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Green Practices and the Resilience of Supply Chains

By

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Global Supply Chain Management

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Tabish Mohd

Projet # 2016-2012 — Green and Resilient practices

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Projet # : 2016-2012 - Green and Resilient practices

Titre du projet de recherche : Green practices and the resilience of supply chains

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Résumé

La sensibilisation des consommateurs, la réglementation ainsi que les pressions des parties prenantes conduisent les entreprises vers des pratiques écologiquement et socialement durables. Les entreprises s'assurent que tous leurs partenaires de leurs chaînes d'approvisionnement (CA) suivent des procédés écologiques. La mise en œuvre de pratiques vertes ou durables nécessite des processus additionnels qui influent sur la structure de la chaîne d'approvisionnement ce qui augmentent sa complexité. On peut s'attendre à ce que cette altération de la structure de la chaîne ait d'avantage d'impact sur la résilience de la chaîne en particulier pour les entreprises qui ont mis en œuvre le concept de gestion rationnelle.

Par exemple, tous les fournisseurs d'une entreprise ne pourraient pas être prêts ou capables de mettre en œuvre des pratiques écologiques, ce qui entraîne une réduction de la base de fournisseurs de l'entreprise. Ces changements revêtent une importance particulière pour les entreprises dont les CA se sont développées à l'échelle mondiale, les rendant plus sensibles aux perturbations. Cela résulte de catastrophes naturelles, de bouleversements politiques, de pandémies, de terrorisme, de menaces activistes et de réglementations gouvernementales.

Cette thèse analyse la faisabilité et à travers quels mécanismes la mise en œuvre de pratiques vertes peut affecter la résilience des CA. Tout d'abord, nous effectuons une analyse approfondie de la littérature des études liées à la gestion de la chaine d'approvisionnement verte, la résilience du CA et la littérature qui tient compte des pratiques vertes et résilientes des chaînes d'approvisionnement réunis. Nous identifions les principales pratiques vertes et résilientes et certains scénarios de leurs interactions.

Sur la base de la revue de la littérature, nous formulons les propositions et proposons la question de recherche. Ensuite, nous présentons les résultats d'entretiens semi-structurés qui ont été menés avec six praticiens de la chaîne d'approvisionnement qui sont expérimentés ou détenant des connaissances sur la mise en œuvre de la gestion de la chaine d'approvisionnement verte. Un consultant en environnement ainsi qu'un responsable de la performance environnementale ont également été interrogés afin de recueillir différentes perspectives.

Notre étude conclut que les pratiques vertes peuvent avoir un impact sur la résilience d'une chaine d'approvisionnement à court terme seulement, surtout pendant les trois ou six premiers mois

pouvant aller à un an. Cependant, nous constatons qu'un certain nombre de facteurs peuvent modérer les impacts de la gestion de la chaîne d'approvisionnement verte. Premièrement, un test de stabilité approprié pour identifier les défis pour la mise en œuvre réelle. Deuxièmement, il a été constaté que le passage à des produits qui sont plus durables peut améliorer la résilience d'une chaîne d'approvisionnement. Troisièmement, l'utilisation accrue de l'informatique renforce non seulement la verdure de la chaîne, mais augmente également sa résilience. Enfin, après la mise en œuvre de la gestion de la chaine d'approvisionnement verte, la surveillance doit être effectuée avec diligence jusqu'à ce que tous les processus soient bien compris.

Les implications de cette étude suggèrent qu'une formation adéquate doit être donnée ainsi qu'une responsabilité appropriée doit être fixée pour la mise en œuvre de la gestion de la chaine d'approvisionnement verte. Les entreprises doivent cartographier les risques et effectuer des tests complets avant la mise en œuvre effective. L'utilisation accrue des technologies d'informations aura des effets positifs sur la gestion de la chaine d'approvisionnement verte ainsi que sur la résilience de cette dernière. Cependant, les entreprises doivent être prêtes à investir dans l'informatique. Tout cela n'est pas possible sans un support de gestion dédié.

Abstract

Consumer awareness, regulation and stakeholders' pressures are leading companies towards environmentally and socially sustainable practices. Companies often make sure that all their partners in their supply chains (SCs) follow sustainable practices. The implementation of green or sustainable practices requires additional processes which impact the structure of the SC and increase its complexity. One can expect that this alteration of SC structure further impacts the resilience of SCs, particularly for companies that have implemented the concept of lean management. For example, not all suppliers of a company might be willing or able to go green, resulting in a reduction of the company's supplier base. Such changes are of particular importance for companies, whose SCs have expanded globally making them more susceptible to disruptions arising due to natural disasters, political upheavals, pandemics, terrorism, activist threats and government regulations.

This thesis analyzes whether and through which mechanisms the implementation of green practices can affect the resilience of SCs. First, we conduct an in-depth literature review of studies related to green supply chain management (GSCM), supply chain resilience (SCR) and literature that considers green and resilient practices of SCs together. We identify the key green and resilient practices and some of the scenarios of their interactions. Based on the literature review, we formulate propositions and propose the research question. Next, we present the results of semi-structured interviews that were conducted with six SC practitioners who have experience or knowledge about the implementation of GSCM. An environmental consultant and an environmental performance manager were also interviewed to gather different perspectives.

This study finds that green practices can impact the resilience of an SC only in the short term, especially during the first three or six months to one year. We find that a number of factors can moderate the impacts of GSCM, however. First, a proper stability testing to identify the challenges for the actual implementation. Second, it was found that switching to products that are green and more durable can aid the resilience of a SC. Third, increased use of IT not only enhances the greenness of the SC but also increases its resilience. Lastly, after the GSCM implementation, monitoring must be done diligently until all processes are well understood.

The implications of this study suggest that proper training must be imparted and proper accountability must be fixed for the implementation of GSCM. Companies must map risks and

perform comprehensive tests before the actual implementation. Increased use of IT will have positive effects on GSCM as well as SCR, but companies must be prepared to invest in IT. All this is not possible without dedicated management support.

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Abbreviations

CSR	Corporate Social Responsibility
EOL	End of Life
FTC	Fair Trade Coffee
GHGs	Green House Gases
GISs	Green Information Systems
GP	Green Purchasing
GSCM	Green Supply Chain Management
IEM	Internal Environment Management
IR	Investment Recovery
KPIs	Key Performance Indicators
NGOs	Non-Governmental Organizations
PET	Polyethylene terephthalate
PP	Polypropylene
PVC	Polyvinylchloride
RFQ	Request for Quote
RoHS	Restriction of Hazardous Substances
SSCM	Sustainable Supply Chain Management
SCM	Supply Chain Management
SCR	Supply Chain Resilience
SME	Small and Medium Enterprise
TQM	Total Quality Management

Chapter 1

Introduction

When the EU mandated the implementation of Restriction of Hazardous Substances (RoHS) regulation in 2006, banning certain hazardous materials like lead and mercury, it was not possible for many suppliers to reduce such substances in their old products because it was too costly for them to re-engineer their old products to remove such materials. As a result, those suppliers started giving the end of life (EOL) notices to their customers for products containing such hazardous materials. As the clients of the products affected by such EOL notices, started searching for other suppliers, they started falling into the trap of vendors supplying counterfeit material which resulted in many supply chain (SC) disruptions (Sheffi, 2015).

1.1 Growing Focus on Green

There is increasing pressure on companies to adopt green practices. Most of the times it is due to regulatory pressures, that corporations are forced to adopt green practices in their SCs, and any non-compliance can lead to the imposition of fines by the government (Ageron, Gunasekaran & Spalanzani, 2012; Seuring & Muller, 2008). The more polluting an industry is, the greater is its susceptibility to regulatory pressures for the implementation of sustainable supply chain management (SSCM), which can be observed in the case of manufacturing industry (Hassini, Surti, & Searcy, 2012). Companies, however, try to delay the implementation of such regulations, rather than innovate to tackle them (Porter & van der Linde, 1995).

Companies adopt green practices also because they face NGO campaigns about global warming and the depletion of natural resources (Ageron et al., 2012). Smaller companies even collaborate with NGOs to participate in environmental projects across the globe (Caniato, Caridi, Crippan, & Moretto, 2012). Companies should consider activism just like any other cost of doing business which like other expenses requires proper and well-planned actions (Spar & La Mure, 2003).

The implementation of environmental practices can also enhance the competitiveness of companies (Porter & van der Linde, 1995; Rao & Holt, 2005; Srivastava, 2007; Seuring & Muller, 2008). Many times companies are forced to offer green products because their competitors are offering such products (Hassini et al., 2012). The implementation of green practices also leads to the enhancement of economic performance (Rao & Holt, 2005). Smaller companies, therefore, want to incorporate green practices to be more competitive whereas adoption of green practices by big firms does not decrease their competitiveness (Caniato et al., 2012).

Companies are also forced to implement environmental and social practices because of their customers' requirements (Seuring & Muller, 2008). This is especially true when clients are separated by vast geographical distances from their suppliers; they prefer their suppliers to have environmental certifications (Rao & Holt, 2005). Implementation of green practices also leads to customer satisfaction (Ageron et al., 2012). Moreover, pollution does not provide any value to clients and is a type of inefficiency, whose costs are borne by customers either directly or indirectly (Porter & van der Linde, 1995).

A concern that has been raised by some companies, however, is that the implementation of green practices leads to higher costs (Porter & van der Linde, 1995; Ageron et al., 2012). This applies in particular for SMEs, and these increased costs are passed to the end customer which necessitates apprising customers about the importance of green practices (Hassini et al., 2012). As a result, large enterprises, as well as small businesses, take initiatives to explain to their customers about the importance of green practices in today's world (Caniato et al., 2012). Innovation by companies will help them to reduce costs, that they have to bear on account of environmental regulations (Porter & van der Linde, 1995).

1.2 Changes in supply chain structure due to the adoption of green

The transformation of traditional SCs to green SCs requires the incorporation of processes like lifecycle stages, reuse, recycle, remanufacture, waste collection and many other procedures. These requirements increase the complexity of SC and result in many uncertainties. All this give rises to operational and strategic issues like the optimization of the SC while also taking into account the environmental criteria (Beamon, 1999). Apart from increased costs and complexity, sustainable SCs also require greater coordination (Seuring & Muller, 2008). Implementing a sustainable SC

becomes easier if a company and its suppliers have strategic relationships (Ageron et al., 2012). Keeping in mind these green practices, suppliers will have to be screened by environmental criteria, which could result in a decrease in the supplier base (Cousins, Lamming, & Bowen, 2004). Moreover, implementing green practices across SCs that are spread globally leads to additional risks for the SC (Wang, Chan, Yee, & Diaz-Rainey, 2012).

1.3 Global supply chains and disruptions

SCs have also become more vulnerable to disruptions as companies ventured out globally in search of low-cost suppliers, product lifecycles got reduced, exposure to diverse regulations increased, and lead times also increased (Blackhurst, Craighead, Elkins, & Handfield, 2005; Chopra & Sodhi, 2014; Ponomarov & Holcomb, 2009; Seuring & Muller, 2008).

Apart from all this, the rise of lean SCs has further exacerbated risks of SC disruptions (Chopra & Sodhi, 2004; Ponomorov & Holocomb, 2009; Chopra & Sodhi, 2014). Managers mostly consider only the Discounted Cash Flow model in SC design, which is fine for normal circumstances but is dangerous during turbulent times and therefore managers should also consider flexibility in the SC. While planning to open a new manufacturing facility, a company might choose the option that is the closest, even though the closest option might be costlier because the closest option provides maximum flexibility in terms of operations and interactions with its internal team (de Treville & Trigeorgis, 2010).

However, it is important to mention that there are almost zero chances of systemic SC risks. The trends of globalization which have made SCs vulnerable to risks have also reduced the systemic risk to SCs. As a result of globalization, production is spread across different regions and countries, and if one company fails, there are always others to take its place as a result of which the end users rarely face any shortage of products (Sheffi, 2015).

1.4 Research Question

From the discussion in the previous sections, it is evident that companies are forced to implement at least the bare minimum GSCM practices. Most of the times, GSCM implementation is due to the manifestation of different kinds of pressures like regulations and activism. This requires

modifications and changes in the SC which might reduce or increase the vulnerability of SCs to disruptions. Therefore, this study tries to ascertain the mechanisms through which GSCM implementation impacts the supply chain resilience (SCR) and the steps that can be taken to moderate such impacts.

1.5 Thesis objectives and structure

This thesis aims to focus on the mechanisms by which the implementation of green practices in an SC impacts its resilience. Following actions would be taken to achieve this:

- A literature review will be conducted to identify the green and resilient practices, their interactions and the mechanisms through which GSCM affects the resilience of a supply chain. The literature review will help in the development of propositions and will also contribute to highlight the research gap

- Based on the analysis of the literature, a questionnaire will be developed which will assist in eliciting the views of the participants, regarding their experiences about the implementation of green practices. The implementation of different green practices, one at a time will be discussed with the participants to identify the steps that were taken by them to neutralize the impact of the GSCM implementation on their SC's resilience

- After the data collection, it will be organized by different questions in the questionnaire, and the primary focus will be on the steps taken to handle the effects of GSCM implementation. This will help to identify the mechanisms through which the resilience of SCs is affected and the corresponding remedial measures that are taken to address such effects

- Suggestions for managers and future research opportunities will be proposed, and conclusions will be drawn

The objectives have been divided into six chapters. After the introduction in this chapter, the next chapter deals with literature review, based on which propositions will be formulated, and the research question will be presented. Chapter three deals with methodology and data collection. The details about the development of the questionnaire will also be discussed. Chapter four

organizes the participants' responses which will help in the data analysis. Chapter five discusses the final results, managerial implications, the limitations of the study, future research directions, and personal contributions regarding this study. Chapter six concludes this research.

Chapter 2

Literature Review

Porter and van der Linde (1995) mention that regulations are necessary to keep the environment habitable. They say that these regulations will lead to an increase in costs, but companies will be able to reduce these costs through innovations and other improvements. They mention the example of the Dutch flower industry, which had to innovate to avoid the release of chemicals in the soil. This ultimately led the industry to grow flowers in water containing the necessary chemicals for flower growth. As a result, the handling costs decreased because such plants were started to be cultivated on specially designed platforms. This innovation resulted in lower environmental impact and also cost reduction, providing better product quality and enhanced competitiveness. Thus, Porter and van der Linde (1995) emphasize that regulations will force companies to become more efficient and will eventually make companies more competitive. Seuring and Muller (2008) say that due to customers' demands companies also ask their suppliers to obey the environmental and social guidelines. For example, they say that companies ask their suppliers to undergo ISO 14001 certification. Ageron, Gunasekaran, and Spalanzani (2012) say that companies could reap competitive advantage by proactively going green, particularly if any green regulations are enforced. In this chapter, first, papers related to green supply chain management (GSCM) are reviewed, followed by papers related to supply chain resilience (SCR) and finally, studies that consider the impact of green practices on SCR are discussed. Next propositions are formulated, and in the end, the research question is proposed.

2.1 Green supply chain

Authors mostly discuss the following facets of sustainability: economic, environmental and social (Carter & Rogers, 2008; Seuring & Muller, 2008). In this thesis, only the environmental dimension of sustainability will be considered. However, as sustainability is a broad term, so first the definition of sustainable SCM (SSCM) will be presented, followed by the definiton of GSCM.

Hassini, Surti, and Searcy (2012) define a sustainable SC as "the management of supply chain operations, resources, information, and funds in order to maximize the supply chain profitability while at the same time minimizing the environmental impacts and maximizing the social well-being" (p. 70). Seuring and Muller (2008) define SSCM as "the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, that is, economic, environmental and social, into account which are derived from customer and stakeholder requirements. In sustainable supply chains, environmental and social criteria need to be fulfilled by the members to remain within the supply chain, while it is expected that competitiveness would be maintained through meeting customer needs and related economic criteria" (p. 1700). The definition of SSCM by Ahi and Searcy (2013) is broader and includes resilience as well: "The creation of coordinated supply chains through the voluntary integration of economic, environmental, and social considerations with key inter-organizational business systems designed to efficiently and effectively manage the material, information, and capital flows associated with the procurement, production, and distribution of products or services in order to meet stakeholder requirements and improve the profitability, competitiveness, and resilience of the organization over the short- and long-term" (p. 339).

As this thesis focuses on the ecological or green dimension of sustainability, so the definition of GSCM is presented next. Srivastava (2007) defines GSCM as "integrating environmental thinking into the SC management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as the end of life management of the product after its useful life" (p. 54-55). Ahi and Searcy (2013) do not propose a separate definition of GSCM and say that GSCM's definition would be similar to their SSCM definition except that it would not have economic and social considerations. The definition provided by Srivastava (2007) is the most encompassing because it considers the entire life cycle of the product, that is from product design till the EOL management of the product.

The literature review in this section is based on the 'antecedents-phenomenon-consequences' scheme as shown in Figure 1. This review methodology has been adapted from Schmeisser (2013). The reviewed papers discuss antecedents, phenomena, and consequences in different ways. Some papers discuss all three of them, some discuss only antecedents, some discuss the phenomena, and some discuss only the consequences. As a result, sections of the reviewed papers have been

accordingly classified under antecedents, phenomena or consequences. The antecedents block identifies the reasons that lead companies to adapt GSCM. From the literature, it was found that companies adopt GSCM due to Corporate Social Responsibility (CSR), drivers like market forces, sector to which the company belongs, and the size of the firm. The phenomena block discusses the results of GSCM practices implementation by companies, as they embark on their journey towards GSCM and the barriers that they encounter during the implementation. The consequences block discusses how green practices help or affect the company and the results and the indicators to assess them.
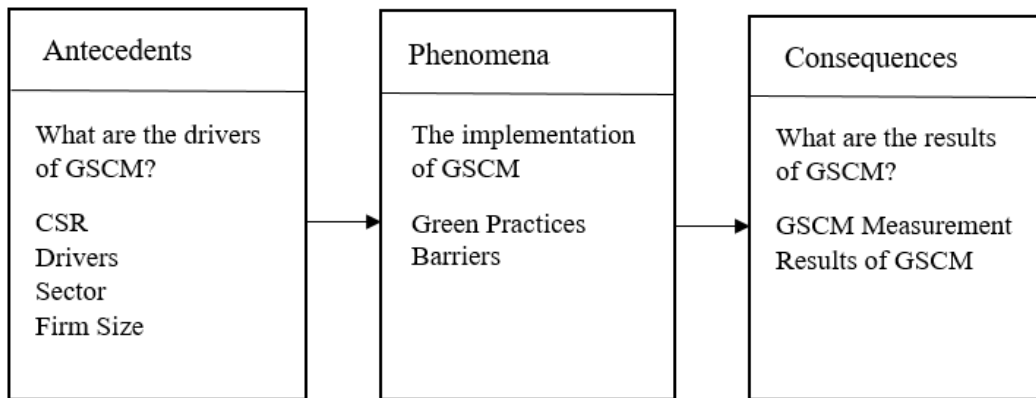
Figure 1. Review scheme for GSCM literature

Source: Adapted from Schmeisser (2013)

2.1.1 Antecedents of GSCM: CSR, drivers, sector, firm size

2.1.1.1 Corporate Social Responsibility

Dahlsrud (2008) mentions that green is one of the aspects of CSR. While reviewing the CSR reports of the top ten UK retailers, Jones, Comfort, and Hillier (2005) found that environmental issues were reported the most often among other categories. Porter and Kramer (2006) mention that companies indulge in CSR due to:

1) *Moral obligation* – To be good citizens and to ensure that their activities do not harm the society.

2) *Sustainability* – This is based on the concept of sustainability by the Brundtland Commission (Brundtland, 1987), which is "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (p.41).

3) *License to operate* – Companies must operate legally with requisite permissions from governments.

4) *Reputation* – Any impacts due to a company's activities will tarnish its image and brand value.

The authors observe that all the aforementioned reasons are based on the assumption that society and business are antagonistic to each other. As a result, CSR efforts of a company are dispersed and not focused, and thus their CSR activities appear more like knee jerk reactions. The relation between business and society should be symbiotic because if both of them do not work together, none of them would be able to exist in isolation (Porter & Kramer, 2002; Porter & Kramer, 2006). Porter and Kramer (2006) further say that no company can handle all social issues, which they term as 'generic social issues.' Therefore, they suggest a company start by trying to handle those problems which can benefit both itself and the society as shown in Figure 2. For instance, they say that carbons emissions could be 1) A generic issue for a finance firm 2) A value chain issue for a logistics firm and 3) A competitive context issue for a car manufacturer.

Figure 2. Corporate Involvement in Society: A strategic approach

Source: Porter and Kramer (2006)

Thus, Porter and Kramer (2006) suggest that businesses should view CSR strategically which will help in achieving a win-win situation for both, businesses and societies. They mention about Toyota's Prius which gave it a head start over its competitors because of which, now its competitors also want to license its green technology. However, companies that excel in CSR activities should still be wary of activists' pressures and threats as underscored by Argenti (2004) about Starbucks. He says that Starbucks was already collaborating with various NGOs and farmers, much before Global Exchange started targeting it in 2000, to purchase Fair Trade Coffee (FTC). He further says that Starbucks was wary of FTC because it did not want FTC to impact the quality of its coffee. Moreover, Starbucks was paying much above the market average for the coffee that it used to purchase. In the end, Starbucks tried to implement FTC for one year to determine the demand of FTC. Its apprehensions about the low demand of FTC and the resulting negative impact on quality proved true. However, Starbucks still collaborated strategically with other NGOs to better help the farmers without compromising on its quality, thus creating a win-win situation. Argenti (2004) therefore, says that Starbucks 'quasi-capitulated' in accordance with fears suggested by variables of transaction cost, brand impact, and competitive position as proposed by Spar and La Mure (2003). From the preceding discussion, it can be observed that CSR should be strategically chosen so that it can benefit both the companies and the society, creating a win-win situation for both. Therefore, companies can start with the options that serve their needs, as well as the communities and environment around them and as they move ahead, they should try to pick more and more such issues and address them.

