 2016), Portugal (Pinto, 2020). Younis et al. (2016) emphasized on the impact of GSCM implementation on the corporate's performance, using a more holistic view, focusing though in the case of United Arab Emirates' context. The majority of the studies, focused on some particular aspects of the performance or focusing solely on the impact on the competitive advantage (Astawa et al., 2021; Masoumik et al., 2014).

As a result, from the direction towards sustainability, there is a wide existing literature exploring the barriers, challenging the implementation of GSCM. Dube & Gawande (2016) explored the different barriers occurring when implementing GSCM, trying to prioritise the most important, as based on their opinion, it is rather difficult for an organization to address them all simultaneously. Similar to the connection between GSCM practices and firm's performance, in the case of the challenges in the implementation of GSCM, there is an extended literature in the context of emerging economies. Hence, they refer also to barriers that may not be applicable anymore in the case of Germany (Rahman et al., 2019). Germany is observed to be one of the leading countries when it comes to sustainability development, having already overcome

several problems that are documented in other countries. This shows a gap on the differences of what is identified as a barrier, regarding sector and country. In the case of Germany, there is also not a significant literature. Researches about the GSCM practices, the impact on the organization's performance and the challenges on the implementation, in the manufacturing sector in the context of Germany is incomplete. Therefore, this thesis aims to identify the practices, the challenges to implement them, whether the relationship between GSCM and performance improvement is positive and which are the benefits on all three dimensions.

The main research questions are:

- Which are the GSCM practices that the manufacturing companies in Germany apply?
- What are the challenges that an organization faces to implement GSCM?
- Is the relationship between GSCM and performance improvement positive and what are the benefits on the performance?

On the basis of the research aim and question, the conceptual framework displays below.



*Figure 2.7: Conceptual framework of GSCM practices, drivers, challenges and impact on the performance (source: Author)*

## Chapter 3: Research methodology

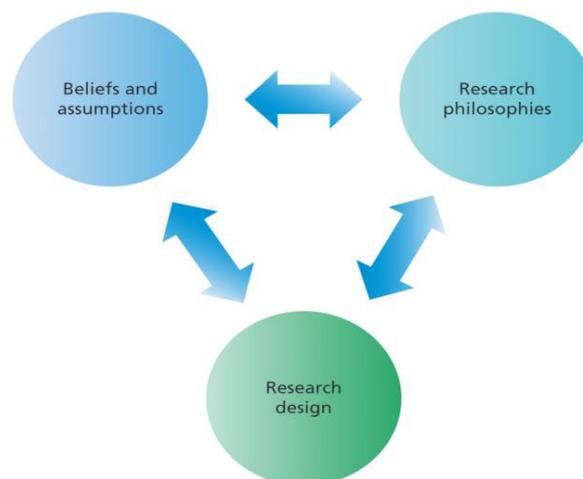
### 3.1 Introduction

This part of the thesis, has to do with the research approach and philosophy which are chosen, in order to be fulfilled the purpose of the research. At first, it is crucial to examine all the five different research methodologies, and after that to evaluate and select the optimal for this case. After analysing the research philosophy and the research strategy for this dissertation, it follows the method of the data collection and analysis. Final part of this chapter, is the ethical implications and the conclusion.

### 3.2 Research philosophies

The objective of a research shall be to deepen the knowledge over a defined field and in order to do that the researcher needs to use many different tools, such as theories and practices, resulting in gaining the necessary knowledge (Saunders et al., 2019).

In the following figure, is presented the interactive relationship between the personal beliefs of the researcher, the research philosophies and the design of the research. This highlights, that each study may take different characteristics, depending on the person conducting it (Mkansi & Acheampong, 2012). It would be a mistake to confuse research philosophies with our own assumptions and would result in wrong results, as the methods and theories would not be used appropriately (Mauthner et al., 2020). That is why it is important to bear that in mind, before choosing the method used, as it will help to distinguish the different opinions stated, before selecting the appropriate philosophy for their study (Saunders, 2019).



*Figure 3.1: Research philosophy relationships (Saunders, 2019, p. 133)*

The main two types of research are considered to be Ontology and Epistemology. Firstly, regarding Ontology, it has been described as the study of the existence or as a theory of objects and their ties (Strauss & Corbin, 1998). In contrast with that, epistemology has to do with defined knowledge and the communication of it (Goertz & Mahoney, 2012). Crucial is though, to perceive these theories with subjectivism and objectivism.

The difference between objectivism and subjectivism lies according to Saunders et. al, (2019) on the fact that in objectivism, one reality is experienced by everyone, in contrast with subjectivism, that the same reality is a result from the behaviours and stance of the social actors with the use of models and insights (Saunders et al., 2019).

Regarding now the research philosophies, the possible approaches mentioned are: positivism, realism, interpretivism, postmodernism and pragmatism. In the positivism way, the focal point is the facts that derive from a scientific method and there is no personal interpretation (Saunders et al., 2019). Interpretivism relies on the individual interpretation, thus the justification includes subjectivity). It takes into consideration, the differences applied in the various cultures and circumstances (Saunders et al., 2019). The main difference with positivism is found in the fact, that interpretivism focuses in the insights gathered and not attempting to explain an issue based on universal laws that apply for everyone (Alharahsheh & Pius, 2020). Critical realism, is considered to have two parts, with one being the experience of an event and the second the feelings management after it. It is summarized as that the truth has the most significant impact (Fleetwood, 2005). On the other hand, pragmatism relates more to an approach of what is going to be the best answer for the questions set in the research. The goal here, is to have a more practical approach, where nothing is fixed but is always questioned (Saunders et al., 2019). Postmodernism as a research philosophy, denies that people have the objective knowledge and focus more in the role of language and of power relations. Hence, it tries to question the conventional ways of thinking and emphasize more to the importance of the language (Saunders et al., 2015).

For this dissertation, the main philosophy approach that will be employed is interpretivism with epistemological assumptions. The primary goal of the research is to examine the impact and the benefits of the GSCM implementation on the firm's performance in the manufacturing sector of Germany, as well the barriers to do that. These concepts are not so explored in the existing literature, in the context of this country, so there is the need to examine and interpret them, in combination with the data findings. That is why, in order to examine in-depth, the concepts of GSCM practices, their impact, the drivers and the challenges applied in Germany, interpretivism can turn out to be valuable. GSCM and sustainability as concepts, include both the business perspective, but also the humanitarian dimension. Therefore, it has social characteristics and an interpretivism approach can be useful to reveal the different opinions and attempt to justify them.

### 3.3 Research approach

In this part, are presented the three main types of research, that are considered to be the inductive, the deductive and the abductive. Those three types, are separated according to Saunders et al., (2019) by their logic behind them, generalisability, use of data and theory.

	<b>Deduction</b>	<b>Induction</b>	<b>Abduction</b>
<b>Logic</b>	In a deductive inference, when the premises are true, the conclusion must also be true	In an inductive inference, known premises are used to generate untested conclusions	In an abductive inference, known premises are used to generate testable conclusions
<b>Generalisability</b>	Generalising from the general to the specific	Generalising from the specific to the general	Generalising from the interactions between the specific and the general
<b>Use of data</b>	Data collection is used to evaluate propositions or hypotheses related to an existing theory	Data collection is used to explore a phenomenon, identify themes and patterns and create a conceptual framework	Data collection is used to explore a phenomenon, identify themes and patterns, locate these in a conceptual framework and test this through subsequent data collection and so forth
<b>Theory</b>	Theory falsification or verification	Theory generation and building	Theory generation or modification; incorporating existing theory where appropriate, to build new theory or modify existing theory

*Table 3.1: Deduction, induction and abduction (Saunders et al., 2019, p.153)*

As an approach, deductive could be said, that it starts from the general and the ‘bigger’ picture and then proceeds to the particular aspects. In research, that translates as starting from a theory, do then the hypotheses and after putting them into test, to examine again the theory (Woiceshyn & Daellenbach, 2018). Contrary to that, induction follows an opposite path. Induction approach moves from the specific to the more general, thus after making observations about a subject, to try to develop a theory supported on that (Locke, 2007). Finally, abduction rejects moving from a general assumption to the specific and vice versa, but rather follows a ‘back and forth’ approach (Saunders et al., 2019).

In the case of this thesis, it starts from utilizing the existing theory of GSCM in other contexts, to assume that GSCM can bring improvements on the environmental, financial and operational performance of a company and then gather data from interviews. Hence, having a deductive approach in this case would be a more appropriate to explain this research process. At the same time, to use data before the theory is proven, defines this research to be qualitative.

### 3.4 Research Strategy

To be able to fulfil the purpose of the research, the researcher must select the appropriate strategy to achieve it. The strategy is what will help to clarify what data shall be collected and what are those methods or concepts that the researcher needs to follow, to be successful for the objective that was set (Saunders et al., 2019).

The four types of strategy are the survey, experiment, case study and grounded theory.

The case study, as a research strategy, is considered to enable the researcher to analyse and explore the data within a particular context (Zainal, 2007). This could be, within the context of a geographical area, of a specific company or a small group of people that share the same issue. A common critic towards case study though, is that due to the narrow set of data collected, it may lack objectivity, hence not being so reliable, in contrast with other methods (Rowley, 2002). However, it is important to acknowledge, that it is mentioned in the literature, that they are used as a method, because they may highlight information and findings that otherwise would not be possible to be revealed (Rowley, 2002). Eisenhardt (1989) points out that case studies may be a really good fit, for research areas that are yet to be explored or that the existing literature is insufficient.

The grounded theory is mentioned as an option to do qualitative research, but also create an inductive theory (Backman & Kyngäs, 1999). According to S. Khan (2014) researches that use the grounded theory approach are much closer to theory building and not to theory testing. That is why, it has a qualitative approach and not a quantitative. Moreover, because it aims to develop a theory in the context of social settings, it has inductive characteristics (Wagner et al., 1968).

Surveys is a really common strategy and has most straightforward characteristics. Usually, surveys are formed in the of a questionnaire or an interview. Questionnaire is one of the ways, to obtain quantitative primary data (Roopa & Rani, 2012). The main advantages of the surveys are that they allow to gather a large and accurate portion of information, they are cost effective, and the researcher can gather data that can be both qualitative and quantitative (Wilson, 2010). Although, there are also some challenges, such as the need to design a questionnaire or an interview, in a way not to lead the interviewee to a particular answer and select the right people to participate in it. This can only ensure the reliability of the results (Taherdoost, 2016).

Last of the research strategies, is the experiment. The main point of focus of this strategy is to explore the causality between certain events and that is why it tries to analyse the various variables involved. Sørensen et al. (2010) define the experimental method as a research strategy that examines the consequences, when a dependent variable is shifted, due to an action upon an independent variable. It is highlighted though researchers may find it challenging drawing safe conclusions, because of the fluctuation in the measured data (Kranz et al., 2022).

Regarding the method used in the research, there are two options and it needs to be decided whether it would be quantitative or qualitative. Quantitative surveys are considered to test the effects of particular independent variables on a defined dependent variable, while being able to measure it in a numerical way (Lakshman et al., 2000). On the other hand, qualitative research is usually used for researches that the examined variables do not produce a numerical outcome.

The focal point is the beliefs and behaviours of people and the most common investigation method, are the interviews. It could be said that one major difference between qualitative and quantitative is that, the first tries to answer the ‘what’, while the second the ‘how often’ (Lakshman et al., 2000).

All the strategies can be meaningful and the selection of it relies on the goal of the research itself. For this particular research, the option selected is to have a qualitative method using interviews, in order to investigate what are the GSCM impact on the manufacturing sector in Germany. Therefore, using interviews of people that are professionally active in this sector, can turn out to be useful for the researcher to ask questions and get insights of how a variety of companies deal with this matter in this sector. Hence, using the data collected, it can be examined further the context of GSCM in Germany in relation with the findings presented in the literature review.

### **3.5 Data collection**

To be able to acquire deeper knowledge in the GSCM practices, implementation and impact on the performance in the manufacturing sector in Germany, primary data will be collected, as no secondary data is available. Germany is selected in this case, because it is considered to be a pioneer in the green sustainability development (Phillis et al., 2011) and the manufacturing sector makes up a large percentage, of the business of a country with a leading economy in Europe. However, in the existing literature it is not extensively explored.

The options to collect data in qualitative research are various and include interviews, questionnaire surveys, focus groups and observation (Macintosh & O’Gorman, 2015). Focus groups, is considered to be a method that collects data through discussions in groups. This can provide valuable data, but has the disadvantage that sometimes it is difficult to keep the focus and receive equal feedback from all the participants (Barrett & Twycross, 2018). Observation, as it captures both verbal and non-verbal actions, is a valuable way to gather data, because it provides a lot of information. However, the findings cannot be always trusted, as often people do not have the same stance, when they are observed (Barrett & Twycross, 2018). Interviews have the advantage of providing valuable data, as there is the possibility to have a meaningful conversation with the participant and analyse extensively the research topic. Interviews though have different type of structures, that define the outcome of the data collection (Barrett & Twycross, 2018).

The different types of interviews are observed to be structured, semi-structured or unstructured. In structured interviews, there is an existent questionnaire, much like a typical survey beforehand to guide the participant, and the interviewer needs to ask the question in the order that it was set up (Brinkmann, 2014). In the semi-structured interviews, there is a theme and key questions. However, the questions may be changed, depending of the industry or the special characteristics that a company has. The flow of the interview will define if more follow-up needed, in order to obtain deeper knowledge or clarifications (Saunders et al., 2015). In the case of unstructured interviews, there are not predefined questions and the topics of discussion change through the interview, as the interviewer has primary the role of the listener (Brinkmann, 2014).

The data in this research, will be collected in the form of one to one, semi-structured interviews. Using this way, the interviewer can have a more active role, trying to keep the conversation as helpful as possible to serve the purpose of the research. Those interviews will be conducted either face to face or through Microsoft teams when it is not possible to meet in person, based on a prepared questionnaire. The reason behind this choice, is to be able to readjust the questions if needed, or follow-up, in order to investigate deeper into this issue (Mathers et al., 1998).

### 3.6 Sample process

In this part, it will be decided the number of people that will be interviewed for this study. In the researches, interviewing the whole population is impossible, as it would require a huge financial investment, amount of time and the researcher would not be able to communicate with all the people that relate to the examined issue. That is why, a sample is an absolute necessity (Ahmed et al., 2016).

As the sample process is taking place, the first step would be to define the population group, which is depended on the research goals and questions (Ziegel & Lohr, 2000). For this particular dissertation, the population would be people working in organisations that work for manufacturing companies in Germany that have implemented fully or partially GSCM in their organisations. However, in order to have a sample that would be manageable, it is crucial to narrow it down to people that are highly qualified in SC issues and have insights over the strategy and the performance of their respective company.

Sample techniques are categorised into two major types. The first one would be the non-probability and the second one the probability sampling (Ziegel & Lohr, 2000). In probability sampling, which is mentioned also as random or representative sampling, every person has a known probability of being included in the sample and to be able to fulfil the research goal, as it could be statistically calculated based on the target group (Saunders et al., 2019). The advantages, that this technique has, are mainly found that it reduces the systematic errors and minimizes the possibility of biases. Contrary, in the non-probability sampling, also known as non-random, not every person has an equal opportunity to take part in the survey (Etikan, 2017). This is a technique that would be appropriate if the population that the researcher is interested in, is too specific and based also on the researcher's opinion, could provide actual valuable information (Etikan, 2017). The pros of this technique are, that it not so time-consuming and suitable for exploratory research, but the disadvantages may be that it is more possible to encounter systematic errors or biases (Alvi, 2016).

In this study, it will be followed the non-probability sampling, as the objective is to generate samples that relate with the specific population that we need to get insights around the topic of GSCM implementation in the manufacturing sector in Germany. The number of participants will be determined by the saturation rate (Cobern & Adams, 2020). By virtue of this, the number will be reached with a minimum of 10 interviews alongside with questionnaires, with the aim to get more in-depth information for the objective of the study. The main purpose is to get information from the interviewees, about what GSCM implementation, according to the objectives set and will support the researcher to have clearer insights over that matter. The

interviewees will be exclusively people working for manufacturing companies in Germany, that have taken over at least some green supply chain management initiatives.

### 3.7 Questionnaire design

The main idea behind the interview part, is that it would be semi-structured and a sequence would be set, but it would also rely on how the discussion goes on, and some changes may apply, depending on the background of the participant (Saunders et al., 2016). The main aim of the question is to deepen the knowledge and get insights about the opinion and experience of the interviewee (Rowley, 2012). The table below, presents all the questions that were asked to the participants, together with the objective and the references behind it.

The questions are set in that way to support the objective of the research and they have been grouped according to that. The first part, is the demographics questions, that will help to understand the background, the years of experience in the specific company and the part of the sector that the company operates in. The second part revolves around what their understanding around the GSCM concept and the practices that their company apply in its operations. It will be valuable to understand at what extent, they have implemented GSCM. After that, the questions have to do the challenges that they faced, while trying to do that. Finally, the last group of questions, are about the impact that GSCM had on the various aspects of the company's performance and what specific benefits they identify.

As the participants live and work in Germany, and have an international background, English will be used as the language of the interview in order to achieve a clearer and standard communication across all the conversations. While interviewing, to keep track of whatever was discussed and be precise, recordings voice typing application will be made, with the permission of the participants.

<b>Theme</b>	<b>Questions</b>	<b>Reference</b>	<b>Purpose of the question</b>
Demographic	<ol style="list-style-type: none"> <li>1. What is your job role?</li> <li>2. How many years have you been in this company?</li> <li>3. In which sector of the manufacturing does your firm operates?</li> </ol>		To learn more about the interviewees and their background
Information about GSCM and level of implementation	<ol style="list-style-type: none"> <li>1. How do you define GSCM?</li> <li>2. What practices of GSCM has your company implemented?</li> </ol>	(Srivastava, 2007); (Rao & Holt, 2005); (Yang et al., 2013); (Zhu et al., 2013)	To learn more about their understanding around GSCM and the level of GSCM adoption in their companies
Challenges to implement GSCM	<ol style="list-style-type: none"> <li>1. Based on manufacturing in Germany, which do you think is the biggest challenge to overcome in order to implement GSCM and why?</li> </ol>	(Dube & Gawande, 2016); (Luthra et al., 2011); (Zailani, 2009)	This question will help to understand better the barriers or obstacles a firm faced to implement GSCM
Relationship between GSCM and performance of the firm	<ol style="list-style-type: none"> <li>1. What impact does GSCM has on your firm performance on an environmental level?</li> <li>2. What impact does GSCM has on your firm performance on a financial level?</li> <li>3. What impact does GSCM has on your firm performance on an operational level?</li> </ol>	(Zhu et al., 2010); (Younis et al., 2016); (Green et al., 2012); (Rao & Holt, 2005); (Yu et al., 2014);	These questions will provide an insight about the relationship that GSCM and a firm's performance have and the particular benefits on it.
Benefits of GSCM on the firm's performance	<ol style="list-style-type: none"> <li>1. What are the main benefits that you identify that GSCM has on the performance of the company?</li> </ol>	(Laari et al., 2016); (Zhu et al., 2012)	These questions contribute to get a better understanding about the identified benefits of GSCM

*Table 3.2: Questions and explanation of the questionnaire (source: Author)*

### 3.8 Data analysis

There can be found numerous data analysis methods, available for researchers. The ones, most often observed though, are considered to be content analysis (CA) and thematic analysis (TA), when it comes to examine results that come in the form of words and not exact numerical values. Content analysis can be defined as a systematic coding to categorize words that are used extensively in a large amount of information found in a text. It can help the researcher to identify possible trends or patterns (Vaismoradi et al., 2013). The goal of CA is to describe the characteristics of the content and usually is preferred by researchers for exploratory work and sensitive phenomena of nursing (Bloor & Wood, 2006). On the other hand, thematic analysis is named as a method to identify and analyse patterns in a data set (Braun & Clarke, 2006). The purpose behind TA is to identify common threads across an interview and try to answer the reasons why people may use a process or a procedure (Ayres, 2007; DeSantis & Ugarizza, 2000). In the figure below, there could be found the main differences between these two approaches.

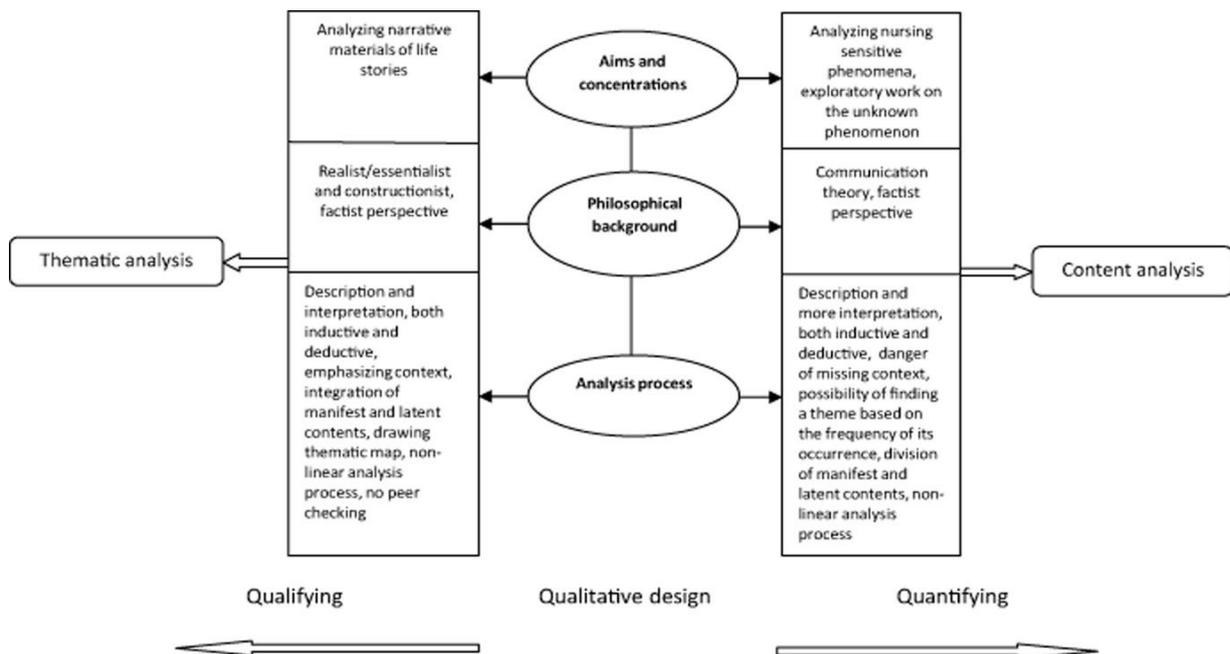


Figure 3.2: Comparison and differences between TA and CA (Vaismoradi et al., 2013)

In this dissertation, TA would be selected as the approach, in order to identify the themes observed in the dataset that will be collected. The insights shall be identified by decoding the relative information from all the interviews (Saunders et al., 2019). As Saunders et al., (2019) further comment over this, it would be possible for the researcher to familiarise with all the findings and identify the patterns. That translates in this case, that all the patterns shall be

derived from the dataset (Guest et al., 2012). Hence, for this research TA seems to be the most appropriate way to continue with.

In terms of the steps that shall be followed, TA demands that first of all the researcher gets to know the dataset that was gathered. After that, it starts the first coding of it and the findings shall be clustered into big groups, while other may be excluded. Moving on, the data shall be examined whether common points are observed. Last step, aside the constant checks to ensure no mistakes happen, is to construct the final report (Braun & Clarke, 2006).

### 3.9 Quality of research

The quality of research is defined by the validity and reliability of itself. In a qualitative type of research, the priority is set to be the capturing of the different opinions and experiences (Golafshani, 2015). In this case, the validity relies on the precision and the honesty of the input of the interviewees and whether the researcher actually measures that it is supposed to be measured. According to Stiles (1993) validity is related to how internally consistent and sound is the interpretation of the results.

The primary goal of a qualitative research should be to collect reliable and valid data, and it is the researcher that shall ensure this (Devetak et al., 2010). The sampling bias, is a real risk that qualitative research enhances, as the participants selected will play a decisive role for the results and this is something that the researcher should take into consideration. It is a possible that the answers could be responded in a way that it will make them seem nicer or to answer what the interviewer may expect to hear from them (Brik, 1993). Another problem could be that the participant may not be eager to share sensitive information about their company and this would also hurt the validity of the results (Brik, 1993). Saunders et al. (2019) mentions also the risk of the cultural differences, but in this case, as all of the participants live in the same county and work on the same field, there shall not be such possibility.

In this research the information that will be gathered, relates with the green supply chain management in the manufacturing sector of Germany. Hence, it could be said, that it has subjective characteristics and it is appropriate for interviews. To ensure the reliability and the validity, it will be mentioned the background information of all the participants that were selected to be included in the sample. Moreover, the researcher will have the consent of the interviewee to participate in the research and that it is their right to withdraw from it at any point they wish. This could help build trust between them.

### **3.10 Ethical implications**

The ethics of a research should focus on protecting the objects of facing harm or unpleasant consequences, related to the data processes or storage and the findings (Saunders et al., 2019). That includes both the researcher and the participants.

The data gathering shall comply with certain obligations that the researcher has. These obligations have to do with dignity, discretion and consent of the participant. No unnecessary personal data shall be gathered about the participant and their respective company. The researcher will give a detailed overview of the information that will be collected before the interview, so that any misunderstanding will be avoided. Furthermore, all the data collected will not be publicly available and are meant to be only for research purposes. Finally, since most of the participants, required that their name and the company's name shall remain anonymous in order to protect their strategy, this information will not be included in the research, rather only their role and the sector that they operate in.

### **3.11 Conclusion**

The purpose of the research methodology is to highlight how the researcher gathered the necessary information and analysed the findings. The chapter, initially, goes through the research philosophy, type and strategy that is appropriate for this research. Afterwards, it is presented the way of data collection and the sample gathering. Moving on, the researcher establishes the methods used to analyse the data. Finally, the last topics presented are those related to the quality of the research and the ethical implications involved.

