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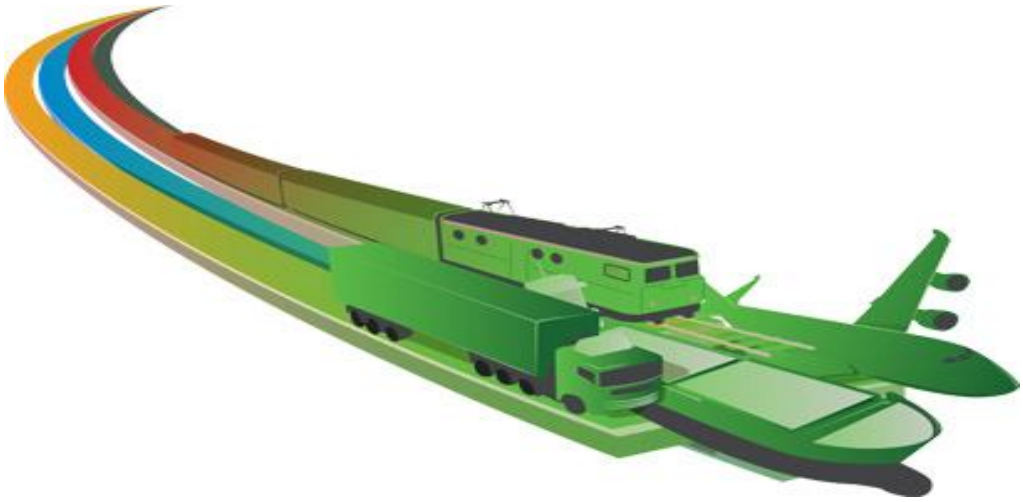

Improving the performance of logistics by means of harnessing the green supply chain practices

A case study of Truck industry

Key words: *Green Supply Chain, Green SCOR Model, Environmental management, Logistics Performance, Dutch truck industry*

Graduation Thesis Report

Author : Shakeel Ahmed
Student Number: 4116372

GENERAL INFORMATION

Thesis Title:	Improving the performance of logistics by means of harnessing the green supply chain practices
Author:	Shakeel Ahmed
Student Number:	4116372
E-mail Address:	s.ahmed-1@student.tudelft.nl
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University:	Delft University of Technology
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Graduation Committee:

Chairman:	Prof. dr. Ir. L.A. Tavasszy Transport and Logistics Organisation (TLO) Technology, Policy & Management (TPM) Delft University of Technology L.A.Tavasszy@tudelft.nl
First Supervisor:	Ir. M.W. Ludema Transport and Logistics Organisation (TLO) Technology, Policy & Management (TPM) Delft University of Technology M.W.Ludema@tudelft.nl
Second Supervisor:	Dr. Ir. U. Pesch Technology Dynamics & Sustainable Development (TSD) Technology, Policy & Management (TPM) Delft University of Technology U.Pesch@tudelft.nl

PREFACE

This Master thesis report is the final part in the graduation procedure for the master degree program of Management of Technology at the TU Delft. This project was started in January 2012 and it is the result of a research that has been conducted at TU Delft under the department of Transport & Logistics Organization.

The motivation behind my decision to opt for the specific project lies on the character and orientation of my studies, as well as on my personal interest to explore the specific area, having the intuition that a substantial advancement can be derived in this direction. Being an MSc student of the program Management of Technology for the past two years, beyond the provision of the basic managerial guidelines, the curriculum of the program predicts the specialization of the students under customized educational profiles. Among them, Integrated Operations and Supply Chain Management was the one I have chosen to follow.

This brings my review to the domain of Supply Chain Management and the selection of my research topic. I was aware of the usage of various green supply chain practices across value chain. But I always had a thought in my mind regarding the impact of these practices on the performance of the organization. Logistics being an important entity for an organization was therefore and obvious choice for me to choose for the research.

The path from the start of the research topic to the completion of this report has never been easy. Apart from dedicated effort, the guidance of my supervisors was several times essential in overcoming the hurdles encountered during the research. In this respect, I would like to express my gratitude to my thesis first supervisor, Ir. M.W. Ludema, for his continuous support and advice during the execution of this research project. Additionally, I would also like to express my warm thanks to the other members of my graduation committee, Prof. dr. Ir. L.A. Tavasszy and Dr. Ir. U. Pesch, for their critical feedback whenever requested. I would also like to thank Mr. Ming Chen from TNO who have shared valuable suggestion during the initial phase of my research. Furthermore, I would like to thank all the supply chain professionals of my case studies that contributed in the completion of this research by participating in the interviews.

Finally, I would like to thank my parents for their great moral support during the research phase. In addition, very special thank goes to all my friends of MOT program who have been a great help during all these years of my stay here in Netherlands.