2.1.1.2 Drivers

The major drivers for the adoption of green practices are governmental regulations, end customers, stakeholders, market forces, climate change, activism, and competitive advantage (Porter & van der Linde, 1995; Seuring & Muller, 2008; Zhu, Sarkis, & Lai, 2008; Hassini et al., 2012; Caniato, Caridi, Crippa, & Moretto, 2012). Porter and van der Linde (1995) say that rather than fighting regulations, companies should innovate and try to solve problems on their own. They mention that some companies innovate just because it is part of their culture for example – German and Scandinavian companies. They underscore the shortcomings of current regulations as well, which focus more on cleanups rather than prevention and mention that regulations should be implemented in a phased manner and not abruptly. They mention the example of asbestos, the way it was

removed in a phased manner starting from the 1900s. As per Porter and van der Linde (1995), the implementation of green practices should be viewed just like the implementation of Total Quality Management (TQM), which was perceived to be costly initially but led to lots of cost reductions and huge savings. Hassini et al. (2012) mention that sustainable SC can be adopted due to: Market Forces, Policy and Regulations, Science and Technology, Product Development, Process Capability, Sourcing and Operations, Transport and Logistics (especially reverse logistics), Marketing and PR, and Social Issues. They say that Marketing and PR help in evoking customer interest in purchasing green products and Social Issues are concerned with the current practices of the company. Porter and van der Linde (1995) also say that customers should be made aware of wastages like the excess packaging.

Caniato et al. (2012) divide the drivers of green practices into 1) Internal costs – They observed that big businesses do not consider the costs much, but are more concerned about the strategic advantage that adoption of green practices will provide them. However, large corporations are also able to keep costs under check by the reduction of material, energy, and wastes. On the contrary, for smaller companies, they observe that after reducing their internal costs they would be able to invest more in the greening process. 2) Market pressures – These were more relevant for the small companies as compared to larger ones. The big businesses themselves tried to educate their customers about the importance of green practices because of the relevance of green practices in today's world as compared to previous decades. 3) Legislation – They also identified that legislation about green practices is not exhaustive for the fashion industry and incorporates only a few aspects like emissions and water pollution.

2.1.1.3 Sector

Most of the studies regarding environmental sustainability have been conducted in the manufacturing sector primarily because of the polluting nature of this industry (Ageron et al., 2012; Beamon, 1999; Green Jr, Zelbst, Meacham, & Bhadauria, 2012; Hassini et al., 2012; Zhu et al., 2008). Beamon (1999) categorizes the impact of manufacturing on the environment into the following categories: waste (all forms), energy use, and resource use (material consumption). Hassini et al. (2012) observe during their review of eighty-seven sustainability-related studies conducted during the last decade that the sustainability studies primarily focused on manufacturing

because it is very polluting, and also because manufacturing garnered more attention from operations research. Studies have also been conducted in the retail sector (Caniato et al., 2012; Jones et al., 2005).

2.1.1.4 Firm size

The response of companies to green and sustainable practices depends on their size and larger companies adopt green practices more as compared to smaller ones (Ageron et al., 2012; Caniato et al., 2012; Hassini et al., 2012). Caniato et al. (2012) study two types of fashion companies: 1) Large and established businesses that are foraying into the green realm incrementally 2) Smaller and local firms which have incorporated green to be competitive. They found that the large corporations focus more on green warehousing activities as most of the times they have outsourced their entire production processes. On the other hand, the small ones try to green their production processes because most of them are done in-house. In the end, the authors observed that large companies could reshape their SCs and are concerned with a wider variety of green practices as compared to the smaller companies. They argue that smaller companies focus on green practices because their customers value such practices. Ageron et al. (2012) observe that the strategies used by SMEs are reactive, whereas those employed by large firms are proactive. Hassini et al. (2012) noted that large companies have better incentives to adopt green practices, as compared to SMEs but even SMEs will have to adopt sustainable practices eventually.

2.1.2 The phenomenon of GSCM: practices and barriers

2.1.2.1 Practices

Beamon (1999) mentions that greening a traditional SC requires the following components: product and packaging recycling, re-use and remanufacturing operations. She also talks about extending ISO 14000 certification. Zhu and Sarkis (2004) mention the following four categories of green practices: 1) Internal Environment Management (IEM) 2) External GSCM 3) Investment Recovery (IR) 4) Eco-design. They say that IR can also be considered as a green practice, although it had already been existing as a business practice. Rao and Holt (2005) take green practices into account which encompass the following areas: inbound logistics, production or internal SC,

outbound logistics and reverse logistics. For inbound logistics, they mention green purchasing, supplier evaluation, aiding suppliers. For production, they mention cleaner production, design for environment, remanufacturing and lean production. For outbound logistics, they take into account environment-friendly packaging, distribution. Srivastava (2007) observed the following practices: 1) Green design and life cycle assessment 2) Green operations – Reverse logistics and network design 3) Waste management – Under this he mentions the location of facilities, transportation network and also some heuristics for waste management. Like Porter and van der Linde (1995), Srivastava (2007) also talks about source reduction and pollution prevention strategy in which the production of waste or pollutants can be minimized at the source itself. Seuring and Muller (2008) observed the following practices 1) Taking into consideration the entire SC 2) Supplier evaluation – self-evaluation by suppliers and also ensuring some minimum set of environmental standards to be followed by the suppliers 3) Cooperation between the partners of the SC.

Zhu et al. (2008) mention the following practices for GSCM 1) IEM – They found that that IEM is the most used GSCM practice 2) Green purchasing (GP) 3) Cooperation with customers 4) Eco-design practices 5) IR. Hassini et al. (2012) mention the following practices 1) Green procurement practices and the monitoring of suppliers by the focal firms 2) Use of renewable sources of energy even though they are costlier 3) Use of non-toxic chemicals 4) Use of recycled paper 5) Planning delivery of items carefully so as to be able to reduce greenhouse gases (GHGs) 6) Reuse, recycle and return. Caniato et al. (2012) observed product design to be the most important part of using green practices. They mention the following practices under product design 1) environment-friendly product design 2) use of green raw materials 3) use of recyclable packages. The SC design practices varied between the established firms and the small businesses. The authors observed the below practices followed by the large and established brands: supplier selection by environmental criteria, code of conduct to be signed by suppliers to ensure that vendors respect the environmental standards, long-term alliances with suppliers to achieve continuous improvement, and transparent and continuous status check of environmental conditions. Caniato et al. (2012) observe that smaller firms follow different practices:

1) Due to their size, small businesses cannot force their suppliers to get certified

2) Instead of just focusing on the inbound SC small companies focus on outbound SCs as well. They also sell their products directly to the end customers to earn higher margins. This helps small

businesses to earn better revenues and hence provide them the capital to invest in environmental practices

3) Small businesses use strategies like 'commercial disintermediation' which allows them to distribute products directly to a single distributor who in turn coordinates with the local exchange community

4) They also conduct workshops for their customers to better inform them about their products. Such workshops also aid in spreading environmental awareness.

Caniato et al. (2012) further say that all companies believed in inculcating a culture of environmental awareness. Some large and established firms involve both their suppliers and their employees in green projects thus sensitizing staff about various green themes. Small companies collaborate with NGOs to participate in environmental projects across the globe, and some of them emphasize that sustainable products are better in quality.

Green Jr et al. (2012) observed the following green practices: 1) IEM 2) Green Information Systems (GISs) 3) GP 4) Cooperation with Customers 5) Eco-design 6) IR 7) Environmental Performance. The practices have been defined in the below table:

Internal environmental management	Internal environmental management is the practice of developing green supply chain management as a strategic organizational imperative through commitment and support of the imperative from senior and mid-level managers
Green information systems	Green information systems are information systems that have been modified and are used to monitor environmental practices and outcomes
Green purchasing	Green purchasing focuses on cooperating with suppliers for the purpose of developing products that are environmentally sustainable
Cooperation with customers	Cooperation with customers requires working with customers to design cleaner production processes that produce environmentally sustainable products with green packaging
Eco-design	Eco-design requires that manufacturers design products that minimize consumption of materials and energy, that facilitate the reuse, recycle, and recovery of component materials and parts, and that avoid or reduce the use of hazardous products within the manufacturing process
Investment recovery	Investment recovery requires the sale of excess inventories, scrap and used materials, and excess capital equipment
Environmental performance	Environmental performance relates the ability of manufacturing plants to reduce air emissions, effluent waste, and solid wastes and the ability to decrease consumption of hazardous and toxic materials

Table 1. Definitions of some important GSCM practices

Source: Adapted from Green Jr et al. (2012)

Ageron et al. (2012) mention the following practices: ISO 14001 certification, lean management, eco-design, production facilities, clean programs, reducing carbon footprints, product life cycle costing or assessment, reducing transportation cost, reverse logistics, and remanufacturing. They also mention that the type of partnership (such as, strategic), location and size of suppliers also impact sustainability. They say that managerial approaches to sustainable supply management could be active, reactive, proactive, collaborative and individual.

2.1.2.2 Barriers

Ageron et al. (2012) mention the following obstacles (in decreasing order of importance): financial costs, green investments, return on investment, supplier's facilities, supplier's human skills, product price, supplier's top management commitment, supplier's firm culture, product

characteristics, focal company's facilities, SC configuration, supplier's firm size, company's human skills, supplier's location, focal firm's previous sustainability experiences, and top management's commitment. Hassini et al. (2012) mention the following barriers to developing sustainable SC metrics: 1) There are so many of them but the context to use them is not clear 2) Consensus to use metrics across the entire SC 3) Earlier metrics were devised for the organizational level but in the current context as the SC is spread across multiple organizations, so it becomes harder to adapt them for the entire SC 4) There is no specific agency which controls the application of these metrics across the whole SC 5) Partners lack trust and therefore hesitate to share the data 6) Alignment of strategies across the entire SC 7) Coordinating competencies is challenging 8) Challenges in streamlining parties in the SC 9) SCs are dynamic.

2.1.3 Consequences: GSCM measurement, results

2.1.3.1 Measurement scales or performance measurement

Beamon (1999) mentions many performance measures as shown in Table 2. This table classifies the performance measures into the following categories: 1) Resource use 2) Product recovery 3) Product characteristics 4) Waste emissions and exposure hazard 5) Economic 6) Economic/emissions. With each category, different performance measures are associated. For example, with the category of Resource use, the associated measures are: total energy consumed and total material consumed. Thus, these performance measures can be used to gauge the performance of the green SC or the extended SC as mentioned by her. It must be noted that this paper was published in 1999, so these performance measures are more than a decade old, but they still give a broad overview of the various steps that can be employed for extending a traditional SC to a green SC.

Performance measure classification	Performance measure (measured over product and process life cycle, except where indicated)
Resource use	Total energy consumed
	Total material consumed (e.g. water, timber, steel)
Product recovery	Time required for product recovery
Remanufacturing	Percent recyclable/re-useable materials (volume or weight) available at the end of product life
Re-use	Percent product volume or weight recovered and re-used

Recycling	Purity of recyclable materials recovered
	Percent recycled materials (weight or volume) used as input to manufacturing
	Percent product disposed or incinerated
	Fraction of packaging or containers recycled
	Material recovery rate (MMR)
	Core return rate (CRR)
	Ratio of virgin to recycled resources
	Ratio of materials recycled to materials potentially recyclable
	Materials productivity: economic output per unit of material input
Product characteristics	Useful product operating life
	Total mass of products produced
Waste emissions and exposure hazard	Total toxic or hazardous materials used
	Total toxic or hazardous waste generated
	Solid waste emissions
	Percent product (weight or volume) disposed in landfills
	Concentrations of hazardous materials in products and by-products
	Estimated annual risk of adverse effects in humans and biota
	Waste ratio: the ratio of wastes to all outputs
Economic	Average life-cycle cost incurred by the manufacturer
	Purchase and operating cost incurred by the consumer
	Average total life-cycle cost savings associated with design improvements
Economic/emissions	Eco-efficiency: adding the most value with least use of resources and the least pollution. Generally, "The ability to simultaneously meet cost, quality and performance goals, reduce environmental impacts, and conserve valuable resources."

Table 2. Extended Supply Chain performance measures

Source: Beamon (1999)

Zhu et al. (2008) developed a scale that consists of twenty-one elements to measure sustainability. As shown in the below table these items were part of the following five categories: IEM, GP, Cooperation with customers, Eco-design and IR.

Factors	Measurement items
Internal environmental management (IEM)	1. Commitment of GSCM from senior managers
	2. Support for GSCM from mid-level managers
	3. Cross-functional cooperation for environmental improvements
	4. Total quality environmental management
	5. Environmental compliance and auditing programs
	6. ISO 14001 certification
	7. Environmental Management Systems exist
Green purchasing	8. Eco-labeling of products
	9. Cooperation with suppliers for environmental objectives
	10. Environmental audit for suppliers' internal management
	11. Suppliers' ISO14000 certification
	12. Second-tier supplier environmentally friendly practice evaluation

Cooperation with customers	13. Cooperation with customers for eco design 14. Cooperation with customers for cleaner production 15. Cooperation with customers for green packaging
Eco-design	16. Design of products for reduced consumption of material/energy 17. Design of products for reuse, recycle, recovery of material, component parts 18. Design of products to avoid or reduce use of hazardous products and/or their manufacturing process
Investment recovery	19. Investment recovery (sale) of excess inventories/materials 20. Sale of scrap and used materials 21. Sale of excess capital equipment

Table 3. List of measurement items for GSCM practices implementation

Source: Zhu et al. (2008)

Caniato et al. (2012) observe the following key performance indicators (KPIs):

1) Materials

2) Energy – includes aspects like direct, indirect energy consumption

3) Water – usage of recycled water and its volume

4) Biodiversity – pertains to impacts on natural habitats

5) Emissions, effluents, and waste – includes direct or indirect greenhouse emissions, water quality

6) Products and services – indicators to check if any initiatives exist to alleviate the impact of products and services

7) Compliance – penalties for non-compliance

8) Transport – assesses the impacts of logistics

9) Business integration – this was adapted specifically for the apparel sector

2.1.4 Results of GSCM implementation

Zhu and Sarkis (2004) found that support from management is imperative for enhancing environmental performance. They say that GSCM leads to an enhancement of both environmental and economic performances and does not result in any adverse impact on environmental performance. They argue that due to globalization Chinese firms could be forced by their foreign customers to adopt green practices. Rao and Holt (2005) found that inbound greening and production greening can lead to a reduction of waste at the source, thus preventing pollution. They also found that both the preceding steps result in outbound greening. All this, they say, ultimately helps companies to gain competitive advantage, enhanced economic performance, and a more integrated SC. Caniato et al. (2012) found that the competitive advantage of big businesses is not impacted as a result of the implementation of green practices. They also found that small companies implement green practices because of their customers' preferences and adopt practices like sourcing from local suppliers, using natural dying processes, and restructuring their SCs. Seuring and Muller (2008) mention the following features of SSCM: 1) SSCM should take into consideration the entire SC because of the large number of issues involved 2) The performance aspects of SSCM are related to environmental and social sustainability 3) Higher cooperation is needed between the partners of the SC to achieve sustainability. Beamon (1999) says that GSCM leads to additional complexity and requires changes in the structure of the SC. Hassini et al. (2012) after performing a case study observe that there is a dearth of indicators that can be used to measure the sustainability of an SC. They emphasize that the measurement of sustainability in SCs is complex so companies can start from high-level indicators.

2.1.5 Summary of green supply chains

In summary, it can be seen that the implementation of GSCM can lead to enhanced economic and environmental performance, cost savings and also provides a competitive advantage to companies. However, in many cases, it leads to greater costs, particularly for SMEs. It was observed that the incorporation of GSCM requires changes in the structure of the SC due to additional green processes and practices leading to additional complexity.

As already seen, these changes can increase the vulnerability of SCs which could impact their resilience due to a reduction of supplier base and old products. Moreover, as previously stated, the

phenomena of outsourcing and globalization have vastly stretched SCs not just through physical, cultural distances but also by increasing the number of players in the SC and complicating the efforts to monitor everything about SC (Sheffi, 2015). Also, when companies procure or source from abroad they also take their brand names as per the spotlight phenomena, due to which they cannot plead ignorance if any of their SC partners is caught, flouting any environmental or social norms (Spar, 1998). A need, therefore, arises to look into the mechanisms through which GSCM implementation can impact an SC's resilience. It must, however, be emphasized, that supply chain resilience (SCR) is an entirely different phenomenon and has its set of terminologies and mechanisms. To address this, papers related to SCR are discussed in the next section.

2.2 Resilient supply chain

To understand the various factors that affect resilience, this section starts off with a discussion on terms related to SCR. Many terms like risk, vulnerability, and robustness are linked to the concept of resilience. It is, therefore, important to clearly state the difference between the meanings of these terms. Waters (2007) says that SC risk management aims "to ensure that supply chains continue to work as planned, with smooth and uninterrupted flows of materials from initial suppliers through to final customers." (…) "Vulnerability describes how likely a supply chain is to be affected by risky events." "The idea of resilience is somewhat different, as it suggests the speed with which a chain can return to normal working after some kind of damage" (p. 86).

Next, the definitions of resilience are presented and any other related terms, as observed in the literature are also clarified. Christopher and Peck (2004) define resilience as "the ability of a system to return to its original state or to move to a new, more desirable state after being disturbed" (p. 2). They also mention that in practice the terms 'robustness' and 'resilience' are used interchangeably, but they can assume different meaning regarding SCs. They say that a robust process does not necessarily lead to a resilient SC. Ponomarov and Holcomb (2009) define SCR as "the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function" (p. 131). Ambulkar, Blackhurst, and Grawe (2015) define the SCR of a firm as "the capability of a firm to be alert to adapt to and quickly respond to changes brought by a supply chain disruption" (p. 112). Out of all the aforementioned

definitions of resilience, the one by Christopher and Peck (2004) will be the used to define resilience in this paper because of its focus on a more desirable state.

In the next section, papers on SCR are reviewed as per the antecedents-phenomena-consequences schemes as shown in Figure 3. This review scheme has been adapted from Schmeisser (2013). The antecedents section, answers the question, "why should companies make their SCs resilient?". The answers to the question lie in the causes of disruption and the categorization of different risks due to which companies should develop resilience in their SCs. The phenomena block tries to answer the question, "what happens when disruptions occur and how SCR can prevent or alleviate them?". This question will be replied to with the help of the following sections: stages of disruptions, mitigation or alleviation, impediments or challenges. Finally, in the consequences section, the results about SCR are discussed. The different parts of the literature addressing the various aspects of SCR have been categorized accordingly under the previously mentioned questions and categories.

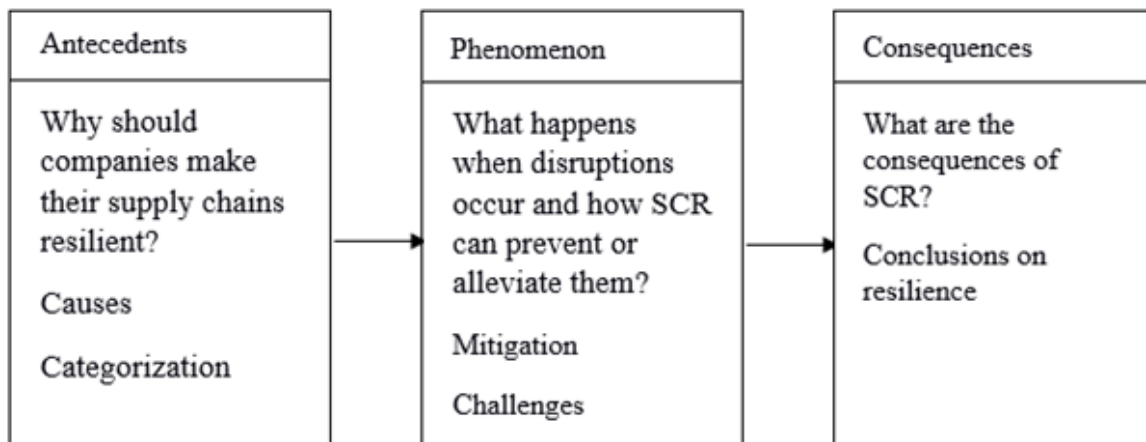| Antecedents	Phenomenon	Consequences
Why should companies make their supply chains resilient? Causes Categorization	What happens when disruptions occur and how SCR can prevent or alleviate them? Mitigation Challenges	What are the consequences of SCR? Conclusions on resilience

Figure 3. Review scheme for literature on SCR

Source: Adapted from Schmeisser (2013)

2.2.1 Antecedents of SCR: causes, categorization

2.2.1.1 Causes

SC disruptions have increased because of the rise in global sourcing, lean SCs, agility requirements and terrorist attacks (Blackhurst, Craighead, Elkins, & Handfield, 2005; Ponomarov & Holcomb, 2009; Roberta Pereira, Christopher, & Lago Da Silva, 2014). In his literature review, Tang (2006) observed that even though many firms are aware that they are susceptible to risks which can disrupt their SCs, they still do not possess any contingency plans in the event of such an occurrence. He observes three reasons: underestimation of the risks, lack of sufficient knowledge about risk management and lack of data for firms to determine the suitability of implementing any risk reduction program. Roberta Pereira et al. (2014) mention that the other reasons contributing to disruptions are high variability in demand, short product lives, and varied customer requirements. They say that disruptions are more pronounced if they occur in the upstream and try to identify that how procurement can create resilience in SCs.

2.2.1.2 Categorization

Risks are usually: low impact or high likelihood risks or frequent risks and high impact or low likelihood or infrequent risks (Ambulkar et al., 2015; Chopra & Sodhi, 2004; Oke & Gopalakrishnan, 2009). Oke and Gopalakrishnan (2009) mention a third type which are medium probability and moderate impact risks. SC risks are interconnected due to which a reduction in one risk can amplify another (Chopra & Sodhi, 2004; Khan & Burnes, 2007). As shown in Table 4, Chopra and Sodhi (2004) categorize SC risks into the following categories: disruptions, delays, systems, forecasts, intellectual property, procurement, receivables, inventory, and capacity. They also mention the drivers of each risk.