## Chapter 4: Data Analysis

The purpose of this section is to analyse in-depth the collected data from the interviews. In total, there were 11 people interviewed, that work for a manufacturing company in Germany and have insights about their firm’s practices and performance. The information about the interviewees is analysed and presented before the data analysis. Finally, the transcripts of the eleven interviews, as well as the questions asked, can be found in the appendix.

### 4.1 Participant information

The goal of the study is to acquire insights and information, about the implemented GSCM practices, the challenges faced to do it and then the impact on the different aspects of a firm’s performance. Finally, it is investigated whether benefits on the performance exist. The table below, provides the background of the participants. The aim was to gather people from different roles and sectors, in order to collect a more diverse set of opinions.

<b>Interviewee</b>	<b>Position</b>	<b>Sector</b>	<b>Experience in the current company</b>
1	Supply Chain Analyst	Automotive	3 years
2	Logistics Operator	Automotive	6 years
3	Supply Chain Manager	Electronics	3 years
4	Product Manager	Machinery	4 years
5	Senior supply chain specialist	Equipment	1 year
6	Supply Chain Manager	Equipment	5 years
7	Head of Procurement	Automotive	2 years
8	ESG Manager	Equipment	2 years
9	Head of Logistics	Pharmaceutical	1 year
10	Engineer	Robotics	2 years
11	Head of Global Fulfilment	Electronics	6 years

*Table 4.1: Participants information and background (source: Author)*

## 4.2 Definition of GSCM and implemented practices

According to the literature, GSCM is defined as the integrating environmental thinking into supply-chain management through the whole life-cycle of the product. That includes from the early stage of the design, until the end-of-life of the product (Srivastava, 2007). It was asked to the interviewees, to see their opinion and understanding of what GSCM is and here is what some of them suggested:

*“I would say that it is to enable sustainability in the supply chain, looking for a way to decrease the negative impact that a company has on the environment.” – Interview 1*

*“GSCM is handling the supply chain tasks, while having a green approach. That means, finding sustainable solutions from the early designs until delivering the product to the end-customer.” – Interview 2*

*“I would characterize GSCM as a concept within the supply chain, that tries to fulfil all those tasks and set up the processes, that a company has, while having an environmental approach and focusing on how you can make a company being competitive, without polluting or degrading the environment in other ways.” – Interview 6*

*“ Well, for me, green supply chain management would basically include assessing your supply chain, your current supply chain from end to end. From the supplier all the way to the customer, looking at the environmental impact that you have all over the supply chain and trying to reduce that negative impact.” – Interview 9*

Based on all the answers, it is clear that all the participants have an understanding of what the GSCM concept is about. All of them underlined the connection within the whole supply chain processes and having environmental considerations, with some of them mentioning also other dimensions such as the financial and social one.

When it was asked, what kind of practices their firms use, it seems that all of them have implemented at least a few of them. Starting with the IEM, 7 of them mentioned to use it, either strategically or at some extent. IEM in this case, is expressed differently from participant to participant, as some of them put it into practice through audit programs and trainings. Other aspect of this practice is going after certifications or altering the energy usage approach within the company. The extent of the use seems to relate at some degree with the available financial resources though. The participants here stated:

*“It is worth telling here though, that this comes also from a general direction that the company has implemented and we try to train our employees and suppliers about sustainability. We think that is necessary to onboard them about the importance of it, and for them to get deeper knowledge about this.” – Interview 1*

*“Starting in 2019, many new decisions were made by the top management in order to move with more decisiveness to a sustainability change. It became an integral part of the company strategy. A lot of trainings and external audits are held, in order to achieve this change to a more a green approach.” – Interview 2*

*“We do use Internal Environmental Management as a practice, and have sustainability probably on top of our agenda. That is why also, we have been certified ISO14001, 45001 and 50001 across all of our operations and manufacturing sites.” – Interview 3*

*“As the company is relatively new with limited financial resources, the decision to move to a greening of our supply chain has come from the fact that we need to follow the legislation of the EU and that is why probably top management committed also to this direction. There is an effort to train and persuade the employees about the importance of it, and change some of our internal operations.” – Interview 6*

Moving on, the way of manufacturing is crucial for a company operating in that field. Green manufacturing is implemented by 5 of them and it is done by using energy efficient machinery, often using alternative natural sources, that are more environmentally friendly. It is though hard to implement if the decision to move to a greener approach is recent, as the investment is high to do so.

*“After that, we use green manufacturing and try to save as much energy as possible, and reduce emission and pollution. As a company that is highly technological and innovative, we try to enable it across our manufacturing not only in Germany but also worldwide.” – Interview 3*

*“We use also a green approach in manufacturing them, as we achieved to use 100% of green electricity, while lowering also the water consumption and waste production.” – Interview 4*

*“We use green manufacturing and I believe it increases manufacturing efficiency. Having the approach that you do not want to keep machines working when they are not operating, you avoid waste of energy.” – Interview 7*

Then, all of them almost all of them, seem to have implemented the eco-design and packaging. The extent of the use, seem once again to relate with the level of adoption and the available resources. Some of the participants focus now on more advanced green designs, that would allow them to be leaders of their market or to unlock further benefits, such as salvage of used parts, while others focus first on easier issues to resolve, such as switching to a more environmentally friendly packaging. All of the participants, except one that stated that this is still too advanced for them, use ED and packaging, showing the importance of this practice for them and the success of the project. Here is what some of them stated on how they do it and the importance of it:

*“So, I would say that Eco-design has a top priority for us. I call it as a top priority, because it is that stage of the production that the product’s characteristics are defined. A part of the success or not, of the GSCM implementation, is decided at this stage. The design of the vehicle and the parts used, are being designed with the ‘greenness’ in our mind.” – Interview 2*

*“Regarding eco-design, we invest many millions in order to be always innovative and leaders in the industry. We always seek ways to further make our products better, with modularity and more efficient for the customer, while not compromising on sustainability” – Interview 3*

*“Our product evolved quickly, and so our design. At first, we focused on how it shall be working correctly and packed it in plastic bags. Now after a few years, we developed it and integrated a more advanced design. Now we care, about how it shall be disposed, or how we can save some parts to reuse them.” - Interview 6*

*“We use as a green practice the design of the product as well, as we are trying to invest on the product modularity. We are using materials that first and foremost fulfil the product quality standards. We may sacrifice a little bit regarding cost efficiency, but we ensure that these materials are recyclable easier to source while having less CO2 emissions.” – Interview 7*

Then, 8 of the participants mentioned to use green procurement. In this case here, procurement is controlling the suppliers and checks all the available material and chooses the one that combines being sustainable and having the necessary quality. That means that except simply buying what was ordered, they have a controlling role, as they need to approve potential suppliers and make sure that they have the correct product and are trustworthy enough, to comply with the GSCM project. The participants here mentioned:

*“I would probably start with the purchasing, I could probably characterize it green purchasing, as all the material sourced complies with certain regulations and comes only from trustworthy suppliers, that comply with regulations as well.” – Interview 1*

*“ Regarding procurement, we constantly review our products and try to avoid resourcing dangerous materials” – Interview 2*

*“Really important of course, is the green procurement, as in order to become someone a supplier of us, needs to follow a certain code of conduct that ensures that we share values. Then, of course, we help them in order for them to be easier to continue being complied.” – Interview 3*

*“We have almost 1k suppliers around the world and all of them have to comply with how they handle the hazardous material and reach certain goals about the sustainability of the raw material that we will eventually buy.” – Interview 4*

*“ The procurement of all parts, which we use in our company is done after we examine all the possible materials that could be used. We end up choosing from different suppliers the ones that will have the best impact on the environment.” – Interview 5*

In addition to that, reverse logistics was mentioned, as one of the most common practices in use in the participants’ firms. Characteristically, the motto “reuse, remanufacture, recycle” seems to be widely accepted, as a way to reduce waste and resources. All of the participants that have the option to use this practice, do it. They understand that having access to their product after they sold it, can give them the opportunity to use some parts again, at a low cost. Simultaneously, they are able to comply with regulations and be more reliable for the customer, as they can guarantee a safe disposal of the defective material. Some of the participants mention several ways that they deal with that:

*“There are cars in our portfolio that almost half of the aluminium used, comes from recycled materials. Same thing applies for batteries, as we involve the customer to return them and we are able to reuse them or at least salvage some of the material.” – Interview 1*

*“We use reverse logistics also, and we try to have a great return management, and either to repair or recycle the machines that we receive. To achieve that and make it easier for the customer, we offer globally free collection for our tools.” – Interview 4*

*“This is worth mentioning that our company after the end-life cycle of the of the product, we offer to the customer the option to return it and recycle it, with some benefits at the at the customer side.” – Interview 5*

*“We have a strategy and deal with our returns in many ways. We control the devices that we have returned, we repair and resell those that we can, otherwise we keep the parts that still function and the rest we recycle them.” – Interview 6*

*“ This happens in two stages. One thing, is about the batteries that we are forced also by law to do it and another one is to receive back the electronic components. Whenever a customer wants to send back his device because it's broken or it went out of function, they have the right to send it back to us and we recycle or try to reuse the parts to other operations of ours. Reverse logistics is one of the most important practices of ours.” – Interview 11*

It is worth mentioning though, that two participants that do not use the reverse logistics is due to the fact that they do not have the option to do so. Interviewee 9 works for a pharmaceutical company, thus are manufacturing a product, that is consumed and interviewee 7 works for an automotive company, but in this case reverse logistics happen by the Original Equipment Manufacturer (OEM). This highlights the importance of it.

After that, 4 of the participants reported that they use green distribution, not only on the way they ship their finished goods to the customer, but also on how they transport the raw material before and between the manufacturing process. As transportation has negative effects on the environment, the participants try to organise it in an effective way, that the unnecessary trips are avoided. Another way mentioned was the mean of transportation that was selected, as the fuel and the vehicle play a role, on the emissions produced. A few examples of that are:

*“The company also tries to reduce the carbon emissions in all the routes involved in the production and the whole vehicle lifecycle. I think also the precision plays an important role, because that way we avoid unnecessary transportations. Likewise, for the finished goods, we try to use our capacity in the best-possible way. We try to effectively plan the routes, depending on the occasion, by rail or sea, taking into consideration though the environmental impact.” – Interview 1*

*“Finally, as a company that operates in the automotive and made such sustainable initiatives, we focus also in the green distribution. We try to use electrical vehicles when it is possible and we try to move that direction, for our distribution channels.” – Interview 2*

*“In terms of the logistics, we were always thinking of how can we really reduce our carbon footprint in combining shipments in reducing the volume of what we ship. Let's say for example, we can combine shipments to the US and ship in bulk volume. We implemented a green distribution system, that increased our effectivity and we cut down unnecessary trips.” – Interview 11*

Then, when it comes to customer collaboration, 4 of the interviewees reported that they try to engage as much as possible with their customer base, in order obtain feedback on their product and exchange ideas and knowledge on how they can manufacture a product that responds better to their needs, but is also green and sustainable. They point out that GSCM is a collaborative project, that requires working together in order to be successful:

*“We always seek ways to further make our products better, with modularity and more efficient for the customer, while not compromising on sustainability. We do try to hear also a lot our stakeholders. For example, we ask openly our customers about what we can do better and exchange ideas to take sustainability a step further.” – Interview 3*

*“One key practice also, is the customer collaboration. We have regular meetings with our key customers in order to understand each other, receive their feedback and see how we can make each other better around sustainability issues.” – Interview 4*

*“In most cases, the OEM, that is our customer, demands our products to be manufactured in that way. In that way, they avoid to face any bottlenecks in their reverse logistics processes and for them to be able to be sustainable and green. We have to work closely with them, in order to be successful for our goals, around sustainability or not.” – Interview 7*

Finally, the investment recovery is mentioned by 5 of the participants view, as a way also to increase their profitability, apart from being greener. It is understood that having access to your product after it is sold, gives some opportunities for additional revenue. It is separated though from reverse logistics, as it includes also the reclaiming of value of assets that the company does not manufacture, such as machinery or other equipment. A few instances, of recovery investment reported by the participants were,

*“Same thing applies for batteries, as we involve the customer to return them and we are able to reuse them or at least salvage some of the material. This is good both for the environment and the company.” – Interview 1*

*“It is also beneficial for us because we can either recycle it or repair it. Then we can either resell it or give it away free of charge for testing purposes for potential new clients. So basically, we are decreasing the level of material used in order to have a finished good.” – Interview 5*

*“It can be said, that we do both reverse logistics and when we can, we do investment recovery. Another case of investment recovery, is that whatever we do not need anymore, or is outdated, we try to sell it, instead of dispose it. This way we minimize the waste and we get something out of it, in a financial way. – Interview 6*

From the above analysis, it is proven that all participants have adopted GSCM at least at some extent, across all the stages of the supply chain. The level of adoption though, seem to relate with the financial resources of the company and the nature of the industry, as in some cases the participants do not have the option to implement it. In the table below, it is presented a comprehensive view of the practices that are implemented by the participants' firms.

<b>GSCM</b>	Int 1	Int 2	Int 3	Int 4	Int 5	Int 6	Int 7	Int 8	Int 9	Int 10	Int 11
IEM	X	X	X	X		X				X	X
ED & Packaging	X	X	X	X	X	X	X		X	X	X
Green Manufacturing	X	X	X	X			X				
Green Procurement	X	X	X	X	X		X	X		X	
Investment Recovery	X	X		X	X	X					
Customer Collaboration			X	X			X			X	
Green Distribution	X	X							X		X
Reverse Logistics	X	X	X	X	X	X		X			X

*Table 4.1: Implemented GSCM practices by the participants (source: Author)*

### **4.3 Challenges to implement GSCM in a manufacturing company in Germany**

Challenges act as delaying factors in this transition, making it even more difficult. In the literature, were recognized multiple different challenges and obstacles that may prevent a company to apply GSCM practices and they need to overcome in order to do it successfully. Those challenges relate mainly around financial requirements, commitment from the company to change or uncertainty of the result of such a transition.

Based on the interviews, the greatest challenge is considered to be the financial costs, because the initial necessary investment is high and many companies do not want to spend that much money. All, except one of the participants, identify it, with the one not doing so, being the only participant working for the pharmaceutical company, claiming that in their case, this is not a significant challenge. There are certain financial resources that are required, that many firms either do not have or do not feel confident spending. The implementation of GSCM, requires money to be spent on different machinery, funding of research, hiring professionals, training the employees, buying alternative material that is green and also potential hidden costs, based on this change. Another aspect identified is that such an implementation, will bring an increase in costs, that it may act as a domino, increasing the price of the end-product, thus hurting their competitiveness. This is a matter that was stressed upon by all the participants, except one and here is what some of them mentioned:

*“The first challenge that I recognise is the financial aspect of it. For a supply chain like ours and business cycle that we currently have, the investment that is required to alter processes and move towards sustainability requires millions of euros in costs. We need either to buy the know-how either through trainings or by hiring the appropriate people.” – Interview 1*

*“One challenge that you have to take into consideration are the financial costs. So far though, our KPIs prove that the balance is positive, based on the ‘return on investment’ index. Even though that, the decision was not easy. We needed to invest a lot of money, that you cannot be 100% sure, that will be repaid. That is a challenge that it may, delayed the implementation of GSCM. At least not before we had enough data, to support this decision.” – Interview 3*

*“The budget is limited, the goals that we need to reach are financial and the budget would be drained if we do massive investments at this stage. Also, I see that green raw material is most expensive and we try to reduce the cost. All of these, make GSCM a hard thing to implement.” – Interview 6*

*“We are talking about the automotive industry and we are working very tight profit margins at the end of the day. All these green change needs to be paid by the consumer and the automotive industry is an industry that's being by every global disruption. So, I would say staying price efficient and price competitive, whereas implementing green techniques and green methodologies into your manufacturing process is difficult because of costs.” – Interview 7*

*“The biggest challenge are the financial costs. Imagine that only for a platform to assess our suppliers the cost is around 20k euros per year. You can imagine the costs, about actually financing the change of processes. When you are working for a company, you need to explain why you need such a large amount of money and you are going to get asked whether the company will have an economical benefit out of it. It is not easy.” – Interview 8*

Closely tied to that, is also the fear of failure, as a major change like this, may hinder dangers to negatively affect the operational and financial performance, if they do not implement it successfully. Companies tend to be sceptic, when they have the chance to alter something in their internal processes, as they feel that it may harm the balance that they have. 4 of the participants recognized as a challenge. Here is what some of the interviewees shared on that:

*“Also, as we try to be innovative and pioneers in this section, we sometimes may invest to discover something that is not there. This can impact negatively the company's performance, as we may waste the money and time invested.” – Interview 1*

*“The other challenge that I see then, is the supply chain complexity that our product has, that a wrong calculation or change, can result to a failed product. This, could be disastrous for us. There is no room for such errors. A change itself is not necessary something that will turn out positive.” – Interview 4*

*“You want to make the processes as optimal as possible and GSCM requires a huge change management procedure. There is a lot bureaucracy attached to that, and then you might not even be able to implement it in the end. We might change, disrupt our processes and fail to do it successfully. We might not be able to reach the quality standards that are set. We cannot afford to fail to reach the standard.” – Interview 9*

Challenging is when the top management is not committing actually to this direction. Not having the support of them, makes such a transition extremely difficult. It delays the project

significantly or keeps it at the bare minimum of implementation. This appears to be connected with the financial risk behind it, that they assess to be higher, than not adopting a green approach. The participants had to say about that:

*“One challenge also for my case, is the upper management commitment. They pay the money and they are quite hard to persuade them, that this will pay off. They see it sometimes more short-term than they should. Even for a theoretically minor decision, we face delays to put it into practice.” – Interview 8*

*“Another challenge is the poor commitment of the top management. There are many things that can be done additionally, except those that we do already. We can buy also even more green parts or design it even better, but in order to do that we need support and budget approved.” – Interview 10*

In addition to the above, the personnel may not have technical expertise to support the implementation of GSCM, that is necessary in order to do it successfully. The design of the product and of the processes is a complicated task, that requires to have the technical knowledge and background to achieve it. As this concept is quite new for the business world, it is often according to some participants, that they feel there is not yet full expertise on that field in the market and cannot always hire that person. That was mentioned as challenge from three participants:

*“We do not have a large experience behind this, so we definitely lack of technical expertise. We sometimes need to hire externally to help us, with such issues. This does not provide flexibility, as we rely often on others.” – Interview 6*

*“It is a new field. It's difficult to find expertise. It's difficult to find people that actually know what they are doing when they are trying to work on a green transformation. There are some consultancies doing that already and there is probably a sufficient know how. If we compare this concept to other manufacturing areas like supply or how to set up a lean production shop, I'd say sustainability is the newest. So, the second challenge is that it is difficult sometimes to find the know-how.” – Interview 7*

*“Green supply chain is when you compare it to the timeline of the whole industry, it's very new. Not all the people, managers or leaders are actually aware of it. Neither the top management has the experience for it, as it is such a new concept. It is complicated, it takes time to understand, to build it up and just to be able to measure it and to report it at the end.” – Interview 11*

Similar to what was mentioned before, is not to train the employees regarding the principles, hence not to persuade them to work towards this direction. GSCM is a major change and to have the support of the whole organization and to know the reasons and the importance of it is crucial and defining for the success of the project. A participant identifies this challenge:

*“Also, people don't have a good knowledge of it yet, so definitely we need to train some people. We need to educate people in that direction. We have some general consciousness about this idea of the green sustainable business but still we need to work on certain details, so that we make it understandable to the whole organization. So definitely some trainings should happen.” – Interview 5*

Moreover, a factor that may prevent a firm from implementing GSCM is the uncertainty in the market. Especially the last few years, with the geopolitical conflicts in Europe and Middle East, combined with the corona virus crisis, raised this issue even more. Supply chains around the world were massively disrupted and this prevented companies from changing too fast. They rather hold a cautious stance, be patient and try to gather more data, before making a decision. This seemed to be the case for a 4 of the participants and here is what a few mentioned about it:

*“Based on the recent experience, I would say the greatest challenge was the uncertainty in the market. The last 3 years, there have been the corona virus situation and the war in Ukraine that made it really difficult to implement GSCM or being able to operate under these circumstances. As we had to procure material from certain sources, we had huge issues and dramatic delays. Maybe if we continued conventionally, we would not face this challenge.” – Interview 2*

*“Also challenging is the uncertainty in the market. I observe that the last two years, there is no stability. It is not the most comfortable thing, to go ,all in’. Sometimes, changing so many things, that GSCM demands us to do, if we want actually to implement it, we need to evaluate all the risks and, in most cases, are many. Especially in some countries that we operate or source.” – Interview 6*

Governments in the EU and subsequently in Germany, have certain demands from the manufacturing companies and their operations strategy. The laws and legislation may be a significant factor, but few of the participants feel that governments demand, but do not support actively enough or motivate them by giving out benefits to their firms. It is felt, that this should be more of a collaborative work, in order to be meaningful and effectively put into use, rather than chasing to simply comply. Two of the participants believe that the government has certain expectations, but it does not meet those from the firm:

*“Personally, last challenge to implement GSCM practices though, is the lack of governmental support. On this aspect it could be better, as I feel that government has only certain expectations, but do not motivate the companies to do it or to make it easier for them to enable them. It is a bit of either you pay the money to do it or you pay money in penalties. They rely only on the fact, that the companies have a certain culture that they will do it either way. That is not ideal to make progress. It should be more meaningful than that.” – Interview 3*

*“Those things are mandatory to us and other companies, but at the same time, since government is actually forcing them, they are not actually supporting us, by giving to us some benefits. So basically, they are creating the laws and bringing them to us, but I can see that they are not supporting us moving to the direction to be compliant. All the companies are left to be alone to find the solution to overcome these challenges and this is a hard task to do.” – Interview 5*

Moving on, a company does not operate uninfluenced by external factors or partners. That means, that often obstacles may be set by them. Suppliers have their own processes and strategy. For a buying company the goal of enabling GSCM and integrating into its processes, goes through the suppliers. If they do not have a green raw material or if they do not fully comply with the laws, means that either they have to persuade them to change as well or find new suppliers. Two of the participants identified it as challenge here what one of them have to say about it:

*“I have to admit though, that one challenge that I identify is our supplier stance. As we source a lot from supplier located in developing countries, in order to produce semiconductors, it is often a difficult task to find suppliers that comply with the set of rules that we established. We try to support them, but this requires that they are willing as well, to accept to work in a certain way.” – Interview 3*

To sum up, many challenges were identified by the participants. A few of them though were not mentioned by any of them, meaning that at least for the manufacturing companies in Germany, do not seem to apply. Those were the poor stakeholder communication and the resistance to adopt new technologies. The same applies with the low customers awareness barrier. Below, there is a figure, that summarizes the challenges, as mentioned by the participants, in relation with the root of it.

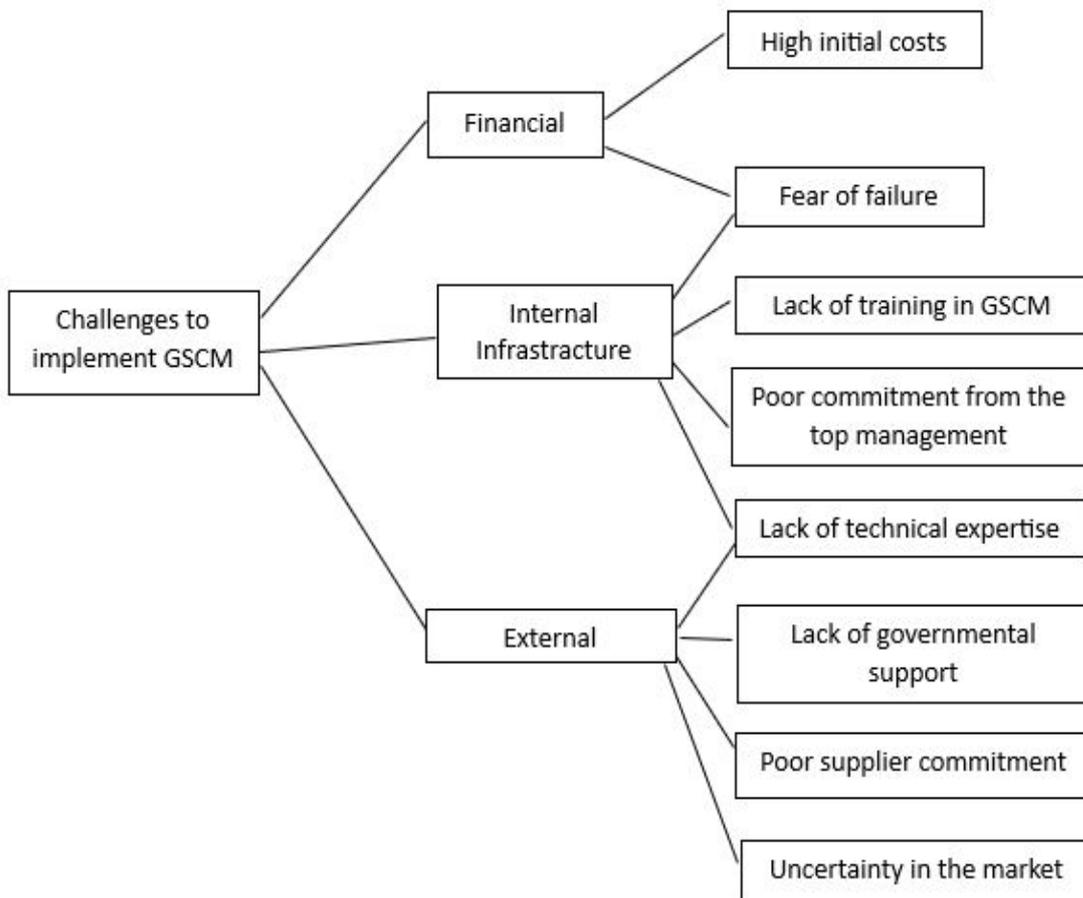


Figure 4.1: Challenges to implement GSCM, as mentioned by the participants (source: Author)

## 4.4 Relationship between GSCM and performance of the firm

As the concept deals with a product from the designing stages, all the way to the handling of it, even after the end-of-life of it, it is crucial to see how GSCM affects the environmental, financial and operational performance, alongside the potential benefits.