Delft,
July 2012
Shakeel Ahmed

EXECUTIVE SUMMARY

This executive summary provides a brief account of the background, approach, analysis and conclusions of this thesis.

Research Background

GSCM has been an important research topic among the researchers for the last two decades. Great deal of empirical and theoretical researches has been carried out by researchers to understand the GSCM philosophy. In most of these researches macro variables were used to evaluate the connection between green SC practices and key performance indicators (Hervani et al., 2005, Susana et al., 2011). However, the effect of each green practice individually was not considered in most of these studies, nor is the relationship between individual green practices and logistic performance taken into account (Hervani et al., 2005, McKinnon et al., 2010, Rao and Holt, 2005, Susana et al., 2011). Therefore, a research is aimed to bridge this gap by exploring and understanding the impact of various types of green SC practices on the performance of logistics of organizations within Dutch commercial vehicle industry covering the commercial vehicle manufacturer and their suppliers. The Dutch commercial vehicle industry is being chosen because of the availability of scope of GSCM, contacts with SC managers and knowledge of the industry environment.

Research problem statement:

There is **no theory** or **model** in the existing scientific literature database which explores or establishes a relationship between Green supply chain practices with the logistics performance. There is **no theory** which can help the manager of an organization in selecting potential green SC practices in the context of enhancing firm's logistics performance.

Research Objective:

The objective of this research is threefold:

- To identify the potential Green SC practices and logistics performance metrics most widely used within SC of Dutch commercial vehicle industry.
- To explore set of Green SC practices that can be deployed across the value chain of Dutch commercial vehicle industry in the context of enhancing the logistics performance.
- To make recommendations based on the findings of case analysis of how the logistics performance can be improved by the companies within the Dutch commercial vehicle industry by harnessing the green practices.

Central research question

"How can the SC managers of organizations within the Dutch Commercial Vehicle industry rightfully choose different types of green supply chain practices in order to improve the performance of logistics of their organization?"

In order to answer the central research question and gain a more in depth view in to the research problem a series of sub question is framed as following:

- What green SC practices are mentioned in the literatures that can be used by organizations across their SC to be considered green?
- Which green SC practices among the ones identified in literature are deployed mostly by the Dutch CV industry in practice across their supply chain?
- According to literature which logistics performance indicators can be used in the economic, environmental and social context of the organizations?
- Which logistics performance indicators identified in literature is used mostly to measure the performance of logistics by Dutch CV industry?

With respect to framing of the relationship model following questions needs to be answered:

- Which green SC practices identified in practice have most influence on the economic, environmental and social logistics performance metrics of an organization?

Research Approach

The objective of the research is to explore and understand the relationship of green supply chain practices with the logistics performance. Due to limited empirical evidence it is too early to develop testable hypotheses therefore this research is exploratory in nature. Therefore a ***qualitative analysis*** is employed to get a better insight of the research topic. The research strategy chosen for the thesis is a combination of "***desk research***" and "***case study***".

Scientific literature in the form of scientific articles and journals was used as the source of both data and knowledge. Various popular journals pertaining to the subject like: *International journal of Supply chain, International journal of Logistics management, International journal of Management reviews, International journal of Operations & Production management, International journal of Production economies, Logistics Information management* were referred. The selections of journals were done based on the number of citations, information given in abstract and conclusion drawn.

Another method that was employed to collect data from the relevant sources was by questioning using the interview technique. Individual interviews were characterized by a limited degree of pre – structuring and a semi-open style of question.

The sample selection was carried out based on the following criterions:

- The *first* criterion was to choose the respondents who are connected with the main component of this research, i.e. GSCM and Logistics.

- The *second* criterion employed was to choose only those companies which were associated with the Dutch commercial vehicle industry. As the focus of the research is towards commercial vehicle industry so it was important to choose the companies associated with it in order to ensure compliance with the research theme.

- The *third* criterion was to choose the companies from various levels of the supply chain of Dutch commercial vehicle industry in order to ensure that the role of green SC practices on logistics performance can be identified comprehensively. For this reason the companies were chosen from OEM till TIER II level of the supply chain.

Research Analysis

The theoretical framework derived from the desk research was used as guide to extract the information from the research objects. The comparative case study variant of case study was used to analyze the data. The comparison was carried out using the hierarchic method. The method involved two steps: 1) each cases are examined independently as if they belong to a series of single case studies. When analyzing these cases and describing the results, care was taken that the cases are studied based on an established pattern; 2) result obtain from the first step were used as input for the comparative analysis of the coherent body of all the cases that were part of the study (Verschuren and Doorewaard, 2010). By doing so, explanations for the similarities and differences between the various cases that emerged from the first step were explored. The advantage of using the case study based research strategy was that it offered flexibility thereby making it easier to change course during the thesis by delimiting the research to manageable proportions. It also raised the possibility of obtaining significant results in spite of the lack of thorough methodological knowledge and training (Verschuren and Doorewaard, 2010, Yin, 2003). A possible disadvantage of the case study strategy is that the external validity of the results is often under pressure. As fewer cases are studied for achieving in depth knowledge, the more difficult it becomes to apply the results to a broader population of interest (Yin, 2003).