Category of Risk	Drivers of Risk
Disruptions	Natural disaster Labor dispute Supplier bankruptcy War and terrorism Dependency on a single source of supply as well as the capacity and responsiveness of alternative suppliers
Delays	High capacity utilization at supply source Inflexibility of supply source Poor quality or yield at supply source Excessive handling due to border crossings or to change in transportation modes
Systems	Information infrastructure breakdown System integration or extensive systems networking E-commerce
Forecast	Inaccurate forecasts due to long lead times, seasonality, product variety, short life cycles, small customer base "Bullwhip effect" or information distortion due to sales promotions, incentives, lack of supply-chain visibility and exaggeration of demand in times of product shortage
Intellectual Property	Vertical integration of supply chain Global outsourcing and markets
Procurement	Exchange rate risk Percentage of a key component or raw material procured from a single source Industrywide capacity utilization Long-term versus short-term contracts
Receivables	Number of customers Financial strength of customers
Inventory	Rate of product obsolescence Inventory holding cost Product value Demand and supply uncertainty
Capacity	Cost of capacity Capacity flexibility

Table 4. Categorization of risks and their drivers

Source: Chopra and Sodhi (2004)

Companies take steps to counter frequent, low-impact risks but they do not take action to counter high-impact and low likelihood risks (Chopra & Sodhi, 2004). Christopher and Peck (2004) categorize risks as: First, internal to the firm and include process and control. Second, risks that are external to the enterprise but internal to the SC network. These include demand and supply risks. Third, risks external to the network, like environmental hazards.

Manuj and Mentzer (2008) provide the below summary of risks and their sources.

Type of risk	Source
Supply Risks	Disruption of supply, inventory, schedules, and technology access; price escalation; quality issues; technology uncertainty; product complexity; frequency of material design changes
Operations risks	Breakdown of operations; inadequate manufacturing or processing capability; high levels of process variations; changes in technology; changes in operating exposure
Demand Risks	New Product introductions; variations in demand (fads, seasonality, and new product introductions by competitors); chaos in the system (the Bullwhip Effect on demand distortion and amplification)
Security risks	Information systems security; infrastructure security; freight breaches from terrorism, vandalism, crime, and sabotage
Macro Risks	Information systems security; infrastructure security; freight breaches from terrorism, vandalism, crime, and sabotage
Policy Risks	Actions of national governments like quota restrictions or sanctions
Competitive Risks	Lack of history about competitor activities and moves
Resource Risks	Unanticipated resource requirements

Table 5. Summary of risks

Source: Manuj and Mentzer (2008)

They, however, mention that risks pertaining to the SC are only the first four. The others are also important, but they manifest themselves as a combination of the first four risks. For risk categorization, Oke and Gopalakrishnan (2009) use the framework from Chopra and Sodhi (2004) and classify risks into supply related, demand related, and miscellaneous risks as follows:

1) Supply risks – These include risks due to imports, climate, man-made disasters, natural disasters, socioeconomic factors, loss of key suppliers

2) Demand risks – These include risk due to economic factors, demand variability/unpredictability, product hazards, pandemics, forecasting errors

3) Miscellaneous risks – These risks lead to higher business costs and could arise due to gas prices, increased global consumption (spikes the cost of such materials), safety regulations by governments and actions by NGOs like PETA.

Trkman and McCormack (2009) say that turbulence is different in different markets and environments, so disruptions also vary from supplier to supplier. They mention that a strategy that might be suitable for a turbulent environment might not be appropriate for a non-turbulent

environment and vice versa. They divide the sources of uncertainty into endogenous and exogenous. They emphasize that such a differentiation is necessary as both endogenous and exogenous sources require different risk alleviation measures. They divide risks into:

1) Continuous risks which include risks like commodity price changes

2) Discrete risks which include major disruptions due to regulatory issues, man-made disasters, natural hazards.

2.2.2 Phenomena of SCR: stages of disruptions, mitigation or alleviation, impediments or challenges

2.2.2.1 Stages of disruptions

Blackhurst et al. (2005) focus on the following three areas of SC disruptions:

1) Disruption discovery – This includes visibility, capacity and predictive analysis and risk indices. Participants of their study were almost unanimous about the benefits of visibility. The participants were concerned that with an increase in global sourcing the busy logistics markets would get saturated and this would require the creation of additional capacity. The authors also stress the importance of incorporating intelligent systems (for predictive analysis) that can predict and manage various aspects in the SC by aiding the human operators of the SC. Such intelligent systems would ultimately lead to better monitoring and prediction of disruptions so that they can be nipped in the bud. In the end, they say that risk indices are necessary so that various regions, ports, facilities can be indexed to discover any possible SC disruption in advance

2) Disruption recovery – This includes real-time SC configuration and reachability analysis. Once a disturbance is discovered managers should be able to bypass the affected node or link by reconfiguring the SC in real time. Under reachability analysis, the authors suggest research for determining the impact of a disruption on the entire SC once the disruption has occurred

3) SC redesign – This includes understanding global SC cost trade-offs and flexible and robust SC optimization tools. They mention many hidden costs like visibility costs, premium freight, and buffers that must be taken into account. Need for models that are optimal and robust to handle disruption is also mentioned. It is worth mentioning that these models should be dynamic and should work in various disruption scenarios and not just one.

Sheffi and Rice Jr. (2005) mention that disruptions have eight stages:

1) Preparation – Sometimes companies can receive early warnings through weather forecasts, cyclone warnings. In such situations, businesses can prepare for disruptions without being caught off-guard. On the other hand, it is not always possible to remain prepared for disruptions in advance

2) Disruptive event – This is the stage when disruptions strike the firm, SCs, and governments

3) First response – This involves responding to the disruption and trying to get the system up and running again as soon as possible. For example, it may have led to facility lockdown, an outage of information systems

4) Initial impact – Some impacts are felt immediately, and some impacts are felt later. For instance, the authors mention that the impact of Union Carbide leak was immediate, whereas strikes have a gradual impact

5) Full impact – Once the full impacts come into picture either immediately or gradually, the actual functioning and operation of the firms drop significantly

6) Recovery preparations – Contingency plans for recovery are implemented soon after the first response and sometimes in parallel with the initial reaction

7) Recovery – To get back to the normal operations and to fulfill backlogs companies work over time in collaboration with suppliers and partners

8) Long-term impact – It takes time to recover from disruptions, but recovery is not always possible. Sometimes it is partial, and sometimes there is no recovery at all. During the duration of disruption customers explore alternative sources, and if they find a better source, they are lost by the company.

2.2.2.2 Mitigation or alleviation

Chopra and Sodhi (2004) mention the below mitigation strategies: 1) Add capacity 2) Add inventory 3) Have redundant suppliers 4) Increase responsiveness 5) Increase flexibility 6) Aggregate or pool demand 7) Increase capability 8) Have more customer accounts. However, some of these also increase risks, like the addition of capacity increases capacity risk greatly. Similarly, adding inventory greatly increases inventory risk. Also, having too many suppliers increases capacity risk. Christopher and Peck (2004) mention the following methods to incorporate resilience in the SCs:

1) SC (re) engineering – Traditional SC designs focus on cost or customer satisfaction. To deal with uncertainties, resilience must also be taken into account during SC design

2) SC understanding – To improve SCR clear information must be gathered about the entire business network. Such information can be gathered by using "pinch points" (bottlenecks) and "critical paths." These risk assessments can also be used to create an SC risk register

3) Supply base strategy – Rather than having just one supplier, which does not make an SC resilient, it is better to have many suppliers. However, companies should understand about the kind of benefits that they want to reap from such suppliers. Even the suppliers should be prepared for risks and not just the focal company. This can be gauged by the risk audit programs being implemented by the suppliers

4) SC design principles – When designing and redesigning SCs, companies must always think about contingency plans which they can use in times of disruptions. The authors admit that this always brings up the discussion on "efficiency versus waste." They agree that one must not go back to the old days when extra capacity and the stock was kept at every stage of the SC but this should at least be held at the pinch points without leading to too much cost inflation.

Christopher and Peck (2004) also mention that SC collaboration should also be achieved and the relationship between the various SC partners must be collaborative rather than adversarial. They also mention that SCs need to be agile which requires visibility and velocity. Sheffi and Rice Jr. (2005) mention that resilience can be created in two ways: redundancy and flexibility. Redundancy, however, leads to additional costs and defeats the 'just in time' philosophy. They, therefore, suggest companies develop flexibility in their SCs. Once this flexibility is incorporated in the SC, it helps to make the SC more resilient and responsive to any disruptions and also provides competitiveness to the firm.

Tang (2006) mentions the following strategies for alleviating SC risks: 1) Postponement 2) Strategic stock 3) Flexible supply base 4) Make-and-buy 5) Economic supply incentives 6) Flexible transportation 7) Revenue management 8) Dynamic assortment 9) Silent product rollover. The first two increase product flexibility. The third and fourth strategies increase supply flexibility. The fifth one increases product availability. The sixth one increases transportation flexibility. The seventh and eighth strategies provide an increased control of product demand and the last one provides a better control of product exposure to customers. Khan and Burnes (2007) observe the

following risk management strategies: 1) Close working relationship with suppliers 2) Purchasing partnerships 3) Supplier quality or auditing or certification programs 4) Supplier improvement programs 5) Multiple sources of supply versus single sourcing 6) Inventory management 7) Communication and early involvement of suppliers in strategic decisions 8) Buffers 9) Strategic alliances 10) Risk/Sharing knowledge transfer 11) Focus on core competence 12) Product differentiation 13) Entrepreneurial/risk taking 14) Proactive supply management.

Manuj and Mentzer (2008) observe that risk management strategies can be divided into the following categories: avoidance, postponement, hedging, control, sharing or transferring and security. Ponomarov and Holcomb (2009) mention that the concept of adaptability is vital for SCR. They say that the gap in the literature is due to the absence of a "holistic conceptual picture." They talk about linking logistics with SCR to develop this holistic picture. The key logistics capabilities identified by them are 1) Delivery speed 2) Reliability 3) Responsiveness 4) Low-cost distribution. Roberta Pereira et al. (2014) observe the following enablers for incorporating SCR during procurement: financial strength, coordination and control, redundancy, flexibility, trust, visibility, risk management, information sharing, collaboration, velocity or acceleration, agility, alignment, SC design, integration, SC design, and company's knowledge.

2.2.2.3 Impediments or challenges

Tang (2006) mentions the below impediments in the implementation of robust SC strategies:

1) Costs versus benefits – Companies are reluctant to invest in the robust strategies because the related benefits are not visible until an actual disruption occurs

2) Strategic benefit – The choice of the robust strategy may not be in alignment with the company's business strategy

3) Proactive execution – Just the incorporation of robustness in the SC does not do any good unless robustness is used in tandem with proactiveness.

Roberta Pereira et al. (2014) observe the following barriers: lack of knowledge, lack of visibility, lack of trust, lack of flexibility, lack of information sharing, lack of collaboration, lack of capacity, lack of integration, lack of coordination and control, complexity, long distance, and long lead times.

2.2.3 Conclusions on SCR

SC risk management must be imbibed in the psyche of the organization (Chopra & Sodhi, 2004; Christopher & Peck, 2004). Chopra and Sodhi (2004) say that SC risk management can be done by stress testing and tailoring. Stress testing is a "What if" exercise where one link is assessed for risk at a time. Tailoring is to modify general risk management and alleviation approaches to suit the needs of their company. Christopher and Peck (2004) say that risk management should not just focus on business continuity, but it should concentrate on the SC business continuity. They argue that most of the times there is a lack of top management's interest in risk management which on the contrary must be most involved in this decision. Tang (2006) says that disruptions will always occur so the idea should be to lessen the impact of disruptions after their occurrence. He suggests the below methods:

1) Supply alliance network – Through such alliances the suppliers can contact other members of the alliance to fulfill the needs of their customers during a disruptive event

2) Lead time reduction – This involves reducing the lead times because the SCs that have a longer lead time are more susceptible to disruptions

3) Recovery planning systems – Investing in and developing such systems helps to increase the visibility of raw materials and inventories across the entire SC. They also assist in improved collaboration and better integration of the SC which makes all the actors in the SC better positioned to tackle any disruptive event.

Khan and Burnes (2007) mention that there is no silver bullet for the mitigation of risks. They underscore the importance of contingency model, that is, risk mitigation based on the context rather than a generalized approach. Ambulkar et al. (2015) also found that in dealing with SC disruptions, context is crucial and SC disruption orientation is not enough to address all kinds of disruptions. They further say that for high disruption events, disruption orientation and resource reconfiguration both are required, and risk management infrastructure might hinder rather than support the alleviation of such high impact disasters.

2.2.4 Summary of resilient practices

In summary, this section provides and understanding of the different types of risks and how resilience can be incorporated in an SC. To incorporate resilience in the SC, focal companies should have multiple suppliers, strategic alliances with important suppliers, flexibility and should be even able to manage their suppliers' suppliers. Companies are not sure about how to prepare for a disruptive event because they are not sure whether it will even occur or not. The lack of certainty about a disruptive event is, therefore, one of the major barriers to achieving SCR. Maintaining a resilient SC can sometimes be contrary to a green SC or vice-versa. For instance, in the section on green SCs, it was observed that the number of suppliers of a company could decrease as a result of supplier screening for green practices, which is contrary to the practice of SCR to have multiple suppliers. To further shed light on such aspects, in the next section studies that discuss green and resilient practices together (explicitly or implicitly) and the impacts of green practices on SCR have been reviewed.

2.3 Impacts of GSCM on SCR

In this section, studies that examine the impacts of GSCM on SCR and the mechanisms through which this occurs, have been reviewed. However, beyond pointing out that GSCM might affect or not affect an SC's resilience, there are very few studies that investigate the mechanisms by which this may occur. Furthermore, as will be seen, not many papers have empirically analyzed the link between GSCM and an SC's resilience. Since there is a shortage of literature on green and resilience, so studies that discuss lean, agile, resilient, and green paradigms, have also been taken into account. However, while reviewing such studies, only the discussions related to green and resilient practices would be focused. Moving further, the focus will be on studies that discuss green and resilient practices together. Finally, studies that mention about the mechanisms through which this occurs, are discussed.

Cousins, Lamming, and Bowen (2004) mention that risks must be explicitly taken into account by companies in their environment related supplier development initiatives. This is possible particularly when companies have a strategic relationship with their suppliers. They divided the environment related supplier development initiatives into: "why bother," "no choice," "go first," and "enthusiasts." "Enthusiasts" foray into such schemes much before others, even when there is

low risk. However, as the number of risk factors increases they can become a "go first" firm. The authors also mention that the "go first" are the most proactive organizations. When the extent of perceived losses is less, firms behave as "why bother." However, if the losses increase a lot, then firms are not left with any choice and therefore are classified by them as "no choice." They say that the actions of a firm can lead to a decrease in exposure and the expected losses but if the intended initiatives are not implemented properly, then it might result in a reduction in the expected losses but will not reduce the actual exposure. They mention the example of supplier screening to avoid suppliers who do not meet any environmental criteria, but this could lead to a decrease in the supplier base.

Carter and Rogers (2008) observed four additional aspects (Figure 4) that support the triple bottom line of sustainability. Risk management is one of the four areas and is concerned with contingency planning, supply disruptions, and outbound SCs. They also argue that 'risk management' was observed by them many times while reviewing the literature on sustainability.
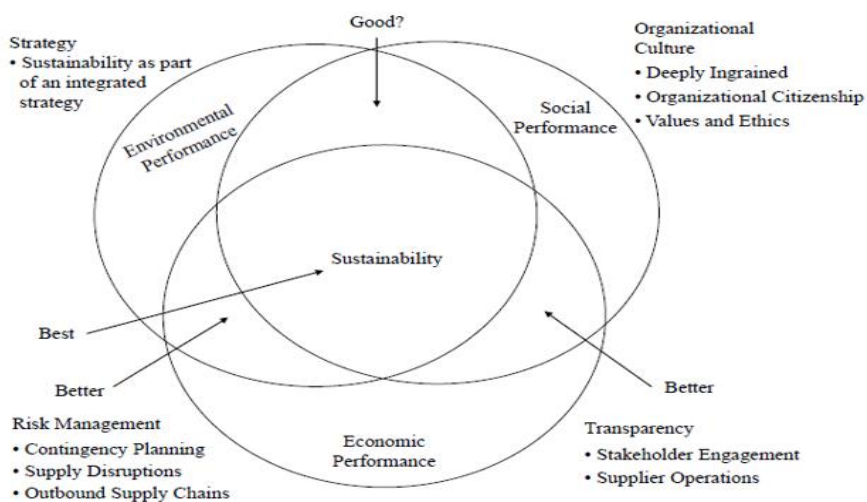

Figure 4. Sustainable supply chain management

Source: Carter and Rogers (2008)

Seuring and Muller (2008) observe that 'supplier management for risks and performance' and 'SCM for sustainable products' are not contradictory to each other but are complementary to each other. Korhonen and Seager (2008) observe that the benefits of eco-efficiency, are numerous but

it can negatively impact the resilience of industrial and ecological systems and therefore impacting the long term sustainability. They say that eco-efficiency has led to greater outputs while using lesser resources and also reducing the impacts on the environment. They further say that some natural ecosystems are only 3% efficient. As per them, this inefficiency or waste is what makes such ecosystems resilient by leading to interactions in those ecosystems. Similarly, they cite the analogy of industrial ecosystems that are in symbiotic relationships. The waste by one organization can help others and so on, thus increasing the resilience of the ecosystem (here the entire SC can be viewed as an ecosystem which could enhance the competitiveness of the whole SC). They conclude that something which might be inefficient regarding eco-efficiency would, in fact, increase the resilience of the industrial ecosystem.

Carvalho, Duarte, and Cruz-Machado (2011) mention that due to the spread of SCs across the entire world and also due to the adoption of lean practices, SCs have become more vulnerable. They state "Resilient supply chains may not be the lowest cost, but they are more capable of coping with the uncertain business environment. Also, environmental practices must be addressed to assure that the management system is sustainable" (p. 152). They compared lean, agile, green, and resilient paradigms on the basis of the following criteria: purposes, manufacturing focus, alliances (with suppliers and customers), organizational structure, approach to choosing suppliers, inventory strategy, lead time focus, product design strategy, product variety and market. Keeping in mind the focus of this study, their comparison between green and resilient paradigms is presented in the below table.

Characteristic	Green	Resilient
Purpose	Focuses on sustainable development - the reduction of an ecological impact on industrial activity	System ability to return to its original state or to a new, more desirable one, after experiencing a disturbance, and avoiding the occurrence of failure modes
Manufacturing focus	Focuses on efficiency and waste reduction for environmental benefit and development of remanufacturing capabilities to integrate reusable/ remanufactured components	The emphasis is on flexibility (minimal batch sizes and capacity redundancies); the schedule planning is based on shared information

Alliances (with suppliers and customers)	Inter-organizational collaboration involving transferring or/and disseminating green knowledge to partners and customer cooperation	SC partners join an alliance network to develop security practices and share knowledge
Organizational structure	Creates an internal environmental management system and develops environmental criteria for risk-sharing	Creates an SC risk management culture
Approach to choosing suppliers	Green purchasing	Flexible sourcing
Inventory strategy	Introduces reusable/remanufactured parts in the material inventory; reduces replenishment frequencies to decrease carbon dioxide emissions; reduces redundant materials	Strategic emergency stock in potential critical points
Lead time focus	Reduces transportation lead time as long it does not increase carbon dioxide emissions	Reduces lead-time
Product design strategy	Eco-design and incorporation of complete material life cycle for evaluating ecological risks and impact	Postponement
Product variety	For a multiproduct analysis, environmental management decisions become increasingly complex	High
Market	Demands more environmentally friendly practices	Have the capabilities to act on and anticipate changes in markets and overcome demand risk

Table 6. Green and Resilient characterization

Source: Adapted from Carvalho et al. (2011)

They also mention that the minimization of environmental impact with which green practices are concerned cannot be performed by negatively impacting quality, cost, service level and time. As shown in Table 7, they mention the synergies and divergences between green and resilient practices with respect to the following SC attributes: 1) Information frequency – One of the resilient practices that they observed was 'demand visibility.' They say that demand visibility enhances information frequency. For green practices, they did not observe any impact on information frequency. 2) Integration level – They say that an SC's 'integration level' also increases because of risk sharing. Green practices also focus on risks, albeit environmental which leads to a more integrated SC. 3) Production lead time – They say that resilient SCs require rapid configuration, so resilience is negatively related to production lead time. As green practices focus on waste minimization or reduction, so they are linked negatively with production lead time 4) Transportation lead times – A resilient SC requires flexible transportation and therefore

transportation lead times are negatively related to resilience. Green practices focus on the reduction of carbon emissions, so they are also negatively related to transportation lead time. 5) Capacity surplus and Inventory level – The capacity surplus and inventory level are positively related to resilience because they act as a cushion during uncertain times. Due to the focus of green practices on efficiency and reduction of redundancy they negatively impact the capacity surplus and also the inventory level. 6) Replenishment frequency – This is positively related to resilience because it helps to provide greater satisfaction to the customers by preventing stock-outs. The replenishment frequency is negatively related to green because of the focus on reducing the emissions as a greater replenishment frequency will also lead to an increased number of emissions.

Attributes	SC paradigms		
	Green	Resilient	
Information frequency	–	↑	Synergies
Integration level	↑	↑	
Production lead time	↓	↓	
Transportation lead time	↓	↓	
Capacity surplus	↓	↑	Divergences
Inventory level	↓	↑	
Replenishment frequency	↓	↑	

Notes: ↑, increase; ↓, decrease; –, without consequence

Table 7. Synergies and Divergences between green and resilient paradigms

Source: Adapted from Carvalho et al. (2011)

Their study although only based on literature review and not on empirical research provides evidence about the importance of considering lean, agile, resilient, and green practices together. From this study, the synergies and divergences about the interaction between green and resilient practices were observed.

Wang, Chan, Yee, and Diaz-Rainey (2012) mention that collaboration with globally dispersed SC partners and the implementation of green practices can have detrimental effects on the SC and could result in an increase in costs or could harm reputations of companies. They develop an

aggregative risk indicator (ARI) to measure the risks that come into picture due to the implementation of green practices for the fashion SC. The model that they adopt consists of two main areas: Performance and SC Structure. They also consider the following case scenarios 1) High street fashion retailer 2) Supermarket chain 3) Luxury fashion group. For the supermarket chain, the highest ARI was obtained for the use of green materials, which was not the case for cases one and two because their customers were willing to shell out more for green products. For the third case, they obtained the lowest ARI, according to which they suggest that the luxury fashion group should implement GSCM. The ARI for reduction of GHGs was almost similar for all three cases. The use of reduced packaging had the highest ARI for the luxury fashion group. The authors suggest that this could be due to the loss of visual appeal for products with reduced packaging.