### 4.4.1 GSCM impact on the environmental performance of a German manufacturing firm

Here, all the participants, were quite clear that the impact is positive. According to them, the more practices that their company has already implemented, the greater the positive impact. They feel that taking environmental measures and enabling GSCM practices, leads to improvement. All of them supported their statements, by presenting benefits that they already experience on their performance. They state that, especially they see a positive impact around the decrease of pollution, waste, energy and water usage and GHG emissions. Most of them have certain environmental goals, usually around decarbonization, for the next few years and they feel that after the implementation of GSCM practices, they are moving in the right direction. They feel that using an alternative way to operate within their supply chain, has a positive impact, because now they are buying environmentally friendly materials and have adjusted their operations in such way, that reduces their carbon footprint, gives them the opportunity to operate also in the future, but also are doing something good for the humanity as well. Some of the them mentioned here:

*“ One of the most significant impacts, that we recognize as well is the reduction of waste. We have zero landfill waste since 2016 and manage the waste responsibly. We recycle whatever we can and what is not possible to be recycled, we try to use it as a fuel. So, all of these contribute that GSCM in our case has a positive impact on the environmental performance by minimizing the emissions and the waste produced.” – Interview 1*

*‘I think this is the easier question to answer. It is a no-brainer that the relationship between GSCM and environmental performance is positive. As we identified that one of the biggest challenges of the modern world is the resources scarcity, we try and succeed so far, to create products that require less resources, such as energy. Moreover, based on our implemented practices, we reduced significantly the GHG emission, by using alternative gases with higher utilization rates and lower GHG emissions.’ – Interview 3*

*“When it comes to our environmental performance the impact is great. Especially year after year, I see better results. We reduce emission and our carbon footprint. We use renewable energy, hence lowering our negative impact on the environment. Through our material usage optimization, we use also resources efficiently. This means, less material and less waste. Based*

*on the fact, that now we have also higher adaptability to changing environments with minimum environmental impact, it supports further this statement.” – Interview 4*

*“On an environmental level, positive. We are keeping track of the last five years of our emissions, and we are measuring this every year and we are seeing a drastic emission reduction already. Although, I would say that when you implement the first measures, you can really see results in the beginning, but if you want to reach net zero, the more you want to progress, the more difficult it gets.” – Interview 7*

*“I think that it is definitely positive. We have a product that utilizes material and try to be as green as possible. In our case, if we used lead batteries, in a case of an accident, this could cause huge issues to the people using it. So, in this way, the environmental accidents are avoided.” – Interview 10*

All of the 11 participants, agree that in their case, implementation of GSCM has brought positive impact on their environmental performance. The figure below, presents the main points that the participants, experience the positive impact of GSCM in their company’s performance.

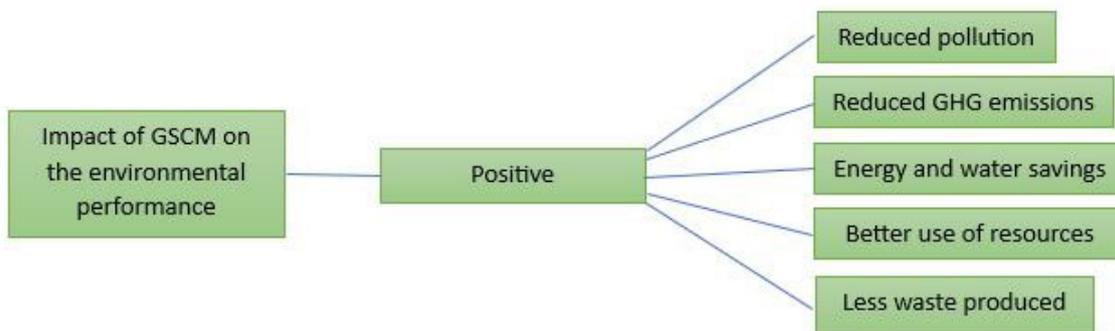


Figure 4.2: Points of positive impact of GSCM on the environmental performance (source: Author)

#### 4.4.2 GSCM impact on the financial performance of a German manufacturing firm

The concept itself, requires a significant investment and this definitely affects the performance. The investment though is done, based on the fact that the companies expect certain benefits on their performance, including the financial. Six of the participants, feel that the impact on their firms' financial performance is also positive at least at some extent. They argue that, they see many avoided costs related to operational costs, material used and avoidance of environmental fines, based on the implementation of GSCM. Extensively is mentioned, among them, that through the 'reuse, remanufacture, recycle' concept, costs are avoided significantly, as they have now the chance to pay less for a finished good, thus increasing the profitability. Here are some of their thoughts:

*"We involve heavily recycled material in our product and we plan to develop it even further. The goal there is to be able to build new vehicles with 50% of secondary raw material. This has, of course, environmental benefits, but let's not underestimate the financial as well. We would require then less sourcing, thus less costs. In the same spirit, the energy saving, leads to other operational costs to be avoided."* – Interview 1

*"Through our GSCM implementation we pay annually less than 10k in fines, that for a company like ours, this amount is insignificant for us. Also, I see less costs in general, as we try to simplify a rather complexed product, that now we pay less for a finished good, thus increasing our profitability."* – Interview 3

*"Positive is the fact that we save operating costs, when it comes to energy used or by the fact that we manage waste correctly and we reuse components in the new machines that we build. This saves costs for us without a doubt."* – Interview 4

*"For the financial performance, we can already see cost savings, regarding energy used. Also, we have avoided so far, any environmental accidents. Our customers never reported a problem regarding this. We have also resource efficiency, as mentioned in the batteries example that I presented before. In the end, we use less material, to produce a robot that performs better. Even if we spent more in some material, the return on investment pays off."* – Interview 10

Moreover, they claim that implementing GSCM helped them to open new markets, thus giving them the chance to increase profitability. Some of them see a positive impact on their competitive advantage, making them frontrunners of their respective market. It is observed, that for some companies, transforming to a green firm is the key to be involved in emerging markets and increased demand. This is for example, the case for all the participants, that work in the automotive sector and see a market tendency towards the electrical vehicles. To be green from their side is crucial, as it separates them from the rest of their competition, thus giving them back financial benefits, that translates to a positive impact on their financial performance. Below are presented some of their experiences about this:

*"Then, I think being innovative and being ahead of the competition because of our sustainability approach, brings competitive advantage. In the end, in the current world everything comes down to market growth and profitability. Based on my experience, GSCM brings a positive impact on both of those. We are able to expand our customer base, increase*

*our demand and by all of the costs avoidance that we achieve to increase profitability as well. To be more specific, with our focus to electric cars, we have now sold over 200k vehicles for 2022.” – Interview 1*

*“I see that now with the direction of producing more electric vehicles, we can sell more and cover the demand of them. It is a fact, that especially public organizations need to comply with certain laws and as a consequence they need to buy mainly electric vehicles.” – Interview 2*

*“First and foremost, the revenue is growing because we are being awarded business, as our clients are valuing highly sustainability and they are happy to buy our products.” – Interview 7*

However not everything is positive here, as some of the participants feels that there are negative points on the impact. The investment required is too high, that for now at least, has a negative effect on the financial situation of their company. Additionally, they feel that the return on investment is not guaranteed, creating as a result an uncertain financial environment for the company’s performance. Here is what was stated:

*“On the other hand, it takes more effort and it costs more to manufacture using green techniques. We need to invest more on our shop floor, for instance programming and adjusting our production in order to be as efficient as possible.” – Interview 7*

*“I think it in this case it makes things more expensive, so it would be a negative impact. The initial investment is high. Because you know, reusable materials are great, but you must send them back and forth, so it increases the cost.” – Interview 9*

In a similar manner, they mention negative impact of the implementation of GSCM in the procurement aspect of it, as they see that the sustainable and greener material tend to cost more, thus increasing the expenses that a company has, in order to produce the end-product. Based on the fact, that the suppliers providing green material are not so many as the ones providing conventional non-green material, this could hurt their chances to find cheaper options and be cost efficient. Here is what they stated:

*“ I see though also other points, that are negative, as for example the cost of the sustainable materials, that in most cases is much more expensive. Also, as we try to procure, mainly from Europe and only from trustworthy sources, I see additional expenses there, that are not so appealing. Sometimes GSCM creates a narrow set of options that is not ideal.” – Interview 4*

*“ The new material will cost more. This new green supply chain in overall, it will cost more at the beginning, but in the long term, as I said, I think that it has the potential to be beneficial. It is not guaranteed though.” – Interview 5*

Finally, three of the participants, concluded that GSCM as a concept, is not proven so far to be either positive or negative, stating examples for both sides. They do acknowledge the cost savings on an operational level or regarding sales, but also underline that the costs are higher on other aspects, such as the investment or the time spent. This led them to characterize it neutral at least for now. Some of their opinions are presented here:

*“In the financial performance, I would say it is somewhere around neutral. What I mean, is that there are certain points that it is neutral, as I do not see direct impact, such as the sales growth that we have. I feel more that it is a part of the reasons, but a bit of complementary and not the main. I do not feel that it is an impact of GSCM.” – Interview 4*

*“I would say neutral. There is certain negative, as the initial costs, but also some positive as our reputation gets better and customers are more open to buy. Maybe in the future it gets better, but I could not predict that yet.” – Interview 8*

On this level, the opinions are mixed, but are favourable towards the positive impact. There are presented certain aspects that bring a positive impact on the financial performance of a company, such as costs avoidance, increased customer base and demand, or opportunities to gain competitive advantage or access new markets and increased profitability. It is viewed for 6 of the participants, that the positive points are more than the negative, thus concluding to such an opinion. Other interviewees though, feel that the investment costs are too high, without having a safe return on investment. Moreover, the costs to produce and source, in a way that complies with the GSCM principles increase significantly the expenses, hence minimizing the profit margin. Finally, 3 of the participants, experience in their opinion equal positive and negative impact on the financial performance, concluding that currently the impact is neutral. In the table below is presented how these opinions are divided and in the figure is presented where the impact, positive or negative, is found on the financial level.

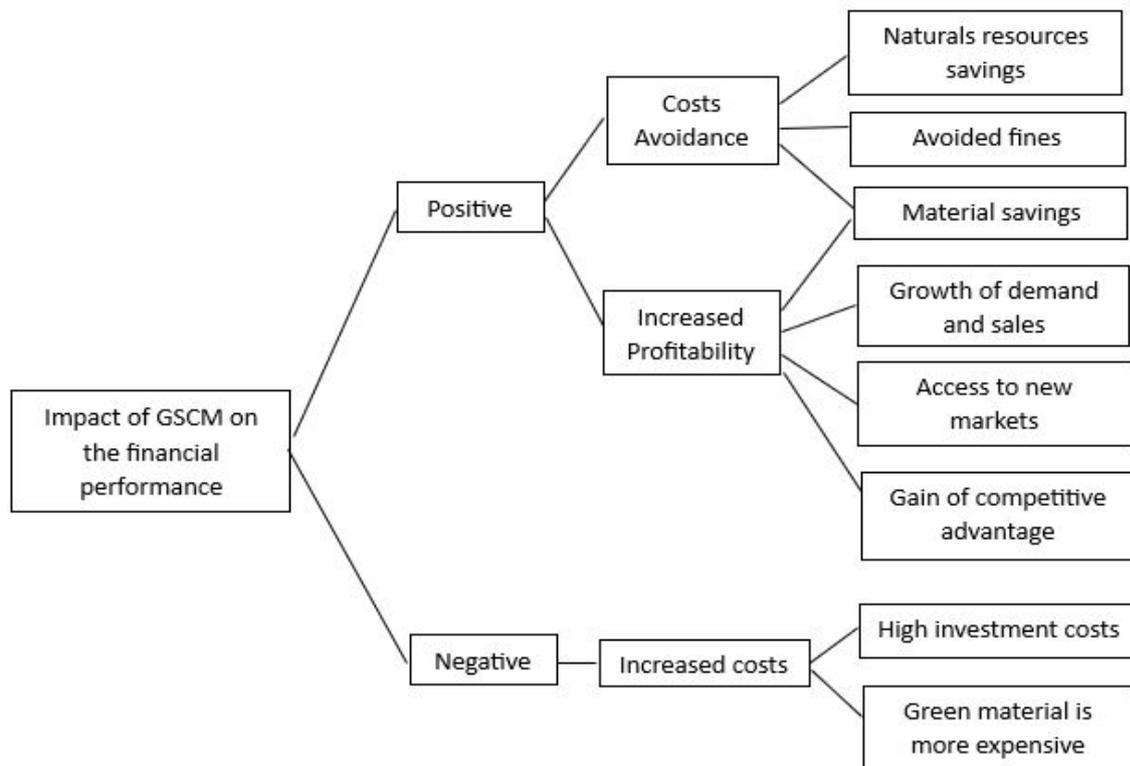


Figure 4.3: Points of impact of GSCM on the financial performance as mentioned by the participants (source: Author)

### 4.4.3 GSCM impact on the operational performance of a German manufacturing firm

GSCM practices affect significantly the operational side, as they alter the processes within a manufacturing company. Usually, according to the existing literature, the operational performance is measured against the effectiveness, quality of the product and times, both for manufacturing and lead times to deliver the end-product to the customer. 10 of the 11 participants claim that they believe that the relationship between GSCM and operational performance is positive at least at some extent.

Extensively is mentioned among them, as 7 of them mentioned it, the increased quality of the end-product, when it is produced, according to the GSCM principles. They see the positive relationship between GSCM and quality improve, first of all, on the material that is now selected that in their case is both green and quality-wise superior than the conventional ones, hence adding value to their product. This results to a lower reject rate and this contribute to have less losses in terms of money and customer satisfaction. Here is what a few interviewees had to state:

*“I would say that, I experience it more in terms of quality. From the first day of designing a product, we aim to design products, in this case cars, that are not only environmentally friendly but also great in quality. In our case, I would not say though that the quality is achieved mainly because of GSCM, but because this is the approach of the company for decades now. So, I would say that it has positive impact, as it contributes also to procure better material and pay attention to the details, that make the difference.” – Interview 1*

*“Operationally, I see also a positive impact. Especially for effectiveness and quality, I see a significant improvement. In many components, such as batteries, the decision to procure and use more sustainable, proved to be the right one. We have fewer defective products, that last longer, thus operationally this is an improvement and it adds value.” – Interview 2*

*“Operationally, I believe that it is positive. Certain aspects are positive, such as the lower reject rate, that it comes from the increased quality. This is a result from procuring better raw material, dealing with less dangerous material and having standardized processes.” – Interview 4*

*“Operationally also positive. We have increased product in terms of quality. As I said before, we produce now a better and more efficient product, with better use of resources. This happens, because we use high quality material, made from greener resources. We have received really positive feedback from our customers, praising the product, that lasts longer than other similar products.” – Interview 10*

In the modern times, it is also considered a major advantage, to be able to modify and develop further a product, that would be able to respond better to the needs of the customers. GSCM has been observed by 5 of the participants, to contribute to that direction, of improving efficiency. Having now as a strategy, to utilize at a maximum degree the materials and capacity, increases the flexibility. This unlocks a new mindset for the firm, that eliminates anything that does not add value. Some participants suggested here:

*“Besides, the reuse of the products, we sometimes change the purpose of use or convert them to activate new features for new products. That way, we improve our efficiency as well and be able to change faster, that I consider to be a massive advantage nowadays.” – Interview 2*

*“I feel that after we focused on what it actually matters, we brought our effectivity up. Now the engineers and designers take that into consideration. The same apply also, to our people involved in the operations and processes. We try to save energy and material and this eventually increases the effectivity and productivity.” – Interview 6*

*“GSCM affects though operationally in the beginning, when we are trying to be efficient, we are trying to use less electricity, less people, less time to manufacture. For these reasons, I'd say it is positive. It affects positively the product design phase and the efficiency.” – Interview 7*

In addition, according to participants, GSCM on the operational side, as it brings them closer to the customers and the suppliers. They see improvements in their processes, based on the collaborative work that is actively promoted by GSCM. Implementing such a concept, appears to bring them closer to their stakeholders, helping them to develop further the product and their processes:

*“I would recognize though, that this GSCM approach seems to have a significant positive impact on the collaboration with suppliers and customers. Being able to exchange information, ideas, feedback helps us to evaluate and develop further our operations.” – Interview 1*

*“Last improvement that I could say, is that we assess the best supplier and we try to focus to source from the those that we have the best collaboration with. In my mind, operations are tightly connected with collaboration, as there are many sides involved and through GSCM, we have activated it. This has also positive impact.” – Interview 3*

Another positive impact, that GSCM has on the operational performance, is mentioned also the time to produce. Taking advantage of the reusing and remanufacturing concept of GSCM, it has been proven to be beneficial for some of the participants, as now they do not always need to build something from scratch.

*“Also, now with the reusing material and maximizing the utilization, we have in many cases reduced time of production, as a part of the product is already produced.” – Interview 4*

On the other hand, participant 9, that works for a pharmaceutical company, sees a negative impact of GSCM on their operational performance, as based on the tight lead times, that they have in their respective industry, GSCM policies makes it even more difficult for them to reach their targets. This happens, because the material is not always easy to access in their case. Here was what was mentioned:

*“Like in operational terms, regarding the packaging we need to plan carefully though, to have enough on site. Regarding times, I see negative impact for us. Some of our products are even seasonal, so if the customer doesn't get it by a certain date, they don't want it anymore. The lead times are tight, and I see that some of the green policies cause a delay. Either in the access to the material or the process itself. There is a negative impact on that in our industry.” – Interview 9*

All in all, 10 of the 11 participants seem to support the opinion, that GSCM has a positive impact on the operational performance of their firm. They find primary advantages on the quality and efficiency across their operations. On the other side, one of the participants, feel that in their case, GSCM has a negative impact on their operational performance and relates it with the delays that they experience because of that implementation. This possibly relates with the fact that working for the pharmaceutical industry, means that they face tighter lead times, with products that have an expiring date, in comparison with the other participants that work for the machinery, automotive, electronics and equipment industry. For products from these industries, the expiration date is not an issue.

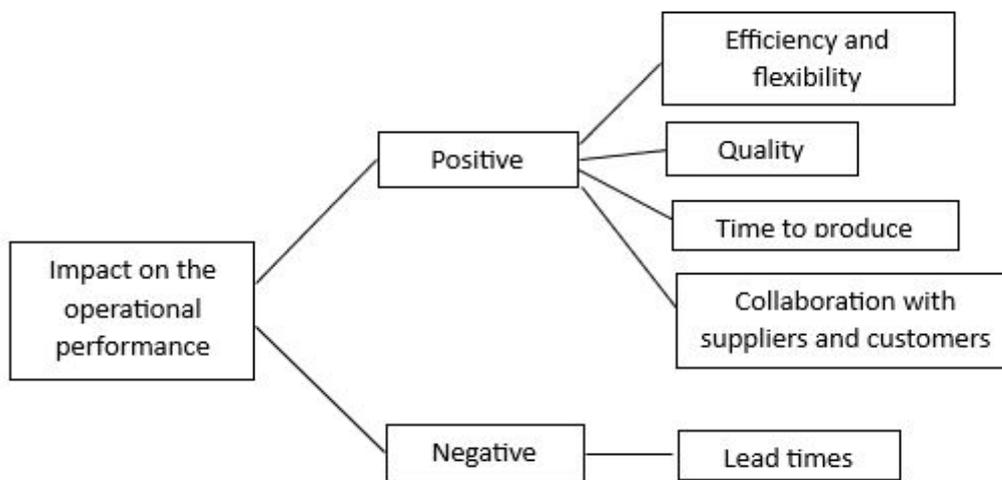


Figure 4.4: Points of impact of GSCM on the operational performance, as mentioned by the participants (source: Author)

## 4.5 Benefits of GSCM on the firm's performance

In this dissertation, one of the objectives was to examine the benefits that the participants see after the implementation of GSCM on their company's performance. Many of them provided multiple benefits, when they were analysing the positive impact of it, on the various dimensions, as they were examined above.

Many of the benefits mentioned, revolve around the environmental performance of the firm, all of them reporting the reduction of the pollution, mainly through the decrease of the waste produced, decrease of emissions, better resources management and decrease of the carbon footprint that these manufacturing companies used to create. Characteristically, some of the participants mention:

*“For example, this new packaging used in Logistics is calculated to save 280 tonnes of CO<sub>2</sub> per year. In addition to that, by reducing the plastic in our operations, we expect to reduce another 1400 tonnes of emissions per year. Based though on our implemented practices, our goal is to avoid 200 million of tons by 2030.” – Interview 1*

*“As a statistic that I am aware is for example that from 2019 to 2020, we managed to reduce the direct emission by 18% and the indirect by almost 32%. At the same time, we reduced also the energy and water used, while keeping the waste at the same level, even though we grew as a business. This could not happen, without implementing certain practices.” – Interview 2*

*“Also, through our investments and the emission reduction strategy we achieve great results on that, avoiding 692,000 tons of CO<sub>2</sub> emissions of our direct emissions. Regarding waste, also 70% of the hazardous and non-hazardous waste is recycled. About energy, 82% of the electricity used relates to green electricity and finally regarding water consumption 60% of the water used, is returned to nature with equal or better quality.” – Interview 3*

*“Environmentally I think I mentioned a lot already. Reduced emissions, waste and carbon footprint are important benefits that is a result of the implementation of GSCM practices. In our case those are achieved by better green packaging, some procurement practices and the establishment of green distribution channels.” – Interview 9*

Extensively mentioned benefits though, have been reported also for the financial side as well. Especially when it comes to costs avoidance, 9 of the participants, feel that through GSCM, they enabled a better resource use, that happens by using recycling, reusing, remanufacturing from one side and by cutting down operations costs on the other side and this appears to be beneficial for the participants. Some of them reported:

*“The total expenses on capital investment and operating expenses were around 16 million euros and the returns on savings from waste recycling and energy, cost avoidance, income and tax incentives were more than 21 million euros.” – Interview 3*

*“Financially, I see the cost savings, as by reusing or remanufacturing, we use less material, we don't need to buy new one and this brings the costs down. In general, there are many costs that we save by implementing these strategies and practices. The resources required are also less and all these mean less costs.” – Interview 6*

*“Financially, as I said, I think it comes later, but something that I recognize already is this resources reduction, helps us to avoid costs. I would say that GSCM contributes to the cost avoidance of a firm. In terms of material but also for energy.” – Interview 11*

Similarly, it is highlighted, that GSCM contributes in profitability. Companies based on these practices, have access to profits, that previously were considered to be lost. Nowadays, the struggle for increasing the profit margin is a topic in the agenda of every supply chain manager. This strategy seems to provide answers to this problem, as the deeper implementation of the practices have the potential to increase this margin and the revenue. Increased profitability is observed to be achieved, through reusing material and access to new markets, that have high environmental awareness. Likewise, the increased brand reputation by implementing GSCM, triggers higher customer demand and loyalty, while it is able to provide a competitive edge, according to some of the participants:

*“We have additional direct profits, by reselling but also by avoiding costs. The reselling part of our business saved material and brought us 50 million euros of extra profits.” – Interview 2*

*“Also, I see that financially we save costs, that increase indirectly our profits. Of course, indirect profits come from the better image profile that we have, because I think that the customers feel more confident to buy from us. Especially for the western markets, that the companies need to buy responsibly, we are a trustworthy supplier for the end-customer.” – Interview 3*

*“The last benefit, that I want to mention and we started now to see is the new markets that they seem to open. Based on the various certifications that we obtain we are able to sell in new markets and also develop a marketing strategy around it. This, in my opinion, helps us to grow our sales.” – Interview 6*

*“Then major benefits are found in the company’s reputation. If we are a trustworthy source, then a customer may be more eager to purchase again. Customers do remember and become more loyal.” – Interview 9*

Similarly, benefits were mentioned by 8 interviewees for the operational side as well, mainly connected with issues such as quality and efficiency across their operations and processes. Those include between others, better end-products in terms of quality and durability, but at the same time also processes that add value to the product, hence avoiding unnecessary actions or waste of capacity. A few of them suggest that:

*“Regarding operations, the highlight for me is the effectivity by trying to eliminate the waste across our operations and the increased quality. It is a situation, that has the characteristics, of ‘killing two birds, with one stone’. When we try to reduce pollution and waste, we stick only to what matters operationally.” – Interview 2*

*“I feel that quality comes from the implementation of standardized processes that are a result from the GSCM implementation, can lead to the zero-defect status. Trusting sustainable raw material and trusted partners, train the employees to have deeper knowledge and trying to maximize the usage of the resources can build a better and sustainable product.” – Interview 3*

*“We do enjoy certain benefits on those points as well, as I mentioned a few already, such as recapturing value or increased quality and less defective products. Also, we are more customer-oriented now that we have implemented those practices. With the repair and reuse culture that we have, we tend to support better the customer and offer also better warranty contracts to them.” – Interview 4*

*“The goal in my mind is, and GSCM operationally benefits this direction is, how to reduce the use of resources and ‘shorten’ the supply chain” – Interview 11*

As a crucial benefit, by 4 of the participants, have been highlighted as well, the new mindset that the company has and the adaptivity to change, so that they can be prepared for the future that will come. Being able to react and adapt, can be crucial for the future of the company and can make a difference for the challenges that will come. This has made companies to value highly being futureproof and adaptive to changes. Some of the participants view this as a key benefit by implementing the GSCM strategy:

*“Another benefit, also in my opinion, is through the implementation of GSCM practices and having now this mindset, we are more open to change and more responsive to adapt. This is a must-have in today’s competitive market.” – Interview 3*

*“The main benefit is that it makes the company future proof. I think that the regulatory environment is going to be stricter and stricter if we want to save the planet at some point. A company investing already in green supply chain management is ensuring that it's it will be allowed to have business also in the future and clients as well. This guarantees to be able operate in the regulatory environment, avoiding being out of the market in terms of price or price competitiveness. So, I would say, future proof is with one word the main benefit.” – Interview 7*

The results are presented holistically, in the chart below, based on the number of mentions throughout the whole interview process, identifying the most crucial ones. From this analysis, it looks that the most important appear to be the increased brand reputation, the reduction of pollution, the optimal use of the available resources and the operational improvements, mainly around quality, efficiency and adaptivity. After that, it is presented figure of how these benefits are connected with the different aspects of the corporate’s performance.