Azevedo, Govindan, Carvalho, and Cruz-Machado (2013) identified green and resilient practices from the literature and then conducted a Delphi study that comprised six practitioners and five academicians, to assign weights to the identified green and resilient practices. After the final round of the Delphi study they found that:

1) "To reduce energy consumption" was the most important green practice 2) The resilient practices found to be the most important were: "sourcing strategies to allow switching of suppliers," "flexible supply base/flexible sourcing" and "creating total SC visibility."

However, they termed strategic stock as the least significant resilient practice. In the end, the authors designed an integrated index for assessing the greenness and resilience of an automotive SC in Portugal. They named it Ecosilient index and also performed a case study which consisted of a Portuguese automaker and three of its Tier-1 suppliers. They wanted to focus on the entire SC, but due to these particular set of companies, they focused only on the supplier and manufacturer link. At the end of the analysis, the authors state that the following practices are fully implemented by the companies: strategic stock and ISO 14001 certification. Services with lower implementation levels were: environmental collaboration with customers and suppliers and environmental monitoring of suppliers. The resulting Ecosilient index was 4.05 on a scale of 1 to 5. This demonstrated the high level of implementation of the green and resilient practices in the SC.

Carvalho, Azevedo, and Cruz-Machado (2014) found that the level of lean, agile, resilient, and green practices implementation does not need to be similar across all the echelons of the SC. It could vary depending on the echelon. They consider the following green and resilient practices: 1) Green: ISO 14001 certification and Environmentally friendly packaging 2) Resilient: Strategic stock and Flexible transportation. In their case study of a Portuguese automaker and three of its Tier-1 suppliers, they found that level of implementation of green practices was same across the automaker and its suppliers but the level of implementation of resilient practices varied.

Mandal (2014) reviewed forty-five papers on SCR that were published during 1980 to 2012 and among many of the topics suggested by him for research, one of the questions was related to identifying the impacts of GSCM on SCR.

2.3.1 Summary of the impacts of GSCM on SCR

The early adoption of GSCM by a company's suppliers, which is less challenging if the company is strategically linked to its suppliers, can help it to stay ahead of its competitors. However, it must be kept in mind that the implementation of sustainability-related practices could expose companies to increased risks because of a decrease in the supplier base. The concept of eco-efficiency, that is, the use of reduced resources to lower costs negatively impacts the resilience of companies. Implementation of green practices does not impact the frequency of information sharing, but the application of resilient practices increases the frequency of exchange of information. Green and resilient practices both lead to a more integrated SC and also focus on reduced lead times (both production and transport) for reducing waste and emissions and for providing faster response. Green practices focus on reduction of inventory and capacity for the reasons of efficiency whereas an increase in capacity and inventory make the SC more resilient. Green practices focus on reduction of the frequency of replenishment whereas resilient practices concentrate on increasing replenishment frequency. The implementation of green practices could increase the risk of the SC particularly for globally dispersed SCs. Moreover, the level of implementation of green practices does not have to be the same across all the echelons of the SC. Out of all the studies discussed in section 2.3 very few papers were based on empirical research. To better understand the mechanisms through which GSCM impacts resilience, a need arises, therefore to conduct an empirical study.

In the next section, first the propositions will be presented, followed by the questions that address the research gap.

2.4 Propositions

Based on the literature review in the previous sections, propositions relevant to the study have been formulated in this section. The first proposition is regarding the size of the firm. It was observed that big businesses are more proactive in implementing a green practice which also provides them immunity in the case of any regulations (Ageron et al., 2012). SMEs are hesitant to implement green practices because of the costs involved (Hassini et al., 2012). Moreover, resilience, as well as risk management in an SC, requires a more proactive approach (Khan & Burnes, 2007; Korhonen & Seager, 2008). The preceding discussion leads to the following proposition:

Proposition 1: The SCR of smaller companies is more likely to be affected by the implementation of GSCM.

It was also seen that businesses that are separated by a vast geographical distance from their suppliers prefer their suppliers to have certifications like ISO 14001 (Rao & Holt, 2005). Chinese companies exporting to the EU are forced to have environmental certifications or regulate themselves (Zhu & Sarkis, 2004). From the preceding discussion it is proposed:

Proposition 2a: The SCR of firms that already export to countries with stringent environmental regulations is less likely to be affected by GSCM implementation enforced by the home government of the firms.

Proposition 2b: The SCs of firms that have GSCM related certifications are more resilient as compared to SCs of firms that implement their own green programs.

Pollution prevention or source reduction involves the reduction of pollution at the source itself (Porter & van der Linde, 1995; Srivastava, 2007). As a result, companies do not have to invest time and money later to green their SCs. However, pollution prevention also requires investment (Porter & van der Linde, 1995). The next proposition therefore says:

Proposition 3: The SCs of firms employing pollution prevention or source reduction strategies are more resilient than firms which employ pollution reduction strategies.

Traditional SCs can be extended to green SCs by incorporating processes like EOL and lifecycle assessment (Beamon, 1999). Taking into account the environmental impact of entire life cycle while designing products is known as green design (Srivastava, 2007). The final proposition therefore says:

Proposition 4: The SCs of firms that take into account green design for their products are more resilient as compared to SCs of firms that do not take green design into account.

2.5 Gap in the literature

Based on the literature review it was observed that many papers have been published regarding the implementation of green practices in the SC. Also, many papers have discussed SCR. However, not many studies examine the mechanisms through which green practices affect the resilience of an SC. Therefore, there is a need to identify the mechanisms by which GSCM impacts resilience of an SC and the ways by which such impacts can be neutralized or minimized. In this regard, following questions are proposed:

1) What changes had companies to make in their SC to implement GSCM?

2) What measures did they take to ensure that their SC continued functioning without any disturbances?

3) How long did it take them to stabilize the SC after the GSCM practices were implemented?

4) What are the tools that can enhance or maintain the resilience of a company's SC in the wake of the implementation of green practices?

In this chapter, studies about GSCM and SCR were reviewed, leading to the formulation of propositions and identification of the research gap. In the next chapter, the methodology for the data collection will be presented.

Chapter 3

Methodology and Data Collection

3.1 Methodology

The methodology for a research study is very important and should be detailed enough so that other researchers can replicate the study, to verify or to incorporate new elements in the study (Bui, 2013). This thesis is based on empirical research which has been depicted in the below figure. Based on the flow depicted in the figure, the different sections have been further discussed.
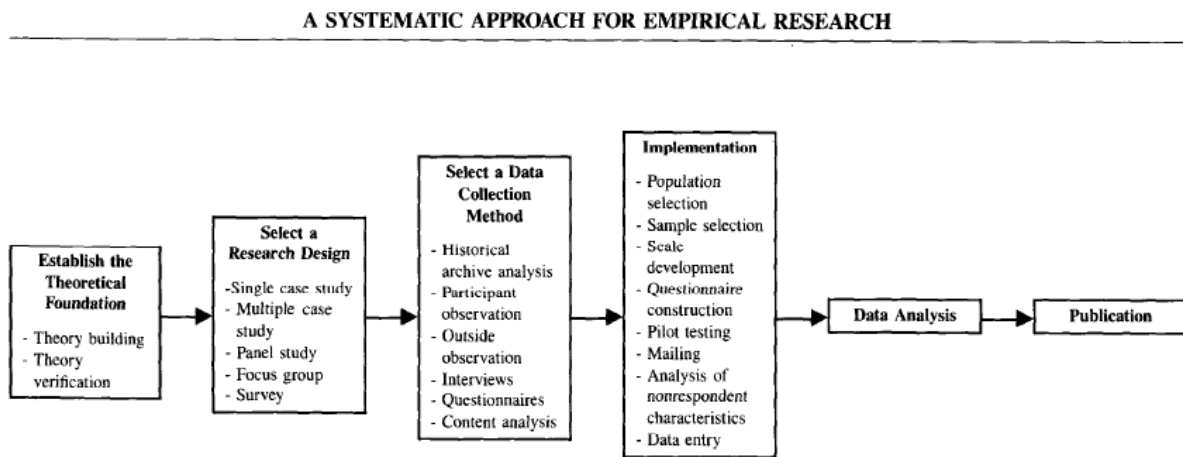
Figure 5. A systematic approach for empirical research

Source: Flynn et al. (1990)

3.1.1 Identification of green and resilience practices from the literature

In the previous chapter, the different types of green and resilient practices, their interactions, and the mechanisms through which green practices impact the resilience of the SC, were discussed.

Propositions were formulated, and the research question was also proposed. As previously stated, this study intends to analyze the mechanisms through which green practices impact the resilience of an SC. In this regard, one green practice at a time would be taken into consideration, and its impact will be assessed on the structure of the SC in light of the participants' responses. The impacts on the SC structure will be further analyzed to see how they affect the identified resilient practices. Table 8 lists the final set of green and resilient practices that were observed during the literature review, and that will be discussed with the participants. It is also important to mention that the participants' companies' might not have implemented all the green practices mentioned in Table 8. They might also have implemented some other green practices. So, firstly, green practices implemented by the companies will be discussed, followed by a discussion on the green practices in the below table.

Green Practices	Resilient Practices
1) Product and package recycling/ environmentally friendly packaging 2) Re-use, re-manufacture, recycle and return 3) ISO 14001 4) Green/Eco-Design and Life Cycle Assessment 5) Green operations – reverse logistics 6) Waste management/reduction/minimization 7) Source reduction/pollution prevention 8) Considering the entire supply chain 9) Supplier evaluation – for minimum set of environmental practices 10) Cooperation between Supply Chain partners 11) Internal Environment Management 12) Green Purchasing 13) Cooperation with customers 14) Investment Recovery 15) Reducing carbon footprint 16) Use of green raw materials 17) Supplier selection on the basis of environmental criteria 18) Code of conduct to be signed by suppliers to ensure that suppliers respect the environmental standards 19) Forge long-term alliances with suppliers to achieve continuous improvement 20) Transparent and continuous status check of environmental conditions 21) Green Information Systems 22) Environmental performance 23) Clean programs 24) Lean management	1) Add capacity 2) Add inventory 3) Redundant/Multiple suppliers 4) Increase responsiveness 5) Demand aggregation/pooling 6) Increased capability 7) Have more customer accounts 8) Supply Chain reengineering to incorporate resilience 9) Supply Chain understanding – to identify the pinch points/bottlenecks 10) Supply Chain Design/Redesign – keep contingency plans in mind 11) Supply Chain collaboration 12) Strategic stock 13) Lead time reduction 14) Postponement 15) Rapid configuration 16) Demand based management 17) Flexible transportation 18) Developing visibility to a clear view of upstream inventories and supply conditions 19) Maintaining a dedicated transit fleet 20) Risk sharing/Knowledge transfer 21) Co-ordination with downstream partners 22) Communication and early involvement of suppliers in strategic decisions

Table 8. Summary of Green and Resilient Practices observed in the literature

Sources: 1) Green Practices: Porter and van der Linde (1995), Beamon (1999), Zhu and Sarkis (2004), Rao and Holt (2005), Srivastava (2007), Seuring and Muller (2008), Zhu et al. (2008),

Carvalho et al. (2011), Ageron et al. (2012), Caniato et al. (2012), Green Jr et al. (2012), Hassini et al. (2012), Azevedo et al. (2013), Carvalho et al. (2014)

2) Resilient Practices: Chopra and Sodhi (2004), Christopher and Peck (2004), Sheffi and Rice Jr. (2005), Tang (2006), Khan and Burnes (2007), Manuj and Mentzer (2008), Oke and Gopalakrishnan (2009), Ponomorov and Holocomb (2009), Trkman and McCormack (2009), Carvalho et al. (2011), Azevedo et al. (2013), Carvalho et al. (2014), Chopra and Sodhi (2014), Roberta Pereira et al. (2014)

3.1.2 Selecting a research design

There is no existing database or record that can help to comprehensively understand the interactions between GSCM implementation and SCR and the mechanisms by which GSCM implementation impacts SCR. As observed in the previous chapter, there is a shortage of studies that consider such aspects. The area of interest for this research is still rudimentary, so an exploratory study suits the research question (Karlsson, 2010; Forza, 2002). Creswell (2009) also says that qualitative research is exploratory and is used when concepts are unknown.

Stake (2010) says that qualitative research is: 1) Interpretive – It focusses on different aspects of human affairs and researchers are at ease with its varied meanings 2) Experiential – It is based on the experiences of the participants in their natural settings and is empirical and field oriented 3) Situational – It depends on the context and is more focused on the uniqueness of the situation rather than on generalizations 4) Personalistic – It is based on the perceptions of the participants and respects their diversity. Stake (2010) also says that qualitative studies overlap with quantitative studies and vice-versa, which is demonstrated in Figure 6. For example, qualitative inquiry helps very well to research about particular situations, which is represented by a thick line between 'qualitative inquiry' and 'learning about particulars.' It can also be observed that qualitative inquiry helps to learn about general situations as well, but 'learning about general' is more suitable for quantitative inquiry, depicted by thin lines. Therefore, as per the figure, it can be observed that qualitative study is more suitable to learn about particulars, professional knowledge, individual experience, and microanalysis. On the other hand, a quantitative inquiry is more suitable for 'learning about general,' scientific knowledge, collective knowledge, and macro-analysis.
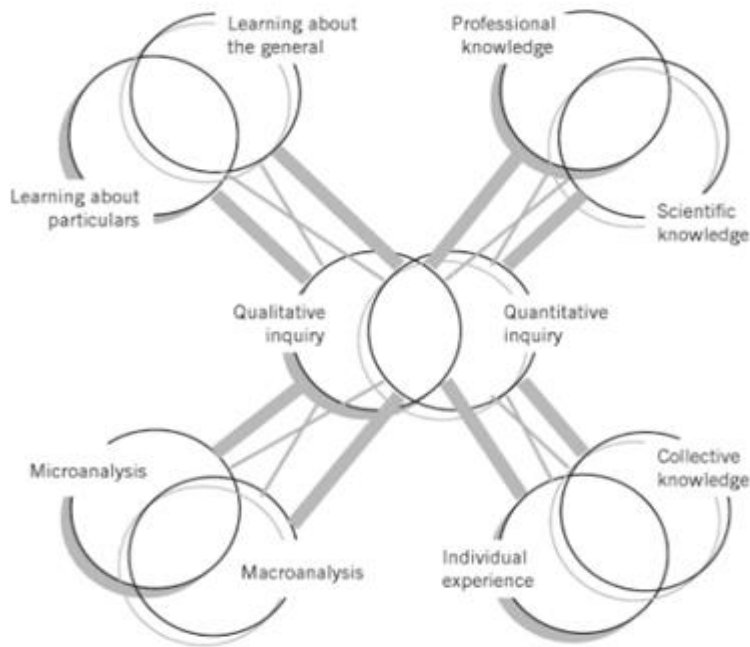
Figure 6. A whirligig of strong and weaker epistemological ties of qualitative inquiry

Source: Stake (2010)

Like all methodologies, qualitative methodology is also not bereft of shortcomings. These shortcomings are due to it being subjective and personalistic, its time-consuming nature and its tendency to raise more questions than the answers (Stake, 2010). This research is based on primary data which was collected through phone and skype based semi-structured interviews which are elaborated in the next section.

3.1.3 Selecting a data collection method

As this study is based on empirical research, in which human subjects are involved, so an approval from the ethics committee at HEC Montreal was requested, which was subsequently approved. For this research, semi-structured interviews were chosen as the data collection method. Creswell (2009) says that interviews can be useful when: it is difficult to observe participants directly, participants can provide historical information, and the researcher has control over the questions

being asked. He also says that interviews are disadvantageous because: they do not take place in the natural setting, the collected data is not direct and passes through the researcher leading to a bias and due to lack of the ability of all participants to be able to express their opinions properly.

The interviews were conducted via phone and Skype. The aim was to conduct face to face interviews with participants based in Montreal. In fact, one of the participants had agreed for a face to face interview, but due to the participant's busy schedule, a personal interview could not be conducted. Therefore, all the interviews were conducted through Skype, even for the participants based in Montreal. It is important to mention that all the interviews were audio based, as per the preference of the participants except the interview of participant F, which was conducted via Skype video call. All the interviews were recorded with the consent of the participants, which helped the author to stay concentrated and also focus properly on the interviews (Forza, 2002).

3.1.4 Sample

A non-random, purposive sample of participants was used for this study, according to which participants are selected if they meet certain criteria (Bui, 2013). To maintain the confidentiality of the participant's none of their first name, last name, company name and even their gender or the date of the interview will be disclosed. For this study selection of participants is based on the following criteria:

1) Professionals who have five or more years of work experience in SC

2) The professionals were part of the implementation of green practices or lead the implementation of green practices in an SC

3) They have knowledge about the green measures related to SCs being undertaken by their company(s) in their current or previous roles

A total of 156 persons were contacted for the interview. 150 persons were contacted using LinkedIn, three persons were contacted using email, and three persons were personal contacts of the author. On LinkedIn, very few persons had mentioned about anything relevant to green practices in their profiles. So, rather than contacting potential participants by whether any green practices were mentioned or not in their profiles, all connections who had five or more years of work experience in SC, were contacted. The message has been attached in Annexe A. All the

persons contacted on LinkedIn worked in some or other part of the SC like sourcing, manufacturing, customer SC, and distribution. Out of the three email contacts, one contact was provided by one of the author's connections on LinkedIn. The other two contacts visited as guest speakers during the author's courses at HEC Montreal. Out of the three personal contacts, the author had only one primary personal contact. The primary personal contact also provided the other two contacts. Table 9 summarizes the total contacts, respondents, and participants.

Contacts		Respondents		Participants	
Persons contacted using LinkedIn	150	Linkedin Respondents	24	LinkedIn participants	4
Persons contacted by email	3	Email Respondents	2	Email participants	1
Personal contacts	3	Personal contact respondents	3	Personal contact participants	3
Total Number of persons contacted	156	Actual Respondents	28	Actual participants	8

Table 9. Total number of contacts, respondents, and participants

Source: Prepared by the author

Qualitative studies have smaller sample size as compared to quantitative studies (Bui, 2013). In the end, eight professionals participated in the study out of which six professionals had extensive experience of SCs, and two professionals were more related to the management of environmental performance. The profile of the participants, month of the interview, job title, years of experience, initial contact method, mode of interview, location, and interview duration have been summarized in Table 10. As previously stated, to prevent the confidentiality of the participants, they have been randomly assigned with alphabets to refer their perspectives in this study. Even the gender of the participants will not be disclosed to conceal their identity. Also, the exact date of the interview will not be disclosed and only the month of the interview will be mentioned.

The minimum work experience among the participants was seven years, and the maximum work experience was twenty-two years. The industries to which the participants belonged or had experiences of, spread across the following: paper, international trading companies, mining, electronics, retail, fast moving consumer goods, aeronautical industry, chemical industry, food manufacturing or processing, and dairy industry. The participants had work experiences in the following regions: China, Middle East, Canada, North Africa, Asia, and Europe. Out of the eight participants, six have experience and knowledge of SCs and green practices. Out of the other two,

one participant is an environmental consultant and the other is environmental performance manager. The environmental performance manager also has experience of SC. The inclusion of these two participants, especially the environmental consultant provided a different perspective to the study as they shared views from the environmental standpoint as well.

Participant	Interview Details
F	Month of Interview – August Title – Head of Demand Years of Experience – 11 Initial Contact – Phone Mode of Interview – Skype video Participant Location – UAE Duration (minutes) – 61 Profile Summary – Worked in global FMCG companies as head of demand and forecasting Green Experience or Knowledge – Paperless project, FSC certified cartons, sea transport, local sourcing
G	Month of Interview – August Title – Environmental Consultant Years of Experience – 20+ Initial Contact – Email Mode of Interview – Phone Participant Location – Canada Duration (minutes) – 50 Profile Summary – Worked in Canada in the Chemical industry, aerospace industry, and food industry Green Experience or Knowledge – Compliance monitoring, certification maintenance, KPIs development
K	Month of Interview – August Title – Supply Chain Analyst Years of Experience – 7 Initial Contact – LinkedIn Mode of Interview – Phone Participant Location – Canada Duration (minutes) – 33 Profile Summary – Worked in the Middle East, Canada as a procurement professional Green Experience or Knowledge – ISO 14001 documentation, toxic byproduct disposal and reverse logistics
L	Month of Interview – October Title – Supply Chain Manager Years of Experience – 20 Initial Contact – Phone Mode of Interview – Skype audio Participant Location – UAE Duration (minutes) – 32 Profile Summary – Ten years of experience in SC. Worked mostly in manufacturing in FMCG companies and almost every part of the supply chain in the Middle East Green Experience or Knowledge – Synthetic soaps to palm oil based soaps, synthetic preservatives to natural, preservatives, waste reduction
M	Month of Interview – July Title – Supply Chain Analyst Years of Experience – 10+

	Initial Contact – LinkedIn Mode of Interview – Phone Participant Location – Canada Duration (minutes) – 38 Profile Summary – Worked in the Middle East, China, and Canada. Responsibilities included searching for suppliers, procurement, basically, the entire SC as mentioned by the participant Green Experience or Knowledge – Consultant for ISO 14001 implementation, waste reduction
N	Month of Interview – August Title – Supply Chain Management Professional Years of Experience – 30+ Initial Contact – LinkedIn Mode of Interview – Phone Participant Location – Canada Duration (minutes) – 54 Profile Summary – Worked for more than 15 years in the supply chain in the grocery industry. Main responsibilities include demand and supply management, forecasting Green Experience or Knowledge – Worked on retail ready packaging, switch from glass to plastic, electric forklifts, efficient warehouses, waste reduction
Q	Month of Interview – October Title – Head of Projects Years of Experience – 18+ Initial Contact – Phone Mode of Interview – Skype audio Participant Location – UAE Duration (minutes) – 63 Profile Summary – 8+ years of experience in supply chain. Worked as a chemical engineer and as a supply chain manager in North Africa and the Middle East Green Experience or Knowledge – Aerosol can thickness reduction, water reuse, PVC to PP, laminates, local production
W	Month of Interview – August Title – Environmental Performance Manager Years of Experience – 7+ Initial Contact – LinkedIn Mode of Interview – Skype audio Participant Location – Canada Duration (minutes) – 31 Profile Summary – Worked in France and currently working in Canada to assess the environmental impacts of the projects. More SC related experience from the previous company and currently working in the operations in the present company. Green Experience or Knowledge – Assessment of projects for their environmental impacts, implementation of carbon emission assessment tool in SAP

Table 10. Summary of the participants' profile

Source: Prepared by the author

3.1.5 Questionnaire, pilot test, and data collection

The initial questionnaire was designed after the literature review and in consultation with the author's thesis supervisor. After this, the questionnaire was tested on 21st May with Q, who is

based in UAE. The pilot testing interview lasted for 43 minutes. The pilot testing helped to determine whether the questions were discernible by the professional. Pilot testing also helped to gauge the validity of the questionnaire (Bui, 2013). The contact provided frank and in-depth feedback. The feedback was discussed with the author's supervisor, and this questionnaire was made the final questionnaire.

The questionnaire (Annexe B) comprised of eight questions and the reasons for including the various questions are mentioned below:

1) The first question was included to ascertain the job experience and the number of years of experience of the participants. Including this question helped to provide insights about the different types of roles and responsibilities that the participants held and to determine things like the responsibilities of the participants with respect to SC, the type of industry in which they worked and the projects that they had led and supervised

2) The second question helped to understand the participants' experience with respect to GSCM and the different GSCM projects that they had lead or had been part of

3) The third question was with respect to the adoption of GSCM by their companies. As it is not possible to be part of every other GSCM project so this helped to provide information about other GSCM practices that their companies were implementing

4) The fourth question was included to understand the background about the reason for the implementation of the green practices. This helped to understand, whether they were just following some regulations, or they had already experienced some non-compliance issues, or they feared any disruption in the future

5) The fifth question helped the author to understand the structural changes in their SC that they had to make as a result of the implementation of GSCM. These structural changes are what might or might not impact the different aspects of the resilience of their SCs

6) The sixth question was asked to determine the impact of one green practice at a time on the different aspects of resilience.

7) The seventh question was asked to determine the risk mappings or analysis that they had done before they went for the implementation of GSCM

8) The final question was asked to determine their key concerns about the different aspects SCR when they were planning to implement GSCM.

After developing the final questionnaire, the first interview was conducted in July by phone. All interviews were conducted as per the preferences of the participants without any pressures. Five interviews were conducted during August, which includes the interviews of participants F, G, K, N and W. Participants L and Q were interviewed during October. In the next chapter, excerpts from the interviews will be presented and organized for analysis.

Chapter 4

Data Analysis

The data collected in the previous chapter was transcribed verbatim. The excerpts presented in this section mostly revolve around the last four questions of the questionnaire (Annexe B), that is, the impacts of GSCM on SC, GSCM effects on different aspects of resilience, implications taken into account for GSCM and the concerns. Excerpts related to other questions have been paraphrased. Since all the individuals belonged to different industries and worked in the various countries, so the transcripts will be analyzed one at a time.

4.1 Organizing the data

The transcripts and the relevant excerpts of the interviews will be presented alphabetically, according to the alphabets assigned to the participants (It must be again emphasized that the alphabets had been allocated randomly to the participants). At the end of each participant's interview, the different green practices, their implementation, and consequences have been tabulated. The column on the implementation of a green practice helps to understand the changes that were done to implement that green practice and identify the mechanisms through which SCR was impacted. The consequences aid to ascertain the impact of the implementation of the practice on the different aspects of resilience, and other aspects like cost savings. Every interview has been tabulated at the end of each interview's discussion, except the interview of participant G who did not have much experience related to SC.

Participant F

F has more than eleven years of work experience in the FMCG industry in the Middle-East. F holds an MBA in SCM. F started working as an SC trainee for a Middle-Eastern company. F is currently based out of Dubai, UAE and is working as the head of supply and demand for a company that provides complete packaging solutions like aseptic cartons for storing milk and juice. These

aseptic cartons greatly increase the shelf life of such perishables. F's company has customers in more than twenty-five countries totaling more than sixty customers and a huge base in the Middle-East.

Green practices

1) SAP Automation – They developed workflows and applications in SAP with the help of their IT team. F mentioned about the following three projects:

a) Paperless SC – F mentioned that across all the processes in an SC like planning, warehousing, logistics, customer service and others about 2500 papers are generated in a year. They had to print documents for themselves, for their clients, for the finance department, and for the bank because SC involves lots of actors. Printing documents leads to inefficiency as it requires lots of space to store these papers. Even for the auditors, they had to provide access to such documentation. As time passes, rooms and cupboards get occupied due to the accumulation of such documents. Even scanning such papers to send them to the customers, wastes much time. This project was initiated by F because it took much time to scan, sign, and send these papers. Moreover, such paperwork is prone to errors. F's management was initially skeptical about this project, but after the successful implementation of the project, it was applauded even by the COO. It was also decided to implement this project in other departments, with SC Department as the leader. F's manager also felt proud due to the achievements of the project.

This project dealt with the implementation workflows in SAP. Once the document gets generated, it goes to the workflow through a web page or some software. These workflows give notifications to F or F's manager. They check and approve the document online. After their approval, it goes to SharePoint where it is stored. The documents are also digitally signed and stamped which helped them prevent paper storage for extended periods of time. They checked with their banks regarding electronically signed documents and their banks also agreed to accept such documents.

b) Automated MRP – They used to run their MRP manually which wasted a lot of energy and time. Again with the help of SAP, they automated their MRP. After inserting the forecast, they just click a button, and all the net material requirement gets calculated. The automated MRP also

raises a purchase order and helped them to reduce the time for MRP execution substantially. The execution time has come down from 3 days to only 3 minutes.

c) Automated invoicing – When F joined the present company the utilization of SAP was only 5 percent because of global control. During the past three years, they have done many other things like invoicing automation. Its automation with the help of SAP helped them to save on paper and time. Manual invoicing was again a waste of paper and energy. Now, they can even club multiple invoices with the help of this automation.

2) FSC certification - F's company is a manufacturer of aseptic cartons which contribute to prolonging the shelf life of perishables like juice and milk. The primary raw material for aseptic cartons is trees, so they decided to go for FSC certification. By this certification, they will have an FSC logo on their products. F mentioned that FSC certification signifies that they are using trees responsibly and it signifies that if they use one tree, they will plant a thousand trees. They are very close to converting all their products to FSC certified and are also in the process to convert even their plants to FSC certified plants. For undergoing the certification, they have the necessary management support and dedicated teams to pursue the goal.

3) Responsible suppliers – They try to make sure that their suppliers are responsible, that is, their suppliers do not cause any unnecessary pollution, do not use child labor and use technologies that help in reducing pollution. They also evaluate their suppliers to make sure that their suppliers do not use any practices that are against their code of conduct or policies.

4) Waste Reduction – The technology used by them is more efficient than their competitors' technologies because their machines and equipment produce less wastage which helps in reducing the consumption of wood and other raw materials.

5) Recycling – F's company makes sure that the products that they manufacture, the cartons, are completely recyclable. Apart from ensuring that the wooden part is recyclable, they also ensure that all other components are recyclable, like the aluminum used in the carton.

6) ISO 14001 – Both they and their suppliers have this certification. F however, did not mention much about it.

7) Sea Transport – They persuade their customers to choose sea transport whenever possible. Although shipment by sea is slowest, ships can transport considerably more freight as compared

to roads. Thus sea shipments help them to reduce emissions as well as energy consumption which make their SC greener.

8) Local Production – Manufacturing locally has obvious effects on greening an SC because the SC becomes much shorter. F did not disclose much regarding their plans to manufacture their cartons locally, due to confidential reasons. Currently, they have to source their material from geographically distant countries like Germany and Thailand, which leads to lots of carbon emissions. They also have to import huge amounts of material. They are planning to do all this locally.

Reasons for the implementation of green practices

They implemented these practices because of their belief to be a responsible company. By responsible company they mean, that they want to be accountable to the environment, to their consumers, to their country, and to their region.

It must also be mentioned that the primary source of their raw material is trees, so they need to make sure that they use trees in a sustainable manner which helps their business grow. As a result, they implemented the FSC certification; they want to grow further which would require a continuous and ample supply of trees. So, they had to make sure that they use trees in a sustainable manner and getting the FSC certification bears testimony to their commitment.

The reasons why they want to produce locally is because importing products is very energy intensive, cost intensive, and time intensive. Moreover, this will provide them much better response times.

Impacts

Paperless projects – The paperless project helped them to save much time because all the approvals were online and after approvals, the documents were automatically signed, stamped and saved in their SharePoint. With the help of the SAP automation which included paperless, and automated invoicing, their lead time decreased by two days. Earlier it used to take six days, but with the help of the paperless project it helped them to do it in just four days:

"The automation, it had the impact on the lead time I would say because it has reduced our documentation lead time. You have a lead time for product confirmation, you have lead time to load your order, you have a lead time for shipment, then you have transit time, product loading and product discharge and then you have a lead time for documentation. Our documentation with this project has reduced substantially. The automation what we did, the automation of invoicing, the automation of what we did. The automation of invoicing, the automation of, or with this workflow the paperless. Our lead time has reduced from 6 to 4 days. You know, it has reduced impact, we are saving a lot of time."

In F's opinion the amount of inventory will decrease due to the automation:

"The amount of inventory will decrease. Because again, it is all related to your output, ok and the way you plan. The amount of inventory I believe it will decrease."

When asked about the effect on responsiveness due to automation, F answered in the affirmative.

Automation helped them to increase their efficiency and removed errors:

"So, now automation this thing, we increase our efficiency and this manual converted to automated documents, then there is no chance of having the manual entry error, you know in the doc. So that is also the positive impact."

The only drawback of automation was related to investment because to develop new workflows and applications they had to invest in IT:

"The only thing is that you know when we talk about the negative, negative is what that we invested some money… ok obviously, there is an investment on having the, because we developed something ok for this workflow and for this automation as well we paid a lot of money."

FSC certification – The main impact of FSC certification was the change in the design of their cartons to incorporate the FSC logo, leading to a delay in the SC. They also had to ensure that their switch to FSC products does not impact their customers. The switch cannot happen overnight, so they have to maintain a proper plan for having products engraved with the FSC logo. The presence of a dedicated team helped them considerably, to reduce the impact of the switch:

"For example, if your product is not FSC you will have different design ok, and then if you have FSC, you need to have the FSC logo in your design. So that is a change, then you will do, you have to change your design, engrave it. That is kind of delays your SC, but as I mentioned the task force

what we have in our organization, they make sure that the implementation of the new FSC products or in a different line or different material, does not impact the customer. It does not impact serviceability to the customer. It should be in phase. SC should have sufficient time to change the design to organize new material because your material will also change, then they should have sufficient time to source this to change the design."

Responsible suppliers – Finding suppliers, who adhere to all their policies is difficult and even developing such suppliers requires time and investment:

"This is the negative point. You will not have different options, you will struggle to you know, to find a good supplier in the market, or you have to invest a lot of time, money or energy to train these suppliers, to develop these vendors."

Sea Transport – For sea transport F mentioned that it increases the lead time, but they can transport bigger shipments. To compensate for the increased lead time, they try to advance the production:

"When we talk about Egypt so here it takes three days but if you ship by sea it will take lot of time for clearance and all, so it is slower but again you need to manage your order, production in such a way that overall the lead time because you can save some time in production, you produce the order in some days in advance and compensate the transit time versus road and sea so here you can impact."

Local Production – The amount of stock will decrease with the help of local production, for obvious reasons:

"The local production project as I mentioned it would reduce our safety stock to significant level ok, because of the sourcing, because of our supplier in different countries we need certain safety stock to tackle all this but this decision of having the local thing will definitely reduce our safety stock."

In general, as per F, all the GSCM projects are part of SC excellence projects, and therefore such projects will help in better utilization of capacity because they can produce more for the same amount of capacity. The risks in the SC also decreased as per F.

Implications that were taken into account

They study all the pros and cons of the project and conduct proper risk analysis and also keep their management informed. Even for scenarios that have a negative impact, they devise appropriate plans and strategies to reduce the impact:

"Because we need to prepare ourselves if there is any negative impact. For example, any delay in SC or the material, or the shipment lead time increase, or availability of capacity, something like that. Then we need to prepare ourselves, you know to tackle this because we cannot take these as a negative point, we have to find out some ways to reduce the impact. Even though you have the impact, but you find out the way to reduce the impact by proper planning."

Concerns

While implementing GSCM, they had the following concerns about their SC's resilience:

First, the collaboration with suppliers because they had to invest time and money for supplier development. Second, lead time was also a concern while shipping by sea. Third, they had to allocate capacity for testing the practices before final implementation. For this, they had to manage production lines in such a way so that they could get sufficient testing time. Finally, for the design change as in the case of FSC certified cartons they had to maintain extra stock till the switchover was complete. Below are the excerpts:

"Collaboration with suppliers as I mentioned was one of the points where we have to invest time, money and to develop our supplier to follow all rules and conducts."

"When you talk about lead time when you use sea shipment so yes the lead time will slightly increase, but that can be tackled with preproduction, better planning."

"Then there is capacity, yes there is a testing time. Regular production then you have to shut down, and then you have to give project team a time to test in the production line, ok but again as I mentioned this is part of the project ok, and you have to get this time ok for the testing before, but yes this is one of the constraint, but again you can tackle it with better planning. You include this in the project, ok this much time is needed for testing and all these things and then prepare ourselves to do our production planning, scheduling accordingly."

"It will have an impact on design change; then it takes time before so many weeks to change the design. What that means that I need to maintain some safety stock means that some safety stock will increase. Ok. At your end or customer, you need to prepare your customer so that they are not out of stock and it does not impact their distribution to the market."

The responses of participant F have been tabulated in the below table.

Practice	Implementation	Consequences
SAP automation	Paperless SC 1. Implementation of SAP through workflows and web applications 2. All documents stored in SharePoint Automated MRP 1. Automation of MRP with the help of IT team 2. All parameters calculated once the forecast is inserted Automated Invoicing Can be used to club multiple invoices	Paperless SC 1. Lead time decreased from 6 days to 4 days 2. Error free 3. No need to maintain any archives or hard copies Automated MRP 1. Automated MRP gives results in just 3 minutes compared to earlier duration of 3 days 2. Raises Purchase Order automatically Automated Invoicing Savings of time, energy and paper All the above three projects required considerable investment
FSC certification	1. All cartons to be FSC certified 2. All plants to be FSC certified	Delays the SC during implementation of the certification
Responsible suppliers	1. Suppliers must adhere to their policies 2. Suppliers should not use child labor 3. Suppliers should not cause unnecessary pollution	1. Decrease in the number of suppliers 2. Investment of time energy and money
Waste reduction	Their machines are efficient and produce much less waste as compared to their competitors	Reduced wastage
Recycling	1. Entire carton is recyclable 2. The metallic parts of the carton are also recyclable	Did not mention any impact
ISO 14001	Both the company and its suppliers have ISO 14001	Did not mention any impact
Sea Transport	Transportation by sea when possible	1. Increased lead time 2. Lesser number of trips
Local production	Produce locally instead of importing	Did not disclose much, but this will have obvious impacts on lead time, inventory, flexibility, responsiveness, postponement

Table 11. Interview summary of participant F

Participant G

G has more than twenty years of experience as an environmental consultant. G has a background in chemistry. Initially, G worked in quality and then in the environment department for a chemical company. After that, G worked for an aeronautical company. Currently, G is working for a grocery company. G mentioned that chemistry is very linked to the environment because of various aspects of calculation of air emissions and water pollutants' concentration. G's main responsibilities include keeping the site compliant with environmental regulations, preparation of environmental KPIs, maintenance of standards and waste reduction. G does not have any experience of the SC department, but a perspective from an environmental consultant will be useful to identify any other negative or positive impacts of implementation of green practices in a company.

Green practices

1) Recycling – G mentioned about recycling experience from two companies: aerospace and grocery. For the aerospace company, an improved recycling program was implemented by G. Before G's involvement, all kinds of wastes were placed in the same container. G implemented the use of different containers to store ferrous metals versus non-ferrous metals. The implementation of separate containers allowed for better segregation of metals like aluminum and copper. Currently, G is working for a grocery company and mentioned that recycling becomes a challenge in the grocery industry if there is some contamination in the production chain. When this happens, they are not able to segregate packaging from organic waste which leads to huge monetary losses amounting to millions of dollars. G also mentioned that recycling is only prioritized by companies if they get some money as a result of the recycling. If they do not see any monetary benefits, they do not indulge in any recycling.

2) ISO 14001 – G did not implement ISO 14001 certification and was always in a place where certifications had already been implemented. G was tasked to maintain the existing certifications. However, as per G, maintaining the certification was very costly. G mentioned that the aerospace company decided to leave the certifications. Similar was the case with the grocery company. Between 2004 to 2008 there was a huge push for ISO 14001 in the grocery business, but after that, they decided to move out of the certifications because ISO 14001 was proving too costly to maintain.

For the ISO 14001 certification G mentioned that management gets concerned about any non-implementation or improper implementation of green practices only if that leads to some fines or monetary expenses or can help them to save money. For the ISO 14001 certification, there is a requirement of periodic review. G just sends reports but does not receive any responses except when there is some non-compliance.

3) NPRE standard – As per G this is a standard that was developed by big companies like IBM and Dell to make sure that their EOL electronic materials do not end up in China or Africa. G implemented this for a small electronic company, but even maintaining the most basic form of NPRE proved costly for the company and so the small firm decided to move out of this certification.

Reasons for the implementation of green practices

G emphasized that the overarching reason for the implementation of green practices is only financial. G's current company abolished the post of environmental director about eight years ago. Currently, those responsibilities are vested with the manager of health and safety. Even the hard chemicals company for whom G initially worked, also abolished the post of environmental and quality coordinator and those responsibilities were assigned to the process engineer.

In the case of hazardous wastes generated in the chemical industry these things are well implemented:

"For me from my experience, I would say that in hard chemicals, I would say that everything was implemented and there was no new product. Everything is stable you know for the production and more we have to say, and the volume of production will decrease a little bit each year, so all the environmental impacts were analysed few years ago, maybe 10 or 15 years ago, and they know everything, and now everything is stable and they do not really change anything except in the energy case."

"This is well implemented in all the companies because the health and safety risk behind that and community risk also or the shareholders will impact. With hazardous they are more regulated I would say."

Impacts

As participant G did not have much experience of the SC so G could not mention any impacts of the implementation of green practices on SC. G, however, mentioned that they lead to an increase in costs, especially for the certifications and standards. As a result, any tabulation of the green practices, their implementation, and consequences has not been done for G's interview.

Participant K

K has more than seven years of work experience and is currently working as an SC analyst for an electronics company. Before this, K was working for a mining company in the Middle-East. K has previously worked in purchasing and materials management and is currently responsible for global forecasting of solar inverters that K's current company manufactures.

Green practices

1) ISO 14001 – K was personally involved with the implementation of ISO 14001 certification in a mining company. K's responsibilities included the incorporation of statements as per the ISO 14001 certification in the preparation of documents. K also updated the terms and conditions for purchase orders to ensure that energy efficient appliances will be given priority over other devices. These changes were used in the purchase orders and the request for quote (RFQ) documents.

2) Pallet reuse – They reused the pallets on which their products were delivered. It was a much smaller project, and in this practice as well, K was directly involved.

3) Phosphogypsum Disposal – K mentioned about the project to dispose of phosphogypsum which is generated as one of the byproducts during mining of phosphate rocks. As per K, it is similar to normal gypsum but has phosphorous in it and is radioactive. K said that previously phosphogypsum was just dumped into the ocean without any proper treatment leading to many detrimental effects on the environment. Due to this, the mining company had to come up with a proper disposal plan for phosphogypsum. They had to install conveyor belts from the point of generation of the phosphogypsum to the point of its complete elimination. To deal with all these challenges they had to consult a third party for the full disposal process.

4) Reverse Logistics – In K's electronics company, they used to throw away malfunctioning products. K, however, mentioned that in reality, only a few components could be malfunctioning and not the entire product. So they decided to take back such products and replace the faulty elements of the product and resell the product as a refurbished product.

5) Environment-friendly packaging – They also use environment-friendly packaging. However, K could not discuss much because it is done at a different location.

6) Green procurement – In K's current company they have green procurement and energy efficient procurement, but K is not involved much with procurement in the current company.

7) Supplier related green practices – They evaluate their suppliers for greenness by including questions related to greenness as part of the questionnaires while managing supplier relationships.

Reasons for the implementation of green practices

They implemented green practices like ISO 14001 due to customer pressures. They are a global company and face lots of thrust from their management.

For the phosphogypsum, they had to ensure its proper disposal because of regulatory pressures. Non-compliance was punishable with fines.

Reverse Logistics helped them to save costs because as previously stated not all components were failing except only some of them.

Smaller projects like pallet reuse were more related to costs savings.

Impacts

ISO 14001 – With ISO 14001 they did not observe any impacts. K mentioned that they just had to insert the clauses and conditions for ISO 14001 certification. It is also important to mention that they were implementing this certification within their organization and not at their suppliers' end:

"I think ISO 14001 did not have any impact on the SC. We inserted the clause into our terms and conditions, but there was not any change from the supplier side. Just to meet the regulations we added the clause, but it did not have any impact."

Phosphogypsum disposal – For the phosphogypsum project, there were substantial costs involved. First, they had to bring in external consultants to ensure that the disposal process was diligently implemented. Second, if there was any slack in the disposal, there was always the threat of fines by the government. Finally, due to the exigency of the situation they had to maintain three conveyor belts which helped to ensure that even if one conveyor belt went down, the other two could continue to function:

"There were huge financial impacts of bearing the consultants just to do that. In addition to that if there was any breakdown of that phosphogypsum line there because if phosphogypsum was not treated on time and not treated properly, so we were fined by the government. So it was very important to have the phosphogypsum line running at all times. We had three lines at a time so in case one goes down, we still had two conveyors running to get the phosphogypsum to that location."

Reverse Logistics – For the reverse logistics, the impacts were mostly related to costs because they had to bring back the products. The refurbished stock and old stock also increased the inventory levels for them, although not in the true sense. However, they could provide their customers with both refurbished and new products:

"Yes, it did have an impact because we had to bring back the products back to us. It did cost some additional money but it was the need of the hour, the scarcity of the product and so we had to take that extra cost to get those pieces back." "The inventory levels went up because we had good stock and refurbished stock."

F did not mention any impacts due to small projects like pallet reuse.