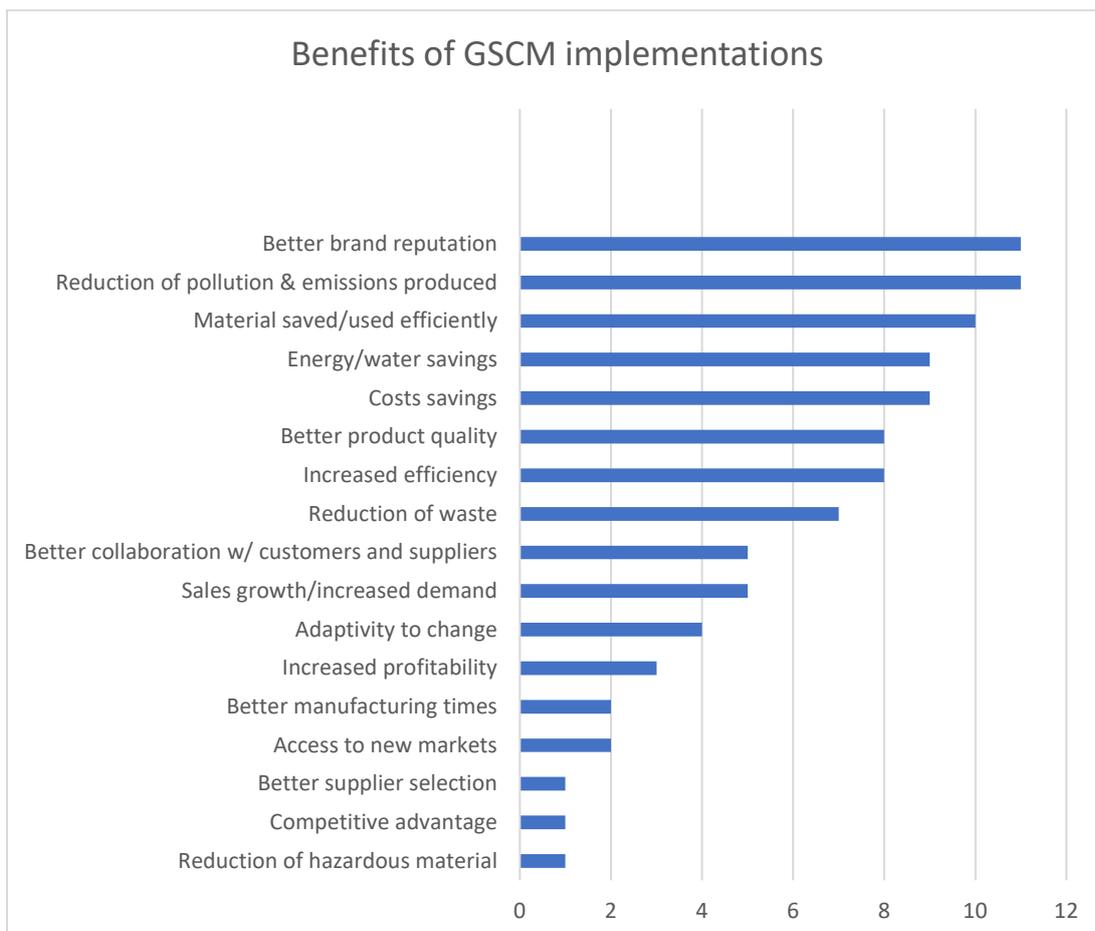


Figure 4.5: Benefits of the GSCM implementation, based on the number of mentions by the participants (source: Interviews)

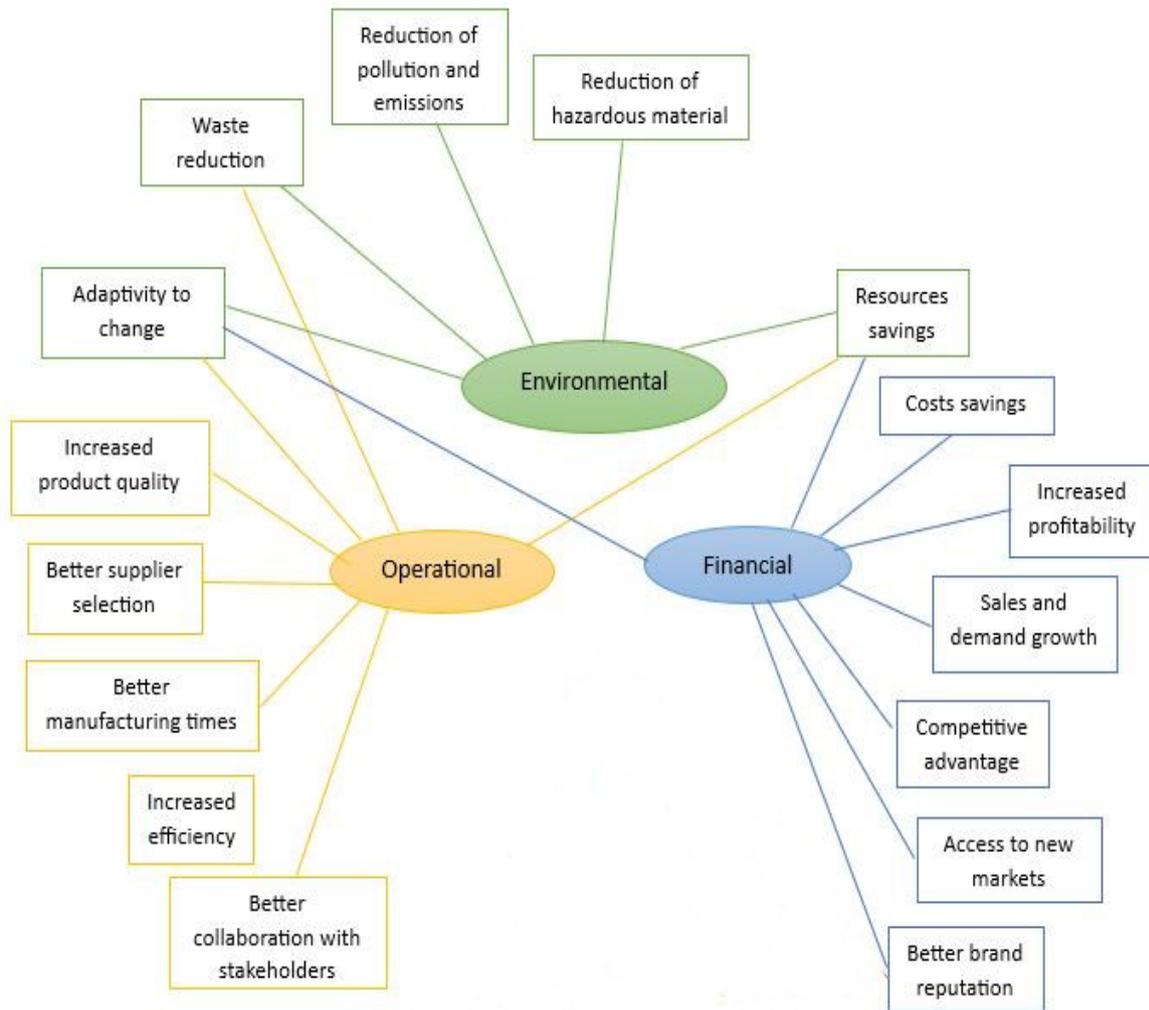


Figure 4.6: Benefits of the GSCM implementation, based on the performance aspect, as mentioned by the participants (source: Author)

## 4.7 Summary and conclusion

### 4.7.1 Summary

From the assessment, it is proved that all the participants, have knowledge over the GSCM concept and have implemented GSCM practices at least at some extent, with some of them having it done, almost fully. Especially, Eco-Design and packaging, alongside with Green Procurement and Reverse Logistics, has been implemented by the vast majority of them. Then, Internal Environmental Management has been implemented by 6 of them, and 5 of them, have implemented Green Manufacturing and Investment Recovery. Finally, 4 of them, have enabled Customer Collaboration and Green Distribution and those were the least implemented GSCM practices. There seems to be a relation of the available financial resources, with the extent of adoption of GSCM.

When it comes to the challenges, here almost all of them, agreed, that the biggest challenge are the financial costs, that GSCM requires, in order to be implemented. Then, some of them acknowledged as barriers, the fear of failure, the lack of technical expertise, the uncertainty in the market, the poor commitment from the top management, the lack of training in GSCM, the lack of governmental support and the poor supplier commitment. Finally, even though it was mentioned in the literature, no participant recognised as a barrier the resistance to adopt new technologies, the low customers awareness and the poor stakeholder communication.

Regarding the impact of the GSCM implementation on the company's performance, all of the participants agree that the impact on an environmental is exclusively positive. Similarly, on an operational level, all of the participants, except one that thinks it is negative, all believe that it is beneficial. Last examined dimension of the performance, is the financial one and here were found to be the most mixed results. The slight majority, 6 out of the 11, support the opinion that the impact is positive there as well. The rest of them, 3 of them think it is neutral and 2 of them, that it is negative.

Lastly, regarding the benefits, those that seem to be the most common mentioned are the environmental ones, mainly around the reduction of pollution, energy and waste saved. On an operational level, beneficial is found to be the increase in the quality and effectiveness. Finally, regarding the benefits on a financial level, 9 out of the 11 interviewees, believe that cost savings, is an important benefit and the majority of them highlighting also the opportunities for increased profitability.

### 4.7.2 Conclusion

The primary objective of this chapter was to examine the information obtained from the conducted interviews. Those that were analysed and evaluated here were, the GSCM practices implemented, the barriers to do so, the impact of GSCM on the performance and the various benefits.

## **Chapter 5: Discussion of research findings**

### **5.1 Introduction**

The key goal of this chapter is to summarize the research findings, based on the aim, questions and objectives of this dissertation. To be more specific, in this chapter, it will be presented an outline of the findings of the literature review and the results of the data that was analysed in the previous chapter with the aim to come to a final conclusion. To do that, this research produces in-depth interviews with 11 participants, that have a different background, roles and industry within the manufacturing sector in Germany and uses the methodology of TA.

### **5.2 Research summary**

This dissertation has the goal of exploring the GSCM implementation in the manufacturing sector in Germany. This includes the practices of GSCM implemented, the drivers and challenges to do so, the impact of them on the corporate performance and finally identify the benefits that comes with it. Based on the environmental crisis that has been recognized widely the last decades and the increasing public awareness, the whole world moves to the direction of integrating sustainability measures in their behaviour and processes. This situation, due to the current enforced legislation, alongside potential benefits on their performance, has led many German manufacturing companies to investigate how they can do it effectively and altered their supply chain strategy, implementing the GSCM strategy more and more widely. They integrated a wide set of practices, both internal and external, to be able to comply with the current legislation, but also to improve their performance. However, they face challenges, that mainly relate with the financial costs, the uncertainty in the market and lack of technical expertise, as the concept itself is relatively new. It is reported though, that as they deeper enable the GSCM strategy into their supply chain, they are able to experience multiple benefits, such as the reduction of pollution that they produce, enhanced brand reputation and costs savings, due to the fact that they manage their resources more efficiently. In this section, though, it will be analysed the practices, drivers, challenges, impact and benefits on the corporate's performance of the GSCM implementation in the German manufacturing context.

#### **5.2.1 Discussion about GSCM practices implementation by the manufacturing firms**

The GSCM practices are often found in the literature to be classified into internal and external (Rao & Holt 2005; Yang et al. 2013; Zhu et al. 2013). The internal are the IEM, the Eco-Design and packaging and the green manufacturing. The IEM refers to the commitment from the top management to promote the GSCM concept across the organization and its operations (Sarkis

et. al, 2011). The ED and packaging, has to do integration of the green principles into the design and development of the product and the packaging (Van Weenen, 1995) and finally the Green Manufacturing is the production of the product in a green way, that minimizes the environmental impact. When it comes to the external, there are the Green Procurement, the Investment Recovery, the Customer Collaboration, the Green Distribution and the Reverse Logistics. Firstly, the GP is the purchasing of the raw material and the services required for the production of the good, that are eco-friendly (Tassabejhi & Moorhouse, 2008). Then, IR is the practice, that promotes the recycling, reuse and remanufacturing of the used products, with the goal to recapture some of the value, while minimizing the waste produced (Susanty et. al, 2019). Customer Collaboration refers to the involvement of the customer by exchanging information and knowledge, in order to achieve better environmental results (Shah & Siddiqui, 2019). Green Distribution is the use of green transportation channels across the firm's operations (Ninlawan et. al, 2010). Last external practice is the Reverse Logistics, that is the management of the returns in a way that would be promoted the recycle, reuse, remanufacturing or disposal of the waste, in an eco-friendly way (Zhu et. al, 2008).

On analysing these practices, in relation with the interviews conducted, it was found that all the participants' firms, have implemented at least a few of them and aligned with the literature, as they did not mention anything that was not included there. Especially, ED and packaging, Green Procurement and Reverse Logistics, have been implemented by most of the interviewees, proving that GSCM is a concept that is already implemented and developed at a significant extent in German manufacturing companies.

### 5.2.3 Discussion about the challenges to implement GSCM

GSCM is a concept that requires a lot to be changed within an organization and alter processes that they may have implemented for years already, that is why it is suggested that many challenges may occur. Dube & Gawande (2016) in their study identify the financial challenge as one the most important one, as the practices of GSCM require extensive funding on materials, expertise and machinery. This is confirmed also in the study, as the participants recognize it also the most significant barrier. However, based on the findings, it is supported the opinion among them, that as the company implement more GSCM practices, the better is the return on the investment, supporting these voices in the literature, that the initial investment as a 'necessary evil' (Kurapatskie & Darnall, 2012). Although, as it would make sense, how big of a challenge, the financial costs are, depend highly on the available resources. The participants in the automotive industry, even though they categorise it as a challenge, it was not preventive for them to fund the project. Possible solutions though are suggested by the literature to seek for alternative funding either by a bank or external investors, based on the fact that the forecasts for manufacturers and GSCM, show promising results (D. Wu et al., 2019). Other challenges that were identified in the study is that the companies tend to be hesitant to change, mainly because the fear of failure or the uncertainty in the market, that especially the last years was high. This is in fact consistent with the literature, as multiple studies identify those barriers. Fear of failure is connected with both financial fails, wasted time and is believed to be derived from the organisational culture (Nusa et al., 2023). Moreover, a challenge observed again both in literature and this study is the lack of top management commitment (Sarkis, 2012; Luthra et

al., 2011). It is observed to be an extension of the previous two, as it relates with the uncertainty of the top management to commit to such a big change, due to the fear of not favourable results. The participants suggest that in their case, it is required to build a strong business case to persuade them, that such a transition will bring positive impact. That means that is required a deep understanding of the matter. Uncertainty in market is a challenge identified in previous studies since years (Chien & Shih, 2007; Walker et al., 2008), but is still relevant due to the recent crisis. Although, recent study suggest about this issue, supports that GSCM has the potential to grow a firm in competitiveness even during the COVID-19 crisis (Zhang et al., 2022). That is not supported though, by some of the participants, as they mentioned to face disruptions that they could not resolve and this highlights the need to evaluate and select reliable green suppliers, that are transparent and properly evaluated in order to minimize these problems (Roehrich et al., 2017). Then, both in this study and in the literature, is mentioned as a challenge the lack of technical expertise (Dube & Gawande, 2016; Bowen et al., 2009). As it is a relative new concept, it is not easy to find sufficient know-how and deep understanding of the topic in the talent pool, causing often delays for the firms to move forward with this project (V. Kumar et al., 2018). However, some of the participants suggested that they overcome this issue by hiring external consulting companies, specialised in this field or investing on their brand reputation with the goal to be a more attractive destination for the top talents. Last identified challenges and aligned with the literature were the lack of governmental support (Zailani, 2009) and the poor supplier commitment (Wycherley, 1999; Bai & Satir, 2020). In the study it is mentioned as some of the suppliers are found to be in countries with poorly enforceable regulatory frameworks, that sometimes is difficult to be persuaded to invest from their side to be green. Roehrich et al., 2017 underlines the important for the careful supplier selection, by developing the correct tools for their assessment. Similarly, the participants suggested that it is important to actively support those suppliers, that initially do not commit, by sharing knowledge around this topic. To sum up, the last two challenges that are mentioned in the literature were the resistance to adopt new technologies (Hosseini, 2007; Luthra et al., 2011), the low customers' awareness (Gong et al., 2019; Sreejith, 2012) and the poor stakeholder communication (Walker et al., 2008). Those do not seem to apply in the context of the manufacturing sector in Germany, as it could not be confirmed by any of the participants. This may happen, because Germany is a leading economy in the global market, with high customer awareness and some of the studies refer mainly to countries with other cultural background, such as Sreejith (2012) for United Arab Emirates or Luthra et al. (2011) refer primary to India.

#### **5.2.4 Discussion about the impact and benefits on the environmental performance of the firm**

GSCM is reported to be as a concept that has direct and positive impact on the firm's environmental performance, as most of the practices revolve around the reduction of pollution, resources used and waste (Green et al., 2012; Zailani et al., 2012; Zhu et al., 2008). GSCM contributes to build an organization that can be more adaptable to changes and be more resilient (Seman et al., 2019). The benefits found in the literature have to do with the reduction of pollution and GHG emissions, as the product is designed, material is procured, manufactured,

distributed and disposed after the end-of-life of the product in an environmentally friendly way (Fianko et al., 2021; Rizet et al., 2018; Guajardo, 2018; Ghosh, 2019). These views are also compliant with the findings, as the interviewees identify those benefits in their case, as they acknowledge that even early initiatives of GSCM practices can contribute to an improved environmental performance. In terms of reduction of pollution, the impact is direct and the first positive results easy to get, as it can be achieved by using many different practices depending on the characteristics of its company and industry. Although, they mention that reaching a point of being carbon-neutral is a goal for the future with the earliest mentions to be for 2030. Then, in the findings, it is mentioned that other benefits include energy and water savings, based on the green way that the company now operates with efficient machinery and defined strategy, thus bringing an environmental improvement. Those views are also compliant with Iqbal et al. (2020) that underlines this can be achieved by setting appropriate production sequences. Similarly, material is also saved and used efficiently, preventing the companies from buying and using more resources (Saruchera & Asante-Darko, 2021). This was also aligned with the findings, as the majority put it into use. Another benefit is considered to be the waste reduction and proper disposal, based on the use of recycling and improving efficiency across the supply chain operations (Alcaráz et al., 2022). Finally, beneficial is also the collaboration with the stakeholders, such as the customers or the suppliers, based on the GSCM implementation, as they end up being more involved in this process (Ottman et al., 2006). Participants confirm it as well, stating that GSCM has collaborative characteristics and it is crucial for the successful implementation.

### **5.2.5 Discussion about the impact and the benefits on the financial performance of the firm**

The GSCM practices are mainly referring to initiatives within the supply chain with eco-friendly characteristics, but as they define the operations of the firm, they have a significant impact on the financial performance of it. Here a large share of the literature highlights the positive impact that GSCM has on that area, bringing multiple benefits. GSCM is connected with costs avoidance that mainly comes from the energy and water savings (Rao & Holt, 2005) and the savings on material by designing it in a more environmentally friendly way, that requires less of them (Cicconi, 2020). Related to costs avoidance is also potential fines due to poor environmental performance, that the implementation of GSCM prevents from happening (Onyango et al., 2014; Laari et al., 2016). The majority of the findings align with these statements. The most major benefit on the financial performance is considered to be the avoided costs, that can have a major contribution to the financial sustainability of the company. Increased profitability can happen either by cutting costs or selling more. According to the participants, from the designing stages until the disposal of the product there are opportunities to act in a greener way and avoid costs. By using recycling, remanufacturing reusing and investment recovery helps to reduce the costs within the supply chain (Saruchera & Asante-Darko, 2021; Gallo et al., 2012). Moreover, in the literature is reported that GSCM is considered to help strengthen the relationship, thus the collaboration with the suppliers, that can translate to financial benefits by having better access to material and better cost management (Hollo et

al., 2012). However, there is an inconsistency there, as in the findings is stated that green material is both more expensive and less possible suppliers to buy from. Those two factors, are connected as the demand and offer, influence the price. Nonetheless, in the findings, there is the statement that green material tends to last more, so long-term may be more cost efficient. Furthermore, supportive to a positive financial impact has the fact that GSCM has ties with increased brand reputation, customer loyalty and access to new markets by having such an approach that can result to higher profitability friendly (Chang & Fong, 2010; Klassen & McLaughlin, 1996; Rao & Holt, 2005). The findings support that, as they feel that as the existing markets are largely shared, they see key opportunities in new markets, that can boost their sales growth and the green market is relatively unexplored. Based on the fact that legislation forces towards that direction, they suggest that they expect more opportunities to be created, so they are trying to be prepared to win a large share of that.

However, there is a part of the literature that has concerns, doubting the fact that GSCM has a positive impact on the financial performance, mainly because of the high investment costs that are required to do such a massive change in the core of the firm, that is the supply chain (Green et al., 2012; Khan et al., 2021). Many companies, especially those that do not have many years of operations, tend to be more sceptical, as they do not have the necessary resources and it is easier to find themselves in a difficult situation. Those participants, that mentioned that work for relatively new companies or that GSCM concept now starts to be implemented, feel more unsure about investing a lot and implementing all the practices. Yet, those that have implemented most of the practices seem to support Kurapatskie and Darnall (2012) that point out that adopting more green practices, relate with achieving a better financial performance. All in all, the experience of the impact and the benefits on the financial performance, seem to relate with factors such as size of the company and industry (Younis and Sundarakani, 2019)

### **5.2.6 Discussion about the impact and the benefits on the operational performance of the firm**

The operational performance is measured most commonly against quality, time, costs and flexibility (Narasimhan & Das, 2001). Alongside those points, effectiveness is considered to be another key element (Yu et al., 2014). As GSCM alters significantly the processes of a company, it is widely believed according to literature, that it can have positive impact on the operational performance of it (S. a. R. Khan & Dong, 2017; Green et al., 2012). The benefits recognized to support the positive impact, relate around these points. Quality is considered to be increased, as GSCM focuses on the selection of machinery and material, while the close connection with customers and suppliers can bring a reduced reject rate (Sroufe, 2009; Vachon & Klassen, 2008). The findings here align with the literature as in the interviews is mentioned that quality is achieved procuring more reliable, greener and less hazardous material. Likewise, the close monitoring of the suppliers, contribute also to the consistent delivery of high-quality material (Y. Yu et al., 2017). Concepts such as reusing and remanufacturing can have a contribution to reduce times to produce, as less processes would be required to manufacture it (Saruchera & Asante-Darko, 2021). Extensively is mentioned across the literature as a positive impact of GSCM the efficiency increase, as through the GSCM practices is achieved waste reduction,

thus leading the company to focus only to what matters, hence identifying all these points that do not add value and eliminate them (Porter and Van Der Linde, 1995). Findings in the interviews support it extensively, as they suggest that GSCM promotes efficiency in terms of less processes involved, shortening the supply chain, but also freeing up capacity regarding people and available time. This can be the key for the personnel to focus on other projects as well.

However, there is reported as well, points that could bring a negative impact on the operational performance, as they may be more vulnerable to disruption during the implementation, as it is a big change (Handfield et al., 2005) or based on the fact that GSCM as a concept complies with less suppliers, thus hurting the flexibility of the firm (Svensson, 2007). Those points were not found in the interviews, thus not showing any relation with German manufacturing companies, as they seem to have achieved some level of adaptability and flexibility, by enabling product modularity and having active change management. Only one participant, working for a pharmaceutical company stated a negative point, about the lead times, as the material is not easy to access and the strict framework of GSCM causes delays. That was not found in the literature though. This may have to do with the special characteristics of the specific industry that operates with tighter lead times, in comparison with the other industries, as their product expires. That is not the case for the rest of the participants that are operating with hardware products.

## **Chapter 6: Conclusion, research implications, limitations and future research**

### **6.1 Research introduction**

The objective of this chapter is to highlight practical and theoretical implications from the literature review. Moreover, the limitations of the study are reported here, alongside the future research suggestion.

### **6.2 Theoretical and practical contributions**

This research offers insight into the GSCM concept and more specifically about the drivers, challenges to implement it and the impact that it may have on the firm's performance with the goal of improving their organization. From a theoretical perspective, this dissertation enriches the research about the value of GSCM implementation in the manufacturing sector and the relationship between GSCM and the firm's performance. From the practical point of view, this thesis provides a comprehensive information about the implementation of this strategy, trying to highlight the practices and the potential benefits of them. However, this study relates to the GSCM implementation in the German manufacturing context and this can help the companies identify whether GSCM fits their development plan and what they shall expect regarding potential benefits or challenges, if it is decided to be put into practice.

Nowadays, the environmental crisis is deep and there is the need, based on the various legislations as well, for the manufacturing companies to alter their processes, to adjust and change to a more sustainable model. However, the manufacturing companies cannot afford to sacrifice their financial sustainability and operational efficiency, in order to be environmentally sustainable, as otherwise they could not be able to operate anymore. Therefore, there is an actual need of a supply chain concept that has the potential to bring positive results on all these aspects of the performance of a firm. These positive results can be achieved by implementing the principles of GSCM. GSCM is defined as a concept that addresses environmental and financial issues, while operating with high efficiency across the supply chain (Laari, 2016).