Implications that were taken into account

They took into account the implications of the green practices implementation on their SC's resilience depending on the size of the project. For projects that involved huge costs like the phosphogypsum disposal and the reverse logistics project they considered the implications, but for the smaller projects like pallet reuse they did not consider many implications. Below are the excerpts:

"Also for the phosphogypsum yes we did the analysis of how much it is gonna cost us, it was something that we could not leave because it was going to be environmentally bad."

"For the reverse logistics, yes they did a complete analysis: what the expected cost would be and what are the upsides."

They did not conduct any analysis for smaller projects like pallet reuse because such projects were small and did not involve any significant costs:

"The smaller ones, like reusing pallets, for energy efficient purchasing there was not any cost benefit analysis done for those but in bigger projects when we were doing a process change or starting up a new process, there we did a cost-benefit analysis."

Concerns

For the ISO 14001 certification, they did not have any concerns because as per F they just had to make changes in the documentation. For the phosphogypsum project, they were really concerned because that was impacting their business continuity and they were facing fines from the government. Their main concern regarding reverse logistics was that it should not impact their customer service in any manner. Below are the excerpts:

"For the phosphogypsum, it was mostly about business continuity. Management was looking at that."

"For the reverse logistics customer relations was important and that we do not have a negative impact on the customer."

Below table summarizes the different green practices mentioned by participant K.

Practice	Implementation	Consequences
ISO 14001 implementation	Inclusion of ISO 14001 related rules and regulations in contracts and other relevant documents	No impact
Pallet reuse	Reusing the pallets on which products are received	No impact
Phosphogypsum disposal	Proper disposal of phosphogypsum due to government regulations	1. Cost impact 2. External consultants 3. Extra capacity, three conveyor belts to maintain uninterrupted processing and appropriate disposal

Reverse logistics	Take back defective products, repair them and sell as refurbished products	1. Increased inventory 2. Increased costs
Environment-friendly packaging	Use of environment-friendly packaging	Could not mention any impacts
Green procurement	Not much mentioned	No impact
Supplier related green practices	Use of questionnaires to determine the suppliers' environmental friendliness	No impact

Table 12. Interview summary of participant K

Participant L

L has about twenty years of experience out of which L's SC experience is almost ten years. L is a chemical engineer and has worked mostly in manufacturing in FMCG companies in the Middle-East. L has worked in nearly every part of the SC, as well as in production.

Green Practices

1) Synthetic ingredients to natural ingredients – L mentioned that they had to switch from synthetic chemicals to natural ones. They switched because of harmful nature of the synthetic ingredients. L mentioned about two such projects:

a) Synthetic chemicals based soaps to palm oil based soaps

b) Chemical preservatives to natural preservatives.

For both the projects, L mentioned that although natural ingredients are costly, they are safer than synthetic ones. L also mentioned that natural ingredients are in shorter supply as compared to synthetic ingredients.

2) Waste Reduction – L further, referred to the example of waste reduction by proper handling of pallets. It must be mentioned here that they use wooden pallets and not plastic ones because plastic pallets cost them more. L said that if pallets are not stacked properly, they cannot be used more than three or four times because the pallets get damaged. L, therefore, said that if proper handling, stacking is done and suppliers are provided adequate training then these pallets will not be damaged and will help in reducing waste.

Reasons for the implementation of green practices

L said that they phased out such chemicals mostly due to regulations. L mentioned that authorities proscribe such chemicals only after proper research and give sufficient time for phasing them out. L also said that such chemicals are not safe for end users as well and authorities ban such ingredients only after proper research. Apart from that, L underscored the fact that it is also difficult to manage such chemicals.

The proper use of pallets was more to do with cost savings.

Impacts

Synthetic ingredients to natural ingredients – L mentioned that impacts of switching are only observed during the transition phase, that is when a product or process is being changed to a greener one. Once the routine operations are established like regular supplies and routine orders, then the SC is stabilized. While switching, they have to maintain buffer stocks and handle longer lead times:

"Only impact will come that will in changeover time. Because see you started with synthetic products also, you will have the problem for sure, but once it is routine like, the routine order is there, routine supply is there, like proper supplier, you will not face any issue. You have to keep some buffer stock, lead time and all. So that is there, even if you are moving to other the only thing is the changeover time. That time is critical, once the user will get a routine supply of the chemical product or the natural product. It is only the change over time that you have to care."

L could not mention much about any impacts due to waste reduction.

Implications that were taken into account

L said that in their case, most of the times the implementation of green practices is due to regulations. Moreover, in such scenarios, they have to move to a green practice or product even if it could threaten their SC. They also consider whether the product is a critical product and is frequently versus a non-critical product that is seldom used. In the case of essential products, they move fast and try to find new suppliers and sources as soon as possible. For non-critical products they take the necessary actions in a more relaxed manner:

"Sometimes the regulation is there that this material is not allowed, then they give the timeline. It is not like; you know that suddenly they stop, because what happens that in some countries that product is still allowed and some countries it will be banned. But this country regulation, if suppose they ban and they give the timeline, so we have to move, but they will give some timeline. Some time will be there for sure; other thing is there that it is a very critical product that we have to work fast, other supplier. If it is not like, you know very routine product rarely used; then we are not much bothered."

Concerns

For them, the number of suppliers was one of the most important things that they were concerned about while switching to a green product. Their other concerns were related to the lead time and also the price:

"If you are releasing a new product, the number of suppliers is more important because the thing is, suppose your quantity required, maybe one supplier cannot fulfill that sometimes, so it cannot give you that quantity. So there is always a risk, we always see that we approve suppliers on time so that supplier cannot get more burden. If a thing is not there, which we require, so we move to the other supplier very fast. Price factor is also there because all suppliers will not have the same price. You always look for like, less price good quality and short lead times."

Below table summarizes participant L's interview.

Practice	Implementation	Consequences
Synthetic ingredients to natural ingredients	Palm Oil Based Soaps Switching from chemical based soaps to palm oil based soaps Natural preservatives Use of natural occurring preservatives instead of synthetic preservatives	1. Only impacts observed during the transition phase because of lesser number of suppliers and longer lead times 2. Costlier than synthetic ones 3. Reduced availability of natural products
Waste Reduction	Reusing pallets by ensuring proper stacking, handling and training the suppliers	No impacts

Table 13. Interview summary of participant L

Participant M

M has almost ten years of work experience in SC. Presently M is working as an SC analyst in Canada. Initially, M was working for an international trading company and was looking after purchasing and searching suppliers. M said that as SC is a very vast area so all of M's positions could be considered as part of SC. M has worked in China and some Middle-Eastern countries as well.

After the study was introduced, M mentioned three scenarios about green practices. First, companies adopt green practices due to some law or regulation or when they have to export to a country that mandates certain regulations. M mentioned the example of HSCCP certification which is prevalent in the food industry and is mandated by some countries if one wants to export to them. Second, managers like to go for green practices if they observe any incentives being given by the government or due to branding and marketing reasons. Finally, the last option is when a company goes for green practices just for the sake of being green, which is not very easy and is infeasible for the survival of business.

M further mentioned that the best solution would be to provide incentives to existing suppliers because it is hard to find new suppliers quickly, as many scrutinies are required to select new suppliers. These incentives include schemes like buying in a higher volume for the next few months or even a slight compromise on quality if a supplier is willing to go green. However, M said that if there is no incentive or there is no coercion from the government, then it is tough to persuade suppliers to go green. M said that usually, suppliers are small and are themselves are trying to stay in business.

Green practices

1) ISO 14001 – M worked as a consultant for a paper company in the Middle-East which is one of the biggest paper manufacturing companies. M mentioned that the paper company had already undergone ISO 14001 certification three to four years back. It wanted its suppliers to implement ISO 14001 certification, but there was not any force. M also said that they first decided to go for standards or certifications, because these are tangible and can be shown to the government for obtaining incentives.

2) Waste Reduction – The second thing that the company wanted was to help the suppliers to reduce waste. Every two or three months, the paper company sends some of its employees to visit its suppliers to help them in reducing waste. Here again, M mentioned that they were more focused on standards and then the amount of waste because the waste reduction could also be somehow proved. They also provided their suppliers with some incentives and not just purchasing in increased quantities.

M again emphasized that both ISO 14001 and the waste reduction could be proved easily and were more tangible. Both these could be proved by the paper company to receive incentives.

Reasons for the implementation of green practices

They implemented green practices because of their social responsibilities and due to regulations imposed by the governments. The government also provides incentives to companies for the implementation of green practices. As was previously mentioned, they had global customers, so they had already undergone certifications.

Impacts

ISO 14001 – M mentioned that they observed turbulences during the implementation of the ISO 14001 certification during the first six months to one year. It is important to note that the disturbances were not many and they were able to deal with all such disturbances by continuous collaboration:

"We had, let's say some turbulences for short time because they had to go through the different steps. They had to implement the standards; they had to have people. So for a short period of time let's say six months or one year, it depends on the company. For us, it was like a year. Our suppliers we monitored the little bit turbulence, but after that, it was again the same."

Due to some processes involved in the implementation of a standard, the amount of inventory is impacted but only for a short duration:

"When you want to implement a standard, you have to go through all the documentation, or you have to go through all the processes, you have to go through everything like for 9001, 14001 you have to go through all the processes that are involved in your company. That takes some time of

the people. The managers like the lead managers. They keep them busy, and then you are working with their suppliers, you are working on processes they are working. Every aspect of the manufacturing process, so that a little bit reduces the speed of the manufacturing. It impacts the inventory. So that was the biggest deal for that short period of time. But according to my experience, it was always better."

For products that were dependent on their suppliers, the lead times increased. Since the materials were already being supplied late from their suppliers' end so during the implementation phase it impacted them more:

"When we gave them enough incentives to, for them to start implementing standards and practicing some green sources it was only about the rate of materials that was coming into our company. So anything related to that, lead time stuff like that."

M said that they had already implemented the certification 3-4 years back. The delays and turbulences were occurring at their suppliers' end:

"Actually, it took our suppliers to get back into the previous pace and not us. It does not impact us that much because like for that company I was working for they had to have the standards, many years ago because they had customers all around the world."

They did not observe any impact due to the implementation of waste reduction at their suppliers' end.

Implications that were taken into account

When they were told by the government to implement the standards, they gave their suppliers some deadline and also started looking for new suppliers. It was difficult for them to persuade their managers to go with new suppliers because as per M, managers tend to stay with their old suppliers. However, it was comparatively easier for them to convince their managers to go with new suppliers because the force for the implementation of the standards was from the government. Below are the excerpts:

"Actually we had, when we were told by the government, I am again talking from the position I had in the paper manufacturing company. When we were told by the government, for sure, we had some time to implement this green SC. So we told all of our suppliers, we need this, and we gave

them a deadline, and then at the very first moment we started looking for other suppliers and give them this chance to become one of our permanent suppliers by having these standards. So at the same time for having some incentives for our like old, like long-term suppliers. We also gave this chance to other suppliers to join our SC by having these standards."

"In positions like that, for example, the government asks you to work with the people, or your customers or the society, the people around you are asking that. That was the easy part to convince a manager or a boss to go with a different supplier."

Concerns

Although they already met the requirements of hazardous wastes reduction, they still wanted to do better and even brought in external consultants for support:

"For us in that company, we already met the standard level of the ppm of the hazardous parts in our waste. But we wanted to do better, so every year we had a specific budget, and we brought some experience to work on that. If it was our production, any of our production cycle steps. It was related to our, like materials anything related to that. So we were looking at the whole company to reduce the waste. And at last to somehow filter the waste that we are producing. And then, yeah that was things we were doing for our waste reduction. They brought in some experts and looked at all the processes and to somehow filter the waste that we produce."

Their main concerns were related to the number of suppliers and the lead times:

"Well, for sure we knew that quality would be the same or better. And we were only worried about the lead times and also the number of suppliers that we have. So this three could be the most important points, that I remember right now."

Below table summarizes participant M's interview.

Practices	Implementation	Consequences
Standards or certifications	Implementation of ISO 14001 at their suppliers' end	1. Decrease in the number of suppliers 2. Increase in lead time
Waste reduction, particularly hazardous waste	Monitoring from external consultants to reduce hazardous waste	No impacts

Table 14. Interview summary of participant M

Participant N

N has more than thirty years of work experience out of which N has more than fifteen years of professional experience in SC. N's first job in SC was as a logistics administrator. Currently, N collaborates as a demand planning manager in Toronto, Canada for a baking company whose parent company is one of the biggest baking businesses in the world. Before joining the baking company, N was working for a grocery company.

Green practices

1) Retail ready packaging – N's previous company implemented retail ready packaging for two of their customers who are big retail enterprises. N mentioned that a retail ready package is simply a set of products in a carton whose top cover can be removed and the carton can be directly placed on shelves at the retail store. Retail ready packaging reduces the need to individually remove every single product and then arrange them on the shelf which primarily reduces the extent of handling. N said that it also reduces the amount of packaging and also the thickness of cases and therefore it is greener compared to traditional cases because it reduces the amount of plastic.

2) Enhanced aerodynamics – N's previous company also enhanced the aerodynamics of its trucks to reduce fuel consumption which in turn helped to cut emissions by improving their trucks' fuel efficiency. With the aid of foils on their trucks' roofs, they reduced the drag which helped them to achieve a better fuel efficiency.

3) More efficient warehouses – N's previous company also constructed new and efficient warehouses that helped them to reduce the carbon footprint from the warehouses.

4) Rechargeable forklifts – They also started using rechargeable forklifts for some of their warehouses. These forklifts helped them to reduce their carbon footprint because the previous forklifts were based on propane. At the end of each shift, these forklifts go to recharging stations.

5) Recycled materials – N's previous company also used packaging that was 100% recyclable.

6) Waste reduction – N's present company is a baking company, and they are trying to reduce the waste due to the short shelf life of their products. Each day they receive back much bread which they either supply to food banks or to farms where the bread is shredded along with the plastic

packs and fed to animals. N said that it is a huge challenge for them to reduce this waste. Even the return of products requires much fuel and time consumption.

7) Glass to plastic – As per N the biggest practice that N's previous company implemented was to move from glass to plastic bottles. Switching from glass to plastic is also beneficial as it helped them to reduce the energy consumption for recycling because plastic consumes lesser energy than glass for recycling. This change also helped them to reduce emissions from their trucks because plastic bottles weigh less.

Reasons for the implementation of green practices

The retail ready packaging project was implemented because of their customers' requirements. The design of the boxes was approved by both customers, and only then they went ahead and implemented the project. However, one customer continued with it (even though it faced lots of issues and damages due to improper handling of the packages) but the other customer did not pursue the project because its end customers did not like the packaging much.

The project on the enhanced aerodynamics of trucks was done to save costs.
Rechargeable forklifts project was implemented for cost savings and also for emission reduction. Mostly, all such projects were related to cost savings, but the projects also depended on the payback time.

Impacts
The biggest impact was related to the reduction of transportation cost with the help of enhanced aerodynamics of trucks:
"The one that is ongoing, probably had the biggest impact, is reducing the transportation cost because this also had an impact on the environment. We tried to maximize our trailers as much as we can, that impacted the pulling the product around."

N did not observe any negative impact of green practices except in the case of retail ready packaging. The adverse effect observed was also due to the lack of training:

"I would say that it did not have any negative impact. The packaging certainly saved us money and using electric forklift also saved us money so in most cases, almost all cases, the company saved money. I cannot think of a case where it cost us more money."

Implications that were taken into account

Retail ready packaging was demanded by their customers, so they had to do it. They took into account first the costs and then the risks. If a project involved very high costs, they did not go ahead with it:

"Yes, we did the risk analysis, because the risk was not really much because it was just retail ready packaging case. It was not really a matter of risk because they were demanding that we do it, so the risk was not doing it. So it was a pretty simple analysis." "I cannot think of an initiative turned down because of risk. Usually, we just put brakes on it, when it costs too much money, or we are not going to do it because the risk is too high."

They took into account the implications of implementation of various GSCM practices. The practices that they implemented did not cause any changes in their SC. All the implications that they took into considerations were related to costs:

"Yeah, we took into account but it was more of a matter of studying costs, this will whether cost us more money or not cost us more money. It did not really change the model in terms of the SC. I am sure that there is less packaging used because plastic tends to be thinner than glass. Though I would say that there was a callback, but in some cases, we reduced the actual thickness of the cases and reduced the waste. That was the other part about retail ready packaging. It was less; the case was not as full so in order for... what I mean by that the product was not completely covered like in a traditional case. But have an open end so that you can actually view the product."

Concerns

They had their concerns about the retail ready packaging because they did everything as per the requirements of their clients. In one case it worked perfectly fine (although in this instance the client later shelved the project because the retail ready packaging was not liked by its own

customers) but in the other case it did not work out (due to insufficient training which resulted in damage to boxes as they were ripping off):

"The company did not test it within their own warehouses. The opening was designed for the company to give visibility inside the product. What happened was unanticipated consequence was that they do not do a testing within their own warehouse. And so in terms of handling the product. So you can imagine the box, so what was happening that the warehouse workers were basically putting their hands on the opening. We had wastage; we had damaged packaging. The cardboard boxes were ripping open because they were grabbing them at the open end. So what was happening was that they were losing products. They were threatening the charges even though they had approved the design, so that was the bump in the road for use because we had to manage a huge amount of money."

"They were tearing open the perforations before they had got into the store. So that was a major problem. So we had to change it and get the money back, it was really their fault, they should have tested it."

"That was an unintended consequence for something did not go right because of this. We thought it would be greener, it would be better, but it ended up costing more money to us maybe not to our customer and the issue on top of this that we had to quickly resolve the issue. That means that we had to work with our suppliers. To change the design of the box."

"No, with other company we did not face this issue. It is possible that they just informed their workers to work carefully. That is what we had suggested to the company facing the issue, to coach the workers, but they asked us to change the packaging."

Below table summarizes participant N's interview.

Practice	Implementation	Consequences
Retail ready packaging	Cardboard case containing products could be directly placed on shelf without the need to unpack each item separately	1. Reduced handling and amount of packaging 2. Unintended consequence for one customer had to change the design 3. Saved the amount of packaging
Better fuel efficiency	Improved aerodynamics of trucks using foils on roofs	No impacts except cost savings
More efficient warehouses	Energy efficient warehouses with reduced handling	No impacts except cost savings

Rechargeable forklifts	Use of electric forklifts rather than propane or natural gas based	No impacts
Recycled materials	Use of 100% recycled packaging and plastic	No impacts
Waste reduction	Return of bread and waste reduction	No impacts
Glass to plastic	Switch of packaging bottles from glass to plastic	No impacts

Table 15. Interview summary of participant N

Participant Q

Q has more than eighteen years of experience in the FMCG industry out of which seven years are in the SC. Q has worked for global FMCG companies and has extensive expertise in the Middle-East and North Africa. Presently, Q collaborates as the head of projects in Dubai, UAE for a contract manufacturing company which is a supplier for global FMCG companies. It manufactures products like handwashes, dishwashers, and detergents. Q deals with supply excellence projects, cost savings, and extreme projects.

Green practices

1) Aerosol Can thickness reduction – Q was part of this project, and it dealt with the reduction of the thickness of aerosol cans. A decrease in the can's thickness led to the saving of tin consumption and reduced the weight, which helped them to save fuel and thus reduce their carbon emissions. However, the problem was that the country where they wanted to reduce the can's thickness is in Middle-East, where temperatures can go very high. To address this, the can's thickness was reduced incrementally from .24 mm to .21 mm and then till .18 mm. The incremental reduction was made because the can could explode due to the type of chemicals inside it and the scorching temperatures outside. Even if a single can had exploded, it would have caused huge damage to the entire factory or the vehicle transporting it.

2) Bottle related green practices – Q's company used bottles made of different types of materials. Initially, they were using Polyvinylchloride (PVC) bottles. Q said that PVC bottles are non-biodegradable, so they switched to Polypropylene (PP) bottles. They are also planning to move from PP to Polyethylene terephthalate (PET) and have further plans to move to laminates. They

also use bottles consisting of 20-30 % of regrind plastic. Below are the details about the different types of bottle related green practices:

a) PVC to PP to PET – Q's company decided to move from PVC bottles to PP bottles because PP bottles are biodegradable. PP bottles, however, cost them more, but as per Q, PP bottles are more durable and also have a reduced weight which further helped them to reduce carbon emissions. PVC bottles, on the other hand, are prone to breakage and can also start to leak as they age. They are also planning to introduce PET bottles because PET bottles are lighter, which will help them to reduce further the bottle weight leading to a reduction of carbon emissions.

b) Bottles to laminates - The next thing that Q's company is trying to do, is to move from bottles to laminates. They are encouraging their customers to purchase laminates or refills. By switching to laminates, they will be able to save on storage, consumption, and costs. The amount of plastic will be substantially decreased because in the case of laminates they will just have a pouch. Customers can just purchase and use them. The pouch will not have caps and labels. These laminates will help them to reduce their carbon footprint. Q mentioned an example that bottles have a weight of fifty grams with the caps weighing an additional five grams. The use of laminates can, therefore, reduce much weight.

c) Regrind plastic – They also use bottles consisting of regrind plastic. Regrind plastic is the waste plastic that is generated when new bottles are blown. So the waste plastic is taken and reground, and then added to the virgin material. For instance, they use bottles consisting of 80 % virgin material, and 20% regrind plastic.

3) ISO 14001 – After implementing ISO 14001, they started collecting waste and also got more disciplined regarding waste collection. Due to the implementation of ISO 14001, they also started segregating the waste. Before its implementation, all waste used to go just in one bin. The waste segregation also helps them in the recycling of some of the garbage.

4) Dust emission reduction – Q's company manufactures detergent, which also leads to dust emissions due to the fine dust involved in its manufacture. To prevent dust emissions, they

diligently monitor the input of raw materials for the production of detergent versus the output. Q said that if the input does not equal to output, then it signifies that dust collection has some glitches. Q's company with the help of SAP ERP also determine the extent of dust emissions during the detergent manufacture process. SAP ERP helps them to monitor the correct input and output quantities.

5) Green raw materials – Q mentioned that they are also using green raw materials. They currently use sodium tripolyphosphate in their detergents. Sodium tripolyphosphate is harmful to the aquatic life. They plan to switch to zeolite which is not harmful to aquatic life. Q also mentioned that zeolite is already used in Europe. Thus, the use of zeolite will also help them to export detergent to Europe, if they need to. Also, if any regulation comes into force that proscribes sodium tripolyphosphate, so they will be able to pre-empt any disruption due to that.