Implementing GSCM, alters the processes and the supply chain significantly, as it is a concept that starts from the early stages of designing a product and goes all the way on how to deal with a product after the end of its life. It can have a direct positive impact on the environmental performance of the company, as the practices aim to reduce pollution and resources used, while finding alternatives that are green and sustainable. Simultaneously though, it does not

underestimate the financial sustainability, as the environmental savings, go hand-to-hand with the financial costs savings, as it was presented in the findings of the research. In addition, there appears to be room for increased profitability, based on the fact that the reuse of products, can reclaim some of their value and the brand reputation is enhanced. Operationally, one of the key principles of GSCM, is to avoid unnecessary processes that do not add value to the product, thus increasing the efficiency and the quality.

One important aspect though is to implement it as holistically as possible, so that they experience the positive impact of GSCM. The most significant challenge to do it though, are the high investment costs. That is why, it is crucial to secure the support of the top management and investors, in order to implement it and be able to finance these changes. From their side, the upper management, has certain expectations, that often revolve mainly around the financial sustainability of the firm, so in order to persuade them to invest a massive amount of money, the manager needs to be well-educated. As the concept is relatively new, it is pivotal to educate the personnel about it, because otherwise it cannot be successful. In terms of drivers to be more sustainable, there are the stricter legislations, such as the Paris Agreement, that sets minimum expectations that the countries shall meet. However, it may also be an opportunity to upgrade the organization, as there are also performance benefits that lie ahead, if GSCM is implemented correctly.

### **6.3 Limitations and future research**

This dissertation provides an overview of the implementation of GSCM for the manufacturing companies in Germany. However, this research has potential limitations which can act as the triggering event for future research. Initially, one limitation is the selected industry in this case, which covers only a part of the businesses. In order to have a more holistic view, it is crucial to be analysed other industries as well, such as the construction industry. That is why researchers can focus also on other industries as well, with different characteristics. Moreover, another limitation relates with the country selected, as Germany is a developed country and a pioneer, when it comes to manufacturing, thus giving those companies the chance to be more eager to invest and change. Moreover, the various stakeholders have different expectations, demands and awareness, in comparison with other countries. Hence, researchers can focus also on other countries, that may not be so developed when it comes to issues, such as sustainability and being green. In addition to that, a worth-mentioning limitation is the research method itself, as it was qualitative, thus having a smaller sample and not a broad gathered information. This limitation, could be resolved, especially as the GSCM gets more implemented in the future, by conducting quantitative researches with data collected by surveys, hence guaranteeing a more accurate result. Finally, it should not be underestimated the fact that many participants in such researches, have the tendency not to reveal all the weaknesses that their company may have, thus affecting the research findings.



## 6.4 Conclusion

To sum up, it is evident that being sustainable, is a concept that gains more and more followers in today's world. The companies aim to be greener, not only for the environmental benefits that come with it, but also for the financial opportunities and the operational efficiency. This study explored the different GSCM practices, alongside challenges to implement them. It was further analysed the impact that such an implementation may have on the corporate performance on an environmental, financial and operational level. As the case here was the GSCM implementation in manufacturing companies in Germany, 11 interviews with specialists were conducted and the challenges and impact on the performance, together with the benefits, were recognized. It was highlighted that GSCM in Germany, can be implemented successfully as the country seems to be supportive for such ideas and the companies have the opportunity to experience the various benefits that come with it.

## References

- Abbasi, M., & Nilsson, F. (2012). Themes and challenges in making freight Transport sustainable: A logistics service providers' perspective. *RePEc: Research Papers in Economics*. <https://doi.org/10.22004/ag.econ.207087>
- Abualigah, L., Hanandeh, E. S., Zitar, R. A., Cuong-Le, T., Khatir, S., & Gandomi, A. H. (2023). Revolutionizing sustainable supply chain management: A review of metaheuristics. *Engineering Applications of Artificial Intelligence*, 126, 106839. <https://doi.org/10.1016/j.engappai.2023.106839>
- Ahmed, V., Opoku, A., & Aziz, Z. (2016). *Research Methodology in the Built Environment: A Selection of Case Studies* [Google Books]. Routledge.
- Alcaráz, J. L. G., Reza, J. R. D., Arredondo-Soto, K. C., Hernández-Escobedo, G., Happonen, A., Puig, R., & Jiménez-Macías, E. (2022). Effect of green supply chain management practices on environmental performance: case of Mexican manufacturing companies. *Mathematics*, 10(11), 1877. <https://doi.org/10.3390/math10111877>
- Alharahsheh, H. H., & Pius, A. (2020). A Review of key paradigms: positivism VS interpretivism. *Global Academic Journal of Humanities and Social Sciences*, 2(3), 39–43. <https://doi.org/10.36348/gajhss.2020.v02i03.001>
- Alvi, M. (2016). A manual for selecting sampling techniques in research. MPRA Paper. <https://ideas.repec.org/p/pramprapa/70218.html>
- Am, J. B., Doshi, V., Noble, S., & Malik, A. (2023, February 6). Consumers care about sustainability—and back it up with their wallets. McKinsey & Company. <https://www.mckinsey.com/industries/consumer-packaged-goods/our-insights/consumers-care-about-sustainability-and-back-it-up-with-their-wallets>
- Amemba, C. S., Nyaboke, P., Osoro, A., & Mburu, N. (2013). Elements of green supply chain management. *European Journal of Business and Management*, 5(12), 51–61. [http://pakacademicsearch.com/pdf-files/ech/517/51-61%20Vol%205,%20No%2012%20\(2013\).pdf](http://pakacademicsearch.com/pdf-files/ech/517/51-61%20Vol%205,%20No%2012%20(2013).pdf)
- Ardakani, D. A., Soltanmohammadi, A., & Seuring, S. (2022). The impact of customer and supplier collaboration on green supply chain performance. *Benchmarking: An International Journal*, 30(7), 2248–2274. <https://doi.org/10.1108/bij-12-2020-0655>
- Astawa, I. K., Pirzada, K., Budarma, I. K., Widhari, C. I. S., & Suardani, A. a. P. (2021). THE EFFECT OF GREEN SUPPLY CHAIN MANAGEMENT PRACTICES ON THE COMPETITIVE ADVANTAGES AND ORGANIZATIONAL PERFORMANCE. *Polish Journal of Management Studies*, 24(1), 45–60. <https://doi.org/10.17512/pjms.2021.24.1.03>
- Ates, A., & Bititci, U. (2011). Change process: a key enabler for building resilient SMEs. *International Journal of Production Research*, 49(18), 5601–5618. <https://doi.org/10.1080/00207543.2011.563825>
- Ayres, L. (2007). Qualitative Research Proposals—Part II. *Journal of Wound Ostomy and Continence Nursing*, 34(2), 131–133. <https://doi.org/10.1097/01.won.0000264823.57743.5f>



- Azevedo, S. G., Carvalho, H., & Cruz-Machado, V. (2011). The influence of green practices on supply chain performance: A case study approach. *Transportation Research Part E: Logistics and Transportation Review*, 47(6), 850–871. <https://doi.org/10.1016/j.tre.2011.05.017>
- Baah, C., Acquah, I. S. K., & Ofori, D. (2021). Exploring the influence of supply chain collaboration on supply chain visibility, stakeholder trust, environmental and financial performances: a partial least square approach. *Benchmarking: An International Journal*, 29(1), 172–193. <https://doi.org/10.1108/bij-10-2020-0519>
- Backman, K., & Kyngäs, H. (1999). Challenges of the grounded theory approach to a novice researcher. *Nursing & Health Sciences*, 1(3), 147–153. <https://doi.org/10.1046/j.1442-2018.1999.00019.x>
- Bai, C., & Şatır, A. (2020). Barriers for green supplier development programs in manufacturing industry. *Resources, Conservation and Recycling*, 158, 104756. <https://doi.org/10.1016/j.resconrec.2020.104756>
- Barrett, D., & Twycross, A. (2018). Data collection in qualitative research. *Evidence-Based Nursing*, 21(3), 63–64. <https://doi.org/10.1136/eb-2018-102939>
- Bloor, M., & Wood, F. (2006). *Keywords in qualitative methods: A Vocabulary of Research Concepts*. SAGE Publications Limited.
- BMWK - Federal Ministry for Economics Affairs and Climate Action. (n.d.). A modern industrial policy. <https://www.bmwk.de/Redaktion/EN/Dossier/modern-industry-policy.html>
- Bowen, F., Cousins, P. D., Lamming, R., & Farukt, A. C. (2009). THE ROLE OF SUPPLY MANAGEMENT CAPABILITIES IN GREEN SUPPLY. *Production and Operations Management*, 10(2), 174–189. <https://doi.org/10.1111/j.1937-5956.2001.tb00077.x>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Brinkmann, S. (2014). Unstructured and semi-structured interviewing. *The Oxford handbook of qualitative research*, 2, 277-299.
- Brown, K., Willis, P., & Prussia, G. E. (2000). Predicting safe employee behaviour in the steel industry: Development and test of a sociotechnical model. *Journal of Operations Management*, 18(4), 445–465. [https://doi.org/10.1016/s0272-6963\(00\)00033-4](https://doi.org/10.1016/s0272-6963(00)00033-4)
- Çankaya, S. Y., & Sezen, B. (2019). Effects of green supply chain management practices on sustainability performance. *Journal of Manufacturing Technology Management*, 30(1), 98–121. <https://doi.org/10.1108/jmtm-03-2018-0099>
- Carter, C.R. and Ellram, L.M. (1998). Reverse logistics: a review of the literature and framework for future investigation. *Journal of Business Logistics*, 19, 85–102.
- Carter, C. R., & Rogers, D. S. (2008). A framework of sustainable supply chain management: moving toward new theory. *International Journal of Physical Distribution & Logistics Management*, 38(5), 360–387. <https://doi.org/10.1108/09600030810882816>
- Chang, N., & Fong, C. (2010). Green product quality, green corporate image, green customer satisfaction, and green customer loyalty. *African Journal of Business Management*, 4(13), 2836–2844. <https://doi.org/10.5897/ajbm.9000310>
- Chien, M., & Shih, L. (2007). Relationship between management practice and organisation performance under European Union directives such as RoHS: A case-study of the electrical and electronic industry in Taiwan. *African Journal of Environmental Science and Technology*, 1(3), 37–48. <https://doi.org/10.5897/ajest.9000091>

- Choi, S., Min, H., Joo, H., & Choi, H. (2016). Assessing the impact of green supply chain practices on firm performance in the Korean manufacturing industry. *International Journal of Logistics*, 20(2), 129–145. <https://doi.org/10.1080/13675567.2016.1160041>
- Christophe Rizet, Antoine Montenon (2018). Reducing Freight Transport Pollution by using electric vehicles. TAP 2016 : 21st International Transport and Air Pollution Conference, May 2016, Lyon, France. 15p. fffal-01783526f
- Cicconi, P. (2020). Eco-design and Eco-materials: An interactive and collaborative approach. *Sustainable Materials and Technologies*, 23, e00135. <https://doi.org/10.1016/j.susmat.2019.e00135>
- Cobern, W. W., & Adams, B. (2020). When interviewing: how many is enough? *International Journal of Assessment Tools in Education*, 7(1), 73–79. <https://doi.org/10.21449/ijate.693217>
- DeSantis, L., & Ugarriza, D. N. (2000). The concept of theme as used in qualitative nursing research. *Western Journal of Nursing Research*, 22(3), 351–372. <https://doi.org/10.1177/019394590002200308>
- Devetak, I., Glažar, S. A., & Vogrinc, J. (2010). The role of qualitative research in science education. *Eurasia Journal of Mathematics, Science and Technology Education*, 6(1). <https://doi.org/10.12973/ejmste/75229>
- Dheeraj, N., & Vishal, N. (2012). An Overview of Green Supply Chain Management in India. *Research Journal of Recent Sciences*. <http://www.isca.in/rjrs/archive/v1/i6/14.ISCA-RJRS-2012-130%20Done.pdf>
- Digalwar, A.K., & Metri, B.A. (2004). Performance Measurement Framework for World Class Manufacturing. *International Journal of Applied Management and Technology*, 3(2), 83-101. ISSN: 1554-4740([www.ijamt.org](http://www.ijamt.org)).
- Drei Viertel der Deutschen achten beim Einkaufen auf Nachhaltigkeit. (n.d.). <https://www.umweltdialog.de/de/verbraucher/lebensmittel/2016/Drei-Viertel-der-Deutschen-handeln-nachhaltig.php>
- Dube, A. S., & Gawande, R. S. (2016). Analysis of green supply chain barriers using integrated ISM-fuzzy MICMAC approach. *Benchmarking: An International Journal*, 23(6), 1558–1578. <https://doi.org/10.1108/bij-06-2015-0057>
- Dubey, R., Gunasekaran, A., & Παπαδόπουλος, Θ. (2017). Green supply chain management: theoretical framework and further research directions. *Benchmarking: An International Journal*, 24(1), 184–218. <https://doi.org/10.1108/bij-01-2016-0011>
- Eisenhardt, K. M. (1989). Building Theories from Case Study Research. *Academy of Management Review*, 14(4), 532–550. <https://doi.org/10.5465/amr.1989.4308385>
- Etikan, İ. (2017). Sampling and sampling methods. *Biometrics & Biostatistics International Journal*, 5(6). <https://doi.org/10.15406/bbij.2017.05.00149>
- Falck, O., & Heblich, S. (2007). Corporate social responsibility: Doing well by doing good. *Business Horizons*, 50(3), 247–254. <https://doi.org/10.1016/j.bushor.2006.12.002>
- Federal Environment Agency, Press Release 11/2023 from March 15, 2023; gross value added: Federal Statistical Office of Germany 2023, Inlandsproduktberechnung - Lange Reihen ab 1970, FS 18, R 1.5 - Tabelle 2.2
- Feng, M., Yu, W., Wang, X., Wong, C. Y., Xu, M., & Xiao, Z. (2018). Green supply chain management and financial performance: The mediating roles of operational and environmental performance. *Business Strategy and the Environment*, 27(7), 811–824. <https://doi.org/10.1002/bse.2033>

- Fianko, S. K., Amoah, N., Afrifa, S., & Dzogbewu, T. C. (2021). Green Supply Chain Management and Environmental Performance: The moderating role of Firm Size. *International Journal of Industrial Engineering and Management*, 12(3), 163–173. <https://doi.org/10.24867/ijiem-2021-3-285>
- Foo, P. Y., Lee, V., Tan, G. W., & Ooi, K. (2018). A gateway to realising sustainability performance via green supply chain management practices: A PLS–ANN approach. *Expert Systems With Applications*, 107, 1–14. <https://doi.org/10.1016/j.eswa.2018.04.013>
- Gallo, M., Romano, E., & Santillo, L. C. (2012). A perspective on Remanufacturing Business: Issues and opportunities. In *InTech eBooks*. <https://doi.org/10.5772/48103>
- Geffen, C., & Rothenberg, S. (2000). Suppliers and environmental innovation. *International Journal of Operations & Production Management*, 20(2), 166–186. <https://doi.org/10.1108/01443570010304242>
- Ghobakhloo, M., Tang, S. H., Zulkifli, N., & Ariffin, M. K. a. M. (2013). An Integrated Framework of Green Supply Chain Management Implementation. *International Journal of Innovation, Management and Technology*. <http://ijimt.org/papers/364-K3001.pdf>
- Ghosh, M. (2019). Determinants of green procurement implementation and its impact on firm performance. *Journal of Manufacturing Technology Management*, 30(2), 462–482. <https://doi.org/10.1108/jmtm-06-2018-0168>
- Goicoechea, Itziar & Fenollera, Maria, (2012). Quality Management in the Automotive Industry, Chapter 51 in DAAAM, *International Scientific Book 2012*, pp. 619-632, B. Katalinic (Ed.), Published by DAAAM International, ISBN 978-3-901509-86-5, ISSN 1726-9687, Vienna, Austria, DOI:10.2507/daaam.scibook.2012.51
- Golafshani, N. (2015). Understanding reliability and validity in qualitative research. *The Qualitative Report*. <https://doi.org/10.46743/2160-3715/2003.1870>
- Gong, M., Gao, Y., Koh, L., Sutcliffe, C., & Cullen, J. B. (2019). The role of customer awareness in promoting firm sustainability and sustainable supply chain management. *International Journal of Production Economics*, 217, 88–96. <https://doi.org/10.1016/j.ijpe.2019.01.033>
- González-Benito, J., & González-Benito, Ó. (2005). Environmental proactivity and business performance: an empirical analysis. *Omega*, 33(1), 1–15. <https://doi.org/10.1016/j.omega.2004.03.002>
- Govindan, K., Mathiyazhagan, K., Kannan, D., & Haq, A. N. (2014). Barriers analysis for green supply chain management implementation in Indian industries using analytic hierarchy process. *International Journal of Production Economics*, 147, 555–568. <https://doi.org/10.1016/j.ijpe.2013.08.018>
- Govindan, K., Soleimani, H., & Kannan, D. (2015). Reverse logistics and closed-loop supply chain: A comprehensive review to explore the future. *European Journal of Operational Research*, 240(3), 603–626. <https://doi.org/10.1016/j.ejor.2014.07.012>
- Green, K. W., Zelbst, P. J., Meacham, J., & Bhadauria, V. S. (2012). Green supply chain management practices: impact on performance. *Supply Chain Management*, 17(3), 290–305. <https://doi.org/10.1108/13598541211227126>
- Guajardo, M. (2018). Environmental benefits of collaboration and allocation of emissions in road freight transportation. In *Operations research, computer science. Interface series* (pp. 79–98). [https://doi.org/10.1007/978-3-319-62917-9\\_6](https://doi.org/10.1007/978-3-319-62917-9_6)
- Guest, G., MacQueen, K. M., & Namey, E. (2012). *Applied Thematic Analysis*. <https://doi.org/10.4135/9781483384436>

- Gunasekaran, A., Patel, C., & McGaughey, R. E. (2004). A framework for supply chain performance measurement. *International Journal of Production Economics*, 87(3), 333–347. <https://doi.org/10.1016/j.ijpe.2003.08.003>
- Handfield, R., Sroufe, R., & Walton, S. V. (2005). Integrating environmental management and supply chain strategies. *Business Strategy and the Environment*, 14(1), 1–19. <https://doi.org/10.1002/bse.422>
- Hasan, M. (2013). Sustainable supply chain management practices and operational performance. *American Journal of Industrial and Business Management*, 03(01), 42–48. <https://doi.org/10.4236/ajibm.2013.31006>
- Herrmann, F. F., Barbosa-Póvoa, A. P., Butturi, M. A., Marinelli, S., & Sellitto, M. A. (2021). Green Supply Chain Management: Conceptual Framework and Models for analysis. *Sustainability*, 13(15), 8127. <https://doi.org/10.3390/su13158127>
- Hollos, D., Blome, C., & Foerstl, K. (2012). Does sustainable supplier co-operation affect performance? Examining implications for the triple bottom line. *International Journal of Production Research*, 50(11), 2968–2986. <https://doi.org/10.1080/00207543.2011.582184>
- Hong, P., Kwon, H., & Roh, J. J. (2009). Implementation of strategic green orientation in supply chain. *European Journal of Innovation Management*, 12(4), 512–532. <https://doi.org/10.1108/14601060910996945>
- Iqbal, M. W., Kang, Y., & Jeon, H. W. (2020). Zero waste strategy for green supply chain management with minimization of energy consumption. *Journal of Cleaner Production*, 245, 118827. <https://doi.org/10.1016/j.jclepro.2019.118827>
- Jayasinghe, R. S., Chileshe, N., & Rameezdeen, R. (2019). Information-based quality management in reverse logistics supply chain. *Benchmarking: An International Journal*, 26(7), 2146–2187. <https://doi.org/10.1108/bij-08-2018-0238>
- Johansson, G. (2002). Success factors for integration of ecodesign in product development. *Environmental Management and Health*, 13(1), 98–107. <https://doi.org/10.1108/09566160210417868>
- Khan, K. I., Babar, Z., Sharif, S., Iqbal, S., & Khan, M. I. (2021). Going green Investigating the role of GSCM practices on firm financial and environmental performance through green innovation. *International Journal of Procurement Management*, 14(6), 681. <https://doi.org/10.1504/ijpm.2021.117894>
- Khan, S. (2014). Qualitative research method: grounded theory. *International Journal of Business and Management*, 9(11). <https://doi.org/10.5539/ijbm.v9n11p224>
- Khan, S. a. R., & Dong, Q. (2017). Impact of green supply chain management practices on firms' performance: an empirical study from the perspective of Pakistan. *Environmental Science and Pollution Research*, 24(20), 16829–16844. <https://doi.org/10.1007/s11356-017-9172-5>
- Klassen, R. D., & McLaughlin, C. P. (1996). The impact of environmental management on firm performance. *Management Science*, 42(8), 1199–1214. <https://doi.org/10.1287/mnsc.42.8.1199>
- Klassen, R. D., & Whybark, D. C. (1999). THE IMPACT OF ENVIRONMENTAL TECHNOLOGIES ON MANUFACTURING PERFORMANCE. *Academy of Management Journal*, 42(6), 599–615. <https://doi.org/10.2307/256982>
- Kranz, J., Baur, A., & Möller, A. (2022). Learners' challenges in understanding and performing experiments: a systematic review of the literature. *Studies in Science Education*, 59(2), 321–367. <https://doi.org/10.1080/03057267.2022.2138151>



- Kumar, V., Sabri, S., Garza-Reyes, J. A., Nadeem, S. P., Kumari, A., & Akkarangoon, S. (2018). The challenges of GSCM implementation in the UK manufacturing SMEs. 2018 International Conference on Production and Operations Management Society (POMS). <https://doi.org/10.1109/poms.2018.8629449>
- Kurapatskie, B. C., & Darnall, N. (2012). Which Corporate Sustainability Activities are Associated with Greater Financial Payoffs? *Business Strategy and the Environment*, 22(1), 49–61. <https://doi.org/10.1002/bse.1735>
- Laari, S., Töyli, J., Solakivi, T., & Ojala, L. (2016). Firm performance and customer-driven green supply chain management. *Journal of Cleaner Production*, 112, 1960–1970. <https://doi.org/10.1016/j.jclepro.2015.06.150>
- Lai, K., & Wong, C. W. (2012). Green logistics management and performance: Some empirical evidence from Chinese manufacturing exporters. *Omega*, 40(3), 267–282. <https://doi.org/10.1016/j.omega.2011.07.002>
- Lakshman, M., Sinha, L., Biswas, M., Charles, M., & Nk, A. (2000). Quantitative Vs qualitative research methods. *Indian Journal of Pediatrics*, 67(5), 369–377. <https://doi.org/10.1007/bf02820690>
- Lee, S., & Klassen, R. D. (2008). Drivers and enablers that foster environmental management capabilities in Small- and Medium-Sized suppliers in supply chains. *Production and Operations Management*, 17(6), 573–586. <https://doi.org/10.3401/poms.1080.0063>
- Lee, V., Ooi, K., Chong, A. Y., & Seow, C. (2014). Creating technological innovation via green supply chain management: An empirical analysis. *Expert Systems With Applications*, 41(16), 6983–6994. <https://doi.org/10.1016/j.eswa.2014.05.022>
- Li, J., & Sarkis, J. (2021). Product eco-design practice in green supply chain management: a China-global examination of research. *Nankai Business Review International*, 13(1), 124–153. <https://doi.org/10.1108/nbri-02-2021-0006>
- Li, X., Liu, D., Zhang, Z., Cheng, T., Liu, L., & Yuan, J. (2022). The impact of internal and external green supply chain management activities on performance improvement: evidence from the automobile industry. *Heliyon*, 8(11), e11486. <https://doi.org/10.1016/j.heliyon.2022.e11486>
- Lintukangas, K., Kähkönen, A., & Ritala, P. (2016). Supply risks as drivers of green supply management adoption. *Journal of Cleaner Production*, 112, 1901–1909. <https://doi.org/10.1016/j.jclepro.2014.10.089>
- Locke, E. A. (2007). The case for inductive Theory building†. *Journal of Management*, 33(6), 867–890. <https://doi.org/10.1177/0149206307307636>
- Luthra, S., Kumar, V., Kumar, S., & Haleem, A. (2011). Barriers to implement green supply chain management in automobile industry using interpretive structural modeling technique: An Indian perspective. *Journal of Industrial Engineering and Management*, 4(2). <https://doi.org/10.3926/jiem.2011.v4n2.p231-257>
- MacIntosh, R., & O’Gorman, K. (2015). *Research methods for business and management. A guide to writing your dissertation*, 558.
- Mangla, S. K., Kumar, P., & Barua, M. K. (2015). Prioritizing the responses to manage risks in green supply chain: An Indian plastic manufacturer perspective. *Sustainable Production and Consumption*, 1, 67–86. <https://doi.org/10.1016/j.spc.2015.05.002>
- Masoumik, S. M., Abdul-Rashid, S. H., & Olugu, E. U. (2014). Gaining Competitive Advantage through Strategic Green Supply Chain Management: From a Literature Review towards a Conceptual Model.

- International Journal of Supply Chain Management, 3(3).  
[https://www.researchgate.net/profile/S\\_Maryam\\_Masoumik/publication/266376251\\_Gaining\\_Competitive\\_Advantage\\_through\\_Strategic\\_Green\\_Supply\\_Chain\\_Management\\_From\\_a\\_Literature\\_Review\\_towards\\_a\\_Conceptual\\_Model/links/542e16590cf277d58e8e98fb.pdf](https://www.researchgate.net/profile/S_Maryam_Masoumik/publication/266376251_Gaining_Competitive_Advantage_through_Strategic_Green_Supply_Chain_Management_From_a_Literature_Review_towards_a_Conceptual_Model/links/542e16590cf277d58e8e98fb.pdf)
- Mathers, N. J., Fox, N. J., & Hunn, A. (1998). Using interviews in a research project. NHS Executive, Trent.
- Mathiyazhagan, K., Diabat, A., Al-Refaie, A., & Xu, L. (2015). Application of analytical hierarchy process to evaluate pressures to implement green supply chain management. *Journal of Cleaner Production*, 107, 229–236. <https://doi.org/10.1016/j.jclepro.2015.04.110>
- Mathiyazhagan, K., Govindan, K., NoorulHaq, A., & Geng, Y. (2013). An ISM approach for the barrier analysis in implementing green supply chain management. *Journal of Cleaner Production*, 47, 283–297. <https://doi.org/10.1016/j.jclepro.2012.10.042>
- Mauthner, N. S. (2020). 12. Research philosophies and why they matter. *How to Keep your Doctorate on Track: Insights from Students' and Supervisors' Experiences*, 76.
- Menon, R. R., & Ravi, V. (2021). An analysis of barriers affecting implementation of sustainable supply chain management in electronics industry: a Grey-DEMATEL approach. *Journal of Modelling in Management*, 17(4), 1319–1350. <https://doi.org/10.1108/jm2-02-2021-0042>
- Merschmann, U., & Thonemann, U. W. (2011). Supply chain flexibility, uncertainty and firm performance: An empirical analysis of German manufacturing firms. *International Journal of Production Economics*, 130(1), 43–53. <https://doi.org/10.1016/j.ijpe.2010.10.013>
- Meythi, & Martusa, R. (2013). Green Supply Chain Management: Strategy to gain Competitive advantage. *Journal of Energy Technologies and Policy*, 3(11), 334–341. <https://repository.maranatha.edu/5602/>
- Min, H., & Kim, I. (2012). Green supply chain research: past, present, and future. *Logistics Research*, 4(1–2), 39–47. <https://doi.org/10.1007/s12159-012-0071-3>
- Mishra, A., Dutta, P., Jayasankar, S., Jain, P., & Mathiyazhagan, K. (2022). A review of reverse logistics and closed-loop supply chains in the perspective of circular economy. *Benchmarking: An International Journal*, 30(3), 975–1020. <https://doi.org/10.1108/bij-11-2021-0669>
- Mitra, S., & Datta, P. P. (2013). Adoption of green supply chain management practices and their impact on performance: an exploratory study of Indian manufacturing firms. *International Journal of Production Research*, 52(7), 2085–2107. <https://doi.org/10.1080/00207543.2013.849014>
- Mkansi, M., & Acheampong, E. A. (2012). Research philosophy debates and classifications: students' dilemma. *The Electronic Journal of Business Research Methods*, 10(2), 132. <https://academic-publishing.org/index.php/ejbrm/article/view/1295>
- Molina-Besch, K., & Pålsson, H. (2015). A Supply Chain Perspective on Green Packaging Development-Theory versus Practice. *Packaging Technology and Science*, 29(1), 45–63. <https://doi.org/10.1002/pts.2186>
- Muduli, K., Luthra, S., Mangla, S. K., Jabbour, C. J. C., Aich, S., & De Guimarães, J. C. F. (2020). Environmental management and the “soft side” of organisations: Discovering the most relevant behavioural factors in green supply chains. *Business Strategy and the Environment*, 29(4), 1647–1665. <https://doi.org/10.1002/bse.2459>

- Murray, J. C. (2000). Effects of a green purchasing strategy: the case of Belfast City Council. *Supply Chain Management*, 5(1), 37–44. <https://doi.org/10.1108/13598540010312954>
- Narasimhan, R., & Das, A. (2001). The impact of purchasing integration and practices on manufacturing performance. *Journal of Operations Management*, 19(5), 593–609. [https://doi.org/10.1016/s0272-6963\(01\)00055-9](https://doi.org/10.1016/s0272-6963(01)00055-9)
- Ninlawan, C., Seksan, P., Tossapol, K., & Pilada, W. (2010). The Implementation of Green Supply Chain Management Practices in Electronics Industry. *Proceedings of the International MultiConference of Engineers and Computer Scientists*, 3, 3.
- Nishitani, K. (2009). An empirical study of the initial adoption of ISO 14001 in Japanese manufacturing firms. *Ecological Economics*, 68(3), 669–679. <https://doi.org/10.1016/j.ecolecon.2008.05.023>
- Nusa, F. N. M., Isa, C. M. M., Rahman, S. H. A., Tarudin, N. F., Mohamad, N. D., Soffi, N. S. M., Mohamad, M. M., Fam, S. F., & Preece, C. N. (2023). The challenges of green supply chain management (GSCM) system implementation in civil construction project. *IOP Conference Series: Earth and Environmental Science*, 1151(1), 012011. <https://doi.org/10.1088/1755-1315/1151/1/012011>
- Onyango, M. B., Nyaoga, R. B., Matwere, R. B., & Owuor, O. J. (2014). Green Supply Chain Management and Economic Performance: A Review of Tea Processing Firms in Kericho and Bomet Counties, Kenya. *International Journal of Science and Research*, 3(11), 2463–2464.
- Orlitzky, M., Schmidt, F. L., & Rynes, S. L. (2003). Corporate Social and Financial Performance: A Meta-Analysis. *Organization Studies*, 24(3), 403–441. <https://doi.org/10.1177/0170840603024003910>
- Ottman, J., Stafford, E. R., & Hartman, C. L. (2006). Avoiding Green Marketing Myopia: Ways to improve consumer appeal for environmentally preferable products. *Environment*, 48(5), 22–36. <https://doi.org/10.3200/envt.48.5.22-36>
- Phillis, Y. A., Grigoroudis, E., & Kouikoglou, V. S. (2011). Sustainability ranking and improvement of countries. *Ecological Economics*, 70(3), 542–553. <https://doi.org/10.1016/j.ecolecon.2010.09.037>
- Pigosso, D. C. A., Rozenfeld, H., & McAloone, T. C. (2013). Ecodesign maturity model: a management framework to support ecodesign implementation into manufacturing companies. *Journal of Cleaner Production*, 59, 160–173. <https://doi.org/10.1016/j.jclepro.2013.06.040>
- Pinto, L. (2020). Green supply chain practices and company performance in Portuguese manufacturing sector. *Business Strategy and the Environment*, 29(5), 1832–1849. <https://doi.org/10.1002/bse.2471>
- Plastic waste and recycling in the EU: facts and figures | News | European Parliament. (n.d.). [https://www.europarl.europa.eu/news/en/headlines/society/20181212STO21610/plastic-waste-and-recycling-in-the-eu-facts-and-figures?at\\_campaign=20234-Economy&at\\_medium=Google Ads&at\\_platform=Search&at\\_creation=RSA&at\\_goal=TR\\_G&at\\_audience=plastic%20waste%20statistics&at\\_topic=Plastic Waste&at\\_location=DE&gclid=EAIaIQobChMIr8CNyZ6PggMvRjGDBx0Tfgb2EAMYASAAEgIwPPD\\_BwE](https://www.europarl.europa.eu/news/en/headlines/society/20181212STO21610/plastic-waste-and-recycling-in-the-eu-facts-and-figures?at_campaign=20234-Economy&at_medium=Google Ads&at_platform=Search&at_creation=RSA&at_goal=TR_G&at_audience=plastic%20waste%20statistics&at_topic=Plastic Waste&at_location=DE&gclid=EAIaIQobChMIr8CNyZ6PggMvRjGDBx0Tfgb2EAMYASAAEgIwPPD_BwE)
- Porter, M. E., & Van Der Linde, C. (1995). Green and competitive: ending the stalemate. *Long Range Planning*, 28(6), 128–129. [https://doi.org/10.1016/0024-6301\(95\)99997-e](https://doi.org/10.1016/0024-6301(95)99997-e)
- Preuss, L. (2001). In Dirty Chains? Purchasing and Greener Manufacturing. *Journal of Business Ethics* Volume, 34(3–4), 345–359. <https://doi.org/10.1023/A:1012549318786>
- Psomas, E., Fotopoulos, C., & Kafetzopoulos, D. (2011). Core process management practices, quality tools and quality improvement in ISO 9001 certified manufacturing companies. *Business Process Management Journal*, 17(3), 437–460. <https://doi.org/10.1108/14637151111136360>

- Rahman, T., Ali, S. M., Moktadir, M. A., & Kusi-Sarpong, S. (2019). Evaluating barriers to implementing green supply chain management: An example from an emerging economy. *Production Planning & Control*, 31(8), 673–698. <https://doi.org/10.1080/09537287.2019.1674939>
- Rao, P., & Holt, D. (2005). Do green supply chains lead to competitiveness and economic performance? *International Journal of Operations & Production Management*, 25(9), 898–916. <https://doi.org/10.1108/01443570510613956>
- Revell, A., & Rutherford, R. (2003). UK environmental policy and the small firm: broadening the focus. *Business Strategy and the Environment*, 12(1), 26–35. <https://doi.org/10.1002/bse.347>
- Roehrich, J., Hojmosse, S., & Overland, V. (2017). Driving green supply chain management performance through supplier selection and value internalisation: A Self-Determination Theory Perspective. *Social Science Research Network*. [https://papers.ssrn.com/sol3/Delivery.cfm/SSRN\\_ID2955125\\_code1871544.pdf?abstractid=2955125&mirid=1](https://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID2955125_code1871544.pdf?abstractid=2955125&mirid=1)
- Roopa, S., & Rani, R. R. R. (2012). Questionnaire designing for a survey. *The Journal of Indian Orthodontic Society*, 46, 273–277. <https://doi.org/10.5005/jp-journals-10021-1104>
- Rowley, J. (2002). Using case studies in research. *Management Research News*, 25(1), 16–27. <https://doi.org/10.1108/01409170210782990>
- Rowley, J. (2012). Conducting research interviews. *Management Research Review*, 35(3/4), 260–271. <https://doi.org/10.1108/01409171211210154>
- Saada, R. (2021). Green transportation in green supply chain management. In IntechOpen eBooks. <https://doi.org/10.5772/intechopen.93113>
- Salam M.A., (2008) “Green procurement adoption in manufacturing supply chain,” Proceedings of the 9th Asia Pasific Industrial Engineering & Management Systems Conference (APIEMS2008), Indonesia, pp.1253-1260.
- Sangode, P. B., & Tjprc. (2019). Green Supply Chain Practices for Environmental Sustainability A Proposed Framework for Manufacturing Firms. *International Journal of Mechanical and Production Engineering Research and Development*, 9(2), 287–298. <https://doi.org/10.24247/ijmperdapr201928>
- Sarkis, J. (2003). A strategic decision framework for green supply chain management. *Journal of Cleaner Production*, 11(4), 397–409. [https://doi.org/10.1016/s0959-6526\(02\)00062-8](https://doi.org/10.1016/s0959-6526(02)00062-8)
- Sarkis, J. (2012). A boundaries and flows perspective of green supply chain management. *Supply Chain Management*, 17(2), 202–216. <https://doi.org/10.1108/13598541211212924>
- Sarkis, J., Zhu, Q., & Lai, K. (2011). An organizational theoretic review of green supply chain management literature. *International Journal of Production Economics*, 130(1), 1–15. <https://doi.org/10.1016/j.ijpe.2010.11.010>
- Saruchera, F., & Asante-Darko, D. (2021). Reverse logistics, organizational culture and firm operational performance: Some empirical evidence. *Business Strategy and Development*, 4(3), 326–342. <https://doi.org/10.1002/bsd2.161>
- Saunders, M. N. K., Bristow, A., Thornhill, A., & Lewis, P. (2015). Understanding research philosophy and approaches to theory development. In Pearson Education eBooks. <http://oro.open.ac.uk/53393/>
- Saunders, M. N. K., Lewis, P., & Thornhill, A. (2019). Research methods for business students, 8th ed. In Pearson eBooks. <http://dspace.uniten.edu.my/handle/123456789/18304>

- Seman, N. a. A., Govindan, K., Mardani, A., Zakuan, N., Saman, M. Z. M., Hooker, R. E., & Ozkul, S. (2019). The mediating effect of green innovation on the relationship between green supply chain management and environmental performance. *Journal of Cleaner Production*, 229, 115–127. <https://doi.org/10.1016/j.jclepro.2019.03.211>
- Seuring, S., & Müller, M. (2008). From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production*, 16(15), 1699–1710. <https://doi.org/10.1016/j.jclepro.2008.04.020>
- Shah, A. U., & Siddiqui, D. A. (2019). Customers' driven green supply management and organization performance. *Global Disclosure of Economics and Business*. <https://doi.org/10.18034/gdeb.v8i2.99>
- Shaik, M. N., & Abdul-Kader, W. (2012). Performance measurement of reverse logistics enterprise: a comprehensive and integrated approach. *Measuring Business Excellence*, 16(2), 23–34. <https://doi.org/10.1108/13683041211230294>
- Sørensen, F., Mattsson, J., & Sundbo, J. (2010). Experimental methods in innovation research. *Research Policy*, 39(3), 313–322. <https://doi.org/10.1016/j.respol.2010.01.006>
- Sreejith, Balasubramanian, (2012): A hierarchical framework of barriers to green supply chain management in the construction sector 2012, 15-27. <https://ro.uow.edu.au/dubaipapers/569>
- Srivastava, S. K. (2007). Green supply-chain management: A state-of-the-art literature review. *International Journal of Management Reviews*, 9(1), 53–80. <https://doi.org/10.1111/j.1468-2370.2007.00202.x>
- Sroufe, R. (2009). EFFECTS OF ENVIRONMENTAL MANAGEMENT SYSTEMS ON ENVIRONMENTAL MANAGEMENT PRACTICES AND OPERATIONS. *Production and Operations Management*, 12(3), 416–431. <https://doi.org/10.1111/j.1937-5956.2003.tb00212.x>
- Statista Search Department (2023 Germany: Share of economic sectors in gross domestic product (GDP) in 2022 [Infographic]. Statista. <https://www.statista.com/statistics/295519/germany-share-of-economic-sectors-in-gross-domestic-product/>
- Stiles, W. B. (1993). Quality control in qualitative research. *Clinical Psychology Review*, 13(6), 593–618. [https://doi.org/10.1016/0272-7358\(93\)90048-q](https://doi.org/10.1016/0272-7358(93)90048-q)
- Sundar, R., Balaji, A., & Kumar, R. (2014). A review on lean manufacturing implementation techniques. *Procedia Engineering*, 97, 1875–1885. <https://doi.org/10.1016/j.proeng.2014.12.341>
- Susanty, A., Sari, D. P., Rinawati, D. I., & Setiawan, L. (2019). The role of internal and external drivers for successful implementation of GSCM practices. *Journal of Manufacturing Technology Management*, 30(2), 391–420. <https://doi.org/10.1108/jmtm-07-2018-0217>
- Svensson, G. (2007). Aspects of sustainable supply chain management (SSCM): conceptual framework and empirical example. *Supply Chain Management*, 12(4), 262–266. <https://doi.org/10.1108/13598540710759781>
- Taherdoost, H. (2016). How to Design and Create an Effective Survey/Questionnaire; A Step by Step Guide. HAL (Le Centre Pour La Communication Scientifique Directe). <https://hal.archives-ouvertes.fr/hal-02546800>
- Tan, X., Liu, F., Cao, H. J., & Zhang, H. (2002). A decision-making framework model of cutting fluid selection for green manufacturing and a case study. *Journal of Materials Processing Technology*, 129(1–3), 467–470. [https://doi.org/10.1016/s0924-0136\(02\)00614-3](https://doi.org/10.1016/s0924-0136(02)00614-3)

- Tassabehji, R., & Moorhouse, A. J. (2008). The changing role of procurement: Developing professional effectiveness. *Journal of Purchasing and Supply Management*, 14(1), 55–68. <https://doi.org/10.1016/j.pursup.2008.01.005>
- UDDIN, M. (2021). Exploring Environmental Performance and the Competitive Advantage of Manufacturing Firms: A Green Supply Chain Management Perspective. *Int. Journal of Economics And Management*, 2(15), 219–239.
- Vachon, S., & Klassen, R. D. (2008). Environmental management and manufacturing performance: The role of collaboration in the supply chain. *International Journal of Production Economics*, 111(2), 299–315. <https://doi.org/10.1016/j.ijpe.2006.11.030>
- Vaismoradi, M., Turunen, H., & Bondas, T. (2013). Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nursing & Health Sciences*, 15(3), 398–405. <https://doi.org/10.1111/nhs.12048>
- Van Weenen, J. (1995). Towards sustainable product development. *Journal of Cleaner Production*, 3(1–2), 95–100. [https://doi.org/10.1016/0959-6526\(95\)00062-j](https://doi.org/10.1016/0959-6526(95)00062-j)
- Wagner, H. R., Glaser, B. G., & Strauss, A. L. (1968). The Discovery of Grounded Theory: Strategies for Qualitative Research. *Social Forces*, 46(4), 555. <https://doi.org/10.2307/2575405>
- Walker, H., Di Sisto, L., & McBain, D. (2008). Drivers and barriers to environmental supply chain management practices: Lessons from the public and private sectors. *Journal of Purchasing and Supply Management*, 14(1), 69–85. <https://doi.org/10.1016/j.pursup.2008.01.007>
- Wandosell, G., Parra-Meroño, M. C., Alcayde, A., & Montoya, F. G. (2021). Green Packaging from Consumer and Business Perspectives. *Sustainability*, 13(3), 1356. <https://doi.org/10.3390/su13031356>
- Wiendahl, H., & Scholtissek, P. (1994). Management and control of complexity in manufacturing. *CIRP Annals*, 43(2), 533–540. [https://doi.org/10.1016/s0007-8506\(07\)60499-5](https://doi.org/10.1016/s0007-8506(07)60499-5)
- Wilke, S. (n.d.-a). “Grüne” Produkte: Marktzahlen. Umweltbundesamt. <https://www.umweltbundesamt.de/daten/private-haushalte-konsum/konsum-produkte/gruene-produkte-marktzahlen#marktanteile-gruner-produkte>
- Wilke, S. (n.d.-b). Indicator: Greenhouse gas emissions in industry. Umweltbundesamt. <https://www.umweltbundesamt.de/en/data/environmental-indicators/indicator-greenhouse-gas-emissions-industry#at-a-glance>
- Wilson, J. (2010). *Essentials of Business Research: A guide to doing your research project*. <http://ci.nii.ac.jp/ncid/BB17375133>
- Woiceshyn, J., & Daellenbach, U. (2018). Evaluating inductive vs deductive research in management studies. *Qualitative Research in Organizations and Management: An International Journal*, 13(2), 183–195. <https://doi.org/10.1108/qrom-06-2017-1538>
- Wright, R., Kanter, R. M., Stein, B. A., & Jick, T. D. (1993). The challenge of organizational change: how companies experience it and leaders guide it. *Contemporary Sociology*, 22(5), 718. <https://doi.org/10.2307/2074647>
- Wu, D., Yang, L., & Olson, D. L. (2019). Green supply chain management under capital constraint. *International Journal of Production Economics*, 215, 3–10. <https://doi.org/10.1016/j.ijpe.2018.09.016>
- Wycherley, I. (1999). Greening supply chains: the case of The Body Shop International. *Business Strategy and the Environment*, 8(2), 120–127. [https://doi.org/10.1002/\(sici\)1099-0836\(199903/04\)8:2](https://doi.org/10.1002/(sici)1099-0836(199903/04)8:2)



- Yang, C., Lu, C., Haider, J., & Marlow, P. B. (2013). The effect of green supply chain management on green performance and firm competitiveness in the context of container shipping in Taiwan. *Transportation Research Part E: Logistics and Transportation Review*, 55, 55–73. <https://doi.org/10.1016/j.tre.2013.03.005>
- Younis, H., & Sundarakani, B. (2019). The impact of firm size, firm age and environmental management certification on the relationship between green supply chain practices and corporate performance. *Benchmarking: An International Journal*, 27(1), 319–346. <https://doi.org/10.1108/bij-11-2018-0363>
- Younis, H., Sundarakani, B., & Vel, P. (2016). The impact of implementing green supply chain management practices on corporate performance. *Competitiveness Review*, 26(3), 216–245. <https://doi.org/10.1108/cr-04-2015-0024>
- Yu, W., Chávez, R., Feng, M., & Wiengarten, F. (2014). Integrated green supply chain management and operational performance. *Supply Chain Management*, 19(5/6), 683–696. <https://doi.org/10.1108/scm-07-2013-0225>
- Yu, Y., Zhang, M., & Huo, B. (2017). The impact of supply chain quality integration on green supply chain management and environmental performance. *Total Quality Management & Business Excellence*, 30(9–10), 1110–1125. <https://doi.org/10.1080/14783363.2017.1356684>
- Zaabi, S. A., Dhaheri, N. A., & Diabat, A. (2013). Analysis of interaction between the barriers for the implementation of sustainable supply chain management. *The International Journal of Advanced Manufacturing Technology*, 68(1–4), 895–905. <https://doi.org/10.1007/s00170-013-4951-8>
- Zailani, S. (2009). Going Green In Supply Chain Towards Environmental Sustainability. *Global Journal of Environmental Research*, 3(3), 246–251. <https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=eea2a5117b43a4cfd1f3c8a36452c0d5f57291c8>
- Zainal, Z. (2007). Case study as a research method. *Journal Kemanusiaan bil*, [online] 5(1), p.352. Available at: <<https://jurnalkemanusiaan.utm.my/index.php/kemanusiaan/article/view/165>>.
- Zhang, Q., Gao, B., & Luqman, A. (2022). Linking green supply chain management practices with competitiveness during covid 19: The role of big data analytics. *Technology in Society*, 70, 102021. <https://doi.org/10.1016/j.techsoc.2022.102021>
- Zhu, Q. (2009). Empirical Study on Practices and Performances of Green Purchasing among Manufacturing Enterprises. *Chinese Journal of Management*. [http://en.cnki.com.cn/Article\\_en/CJFDTOTAL-GLXB200907013.htm](http://en.cnki.com.cn/Article_en/CJFDTOTAL-GLXB200907013.htm)
- Zhu, Q., & Sarkis, J. (2004). Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. *Journal of Operations Management*, 22(3), 265–289. <https://doi.org/10.1016/j.jom.2004.01.005>
- Zhu, Q., Sarkis, J., & Geng, Y. (2005). Green supply chain management in China: pressures, practices and performance. *International Journal of Operations & Production Management*, 25(5), 449–468. <https://doi.org/10.1108/01443570510593148>
- Zhu, Q., Sarkis, J., & Lai, K. (2008). Green supply chain management implications for “closing the loop.” *Transportation Research Part E: Logistics and Transportation Review*, 44(1), 1–18. <https://doi.org/10.1016/j.tre.2006.06.003>
- Zhu, Q., Sarkis, J., & Lai, K. (2012). Examining the effects of green supply chain management practices and their mediations on performance improvements. *International Journal of Production Research*, 50(5), 1377–1394. <https://doi.org/10.1080/00207543.2011.571937>



Zhu, Q., Sarkis, J., & Lai, K. (2013). Institutional-based antecedents and performance outcomes of internal and external green supply chain management practices. *Journal of Purchasing and Supply Management*, 19(2), 106–117. <https://doi.org/10.1016/j.pursup.2012.12.001>

Ziegel, E. R., & Lohr, S. L. (2000). Sampling: Design and analysis. *Technometrics*, 42(2), 223. <https://doi.org/10.2307/1271491>

Zsidisin, G. A., & Hendrick, T. E. (1998). Purchasing's involvement in environmental issues: a multi-country perspective. *Industrial Management and Data Systems*, 98(7), 313–320. <https://doi.org/10.1108/0263557981024177>

## Appendix A: Interview Questions

The form of the interviews was semi-structured.

First category is the demographic, together with some background information.

Q1. What is your job's role?

Q2. How many years have you been in this company?

Q3. In which sector of the manufacturing does your firm operates?

Then, we move on to ask some questions about the GSCM strategy and level of implementation, in your company.

Q4. How do you define GSCM?

Q5. What practices of GSCM has your company implemented?

In the literature there have been named eight, divided into internal and external.

- Internal Environmental Management
- Eco-Design and packaging
- Green Manufacturing
- Green Procurement
- Investment Recovery
- Customer Collaboration
- Green Distribution
- Reverse Logistics

However, there are also challenges, making the implementation more difficult or delaying it.

Q6. Based on manufacturing in Germany, which do you think is the biggest challenge to overcome in order to implement GSCM and why?

Here again the literature suggests:



- Poor commitment from upper management
- Financial costs
- Resistance to adopt new technologies
- Fear of failure
- Lack of training in GSCM
- Lack of technical expertise
- Uncertainty in the market
- Low customers awareness
- Lack of governmental support
- Poor supplier commitment
- Poor stakeholder communication

Now we move on to the relationship between GSCM and performance of the firm. This shall be discussed on four different dimensions.

Q7. What impact does GSCM has on your firm performance on an environmental level?

Q8. What impact does GSCM has on your firm performance on a financial level?

Q9. What impact does GSCM has on your firm performance on an operational level?

Q10. What are the main benefits that you identify that GSCM has on the performance of the company?

## Appendix B: Interview Transcripts

### Interview 1:

Q1. Analyst

Q2. 3 years

Q3. Automotive

Q4. If I could define somehow GSCM, I would say that it is to enable sustainability in the supply chain, looking for a way to decrease the negative impact that a company has on the environment. Especially for the automotive industry, there is a lot analysis going on about the negative environmental impact that the industry causes, especially in the previous years.

Q5. As the company operates on many different levels and the end-product itself is quite complexed there are a lot of practices related to GSCM used. If I could name them one by one, I would probably start with the purchasing, I could probably characterize it green purchasing, as all the material sourced complies with certain regulations and comes only from trustworthy suppliers, that comply with regulations as well. We work also really closely with suppliers to achieve sustainability and being innovative. So, I could say that we invest heavily on the sourcing part. Another practice, is the design of the product, that now requires less material and we try to use as less as possible dangerous materials. For example, the batteries in our products now include less than 10% of cobalt and this is a great win for us. Similarly, we invest strategically a lot to produce more electric cars and this a direction that the whole market moves to. It is worth telling here though, that this comes also from a general direction that the company has implemented and we try to train our employees and suppliers about sustainability. We think that is necessary to onboard them about the importance of it, and for them to get deeper knowledge about this. About the production phase, we started now a process to decarbonize the whole process. It is the goal to use exclusively renewable energy instead of natural gas. Another point to mention is the recycle part. There are cars in our portfolio that almost half of the aluminium used, comes from recycled materials. Same thing applies for batteries, as we involve the customer to return them and we are able to reuse them or at least salvage some of the material. This is good both for the environment and the company. In terms of the logistics used, as far as I know, the company also tries to reduce the carbon emissions in all the routes involved in the production and the whole vehicle lifecycle. I think also the precision plays an important role, because that way we avoid unnecessary transportations. Likewise, for the finished goods, we try to use our capacity in the best-possible way. We try to effectively plan the routes, depending on the occasion, by rail or sea, taking into consideration though the environmental impact. Let me not forget also, the packaging that there is also a use now of environmentally friendly material and we avoid using plastic as much as possible. Now we use, expanded polypropylene and is really promising. To sum up, I could say, that the practices are used in a

quite high degree and we aim to expand them even more in the future. To use and develop them even further.