6) Local Production – They also started production of some of their products locally, which will help them to reduce a considerable amount of emissions and energy consumption. As local production was explained in great detail by Q, so it is presented after the concerns section of Q's interview.

7) Recycled cartons – Q mentioned that they started switching slowly from virgin cardboards to recycled cardboards, which again had its set of risks, so they again switched in step by step fashion.

8) Supplier evaluation – Q mentioned in detail about the assessment of suppliers. They ascertain how a supplier is doing its process, how does he handles waste and reprocessing. For example, Q mentioned that if a supplier is not reprocessing waste properly, then it might increase the arsenic or lead concentration in the ground water. So, they take into account all such scenarios while evaluating their suppliers.

9) Waste water reuse – Q said that they reuse waste water generated during reverse osmosis. They use the waste water both for irrigating their fields and also for detergent manufacture. They, however, are not able to use 100% of the waste water because it is not possible to reuse all the waste water.

Reasons for the implementation of green practices

Aerosol can thickness reduction was mainly done for cost reduction because reduced can thickness also helped them to save on the consumption of tin.

They switched to PP because of regulations and their commitment to stakeholders.

Regrind plastic helped them to save on costs, and it helped the environment as well.

They implemented ISO 14001 because they have customers worldwide and also because authorities question them about such certifications.

They had to prevent the dust emissions because of regulations. Q did not mention any particular impact on their SC except that they had to install filters to collect the dust.

For detergents, they are switching to zeolite because it is environment-friendly and also to pre-empt any regulations.

Use of recycled board and waste water helps them to save costs and also makes them environment-friendly.

Impacts

PVC to PP – Q mentioned many impacts on different aspects of resilience when they were moving from PVC to PP:

First, they have to start looking for suppliers of PP, which were not as abundant as PVC bottle suppliers. They audit suppliers when they take in new suppliers so that also delays their SC. Moreover, blowing PP bottles requires different expertise as compared to blowing PVC bottles, so they also had to make sure that the suppliers of PP bottles have proper experience:

"New supplier, because then this is a new material for you. So you go, you are cautious, you audit your supplier, you identify your supplier, and you make your SC robust that it should not fail. Whether the capacities are there for the supplier because all of a sudden you had one or two suppliers who supply you PVC bottle and every Tom, Dick, and Harry is supplying you the bottle, PVC. When you go to PP, PP thing is there it can be blown out of certain machines. So the challenge was there to identify those suppliers and just ensuring that they know how to blow the thing across. Everybody cannot blow polypropylene. They have got an experience and the machine."

The amount of inventory of PVC bottles increased due to the backup plan of keeping sufficient PVC bottles till they completely switched to PP bottles:

"So you need to make that, you need to have enough of safety stock. Initially, you need to keep the safety stock of PVC bottles just to ensure that if something happens, some fallback is there. That is always there that you weigh the pros and cons. Once you went to the new project, you have taken all the learnings; all those things are there to ensure that it is implemented in the correct way, in a proper way. Learning is always there."

After they start producing the PP bottles as per their requirements, they further start searching for other suppliers, which itself is a challenge because of a lesser number of PP bottle suppliers. The blowing process of PP bottles is also different, so here again, they faced a reduction in the number of suppliers:

"And then slowly-slowly there should be a plan to see that once this grows that you cannot have a mono source. You need to have then long run, one year or two years after the plan, whom we should develop, another supplier, fallback option. You go and start working on that; your procurement team starts working on that. Then you should have a second source also who can blow the bottles for you and then the inventory was not impacted because of the bottle versus the bottle."

Regrind plastic – Q mentioned that bottles containing regrind plastic possess a reduced strength and they also could not create bottles that were made of 100% regrind plastic because of the smell, as the regrind plastic would have burnt twice:

"Then regrind consequences are there; you are going to lose your strength of the bottle, so you are going to need to see your top load is fine all those things are fine, but you are helping the environment by regrinding it. (…) . You cannot use a 100% regrind product; then you can smell the product because it has burnt twice in the blow molding process or in the injection molding process."

Moreover, bottles containing regrind plastic could not be used for cosmetics because of loss of visual appeal of the bottles which contain regrind plastic.

Implications that were taken into account

Q mentioned that the implications of implementing a green practice must be taken into consideration. This requires proper risk mapping and also a three-month stability test:

"See the risk factor is there, that tomorrow ok the risk factor of doing everything into account. Tomorrow something happens in the market; this thing is there the product starts misbehaving or reacting or leaking or whatever it is. So you need to have a whole thing because if you have done a risk mapping, you will start from a raw material, packaging material, you will just list down all those things. These are the raw materials, what are the risks. You are sourcing from here; you are sourcing with this specification. When you do the packaging material all these things, like label, bottle, carton. Then you have to ensure that you have done a three months stability."

For recycled boards, they conducted transit trials for 2000 km on inbound transit as well as outbound transit which helped them to validate the strength of the recycled cartons:

"So you go and then use a recycled board and then do a transit trial for around 2000 kilometers, one side, coming back 2000. And then you validate the board part of it. So you keep the actual thing. Actual, the product is going. So then slowly-slowly from the virgin board you move to a recycled board and 100% recycled board."

Supplier evaluation – For supplier evaluation, they take into account the implications by starting off with regulations. They check whether their supplier complies with regulations and has processes and facilities for reprocessing units, sludge unit.

Concerns

PVC to PP – While planning to move from PVC to PP they were concerned about customer perceptions as PP bottles have a hazy appearance, and so they were concerned that their clients might view such bottles as counterfeits. They, therefore, had to work with their marketing team to make the PP bottles more attractive:

"And then the consumer perception like we move from PVC to PP. PVC is a shiny bottle. It looks very good on the shelf, it shines. But when you put your product in the PP bottle it is bit hazy, so that is consumer perception, to see how you make it run, you work on the arts work part of it, how to make it look good, how to make it look brighter, can you do a different kind of label. Instead of

the paper label can you do laminate label so that it can shine, it can outshine because once you keep those bottles, PVC and PP it does not look good. So that was always a challenge, marketing worked out very intensively on that to ensure that this happens across, it looks a premium product because the consumer will think, when you go there, they will say, what is this. That might be a counterfeit product or what."

Recycled cartons – They were skeptical whether such cartons will be able to withstand load and whether it might collapse during transit:

"Can it withstand the test, can it withstand the load because it is a risk, tomorrow it will collapse. You are saving something on the carton using a recycle board, but in the transit, it might collapse. The loss will be much bigger on the product."

Supplier evaluation – They have the concern that if their supplier has any liability in the future, then they will have to bear the responsibility:

"When we audit supplier we see that what kind of environmental controls he has. Normally we start with what are the government regulations. Are you in compliance with that, yes he will say I am in compliance with that. I do this, I have got a reprocessing unit, I have got a sludge unit where I treat the sludge before dumping it into the mainstream. Normally in some other countries, regulation is there that you cannot dump into the mainstream, you have to reprocess it, and you have to call certain agencies will come and pick you up and then take it across. So you just ensure that point of it that how he is handling it across."

Moving further, issues and challenges that they observed during the risk analysis of switching from PVC to PP and starting local production are discussed.

PVC to PP

As already discussed, Q's company decided to switch from PVC to PP because unlike PVC, PP bottles are biodegradable. In this section, a more detailed analysis has been conducted with the help of some documents shared by Q regarding this project. The country whose formulation they ultimately decided to use has been referred to as ABC, and the product name and qualities have

not been discussed. The product is also referred generically. All this has been done to maintain the confidentiality. The section has been divided into complexity, pack issues, cost issues, and conclusion.

Complexity

The first problem that they faced was about the formulation. This product is used worldwide, and over the past few years, many local variants developed. For example, the product's formulation in Asia is different from the product's formulation in Europe and so on. To implement this project, they first decided to standardize the formulation, which itself was a challenge. The differences in formulations arose because of local price differences between different ingredients. Ultimately, they decided that they will at least remove the minor variations in the product's formulations and instead use the formulation of country ABC across all the regions. They reached a consensus that whether they move ahead or not with the project, they are going to harmonize the formulation across all the regions so as to reduce complexity.

The next complexity was about the packaging of the product. Worldwide the product had thirteen different sizes and also many diverse pack designs. The bottle material also ranges from PVC to glass for smaller sizes. For bigger packs, they used HDPE bottles and even tin cases. A diverse number of package cap variants also developed over the years ranging from 18mm to 40mm. The smallest sizes ranged from 50ml to 750ml, and the largest size ranged from 500ml to 2000ml.

The product introduction also required approval from local authorities and in most of the countries, the approval time ranged between three to six months. In some countries, only notification was required, and in some countries, no approval was required. They had to take the approval time into account for stability testing and the actual introduction of the changed product.

Pack issues

PP bottles are not as clear as PVC bottles, and so an additive has to be added to increase their clarity. The preferred resin was provided by a European supplier who directly supplies to the European market and through agents in other markets. The number of suppliers of the resin is also very few worldwide, due to which they act as cartels. These suppliers charge high costs in other markets. They also found that there are different types of resins for PP which they might use, but they avoided it because that would have again increased the complexity and variability. They had

thought that they would be able to optimize the bottle weights, leading to a reduction of bottle weight. However, this again proved to be tough.

The optimum bottle weights also required good blowing machines which allow proper weight distribution in the bottle. These machines were even more important because optimum bottle weight distribution would lead to clearer bottles. The bottle weights in their developing markets were more than the bottle weights in the developed markets. So, they decided to reduce the bottle weights in the developing markets. However, this again caused a problem because the bottle blowing machines in the developing markets were usually old and obsolete. There was also a lack of good technical capabilities for blowing the bottles. All this would result in unclear bottles and non-optimal bottle weights.

Financially, they were considering the best case, that is, to optimize bottle weights. However, as mentioned previously, the reduction of bottle weight was going to be a challenge. Even the cycle time for blowing PP bottles is longer as compared to PVC bottles so this again became a hindrance.

Cost Issues

The price of the PP resin was again a hindrance. They found that clarified PP bottles to be about 24-30% costlier than PVC bottles across different markets. They also found that price of PVC bottles was going down because of increased demand for PP bottles which further resulted in higher prices for PP bottles. Initially, they had thought that cost of PP resin would be lower as compared to PVC bottles, which proved to be contrary after more detailed analysis. Moreover, as previously mentioned some of the regions were using glass bottles, and a switch in such regions would increase the costs of goods sold (COGS).

Conclusion

They concluded that moving from PVC to PP will result in an increase in the cost of goods sold. They observed a significant increase in COGS if they switch from PVC to PP. This increase would be more pronounced if they switched from glass to PP.

Technically the project was quite complex because of difficulties in achieving an optimum bottle weights worldwide. A non-optimal weight would also impact the clarity of the bottles which will further complicate the product variability.

After taking into consideration all the aforementioned factors they decided that they will switch only from PVC to PP and not from glass to PP because of a significant increase in the COGS. Keeping in mind all the aforementioned points they decided to go for stability testing.

<u>Local Production</u>

An SC that is local is more green and resilient due to the apparent decrease in the length of the SC, but every product cannot be produced locally due to challenges like customer perceptions and lower volumes. For instance, Q said that the clients might perceive a product imported from the EU to be of higher quality as compared to a product manufactured locally. Q mentioned that for products that do not have very high volumes, it does not make sense to start their local production. Only products that have very high volumes make sense to be produced locally. Q mentioned in great detail about the various aspects of domestic production:

Q said, *"I will just give you an example that we used to import a lot from the UK, USA, and European factories and all. We used to import it across. I was part of that project; we used to import a lot from there. Then we decided, that why not manufacture it locally."*

When asked about the reason for deciding to go for local production, Q mentioned that products that have high volumes make business sense to be produced locally:

"*Some of the finished goods, where the volume justifies, that you have to justify the volume. If somebody wants 100 cases so we cannot get it done, those 100 cases. That does not save the things. So we import it across. It is slow moving. Where the volumes are there, that is the thing only justified. And some of the multinationals take a call depending on their brands, power brands. Which power brand, they want to manufacture locally, which power brand they want to outsource it. It depends on the volume because the end of the day, you have to look at the saving part also. That how much is given as a saving. If you give a saving of 100 dollars, thank you very much, why should I waste my time in all the process? 100,000 dollars is worth looking into it, then let's do it. A lot of efforts goes into it. Because you have to develop the product, you have to do the stability part of it. A lot of resources are required to validate sales, ok, then you go ahead and do it across.*"

As stated in the beginning, the local production itself has challenges due to different customer

perceptions:

"*But that was a challenge because: Made in the UK, Made in France, Made in Europe products are there. The challenge was there, how to bring it on the ground at the same quality, same supplier, same quality of the product to the consumer, so the consumer should not notice it.*"

Even bringing the local production is a challenge and Q's company had to understand their customers' perceptions, do proper testing and validation, and develop local supplier base. The quality of the product should also match the quality of the imported product. All this was a lengthy process which required meticulous execution at each and every step:

i) The first step was market research to ascertain the opinion of customers. If the customers themselves could reject the locally produced products, then it will be of no use to manufacture products locally:

"*Your first objective is that the product should sell. You should not lose your market share. If the change is noticeable, you bring the products from the UK and produce locally, so the change is noticeable, you are going to lose your market share. So first step was there to do a market research and find out how the consumers feel about it, that this is acceptable. It is a planned customer research; you do A sample from local, B sample from import or A sample from import, B from there. The consumer does not know and gives him a feel that can you make out the difference part of it.*"

ii) After the market research, they start to look for local suppliers. As they want to start local production, so they also start looking for local suppliers. Producing locally and sourcing raw materials globally would still lead to delays:

"*And then when the consumer research comes across and says that no, there is no consumer impact then we go to the next stage of working out the cost part of it, that is what cost benefit we have, what are the suppliers available in the market because you cannot have a supplier sitting in Canada, you cannot ask him to supply it from there, again the freight is there. Raw material and all. So you go and validate the suppliers, local manufacturing and local packaging suppliers, raw material suppliers.*"

iii) Next, they conduct the testing and can save a lot of freight, storage and also help the environment:

"You go and get those numbers in, produce a batch and put it on a stability part of it. So while your three-month stability is going on, your numbers are done, all these things are. This is just there too because it is helping the environment. It is related directly to the cost element and the freight element. And imported products once you bring across you have store it also. So you have to pay for that storage also. If you produce it locally, you can just produce it and ship it to the distributor directly, to the distributor warehouse. And the same time you are saving the freight part of it as well as your warehousing part of it. And the gross margin of the product improves because you are doing it locally."

iv) Despite local production they again have to consider risks related to consumer perceptions:

"But there is always a risk element, people say that this is made in UAE, this is not made in the USA, but you have to bring in all the quality parameters in line with the requirement with what they had in Europe or in the USA. It has to be implemented in the same way like we have done it across. So just produce as per the guidelines, exactly the same, it is just a replica including the process, your quality checks, your storage conditions, everything. Then you go and produce and launch the product."

v) They moved gradually one product at a time to minimize the risks:

"So slowly-slowly you move, you do not take in bulk, you take the risk product wise. You take the A product like you take the soap, then you see the response. Then you bring in the liquids and do it across, so that helps the project, the risk is minimized in that. Suppose one of the product fails in the local market because of the local manufacturer, the quality defect is there, so at least one of the product fails, it is not the whole basket of product that's failed. So that is where this thing is there."

vi) Their customers might still resist the local products:

"People will show the resilience, they will say no, it is in the UK, why should I take locally, but you have to convince them by numbers, by showing them the data. You have done a market research that there is no impact on the product.

vii) Local production has obvious impacts on the resilience of the SC like shorter lead times, increased responsiveness:

"This is the benefit that you will get, shorter lead times, lead times from Europe is there, 30 days to 45 days' lead time is there. You are going to shorten your lead time; you are going to improve your margin, you are going to benefit the environment part of it, to make it happen. So all those benefits you have to show it across to prove that the SC is helping the environment also."

viii) After the local production successfully starts, they further look for ways to reduce the bottle weight, the amount of packaging:

"And then the second step is there, when you have done the first step, then you go and see because when you are bringing the product from the USA and all, your weight of the product is quite high, like the bottle weight, the packaging weight that you have to do, 5 ply carton, the bottle weight has to be more. The product has to be very robust to ensure that it takes care of the seas and all those things. High seas and all. When you bring the product, you have launched it locally; then you see how you have to reduce the weights like if it is 30 grams or let's say 100 grams, it can go to 90 grams, so 10 grams you are saving on the weight of the bottle. And 10 million pieces you are selling so that much so that you are bringing to the environment also. So that what was the thing."

As can be seen that local production reduces the lead time and helps the environment as well but local production should be justifiable and should be started only in an incremental manner.

The below table summarizes the different green practices from participant Q's interview.

Practices	Implementation	Consequences
Aerosol can thickness reduction	Reduction of can thickness from .24 mm to .21 mm and then finally to .18 mm	1. They were able to reduce consumption of tin which also resulted in reduction of carbon emissions 2. There were no impacts on the resilience of SC
Bottle related green practices	PVC to PP to PET 1. Switch from PVC to PP bottles as PP bottles are biodegradable 2. Planning to move from PP to PET because PET is lighter Bottles to laminates	PVC to PP to PET 1. PP bottles are more durable and stronger resulting in minor leakages and breakage. 2. Lesser number of PP bottle suppliers 3. PP bottles have hazy appearance, and so they had to work on its visual appeal

	1. Instead of bottles they plan to educate their customers to use laminates 2. Reduction of plastic weight due to no caps, plastic body Use of regrind plastic for bottles Reuse of waste plastic generated during bottle blowing process, 20% waste and 80% virgin	4. No impact mentioned from PET as they are still planning Bottles to laminates Will help in the reduction of inventory Use of regrind plastic for bottles 1. Reduced the strength of the bottle 2. Could not be used for high-end cosmetics
ISO 14001	1. Ensure that proper waste collection and segregation is there 2. They had to be more disciplined	No impact
Dust emission reduction	Use of filters to prevent dust emission during detergent manufacturing due to regulatory requirements	Prevents them from fines
Green raw materials	Zeolite does not harm the aquatic life, but sodium tripolyphosphate is harmful to the aquatic life	Switching to zeolite will help them to pre-empt any regulations that seek to phase out Sodium tripolyphosphate
Local production	Produce products that have a high volume, locally	Obvious impacts on lead time, capacity, inventory, costs
Recycled cartons	To use recycled cartons for packaging	1. The decrease of the strength of the board. 2. Proper trials are required to test the strength
Supplier evaluation	Evaluation of suppliers for regulatory compliances, environment friendliness	Prevent any liability that can lead to supply disruption
Wastewater reuse	Reusing waste water from reverse osmosis for irrigation and detergent manufacture	Helped them to save costs and reduce emissions

Table 16. Interview summary of participant Q

Participant W

W has more than eight years of work experience that includes preparation of environment related KPIs, water use reduction, and environment impact assessment of projects. W worked in a dairy company in France which was quite active in sustainability. W is currently operating in Montreal, Canada as an environmental performance manager. Currently, W is more concerned with operations and manufacturing. Most of the SC related experience was acquired by W in the French company. As per the interview, W's current company is a bit behind in sustainability compared to

W's previous company. However, W's current company is also taking the necessary actions to reach the level of sustainability of the previous company.

Green Practices

1) Environmental impact assessment – This was done in W's previous company. They used to ascertain the environmental impact of each and every project and ensured that only the sustainable projects are implemented. W said that at least one person (if not an entire team) should be entrusted with the responsibility of assessing the environmental sustainability of projects as that would help to fix accountability and would not lead to buck-passing.

2) Carbon footprint measurement using SAP – They had a tool in SAP that can comprehensively assess the carbon footprint of each and every ingredient. This enables them to make informed decisions about emission reduction across the SC.

3) Supplier scorecard – They developed a scorecard to select suppliers by suppliers' environment friendliness while also taking into account the business needs. People from their organization visit suppliers across different countries and rank them by the suppliers' environmental and social practices. W worked in the dairy industry and mentioned about supplier selection on the basis of sustainability, there as well. In one of the large companies where W worked, environmental managers were not the ones who used to visit the suppliers. The environmental managers could make their recommendations, but the actual visits were done by the centralized procurement department.

Reasons for the implementation of green practices

W mentioned that the reasons for the implementation of green practices varied across regions. W said that it is more due to pressure from governments and customers in Europe whereas in North America it is more due to the pressures from shareholders because financial sustainability goes hand in hand with social and environmental sustainability. W also provided a comparison of the previous company and the current company. W's previous company was a French company and was more proactive towards sustainability than W's present company which is North American.

Impacts

W said that when companies want to implement sustainability at their suppliers' ends, they are fearful of disruptions, but in the end, they do not face disruptions due to suppliers because they work collaboratively with their suppliers and try to help them to become sustainable. They do not want to leave their suppliers just because their suppliers are not able to become more sustainable: "*We believe that we could, you know, improve our sustainability through our supply chain we are going to work with you to improve it, so it's more collaborative approach than just, you know disruption of supply chain and ok this is not working, and that is it, so I guess again every company is different so maybe sometimes you know there is sometimes there is disruption in the supply chain in the sense that if a supplier is not willing to switch to more sustainable practice then they would just say ok, and this is it we do not work together anymore but so far I have seen very collaborative, more collaborative approaches*"

W also stated that there were no impacts on lead time and flexibility due to the implementation of sustainable practices as their suppliers' end because W's company was a large corporation having a large pool of suppliers and therefore they had a greater number of suppliers available: "*I do not think it had such a big impact on lead time and on flexibility in the sense that as I mentioned earlier what company usually work through a purchasing platform, so there is a large pool of suppliers, you know if there is one supplier that there is one supplier that is struggling a bit implementing sustainability or meeting our green goals then you know there are always suppliers we can work with. So maybe it is more visible in a smaller company but and again I have not been working in the supply chain but it never truly had an impact on our operations.*"

Implications that were taken into account

As W does not have much experience in SC, so W could not answer the question related to implications, but W does believe that companies do consider the implications of green practices on their SC's resilience. W, however, said that, before implementing a green practice across an SC, companies first have to implement them within their premises. Companies first have to make sure that their operations are sustainable:

"*when a company implements sustainability supply chain usually comes last because you need to*

make sure that first, your own operations are sustainable and that the way they do business is sustainable and then you are going upstream and downstream and its harder to control what's in upstream and downstream but I guess yeah it is assessed, I cannot tell you really how or in which way but you know companies are here to make business they are not here to save the planet."