Q6. There are significant challenges, without a doubt. The first challenge that I recognise is the financial aspect of it. For a supply chain like ours and business cycle that we currently have, the investment that is required to alter processes and move towards sustainability requires millions of euros in costs. We need to buy the know-how either through trainings or by hiring the appropriate people. Also, as we try to be innovative and pioneers in this section, we sometimes may invest to discover something that is not there. This can impact negatively the company's performance, as we may waste the money and time invested. Then, as we may have our headquarters and manufacturing plants in Germany, does not mean that we have everything here. We operate on a global scale. So, when we try to implement and develop further the GSCM practices, we need to take into consideration how unstable the world is, not only regarding natural disasters, but also regarding geopolitical disruptions. All of these cause uncertainty in the market, that should not be underestimated.

Q7. When it comes, to the impact of GSCM on the environmental performance of the company, I guess it is the more direct and easier in way to be measured. It is a common problem that not everything that GSCM does, can be depicted in KPIs. For example, this new packaging used in Logistics is calculated to save 280 tonnes of CO<sub>2</sub> per year. In addition to that, by reducing the plastic in our operations, we expect to reduce another 1400 tonnes of emissions per year. Based though on our implemented practices, our goal is to avoid 200 million of tons by 2030. I feel confident that we are going to achieve it. Another thing, that I see is that we start to save a lot of energy, that it is positive for the environmental performance of the company. One of the most significant impacts, that we recognize as well is the reduction of waste. We have zero landfill waste since 2016 and manage the waste responsibly. We recycle whatever we can and what is not possible to be recycled, we try to use it as a fuel. So, all of these contribute that GSCM in our case has a positive impact on the environmental performance by minimizing the emissions and the waste produced. Also, as I mentioned before as well, since the first day of designing a vehicle, we reduced the hazardous material such as cobalt in the batteries, that has also a positive effect.

Q8. As my expertise revolve more around the financial aspects of our business and operations, I do recognize a positive impact there as well. It may not be so direct like the environmental one, but it is still there. First of all, the recycling that we have implemented, results in major financial benefits. We involve heavily recycled material in our products and we plan to develop it even further. The goal there is to be able to build new vehicles with 50% of secondary raw material. This has, of course, environmental benefits, but let's not underestimate the financial as well. We would require then less sourcing, thus less costs. In the same spirit, the energy saving, leads to other operational costs to be avoided. Then, I think being innovative and being ahead of the competition because of our sustainability approach, brings competitive advantage. In the end, in the current world everything comes down to market growth and profitability. Based on my experience, GSCM brings a positive impact on both of those. We are able to expand our customer base, increase our demand and by all of the costs avoidance that we

achieve to increase profitability as well. To be more specific, with our focus to electric cars, we have now sold over 200k vehicles for 2022. This, in my opinion, that our strategy to move to a greener approach pays off, based on the numbers as well.

Q9. Now on the operational side, I have to admit that is a bit harder to quantify the impact. I would say that, I experience it more in terms of quality. From the first day of designing a product, we aim to design products, in this case cars, that are not only environmentally friendly but also great in quality. In our case, I would not say though that the quality is achieved mainly because of GSCM, but because this is the approach of the company for decades now. So, I would say that it has positive impact, as it contributes also to procure better material and pay attention to the details, that make the difference. I would recognize though, that this GSCM approach seems to have a significant positive impact on the collaboration with suppliers and customers. Being able to exchange information, ideas, feedback helps us to evaluate and develop further our operations. Theoretically, regarding the lead times, I cannot safely say something, as due to the corona virus crisis, I saw a decrease, because of the shortages and the supply chain disruptions that happened globally.

Q10. I think actually that I mentioned a lot of benefits already. If I can somehow prioritize them though, I would say that environmental benefits are the most significant and in way, the safer to expect, when implementing GSCM. Waste management, recycling, being able to reuse material, are only some examples that I see, that result in reducing emission, carbon footprint and pollution in general. Then, if GSCM is properly implemented and developed, I see good results and even greater potential on the financial aspects, as GSCM is tied with the costs avoidance. This can bring an upside to competitive advantage, thus profitability and sales growth. As I mentioned, we use a lot of recycled material in our new vehicles, that brings a significant increase to our profit margin. Last benefit, that I want to mention is the brand image or reputation, as the whole world is moving towards sustainability, and we cannot stay behind.

## Interview 2

Q1. Logistics Specialist

Q2. 6 years

Q3. Automotive

Q4. In my opinion GSCM is handling the supply chain tasks, while having a green approach. That means, finding sustainable solutions from the early designs until delivering the product to the end-customer.

Q5. I would characterize the automotive supply chains highly sophisticated and complicated. There are a lot of processes taking places and many people being involved. Thus, we do use quite a few GSCM practices. Starting in 2019, many new decisions were made by the top management in order to move with more decisiveness to a sustainability change. It became an integral part of the company strategy. A lot of trainings and external audits are held, in order to achieve this change to a more a green approach. Then, I think the two keywords for our operations now are electrification and decarbonization. So, I would say that Eco-design has a top priority for us. I call it as a top priority, because it is that stage of the production that the

product's characteristics are defined. A part of the success or not, of the GSCM implementation, is decided at this stage. The design of the vehicle and the parts used, are being designed with the "greenness" in our mind. Definitely, we promote the reuse of products in it, in order to reach our sustainability goals, but also achieve higher profitability. We characterize it 'circular economy', but it combines the reverse logistics practice with the investment recovery in our case. A typical example of that is that we give motivation to our customers, to return defected engines. Regarding procurement, we constantly review our products and try to avoid resourcing dangerous materials. Altering our manufacturing processes, was also an important thing that contributes to the change. As a part of the decarbonization, was to use energy efficient machinery and build a sustainable and resilient infrastructure. Finally, as a company that operates in the automotive and made such sustainable initiatives, we focus also in the green distribution. We try to use electrical vehicles when it is possible and we try to move that direction, for our distribution channels.

Q6. Based on the recent experience, I would say the greatest challenge was the uncertainty in the market. The last 3 years, there have been the corona virus situation and the war in Ukraine that made it really difficult to implement GSCM or being able to operate under these circumstances. As we had to procure material from certain sources, we had huge issues and dramatic delays. Maybe if we continued conventionally, we would not face this challenge. This is also connected, with the suppliers' commitment issue. I do think that is a bit of a challenge, to find the right suppliers, as many of them do not fully comply. Especially for us, that we procure certain components of countries outside the EU, we do have sometimes this issue. Other than that, I have to admit that I do not see significant blockers, at least not for a company like ours. Except the resources. The resources needed to invest in technology, trainings for our employees and changing the processes are demanding. The amount is high and challenging but, in the end, we do see that all these money spent, is not just spent away, but is a good investment.

Q7. I would say huge impact. If we did not use certain practices, the emissions that our plants would have, would be terrible. The goal is by 2050 to be carbon-neutral and if others companies follow and are successful, it would be amazing news for the whole world. Already, we have lowered significantly the waste, emissions and the energy used. We see potential benefits there and for the next year, there is already the plan to invest for environmental protection projects over 20 million euros. We examine our emission under different scopes. One is the direct emission and the other one is the indirect. For example, we feel responsible also for the emissions that our sold vehicles produce. As a statistic that I am aware is for example that from 2019 to 2020, we managed to reduce the direct emission by 18% and the indirect by almost 32%. At the same time, we reduced also the energy and water used, while keeping the waste at the same level, even though we grew as a business. This could not happen, without implementing certain practices.

Q8. There is also important impact there as well. We did face issues with the instability because of the war, but in general the benefits are there. By promoting the reuse and resell, only for engines for 2022 we had a profit of extra 50 million euros. Also, we see that the better green procurement that we do now, leads to better products in terms of quality. That means for us that our vehicles and various parts that we produce, last more. At least for Germany, that means



good business. I do also see a good impact on all the cost savings that we manage to accomplish, because of the way that we operate now our supply chain and the manufacturing processes. Furthermore, as we sell a lot to public organizations, I see that now with the direction of producing more electric vehicles, we can sell more and cover the demand of them. It is a fact, that especially public organizations need to comply with certain laws and as a consequence they need to buy mainly electric vehicles.

Q9. Operationally, I see also a positive impact. Especially for effectiveness and quality, I see a significant improvement. In many components, such as batteries, the decision to procure and use more sustainable, proved to be the right one. We have fewer defective products, that last longer, thus operationally this is an improvement and it adds value. Also having GSCM implemented, we can utilize better the resources that we have. Besides, the reuse of the products, we sometimes change the purpose of use or convert them to activate new features for new products. That way, we improve our efficiency as well and be able to change faster, that I consider to be a massive advantage nowadays. For the lead times, I have to say that we could not improve them, but as I said the recent events in Europe did not help either.

Q10. I have to admit that I understand that many people may be sceptic about GSCM, but in my opinion the benefits are many. On all three dimensions, the situation is better than it was before the practices were implemented. Environmentally, the emissions and energy use is reduced and the waste is managed properly. Other than that, the recycling rate is over 90%, and this unlocks benefits for the community and for the company. We have additional direct profits, by reselling but also by avoiding costs. The reselling part of our business saved material and brought us 50 million euros of extra profits. Personally, I value highly the quality and based on our internal reports, the materials are better and last longer. It is proven for us, that now we are able to extend the service life of the products and the components. Finally, I do not want to underestimate the importance of having a healthy working environment and product that you feel confident about. In terms of numbers and KPIs though, I see benefits environmentally regarding the emissions and the reduction of pollution, financially I see benefits regarding our sales growth and profitability. Regarding operations, the highlight for me is the effectivity by trying to eliminate the waste across our operations and the increased quality. It is a situation, that has the characteristics, of “killing two birds, with one stone”. When we try to reduce pollution and waste, we stick only to what matters operationally.

### Interview 3

Q1. Supply Chain Manager

Q2. 3 years

Q3. Electronics

Q4. GSCM is the enabling of ecological, economic and social features in the supply chain of a company. This is visible then all across the business operations of the company.

Q5. We are a quite big company and thus we do use multiple practices. We do use Internal Environmental Management as a practice, and have sustainability probably on top of our agenda. That is why also, we have been certified ISO14001, 45001 and 50001 across all of our operations and manufacturing sites. After that, we use green manufacturing and try to save as much energy as possible, and reduce emission and pollution. As a company that is highly technological and innovative, we try to enable it across our manufacturing not only in Germany but also worldwide. Regarding eco-design, we invest many millions in order to be always innovative and leaders in the industry. We always seek ways to further make our products better, with modularity and more efficient for the customer, while not compromising on sustainability. We do try to hear also a lot our stakeholders. For example, we ask openly our customers about what we can do better and exchange ideas to take sustainability a step further. Really important of course, is the green procurement, as in order to become someone a supplier of us, needs to follow a certain code of conduct that ensures that we share values. Then, of course, we help them in order for them to be easier to continue being complied. Moreover, as the nature of the sector is this, electronics tend to break after some point. We use reverse logistics and actively motivate also our clients, that if not possible to fix and reuse, to dispose them responsibly.

Q6. One challenge that you have to take into consideration are the financial costs. So far though, our KPIs prove that the balance is positive, based on the ‚return on investment’ index. Even though that, the decision was not easy. We needed to invest a lot of money, that you cannot be 100% sure, that will be repaid. That is a challenge that it may, delayed the implementation of GSCM. At least not before we had enough data, to support this decision. I have to admit though, that one challenge that I identify is our supplier stance. As we source a lot from supplier located in developing countries, in order to produce semiconductors, it is often a difficult task to find suppliers that comply with the set of rules that we established. We try to support them, but this requires that they are willing as well, to accept to work in a certain way. I do understand that challenges from company to company are different, and it depends on the size of the company. Personally, last challenge to implement GSCM practices though, is the lack of governmental support. On this aspect it could be better, as I feel that government has only certain expectations, but do not motivate the companies to do it or to make it easier for them to enable them. It is a bit of either you pay the money to do it or you pay money in penalties. They rely only on the fact, that the companies have a certain culture that they will do it either way. That is not ideal to make progress. It should be more meaningful than that.

Q7. I think this is the easier question to answer. It is a no-brainer that the relationship between GSCM and environmental performance is positive. As we identified that one of the biggest challenges of the modern world is the resources scarcity, we try and succeed so far, to create products that require less resources, such as energy. Moreover, based on our implemented practices, we reduced significantly the GHG emission, by using alternative gases with higher utilization rates and lower GHG emissions. Also, through our investments and the emission reduction strategy we achieve great results on that, avoiding 692,000 tons of CO<sub>2</sub> emissions of

our direct emissions. Regarding waste, also 70% of the hazardous and non-hazardous waste is recycled. About energy, 82% of the electricity used relates to green electricity and finally regarding water consumption 60% of the water used, is returned to nature with equal or better quality. I think it is clear that after moving to a greener approach the performance is much better than it was before.

Q8. We are large size company and financial performance of course is one of the most important points for us. In my opinion here the relationship is also positive, not so much like the environmental probably, as it more complexed and unstable, but still positive. Through our GSCM implementation we pay annually less than 10k in fines, that for a company like ours, this amount is insignificant for us. Also, I see less costs in general, as we try to simplify a rather complexed product, that now we pay less for a finished good, thus increasing our profitability. Bottom line is, that the reports state that the relationship is positive, so I will not disagree. The total expenses on capital investment and operating expenses were around 16 million euros and the returns on savings from waste recycling and energy, cost avoidance, income and tax incentives were more than 21 million euros.

Q9. On an operational level, I would say that the impact is positive. Regarding effectiveness, with our focus of eliminating waste and processes that do not add value, recycling and reuse, I see definitely an improvement in terms of effectiveness. Now regarding timing, such as lead times, I do not see something positive. Last improvement that I could say, is that we assess the best supplier and we try to focus to source from the those that we have the best collaboration with. In my mind, operations are tightly connected with collaboration, as there are many sides involved and through GSCM, we have activated it. This has also positive impact.

Q10. The main benefits that I identify are related mostly with the reduction of pollution with everything that includes. We reduced emissions, materials. water and energy usage. We cannot be selfish as a company and not consider as benefits something that is beneficial for the environment. Also, I see that financially we save costs, that increase indirectly our profits. Of course, indirect profits come from the better image profile that we have, because I think that the customers feel more confident to buy from us. Especially for the western markets, that the companies need to buy responsibly, we are a trustworthy supplier for the end-customer. Then for me benefits that we enjoy, is the quality. I feel that quality comes from the implementation of standardized processes that are a result from the GSCM implementation, can lead to the zero-defect status. Trusting sustainable raw material and trusted partners, train the employees to have deeper knowledge and trying to maximize the usage of the resources can build a better and sustainable product. Another benefit, also in my opinion, is through the implementation of GSCM practices and having now this mindset, we are more open to change and more responsive to adapt. This is a must-have in today's competitive market.

## Interview 4

Q1. Product Manager

Q2. 2 years

Q3. Machinery, mainly around the construction industry

Q4. I would define GSCM as a concept that takes into consideration the ecological impact of the supply chain in a company's operations. Through this concept, a company may achieve sustainability in the environmental and financial performance.

Q5. About the GSCM practices that we use, I would suppose that everything starts with IEM. One of the first things, that we have when being hired in the company is to be trained around sustainability and GSCM practices. We even try to keep as many meetings as possible remote, in order to avoid business trips. One key practice also, is the customer collaboration. We have regular meetings with our key customers in order to understand each other, receive their feedback and see how we can make each other better around sustainability issues. We use reverse logistics also, and we try to have a great return management, and either to repair or recycle the machines that we receive. To achieve that and make it easier for the customer, we offer globally free collection for our tools. It is I guess a 'win-win' situation for us, because in that way we give our products 'a second life', and we are able to reclaim some value and resell them. We use also a green approach in manufacturing them, as we achieved to use 100% of green electricity, while lowering also the water consumption and waste production. When it comes to the design of our products, we are taking also steps forward and now we managed to have machines that are up to 70% recyclable. Now, we also use eco-packaging and an example of that is that we have multiple initiatives to make it greener and safer. We reuse it, when possible and try to have higher fill rates. Last thing that I want to mention is, that we use also green procurement. We have almost 1k suppliers around the world and all of them have to comply with how they handle the hazardous material and reach certain goals about the sustainability of the raw material that we will eventually buy.

Q6. The challenges that I personally see, are the initial costs. Everything now is budgeted and sometimes we have to operate under strict budgets. Doing such a big change, required massive investments that is quite challenging. In my experience, usually for a firm, what prevents them from doing something good, is money. I see no difference here. If I see a disadvantage of GSCM, is the money. The other challenge that I see then, is the supply chain complexity that our product has, that a wrong calculation or change, can result to a failed product. This, could be disastrous for us. There is no room for such errors. A change itself is not necessary something that will turn out positive. Other than those important challenges, I do not think that I see others.

Q7. When it comes to our environmental performance the impact is great. Especially year after year, I see better results. We reduce emission and our carbon footprint. We use renewable energy, hence lowering our negative impact on the environment. Through our material usage

optimization, we use also resources efficiently. This means, less material and less waste. Based on the fact, that now we have also higher adaptability to changing environments with minimum environmental impact, it supports further this statement.

Q8. In the financial performance, I would say it is somewhere around neutral. What I mean, is that there are certain points that are neutral, as I do not see direct impact, such as the sales growth that we have. I feel more that it is a part of the reasons, but a bit of complementary and not the main. I do not feel that it is an impact of GSCM. Positive is the fact that we save operating costs, when it comes to energy used or by the fact that we manage waste correctly and we reuse components in the new machines that we build. This saves costs for us without a doubt. Positive is also the fact that we work now closer with the customer and try to do modifications to their needs. This spirit, comes from the GSCM implementation in my opinion and the adaptivity to change, that this concept supports. I see though also other points, that are negative, as for example the cost of the sustainable materials, that in most cases is much more expensive. Also, as we try to procure, mainly from Europe and only from trustworthy sources, I see additional expenses there, that are not so appealing. Sometimes GSCM creates a narrow set of options that is not ideal.

Q9. Operationally, I believe that it is positive. Certain aspects are positive, such as the lower reject rate, that it comes from the increased quality. This is a result from procuring better raw material, dealing with less dangerous material and having standardized processes. Also, now with the reusing material and maximizing the utilization, we have in many cases reduced time of production, as a part of the product is already produced. It is a challenge for us though, to take it one step further. By being innovative, we can be even more effective and achieve better times to produce something.

Q10. The benefits are first of all environmental, as I explained. Reduced pollution, that is an effect of the better waste and resources management is for sure beneficial. For me it is clear, as the company is quite old, our environmental impact is better after implementing GSCM practices, rather than before. I feel now that we have a better image and are closer to the customer and the community, with the focus not being exclusively on our financial and operational performance, but rather having a more holistic overview. We do enjoy certain benefits on those points as well, as I mentioned a few already, such as recapturing value or increased quality and less defective products. Also, we are more customer-oriented now that we have implemented those practices. With the repair and reuse culture that we have, we tend to support better the customer and offer also better warranty contracts to them.

## Interview 5

Q1. Senior Supply Chain Specialist

Q2. 1 year

### Q3. Equipment

Q4. This is, I would say is a bit newer and popular term and actually it also considered part of my current role. Supply chain management is a quite complex thing. We are connected with the suppliers from one side and then we have our own operational manufacturing on the other side. Then, we have customers & suppliers worldwide and we need have a strong relationship with all of them. We need to connect them through our supply chain. Regarding, green supply chain management, it is actually connecting all these parts together in a sustainable way for a longer period of time.

Q5. We didn't implement a lot of things and some of the things are still ongoing. For example, I would say eco design and packaging. Regarding the design, we have a strong department of Electrical and Mechanical Engineering and they explore and try to find the best possible way to actually design the product, while using the most sustainable parts which are available currently on the market. To finalize a product and give the confirmation for serialized production, we take into consideration how it can be sustainable, that we have access to the correct material and that it can break down in such way, that we can salvage material or parts. At the same time, for example on the packaging side, we decided to change the packaging boxes from the plastic boxes to packaging boxes made out of paper and we are using now also paper tapes. So, this is definitely one part of it, then maybe the second part would be the green procurement practice. The procurement of all parts, which we use in our company is done after we examine all the possible materials that could be used. We end up choosing from different suppliers the ones that will have the best impact on the environment. I would say reverse logistics as well. This is worth mentioning that our company after the end-life cycle of the of the product, we offer to the customer the option to return it and recycle it, with some benefits at the at the customer side. It is also beneficial for us because we can either recycle it or repair it. Then we can either resell it or give it away free of charge for testing purposes for potential new clients. So basically, we are decreasing the level of material used in order to have a finished good.

Q6. We have many challenges, of course. First and biggest challenge is maybe the financial costs. So, in order to actually implement the green supply chain management into the flow, we definitely need to invest a lot of money on it. We have to invest, in order to set up all the processes. Also, people don't have a good knowledge of it yet, so definitely we need to train some people. We need to educate people in that direction. We have some general consciousness about this idea of the green sustainable business but still we need to work on certain details, so that we make it understandable to the whole organization. So definitely some trainings should happen. Moreover, it is a complex industry and we had a lot of issues in in the previous period. We had the COVID-19 crisis also, the impact on our on our business

as well and also on the market of our parts or of the semi-finished goods which we are using in our products, we didn't have any kind of control over that market. So, the uncertainty is huge there. If a crisis, appears again, we need to be prepared. It makes us cautious before changing something. So, this is a huge challenge and we need to pay attention on this one and avoid a similar crisis like we faced 2 years ago. And of course, a challenge is also the regulations. Those things are mandatory to us and other companies, but at the same time, since government is actually forcing them, they are not actually supporting us, by giving to us some benefits. So basically, they are creating the laws and bringing them to us, but I can see that they are not supporting us moving to the direction to be compliant. All the companies are left to be alone to find the solution to overcome these challenges and this is a hard task to do.

Q7. I would say this is a new agenda, but definitely on the environmental impact, if we check only that one, it has for sure only positive impact. In the end, we are all working on this limited space, and we need to keep it clean for the next generations which will come and this is the point of having a sustainable environment. So, we shouldn't pollute our planet, so we need to actually decrease the level of the waste. We need and we do save energy. We need to use energy from some alternative sources, which are acceptable in that direction, and we need to build the company to be resilient, to face future changes and challenges which may occur in some crisis. The main product which we are producing, we need to take care that is actually safe to be used. From the long term perspective, we also check that after the lifecycle of the product it does not become waste. So definitely it brings only benefits.

Q8. Yeah, this is totally the opposite. If we check only the financial level, there are 2 approaches I would say. So, if we want to check the sustainable approach for future benefits and on the long-term it will have benefits. If we just observe the long-term period of time, I think that there is also not a negative financial impact in the long term. But of course, if we just check the investments now, or next year, then definitely it will be negative, yeah, because we need to invest a lot of financial money on this. The new material will cost more. This new green supply chain in overall, it will cost more at the beginning, but in the long term, as I said, I think that it has the potential to be beneficial. It is not guaranteed though. At the beginning it will be negative for sure, at some point of time it could be neutral but overall impact has the potential to be positive on the long term. So far though, we experience the negative side of it.

Q9. I think on the operational level, it brings definitely some increased quality. On the finished good products, we will use sustainable and better materials. Instead of plastic, we use paper and we also found the solution in the batteries, building in the end a more quality product now. It makes us to be more efficient and it takes us also less time to produce. In the future, maybe the lead times will be decreased. I think that we will have a better product overall on an operational level. It could be a bit complex at the beginning of course, but overall, I think the impact is positive.

Q10. For example, I'm in charge for an important project. As I mentioned based on the new regulations, we now contact our suppliers and get some visibility over their operations. This includes anti-corruption, anti-bribery and protection of human rights. Moreover, based on our reports, about aspects regarding pollution of ours and of our suppliers, GSCM has proven to be beneficial. Another benefit is the brand reputation to our customers. I think that we offer a unique solution. Our market is still small, but all the customers appreciate our efforts and everything which we are doing now. We are actually working inside of this small market, but we are the leader of it and I think moves like GSCM, helps us to stay there and build a reputation.

## Interview 6

Q1. Supply chain manager

Q2. 5 years

Q3. Equipment

Q4. I would characterize GSCM as a concept within the supply chain, that tries to fulfil all those tasks and set up the processes, that a company has, while having an environmental approach and focusing on how you can make a company being competitive, without polluting or degrading the environment in other ways.