Concerns

W said that their main concerns were related to costs because they thought that pushing their suppliers for going green will result in higher costs being charged by their suppliers. This, however, did not happen, and costs were not raised by their suppliers. The second thing that they were concerned about was regarding complexity due to the lack of knowledge about implementing green practices. Despite both these concerns, they were still able to work with their suppliers because of collaborative relationships:

"So I think the concern was that our suppliers are going to raise costs because we are more demanding but in the end that that is not what happened."

"...and may be complexity because people do not really know how to implement it and it seemed maybe complex because maybe we would have thought that maybe our suppliers would not want to work with us anymore. Maybe, they would not comply with our goal which did not happen. In the end, we worked together in order to make things better so of course there were concerns, but in the end, everything went well. You know, people were very collaborative."

Below table summarizes participant W's interview.

Practices	Implementation	Consequences
Environmental impact assessment	At W's previous company, they assessed the environmental impact of each and every project	There were no impacts on resilience of the SC, but it helped them to stay safe from any disruptions
Carbon footprint measurement using SAP	This tool helps them assess the carbon footprint of each and every ingredient	Could not mention any impacts
Supplier scorecard	Suppliers would be questioned about their packaging ratio, packaging type	Choose the most sustainable suppliers. They did not observe any impacts because they had a large pool of suppliers which they could afford.

Table 17. Interview summary of participant W

In the next chapter, the results of the analysis are presented and discussed. Managerial implications, limitations of the research, and opportunities for future research have also been mentioned.

Chapter 5

Results, discussion, managerial implications, directions for future research and personal contribution

5.1 Results

Based on the excerpts and analysis in the previous chapter first, the propositions are discussed followed by a discussion on the research question.

5.1.1 Discussion on propositions

Proposition 1: The SCR of smaller companies is more likely to be affected by the implementation of GSCM.

Almost all the participants had experiences of only large firms. Participant W mentioned that they did not observe any disruptions possibly because they are a huge company and may be disruptions due to the implementation of GSCM might be more observable in small enterprises. It is important to mention that W did not have much experience of the SC. Participant M however, has worked in small businesses and mentioned that for small enterprises, it is hard even to convince suppliers to go green. F mentioned that small suppliers could face challenges due to the implementation of GSCM but did not mention anything about what would happen if the focal company itself is small. G mentioned that after the implementation of the NPRE standard for a small business the company did not continue with the standard because it was too costly for it to maintain the standard. This, however, was not stated from an SC point of view. Based on the preceding discussion, it could be said that small companies are more susceptible to disruptions during the implementation of GSCM.

Proposition 2a: The SCR of firms that already export to countries with stringent environmental regulations is less likely to be affected by GSCM implementation enforced by the home government of the firms.

This was not mentioned by any of the participants but was indirectly referred to by Q. Q mentioned that sodium tripolyphosphate is not used in Europe because it is harmful to aquatic life, so they are also trying to move out of it. Q, however, said that it could be a challenge to clean clothes using detergents that lack phosphate because water in UAE has a higher level of hardness. However, still, they are trying to move to zeolite due to its environment friendliness. Therefore, if the UAE government proscribes the use of sodium tripolyphosphate in the future, then it will not disrupt their SC because they would have already replaced it with zeolite, much in advance.

Proposition 2b: The SCs of firms that have GSCM related certifications are more resilient as compared to SCs of firms that implement their own green programs.

Participant F mentioned that one of their biggest aims is to achieve complete FSC certification. As per F, this certification will demonstrate their dedication towards sustainability. M mentioned that the implementation of standards and certifications is more tangible and thus helps companies to receive incentives from the government. This was the reason why the paper company for which M worked, first decided to implement standards. Q also mentioned that when they look for new suppliers, they ascertain whether the supplier has certain certifications as this gives them assurance that the supplier is environmentally friendly. After that, they check the other programs that the supplier has implemented. Other participants also mentioned that having global customers pushes them to have certifications. It could be a possibility that certifications such as ISO 14001 are more recognized and standardized so their implementation could enhance the resilience of an SC rather than a not so properly defined practice.

Proposition 3: The SCs of firms employing pollution prevention or source reduction strategies are more resilient than firms which employ pollution reduction strategies.

This was not mentioned by any of the participants, possibly because they did not implement such practices. However, when F was planning to leave the mining company, its management was planning to reduce the phosphogypsum at the source itself by converting it to some boards.

Proposition 4: The SCs of firms that take into account green design for their products are more resilient as compared to SCs of firms that do not take green design into account.

The interviews did not lead to any final comments for this proposition. Reasons could be manifold. For examples, the target interviewees may not have enough exposure and experience to discuss this subject at length. Another reason could be the companies of targeted interviewees did not have meaningful exposure to this topic.

5.1.2 Answering the research questions

1) What changes had companies to make in their SC to implement GSCM?

a) Supplier related changes – The first change that companies had to make was regarding their suppliers. Some of the participants like M mentioned that they started looking for new suppliers if the old ones could not participate in the implementation of the green practice. Participant F also mentioned that it is hard to find suppliers who have the resources and capability to implement GSCM. As a result, they have to invest time, money and energy to develop such suppliers. W mentioned that companies fear that they will face disruptions at their suppliers' end when they implement GSCM. Participant W further mentioned that this, however, did not happen and they worked collaboratively with their suppliers. However, participant W added a caveat that probably this might not be true in the case of small companies. This was also affirmed by M. Participant Q also faced supplier shortage when they switched from PVC to PP, or they were planning for local sourcing. There were not many PP bottle suppliers and even in the case of local sourcing they wanted to have more than one supplier. Working collaboratively with suppliers can definitely aid in preventing the loss of suppliers as a result of the implementation of GSCM.

It can, therefore, be seen that one of the biggest challenges that companies face with their SC during the implementation of GSCM is the reduction in the number of suppliers. This change could

be further aggravated if the focal company is small because due to its size and lack of too many resources it is hard for it to persuade its suppliers to go green.

b) External consultants and training – The help of experts, eases the implementation of GSCM. However, consultants as well as training, require the expenditure of money and time. The need of external consultants can be more pressing if the company wanting to implement GSCM has no prior experience in GSCM. The example of the mining company that brought in external consultants for proper disposal of phosphogypsum is noteworthy in this regard. G also mentioned that companies just think about manufacturing and they must provide their employees sufficient training regarding green practices. N highlighted the importance of training during the discussion on retail ready packaging where the same practice was implemented in two companies. Due to lack of training, one of the companies faced damages even though the design was approved by it.

c) Increased inventory – Some of the participants mentioned that their companies had to maintain extra inventory for fallback options during the transition from a non-green process to a green process or from a non-green product to a green product. During the transition phase, the amount of inventory increases. This was observed when F mentioned the transition from non-FSC cartons to FSC cartons and when Q mentioned about the transition from PVC to PP bottles. L also expressed a similar opinion about the increase in inventory during the transition phase. During the transition period companies have to maintain extra stocks that can absorb shocks due to unforeseen events.

d) Increase capacity – For processes that were threatening the business continuity, they had to maintain extra capacity as was observed in the case of the disposal of phosphogypsum by the mining company. That is, they had to maintain three conveyor belts to ensure that the process continued without any interruptions even if one of the belts stopped working. Also, as per F, the capacity utilization is enhanced because when GSCM practices are implemented, companies can produce more from the same amount of resources.

e) Increased lead time – Lead times can increase especially during the implementation of a GSCM practice. As a new process is being implemented or a new product is being launched, so SCs again will have to brace for additional lead times. This is particularly true if a company is implementing a GSCM practice at its suppliers' end as observed during the interview of participant M. Since this

leads to a dependency on the pace of production or actions by other members of the SC, so it increases lead times.

f) Testing or Stability – During the conception of GSCM, the requisite amount of testing time, resources, and personnel must be earmarked for the project. This will help in better learning about the processes, products before their actual implementation, thus providing the real world experience for the final implementation.

2) What measures should be taken to ensure the continued functioning of SC without any disturbances?

The most important thing in this regard is proper testing before a process or product is changed. Moreover, as mentioned by Q in many of the examples, this should be done one at a time and in an incremental fashion. This will help companies to have minimal disruptions or disturbances. End to end risk mapping should be done and diligently implemented. This greatly helps to consider most of the factors that the actual launch of the product or process would encounter. Maintaining extra stock, collaboration with suppliers and their training them appropriately will help companies to maintain the continuity of their SCs.

3) How long did it take them to stabilize the SC after the GSCM practices were implemented?

As per some of the participants, it takes between first three months, six months or one year to implement a green practice and stabilize the SC. Although one cannot foresee all scenarios but having this much time will be sufficient as was mentioned by participants in their anecdotes. It is also noteworthy that this is the time duration for testing pilot projects or for releasing single products. So, even if any risk or disruption is encountered all other products are not threatened by the disruption.

4) What are the tools that can enhance the greenness and resilience of a company's SC?

The most important tool that was observed is the utilization of IT in general and ERP systems in particular. The examples of how the increased use of ERP decreased lead times, increased

responsiveness, and enhanced efficiency are noteworthy. The utilization of SAP was observed in the following three cases: one for the automation, second for the correct amount of detergent quantities, and third for the carbon footprint calculation of ingredients. The utilization of ERP can help companies to respond faster to disruptions. Companies can also use it to enhance the greenness of their SCs. However, as mentioned by one of the participants, it requires investments to achieve this, but the results pay off.

5.2 Discussion and managerial implications

In general, it was observed across all interviews, except the interview of participant G, that GSCM leads to cost savings and enhances the competitive advantage of companies. This is as per the findings of Rao and Holt (2005) who mention that GSCM leads to the enhancement of economic performance of firms. Porter and van der Linde (1995) also say that although the implementation of a green practice might be costly initially, but it could help to save costs because companies can innovate.

In the case of FSC certification for the aseptic carton manufacturing company, the company proactively undertook the certification which indicates its willingness to be an environment-friendly company. The aseptic carton company by undergoing FSC certification might have pre-empted to some extent any activist threats to reduce the use of trees. This could have been a possibility as was observed in the case of Starbucks (Argenti, 2004). This is also something similar to what Porter and Kramer (2006) say, that a company should consider its activities strategically, which can benefit itself as well as the society and the environment.

As was observed during the interviews, the use of IT can directly or indirectly help in greening a supply chain. Participants F, Q, and W mentioned about the use of SAP in greening the supply chain. F's company developed many workflows and automated processes with the help of SAP, which helped in the nearly complete removal of paper and also reduced the execution time. Q's company uses SAP to make sure that there is no discrepancy between the input and output quantities for manufacturing the detergent. If they observe any discrepancy, then it gives an indication that dust emissions are not being handled properly by the filters. W mentioned about the use of a comprehensive tool in SAP that assesses the carbon footprint of each and every ingredient. All these responses underscore the importance of green information systems (GISs)

which were mentioned by Green Jr et al. (2012). They say that GISs aid in the decision making to green the SC and help in customer cooperation. As was mentioned by F, the use of SAP helped them to speed up their supply chain to a huge extent. For instance, it helped them to decrease the lead time from six days to four days. Thus, the use of information systems that aid in greening the SC could also help in enhancing the resilience of the SC.

The importance of managerial support to green initiatives was underscored by participants F, K, and M. This is in accordance with the practice of Internal Environmental Management which was mentioned by Zhu and Sarkis (2004), Zhu et al. (2008) and Green Jr et al. (2012). This practice emphasizes the support of mid-level and senior level management towards green programs. Initially, participant F's management was skeptical about the paperless project, but later it was applauded by the management. Even for the FSC certification, they have the requisite management support, as well as, a task force. The disposal of phosphogypsum by participant K's mining company was also being looked after by the management, as a result of which they employed external consultants to treat and dump the phosphogypsum properly. M also mentioned that it is difficult to persuade managers to switch to new suppliers if old suppliers are not able to go green. The implementation of GSCM increases complexity in the SC due to additional processes (Beamon, 1999). It can be therefore seen that the support of management, could help in a smoother implementation of GSCM. This could help to alleviate the detrimental effects on the resilience of the supply chain.

In almost all the interviews, the companies that were mentioned were mostly large companies, and their competitiveness was not impacted by the implementation of green practices which is in agreement with the observations of Caniato et al. (2012) about large and established companies. It was seen that one of the companies was trying to replace sodium tripolyphosphate with zeolite in their detergents. This could provide them a competitive advantage, in case regulations, are imposed, to phase out sodium tripolyphosphate. This is similar to the arguments of Ageron et al. (2012).

It was observed that some of the companies are trying to start local production. One reason mentioned was that they want high volume products to be manufactured locally. This will help them in reducing their SC vulnerabilities. Chopra and Sodhi (2014) observe that global SCs are more vulnerable. Local production will have positive impacts on both GSCM and the resilience of

their SCs, but companies will also have to address customer concerns about products from certain countries manufactured to be better versus products manufactured locally, as was observed during the interview of participant Q. This must be addressed, and customers should be educated regarding this, that how their acceptance of local products can help the entire SC. Educating customers regarding the implementation of GSCM is in line with the views of Hassini et al. (2012) and Caniato et al. (2012).

Participants F and Q had emphasized the importance of testing. This was explained at length by participant Q in almost all the cases of GSCM implementations. Q underscored the importance of testing the practice incrementally and in step by step manner, even for the implementation of a relatively simple GSCM practice like the use of the recycled board. In this case, also, Q emphasized the importance of testing recycled cardboards with full load both for inbound and outbound transit. This was done to make sure that recycled cardboards do not collapse in transit. F also mentioned that during testing of a GSCM process or product, they have to allocate sufficient time during their regular production hours. All these details must be taken into account during the conception of the project. This risk analysis is in accordance with the observation of Carter and Rogers (2008) where they observed risk management as one of the four additional aspects of the SSCM.

The evaluation of suppliers was emphasized in particular by participants F, Q, and W. F mentioned that they make sure that their participants obey the code of conduct, do not cause pollution, and do not use child labor. F's company tries to make sure that they have responsible suppliers. Q mentioned about the importance of supplier evaluation to make sure that they do not face any liability due to a non-compliant supplier. While evaluating suppliers, Q's company makes sure that their suppliers have some certifications and proper waste reprocessing capabilities. W also mentioned that they work collaboratively with their suppliers to help them with the implementation sustainability practices. This is in line with Seuring and Muller (2008), who also say that 'supplier management for risks and performance' is complementary to 'SCM for sustainable products.' Zhu and Sarkis (2004) also make similar observations about Chinese companies that have global customers.

Some of the practices that could be green could increase the risks in the SC as mentioned by Wang et al. (2012). They say this regarding the use of a higher amount of packaging by the Luxury

Fashion Group which they studied. They say that the Luxury Fashion Group uses a greater amount of packaging material to make its products appear more visually appealing. As a result, it cannot reduce the amount of packaging for green purposes. A similar scenario was mentioned by participant Q for regrind plastic. Q mentioned that bottles containing regrind plastic could not be used for high-end cosmetics because using regrind plastic reduces the visual appeal of the bottles.

Based on the above discussion, the following managerial implications can be derived:

First, the GSCM implementation does not impact the resilience of the SC in most of the cases. If proper testing and stability are performed, then this can subvert the chances of disruptions to a huge extent.

Second, companies should try to develop products that can be both green and resilient, for example as was observed in the case of PP bottles. They are both biodegradable as well as durable and do not break during transit or do not leak if stored over long periods of time. This will aid both in the greening as well as the enhancement of the SC's resilience.

Third, the utilization of IT must be increased and further encouraged so that all processes and risks can be mapped properly. Emphasis should be further laid on the development of applications and workflows that can facilitate faster interactions during times of disruptions.

Finally, rigorous training and support for GSCM implementation can help managers to prevent any huge disruption.

5.4 Limitations
This study has the following limitations:

First, the sample size is not huge. A bigger sample size would have provided better results and deeper insights. Although, the author contacted more than 150 people but did not receive any reply from about 130 people.

Second, except one interview which was based on web-conferencing, all other interviews were audio based (either Skype audio or phone call). Face to face interviews would have been more interactive and would have been more detailed.

Third, the study did not focus on any particular sector which was primarily due to the difficulties in finding participants and due to time constraints. Focusing on one sector would have provided more insightful perspectives and would have allowed the author to conduct a more detailed comparison between the responses of different participants.

Fourth, the focus on one particular green practice could have provided diverse perspectives and would have enabled more in-depth comparisons between the responses. Taking just one practice would have helped the author to analyze the nitty-gritty of the practice's implementation.

Fifth, although all participants had experience and knowledge about the implementation of green practices, only a few of them led the actual implementation. Having more such participants would have given more concrete information. The current responses are based more on the perception of the participants that they observed during the implementation of GSCM.

Finally, all participants were only from the focal organizations. Involving suppliers, customers and end customers would have provided diverse perspectives and experiences about the entire SC.

5.5 Future Research

Future research could include research in specific sectors. Moreover, a case study approach from the beginning of a GSCM implementation till its end would shed more light on the different mechanisms by which GSCM impacts the resilience of SC.

Second, it would be interesting to explore the extent to which the use of IT can aid in the greenness and resilience of SCs. An analysis of the use of IT for pollution prevention and its use to alleviate any risks encountered during GSCM implementation would be insightful.

Third, conducting a similar study for SMEs can aid in the identification of whether they face similar or different results. This could, however, be challenging because as observed, it is comparatively difficult for SMEs to implement GSCM. This could be tested in European countries because regulations and customer pressures in the EU are much more stringent, as a result, even SMEs have to adapt GSCM.

Finally, a study where a company faces actual disruption during the implementation of green practices and the extent to which the company took the time to recover would be revealing.

5.6 Personal Contribution

Based on literature review, this study made five propositions which could be used as the building blocks of theoretical frameworks for future studies. Although those propositions could not be tested due to the nature of the study, they were discussed in light of the participants' responses.

Keeping in mind the shortage of literature regarding the interactions between green and resilient practices of SCs, this study also added to the theory regarding the mechanisms through which GSCM implementation impacts an SC's resilience. While many studies acknowledge that GSCM helps in cost reduction and enhances the competitive advantage of companies, this study helped to identify the possible duration of the impacts and the mechanisms through which the implementation of GSCM can impact the resilience of SC.

One of the main contributions of this study is the use of primary data to understand better the mechanisms by which GSCM implementation impacts SCR. The step by step accounts provided by the participants helps to understand the various factors that companies should consider while implementing GSCM.

This study also highlighted the use of IT and the type of products that could help in enhancing both the greenness and the resilience of the SCs. It was found that IT makes SCs much more responsive and eliminates reams of paper. Next, this study found that many products are both environmental friendly as well as more durable and thus make the SC more resilient.

Finally, this study found about the importance of proper testing and training before the final implementation of the GSCM. It was found that, wherever there was a lack of proper and appropriate training and testing regarding the implementation of green practices, companies faced disruptions in their SCs.

Chapter 6

Conclusion

Based on the study the following conclusions can be drawn:

First, GSCM implementation impacts SCR only in the short term. SCR is mostly impacted by the number of suppliers, lead times, capacity requirements, the extent of training and the type of products, particularly products that are hazardous. These impacts are less pronounced for big firms and could be easier to neutralize if the focal company is huge. However, it must be noted that big companies do not just put off their suppliers due to the implementation of any new GSCM practices. They aid and train their suppliers by investing, time, money, and energy. As observed during the study, supplier related challenges were dealt with proper and dedicated collaboration. Small companies might face more challenges, but large companies are more resilient due to their size and their bargaining power.

Second, the impact on SCR due to the implementation of GSCM can be neutralized with better planning, proper testing and of course with unwavering management support. The requisite amount of resources, personnel and time, must be earmarked for the implementation of GSCM. The testing phase is the most important time during which the vulnerabilities in the SC can be ascertained, and appropriate steps can be taken much in advance, to alleviate those vulnerabilities. Testing will also aid in the learning about the new GSCM practices being introduced. Implementing a practice gradually and with proper planning can surely keep the SC immune from any such disturbances. In fact, companies might not even observe any disturbances at all if proper testing is done. However, it must be mentioned that no amount of testing can provide an SC a hundred percent immunity.

Third, the use of IT can aid both the implementation of GSCM as well as prevent any negative effects due to its implementation. It was encouraging to see the role of IT in reducing the environmental impact of SC. However, the use of IT requires investments which could be a hindrance, but this could be overcome with management support. The increased use of IT, therefore, must be pondered over by companies and corresponding investments should be made.

Finally, the notion that GSCM helps to save costs was reiterated with the help of this study. Almost every participant mentioned that GSCM did not have any negative impacts on the SC, and the only negative impact that they could observe was related to investments, but almost all the participants underscored that GSCM implementation helps in the long run. As all the participants had considerable experiences, so it could be concluded that GSCM will have a positive effect on companies strategically.

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Annexe A

Invitation for participation in the study: Green Practices and Resilience of supply chains

Dear Sir/Madam,

Greetings for the day!

Thank you so much for accepting my connection request. I hope that you are doing well. I am pursuing my masters in Global Supply Chain Management at HEC Montreal and am looking for supply chain professionals who have experience in the implementation of green practices across the supply chain, to interview for my thesis. As you are a very experienced professional so your participation would immensely help me in the data collection. My thesis question has been approved by the ethics committee at HEC Montreal. I would also like to inform you that the interview will be anonymized i.e. no first name, last name, company name, of the participants, will be recorded. Only the answers of the participants relevant to the study will be recorded. The interview can be conducted by phone or Skype and would last for about 45 minutes to 1.5 hours. As you are based in Montreal so I can also conduct your interview in person, if you prefer. Request you to please let me know if you would be willing to share your perspectives. I will be really grateful for your help. Please let me know if you have any questions.

Thanking you in anticipation!

Best Regards,
Tabish

Annexe B

Interview Questionnaire

1) Please tell me about your job experience and the number of years of experience that you have with respect to supply chain management.

2) Please tell me about your experience with respect to green practices and supply chain.

3) Has your company implemented green practices? If so, which?

4) Why did your company implement these green practices?

5) Out of the ones implemented, which green practices had the biggest impact on your company's supply chain structure?

6) How did the green practices affect the following things: capacity, inventory, flexibility, responsiveness (all other resilient practices as observed in the literature were mentioned)

7) Did your company actively consider the implications on supply chain resilience when implementing the green practice?

8) What supply chain resilience issues were you most concerned about when implementing the green practices?