Q5. I would say that slowly but steadily we move to sustainability. As the company is relatively new with limited financial resources, the decision to move to a greening of our supply chain has come from the fact that we need to follow the legislation of the EU and that is why probably top management committed also to this direction. There is an effort to train and persuade the employees about the importance of it, and change some of our internal operations. For example, I would say, that we try to minimize the business trips or when it is needed, it is suggested to use the train, instead of an airplane. Then, we use eco-design and packaging. Our product evolved quickly, and so our design. At first, we focused on how it shall be working correctly and packed it in plastic bags. Now after a few years, we developed it and integrated a more advanced design. Now we care, about how it shall be disposed, or how we can save some parts to reuse them. The way that this can happen, is that the product itself can give the opportunity to do it. Now for packaging, we use extensively papers bags, paper also as packaging material and in some cases plastic bags, but that are up to 60% from recycled plastic. We will try though, to eliminate it as well. We do also use reverse logistics and try to manage our returns in the most optimal way. We have a strategy and deal with our returns in many ways. We control the devices that we have returned, we repair and resell those that we can, otherwise we keep the parts that still function and the rest we recycle them. It can be said, that we do both reverse logistics and when we can, we do investment recovery. Another case of investment recovery, is that whatever we do not need anymore, or is outdated, we try to sell it, instead of dispose it. This way we minimize the waste and we get something out of it, in a financial way. Other practices, I do not believe that we use. I mean, that manufacturing and procurement is not done

in a bad way, or have some aspects that would follow the GSCM concept, but we do not move with this in mind. In terms of transportation of our goods, also in most cases, we choose the cheapest option to ship something. I think those practices is something that we will work on the near future, as we develop further and we have the budget to invest more into GSCM practices.

Q6. The challenges are a lot. We do not have a large experience behind this, so we definitely lack of technical expertise. We sometimes need to hire externally to help us, with such issues. This does not provide flexibility, as we rely often on others. Then, for sure, the financial cost is the most important challenge. The budget is limited, the goals that we need to reach are financial and the budget would be drained if we do massive investments at this stage. Also, I see that green raw material is most expensive and we try to reduce the cost. All of these, make GSCM a hard thing to implement. Another challenge that I see, is also that there is an uncertainty whether this investment will pay off. We are at a point, that we cannot risk to do a wrong step as we develop. We need to carefully plan when to invest and how much. Also challenging is the uncertainty in the market. I observe that the last two years, there is no stability. It is not the most comfortable thing, to go ,all in'. Sometimes, changing so many things, that GSCM demands us to do, if we want actually to implement it, we need to evaluate all the risks and, in most cases, are many. Especially in some countries that we operate or source.

Q7. The impact environmentally is positive. I mean that even us, that have not implemented GSCM to the fullest version of it, we see positive changes. We set up plans to be carbon neutral in the next years, and already with the moves that we did, we have succeeded to reduce emissions, waste and energy used. This alone, is something positive. For sure there is room for improvement, but the impact so far is positive and we can see it. Taking environmental measures, cannot have bad impact. They may not give the results that you expect, but at some extent it will sure have a positive impact.

Q8. Financially so far, I would say it has some positive impact, but we did not see massive improvements. There are some benefits with the reduction of the waste, the reuse and the resell of some of our products, the energy saving and the better design that we do. Those all, are translated in economic benefits and better public image and that is good. Other than that, though, as we have not extensively used all of them, we have not experienced all the benefits that there can be.

Q9. Operationally there are positive aspects also. I feel that after we focused on what it actually matters, we brought our effectivity up. Now the engineers and designers take that into consideration. The same apply also, to our people involved in the operations and processes. We try to save energy and material and this eventually increases the effectivity and productivity. Then for quality issues, there is also improvement there. The change of batteries that we use, the better design that comes from this implemented approach, has as a result to bring benefits in the quality. Also, for me as a Supply Chain manager, we focus to find those parts that can combine GSCM and effectiveness with quality in our product. It is a constant challenge, but we see already good things happening there and potentially even more to come.

Q10. The main benefits, I would find them mainly in the environmental side. We are able to reduce pollution, emissions and the carbon footprint in general. Then, operationally I feel that quality and effectivity are crucially benefited by this strategy. Better selection of materials and focusing only on what really matters, is green, but beneficial on these aspects as well. Financially, I see the cost savings, as by reusing or remanufacturing, we use less material, we don't need to buy new one and this brings the costs down. In general, there are many costs that we save by implementing these strategies and practices. The resources required are also less and all these mean less costs. The last benefit, that I want to mention and we started now to see is the new markets that they seem to open. Based on the various certifications that we obtain we are able to sell in new markets and also develop a marketing strategy around it. This, in my opinion, helps us to grow our sales.

#### Interview 7

Q1. Procurement Lead

Q2. 3 years

Q3. Automotive

Q4. Supply chain management entails all the activities needed, from the purchasing of the raw material until the final goods are manufactured and shipped to the client. Supply chain has as a goal to operate while sustaining quality and being cost efficient, while achieving the best results. Then, if we add the green next to the term supply chain, we are adding another dimension. We are looking to optimize the supply chain not only against profits or costs, but also, we are looking at reducing the impact on the environment. That could be reducing GHG emissions. This is the most common lever, but also there are others as well. For example, you may be looking also for the practices about after the "end of life" of the product, use of recycled materials or to manufacture the product to have modularity.

Q5. We have implemented some already and there are even more in the pipeline for the future. Me being on the procurement department, of course, working really close to the manufacturing department, we are making sure that everything is there in terms of supplies and raw materials. First of all, we've included as we are the team that awards the business to a supplier and buy material from them. We are taking into consideration their green performance, as sustainability performance is a key issue for us. Analogously to what I've said about the supply chain, the companies are trying to source based on the cost efficiency, but now we are also rating the clients based on their green portfolios. So, that's a game changing lever comparing to what was happening the last years. We are seeing a drastic change and so that is the first thing, that is the first driver. We use as a green practice the design of the product as well, as we are trying to invest on the product modularity. We are using materials that first and foremost fulfil the product quality standards. We may sacrifice a little bit regarding cost efficiency, but we ensure that these materials are recyclable easier to source while having less CO2 emissions. We are trying to be

as efficient as possible on the shop floor and in our packaging in our outbound logistics as well. When compared to inbound logistics and sourcing, I'd say that sourcing the product out of the company to generate revenue and increasing the efficiency. In inbound and internal operations is the main area where cost efficiency and sustainability are working together and not against each other. We use green manufacturing and I believe it increases manufacturing efficiency. Having the approach that you do not want to keep machines working when they are not operating, you avoid waste of energy. We do not want to keep it running if it is not producing anything. We do not want to create extra waste, so by programming a CNC machine for example, or an assembly machine in our situation, this can be extrapolated to even more levels. For instance, how many hours does the shop floor operates? Then we plan our energy usage accordingly. Because then we save electricity. Some machines also use other chemicals and so on. I would say increasing manufacturing efficiency and reducing manufacturing costs ultimately works in the same direction as increasing and reducing the gas and the chemical emissions from the production. In the automotive sector, as I said, it is really important for us to keep in mind the modularity and the feasibility of the product to be recycled, but we do not use reverse logistics because this is done by the original equipment manufacturer (OEM) who is responsible to use the reverse logistic practices. In most cases, the OEM, that is our customer, demands our products to be manufactured in that way. In that way, they avoid to face any bottlenecks in their reverse logistics processes and for them to be able to be sustainable and green. We have to work closely with them, in order to be successful for our goals, around sustainability or not.

Q6. We are talking about the automotive industry and we are working very tight profit margins at the end of the day. All these green change needs to be paid by the consumer and the automotive industry is an industry that's being by every global disruption. So, I would say staying price efficient and price competitive, whereas implementing green techniques and green methodologies into your manufacturing process is difficult because of costs. Second challenge, I would say, is that GSCM is still new, to measure your ambitions. A company can buy some filters, but there are actually a lot of things that can be done and we might not even know all of them. It is a new field. It's difficult to find expertise. It's difficult to find people that actually know what they are doing when they are trying to work on a green transformation. There are some consultancies doing that already and there is probably a sufficient know how. If we compare this concept to other manufacturing areas like supply or how to set up a lean production shop, I'd say sustainability is the newest. So, the second challenge is that it is difficult sometimes to find the know-how. The third one, the, the third one I'd say is, that it's not an "one man" business and by "man" I mean a company. If we are looking at the supply chain of an automotive car, it consists of 20 to 30,000 parts. It is not enough for 10 or 20% of the parts to have a green manufacturing logic in order for the car to be green, or as green as possible. The majority of the parts need to be green. Big companies have the resources. Sometimes though do not have the degree of freedom. This degree of freedom to invest in sustainability, especially for smaller companies, is a challenge. They are not going to be able to sacrifice some of their profitability in order to be greener and more sustainable. The third challenge is actually to achieve a holistic implementation across the whole supply chain in order to ensure that the product at the end of the day is green.

Narrowing down to manufacturing each and every component must be green to have a result. Use the semiconductors as an example. We are at the middle of the crisis and all the OEMs are struggling to secure some supply. They are not going to risk running out of business, in order to obtain only green material. Third challenge in my opinion is being able to implement GSCM holistically. It needs to be applied from end to end, to be successful.

Q7. On an environmental level, positive. We are keeping track of the last five years of our emissions and we are measuring this every year and we are seeing a drastic emission and pollution reduction already. Although, I would say that when you implement the first measures, you can really see results in the beginning, but if you want to reach net zero, the more you want to progress, the more difficult it gets. Just to quantify this, one unit of effort may be enough to go from 0% to 20% reduction, but then it may take 10 units of effort to go from 20 to 40 and so on. Right now it's positive, and as I said, we're ramping up there, having a good performance. Everyone is seeing why we are doing this. It is not being seen as a waste, but at some point we might hit a wall. We might not be progressing as we are planning and then it's going to be a different discussion. But right now, because it is still new, it is positive and it is a nice to have.

Q8. Well, on a financial level, I cannot quantify this, but there are two sides to look at this. First and foremost, the revenue is growing because we are being awarded business, as our clients are valuing highly sustainability and they are happy to buy our products. On the other hand, it takes more effort and it costs more to manufacture using green techniques. We need to invest more on our shop floor, for instance programming and adjusting our production in order to be as efficient as possible. Sometimes even tweaking our product design to make it more efficient and being recycled. That is why I would say it is neutral. It is difficult to quantify this because there is both good and bad aspects on this level, as I presented above.

Q9. For a product to be approved and good for serial production, I would not say that it is affected by GSCM directly. GSCM affects though operationally in the beginning, when we are trying to be efficient, we are trying to use less electricity, less people, less time to manufacture. For these reasons, I'd say it is positive. It affects positively the product design phase and the efficiency.

Q10. The main benefit is that it makes the company future proof. I think that the regulatory environment is going to be stricter and stricter if we want to save the planet at some point. A company investing already in green supply chain management is ensuring that it's it will be allowed to have business also in the future and clients as well. This guarantees to be able operate in the regulatory environment, avoiding being out of the market in terms of price or price competitiveness. So, I would say, future proof is with one word the main benefit. That being said, people will still want to buy our products and we are going to be able to produce them under even the stricter regulatory terms that may come and our increased reputation. Of course, also everything I mentioned above, regarding environmental, financial and operational are valid here as well.

## Interview 8

Q1. ESG Manager

Q2. 2 years

Q3. Machinery and equipment

Q4. I would say that it is taking into consideration the environmental impact of all the activities in the supply chain. From the raw material, until the customer receives the product that they ordered.

Q5. I would say in terms of green procurement, we started to assess our suppliers in a more holistic way and we take into consideration their performance in all different aspects. Those are the environmental impact and the social. We use now a platform, called Worldfavor and we are collecting information from our suppliers. Based on that we try to reduce our scope 1 emissions, so that we will comply with the laws here in Germany. Those requirements started last June and we need to comply with those. Similarly, for our suppliers, they need to comply with our code of conduct. In terms of procurement, we examine really carefully the material. Other than that, we have awareness in the way that we operate and use wisely the resources, like water and energy in our operations. We also use reverse logistics, as have ongoing initiatives such as warranty programs or disposal. As our product contains electronics, the safe disposal is really important. If not done correctly, it could have a bad effect on the environment. We promote the reverse logistics initiative, because we find benefits there. It gives us the chance to be sure about the disposal of our product after the ‘end of life’ of it and also in some cases to remanufacture it or reuse a part of it. Except those, in an organized way, we do not do anything else, as we are a new company and the projects around sustainability and green development just started.

Q6. The biggest challenge are the financial costs. Imagine that only for a platform to assess our suppliers the cost is around 20k euros per year. You can imagine the costs, about actually financing the change of processes. When you are working for a company, you need to explain why you need such a large amount of money and you are going to get asked whether the company will have an economical benefit out of it. It is not easy. One challenge also for my case, is the upper management commitment. They pay the money and they are quite hard to persuade them, that this will pay off. They see it sometimes more short-term that they should. Even for a theoretically minor decision, we face delays to put it into practice.

Q7. Environmentally so far, the impact is slightly positive. Better that it was before we started our initiatives. Just not significant, as it is too early to say that. I see also a positive impact, because after we started it, we received positive feedback, from our customers and suppliers. That we started paying attention to this topic. It helps also create a bond, especially with bigger suppliers that have a more established sustainability system.

Q8. I would say neutral. There are certain negative, as the initial costs, but also some positive as our reputation gets better and customers are more open to buy, so demand is better. Maybe in the future it gets better, but I could not predict that yet. Also, we may be able to achieve better savings, regarding energy consumption, but it is too early to say. There are some things, that we

tried, like to make even greener our processes, but things were too expensive to do them now. In the future though, I see that it has the potential to be positive.

Q9. I would say slightly positive. We started using material that are sustainable and last longer, so in that sense, it is positive. There are a lot more things to help us and get better though. But in terms of quality, then better. We have less products to be rejected because of the quality and this is good for our efficiency. Other than that, I have no more observations.

Q10. Benefits are to be found for the reputation. It will help the company in many different levels. I see also benefits, in terms of the relationship that we have now with customers and suppliers. There are customers now, that are going to select us instead of other, because of our movement towards sustainability. They are going to choose us, because our product takes into consideration the whole value chain and has less impact on the environment. In the same time, it helps to open a new market, that is also important. Then beneficial is also the reducing of carbon footprint, that we achieve, based on the few initiatives that already had.

## Interview 9

Q1. Head of Logistics

Q2. Less than 1

Q3. Pharmaceutical

Q4. Well, for me, green supply chain management would basically include assessing your supply chain, your current supply chain from end to end. From the supplier all the way to the customer, looking at the environmental impact that you have all over the supply chain and trying to reduce that negative impact.

Q5. Eco design and packaging at some extent. Especially, regarding packaging we use a mixed set of practices. From one side, we need the vaccines for instance need to be cooled down while being transported throughout the different supply chains, in order the product to be at the right quality. On the other side, we use some special reusable packaging, that ensures quality and is sustainable. Since, that needs to happen, there's like different machines that even need to go into the shipment and specific packaging that is required for that. There isn't much more that can be done regarding this, other than that. To explain a bit more the packaging though, I am talking about some special sustainable caps, that protect the shipment. Those covers are reusable and they get sent back and forth between the warehouse in Germany and the one in the US. It is a legal requirement, but it does make it also greener. Regarding manufacturing, I would not call it green, as there are many rules that we need to comply first, so we focus on quality regarding this. The quality issue, in our industry is crucial, as a product can turn easily into waste if not properly handled. Regarding reverse logistics, I would say that we do not have actual returns, most likely waste management. We handle our waste, since it is also chemical, really carefully. Our procurement is strategic and is done centrally and here is done more operational stuff. There are initiatives happening, but I wouldn't call it green. We use as a practice though the green distribution. We prefer sea, rail and road transportation and air freight

is used as a last resort. Regarding the transport lanes, we are quite green. We focus on that, as it is something that can be done, in an industry that is not so sustainable.

Q6. Actually, one challenge itself are all the compliance topics that are very important within pharmaceutical industry, because you have to take all of those regulations into account. You want to make the processes as optimal as possible and GSCM requires a huge change management procedure. There is a lot of bureaucracy attached to that, and then you might not even be able to implement it in the end. We might change, disrupt our processes and fail to do it successfully. We might not be able to reach the quality standards that are set. We cannot afford to fail to reach the standard.

And you cannot fail to reach the standard. I guess because of the quality focus, the commitment from upper management may be low, but also from the employees might be relatively low. Then, I recognize the financial costs. There is required a huge investment behind it, both financial and time. The time required to do such a change is also a really important issue. I think those are the main ones, to be honest.

Q7. I would say like any focus on green supply chain or any changes made, it has a positive impact on the environmental level in the sense that the negative impacts on the environment will go down. In our case, all the practices that we have implemented have a great and positive impact environmentally. Based on the packaging example, the fact that we use reusable packaging, is much better than having to use new one and create additional waste. We save material and resources. Emissions are also reduced, because of our distribution plan.

Q8. I think in this case it makes things more expensive, so it would be a negative impact. The initial investment is high. Because you know, reusable materials are great, but you must send them back and forth, so it increases the cost. Probably over time, as they last more, they might pay off. Regarding transportation, sometimes they tend to be at least not cheaper. As a positive aspect though, I need to mention that it opens some new markets, as certain sustainable measures are required in order to be able to sell to United States. If we couldn't ship there anymore because we wouldn't comply with this rule, then that would be a huge issue. GSCM makes us greener, but also gives us certain financial opportunities. I do not think though that it leads for us to direct benefits, such as revenue.

Q9. It does eliminate waste. Like in operational terms, regarding the packaging we need to plan carefully though to have enough on site. Regarding times, I see negative impact for us. Some of our products are even seasonal, so if the customer doesn't get it by a certain date, they don't want it anymore. The lead times are tight, and I see that some of the green policies cause a delay. Either the access to material or the process itself. There is a negative impact on that in our industry.

Q10. Environmentally I think I mentioned a lot already. Reduced emissions, waste and carbon footprint are important benefits that is a result of the implementation of GSCM practices. In our case those are achieved by better green packaging, some procurement practices and the establishment of green distribution channels. Anything that makes the supply chain greener, has benefits for the environmental performance. Some benefits are related to cost savings, such as

reduced use of material in packaging. Then major benefits are found in the company's reputation. If we are a trustworthy source, then a customer may be more eager to purchase again. Customers do remember and become more loyal.

## Interview 10

Q1. Engineer

Q2. 2 years

Q3. Robotics

Q4. Green Supply Chain Management, how I perceive it, is to operate with efficiency, while considering the environment, material-wise and energy-wise. Moreover, having a sustainable supply chain in terms of plan and strategy, that optimizes all these variables, such as material, energy and personnel.

Q5. In our case, our own product is contributing to the supply chain. We manufacture a robot that moves pallets in a cost and energy efficient way. In our supply chain, we use green procurement, because we try to buy our material in a specific way. The best example is the batteries, that we buy a certain quality of batteries that are lithium, instead of lead batteries. They are better environmentally; have more quality and we can find only advantages by doing this. We use also IEM, as there are initiatives, except the implementing of GSCM practices, about the operational part, such as energy-saving moves in our facilities. Then, we use eco-design and packaging. We examine closely how we design our product, so that it is efficient and respectable towards the environment. Our product as logic, promotes the greening of the operations, so the design of it should have follow the sustainability rules. Finally, we use customer collaboration. We hold regular discussions with them, in order to understand them better and create a product than can be more efficient in terms of performance and energy used.

Q6. As a main challenge I would say the financial costs. I will give again the example of the batteries that we use, that cost much more than those that are not green and sustainable. It was though a decision of the designers of the product, as they can be recycled and have many more benefits than other batteries. Another challenge is the poor commitment of the top management. There are many things that can be done additionally, except those that we do already. We can buy also even more green parts or design it even better, but in order to do that we need support and budget approved. For example, now we use a camera system, that we set up for every customer 250 cameras and each camera need 100 meters of cable. There has not been an effort to go even further and use alternative wider range cameras, for instance. This would reduce costs and use less material. They need to support us more, to go even further.

Q7. I think that it is definitely positive. We have a product that utilizes material and try to be as green as possible and reduce pollution. In our case, if we used lead batteries, in a case of an accident, this could cause huge issues to the people using it. So in this way, the environmental accidents are avoided. Also, in my opinion, using robots instead of humans in some cases, can help the customer to improve their environmental performance. Robots are programmed and

cannot have erratic behavior, such as humans sometimes have. Both us and our customers, using our product, we save energy, as the robots fulfill the purpose, using less energy.

Q8. For the financial performance, we can already see cost savings, regarding energy used. Also we have avoided so far any environmental accidents. Our customers never reported a problem regarding this and this is beneficial for our reputation as well. We have also resource efficiency, as mentioned in the batteries example that I presented before. In the end, we use less material, to produce a robot that performs better. Even if we spent more in some material, the return on investment pays off.

Q9. Operationally also positive. We have increased product in terms of quality. As I said before, we produce now a better and more efficient product, with better use of resources. This happens, because we use high quality material, made from greener resources. We have received really positive feedback from our customers, praising the product, that lasts longer than other similar products. The processes of ours are lean. I wouldn't say that there is an impact regarding the time of manufacturing though.

Q10. It is an automation product, operating in this industry. I see the main benefits, regarding efficiency and safety, based on the changing of our supply chain to a greener way. Then, I see energy and other cost savings as I mentioned above. Then before I mentioned health of employees.

## Interview 11

Q1. Head of Global Fulfillment

Q2. 6 years

Q3. Electronics

Q4. Green Supply chain management, for me it's all about not wasting resources and being green. Basically, it is still the supply chain processes, but with the goal of not wasting resources, while the material gets moved or distributed.

Q5. We are coming from a startup phase. We have this startup background. We set though the question to ourselves. How can we get greener? In terms of the logistics, we were always thinking of how can we really reduce our carbon footprint in combining shipments in reducing the volume of what we ship. Let us say for example, we can combine shipments to the US and ship in bulk volume. We implemented a green distribution system, that increased our effectivity and we cut down unnecessary trips. Moreover, we reduced resources in the packaging by going from plastic bags to paper bags. We had also other initiatives about the packaging and the design of the product, that contributed to us being greener and using less resources to fulfill our goals. Also, we switched from the plastic labels to paper labels. So, as we are in the field of distribution, based on the customer's demands, we always try to get better on that and get a little bit greener, as customers are also requesting it. Then we recycle a lot, and we are registered

for proper waste management in many different countries. There is a big effort there. We are registered in 18 countries currently. It belongs to the IEM, depicted often also in internal trainings and our internal policy on how we choose to operate. For example, regarding use of energy in our operations and others. Finally, we use reverse logistics. This happens in two stages. One thing, is about the batteries that we are forced also by law to do it and another one is to receive back the electronic components. Whenever a customer wants to send back his device because it's broken or it went out of function, they have the right to send it back to us and we recycle or try to reuse the parts to other operations of ours. Reverse logistics is one of the most important practices of ours.

Q6. Green supply chain is when you compare it to the timeline of the whole industry, it's very new. Not all the people, managers or leaders are actually aware of it. Neither the top management has the experience for it, as it is such a new concept. It is complicated, it takes time to understand, to build it up and just to be able to measure it and to report it at the end. After that we have the status quo. It is the next step that needs to be taken, and actively answer the question how can I get greener in the supply chain? The pure fact of the finance challenge, as we need to spend hundreds of thousands only to get started. Even small changes, will skyrocket the budget. Imagine, procuring only the greenest products. This will raise the price and may cause competitiveness issues. Besides that, I see the time needed in order to implement it. I guess we are not speaking about the next two years. We are speaking about the next 20 years where the whole industry needs to change their habits and to have it included in their thinking. We need to change fast and be as lean as possible.

Q7. I would say positive. We also need to find ways to get even better though. Regarding cost savings as well. I mean that a company won't do something, unless they see also commercial benefits. The discussion is always about being more cost effective. Nobody would invest in the green supply chain, if they did not see performance benefits out of it. What I mean is, that the environmental benefits are many but not enough for a company to implement GSCM practices. They need to afford doing it. The business case would get rejected if the benefits were exclusively environmental or financially damaging. To conclude it though, on an environmental level the impact on the performance of the firm is positive, and this is shown especially regarding reduction of pollution and better use of the available resources.

Q8. I would say on a financial level, now, it is not exactly measurable if a green supply chain supports the revenue. I can't say if it is positive. I mean, everyone is saying that they want to work together with a green company, and we see that a lot in the business-to-business environment. I do not know if we make more business, by being greener but I want to believe it that it is the case here, that it has a long-term positive impact. For now, I would characterize it overall positive, but I do not know the exact numbers. Regarding the business reputation, is also positively impacted, and it affects the financial numbers.

Q9. We are able to combine material and combine shipments, yeah, and have them walk lever because I believe that transportation is the worst thing that we have where we can really improve a lot yeah in in in supporting a green supply chain yeah there are plenty of little initiatives but I think they do not have this big effect yeah but reducing carbon footprint and transportation. Our efficiency is increased. In the logistics, by having the GSCM approach, we avoid unnecessary transportations and processes. I recognize also in our case waste elimination. Having this approach as a strategy, I would say that changed our mindset. Now we take always



into consideration how can we have the optimal usage of our capacity. This may refer to space in a truck, but also the material needed for the product or even the usage of our time. Regarding now lead times, I do not know if actually the impact is positive. There are also other things, that I cannot credit GSCM about it. Especially about time of manufacturing or quality. In general, though, the impact now is somewhere between positive and neutral now, so I would say slightly positive. Long term though, it will be probably exclusively positive. GSCM is a concept that needs time to pay off.

Q10. When I have a look on the overall performance, first of all, I feel that we need to invest more to enjoy certain benefits. What I see, is that the more a company invests, the more the benefits. Speaking though for present facts, the benefits that I see is the brand reputation and how the people see us. It is really important for the business-to-business world, to have a strong brand image and GSCM certainly supports this. The financial benefits, in my mind, come at a later stage. Then, I identify many environmental benefits. I mentioned a lot in the beginning. Proper usage of resources and waste elimination, alongside the reduction of the carbon footprint. GSCM actively helps to have benefits around the environmental performance and to have directly good results around it. Financially, as I said, I think it comes later, but something that I recognize already is this resources reduction, helps us to avoid costs. I would say that GSCM contributes to the cost avoidance of a firm. In terms of material but also for energy. In the past transportation was cheap, but also with certain negative effects on the environment. What I want to say, is that globalization is not the best way to have a GSCM. The goal in my mind is, and GSCM operationally benefits this direction is, how to reduce the use of resources and “shorten” the supply chain. This eventually can be a big benefit. GSCM can be beneficial and to have an approach of “think globally, act locally”, can make it even clearer that GSCM is a concept that is worth about investing on.