Conclusions

This research explored the relationships between green supply chain practices and logistics performance measurement metrics. It proposes a set of green practices which could be deployed in the context of Dutch Commercial Vehicle SC, as well as logistics measurement systems which could be used to evaluate the influence of these practices on logistics performance. A comprehensive review of the literature was performed in order to identify the main green supply chain best practices within the GSCM paradigm. From several items of anecdotal and empirical evidence presented in the literature, a theoretical framework was constructed to represent the relationships among logistics performance metrics and green supply chain best practices.

A cross-case analysis was performed in order to assess the environmental behaviour of the commercial vehicle industry supply chain. Furthermore, the research found that the GSCOR level one processes that are considered critical for a supply chain to be considered green are ‘‘GSCOR source,’’ ‘‘GSCOR make and ‘‘GSCOR plan’’. The focus on “GSCOR delivery and return” process is minimal within the Dutch commercial vehicle industry. The most widely adopted green supply chain best practices within the case study companies are ‘‘Minimization of energy consumption and hazardous material usage,’’ ‘‘specification of packaging & delivery requirements,’’ ‘‘choosing suppliers supplying environmental friendly content,’’ ‘‘specifying design specification including environmental requirements” and “managing waste generated during make process” are few. Regarding the logistics performance measures, the ones highlighted by the case companies as the most important to reflect the influence of green supply chain practices on logistics performance are ‘‘flexibility,” ‘‘cost reduction,” ‘‘response to customer needs,” “quality of products” and ‘‘water & energy emission control’’ to be name few. Moreover, the sustainable logistics performance measures that were most extensively used in the case study companies are ‘‘economic metrics’’ and ‘‘environmental metrics’’. The “social metrics” are known and adopted by very few of the companies within the Dutch commercial vehicle industry.

Based on the survey result of four companies belonging to the Dutch commercial vehicle industry supply chain, it was found that the types of green supply chain best practices adopted influences the logistics performance of the organization. This paper supports, to a certain extent, the notion that there is a positive relationship between green supply chain best practice implementation and economic logistic measurable of organizations in terms of ‘‘cost reduction,’’ “productivity,” “transportation,” ‘‘product quality’’ and “customer service level”. Green supply chain best practices also contribute to improved environmental logistics performance, since they have positive influence on ‘‘energy consumption,’’ “air pollutant emissions,” “CO_2 emissions,” “water & fuel consumption” and “waste & packaging recycled” thereby promoting its reduction. Social logistics performance is also improved, and consequently there is a positive relationship between green supply chain best practices and ‘‘hazardous emissions’’ & ‘‘employee training’’. These results confirm the findings of Rao and Holt (2005), who established a connection between greening the inbound, production and outbound SC processes and variables indicating competitiveness, namely efficiency, quality, productivity and cost savings. The empirical research of Zhu and Sarkis (2004) also showed a significant relationship between green supply chain management practices and environmental performance (emissions, waste, use of hazardous materials and frequency of environmental accidents) and economic performance (product availability, quality of products and flexibility).

However, certain relationships associated with the following variables were not confirmed by the analysis: ‘‘better handling and storage of hazardous materials,’’ ‘‘select suppliers with EMS system in place’’ and “don’t physically return product beyond economic repair”. The relationship between environmental logistics metrics and these variables couldn’t be established. In the case of social logistics metrics only relationship with “GSCOR Plan” and “GSCOR Source” best practices could be established.

Based on the within case and cross case analysis of the green supply chain best practices and logistics performance metrics being used by the case companies, three key inferences were drawn as following:

1. The choice and rationale behind implementation of green supply chain practices implementation across the entire supply chain varies from company to company.
2. The choice of logistics performance metrics to measure the influence of the green supply chain practices varies from company to company.
3. The visibility of supply chain for the OEMs is limited to only TIER I companies as beyond that the suppliers are monitored by the subsequent TIER companies.

These three inferences drawn acted as the basis for answering the main research question which is associated with finding the answer to improving the logistics performance metric by means of harnessing the green supply chain practices. In order to improve the logistics performance it is essential to increase the visibility across the supply chain of the product. This is because logistics performance is influenced by two other interrelated elements namely: Process and Product. The impact is from both, products and processes on the performance. Product is the subject of the Supply Chain. Processes change the product, or support product delivery. Therefore a twofold strategy is articulated as an answer to the main research question.

1. Product oriented monitoring
2. Creation of a univocal logistics performance measurement method

Product oriented monitoring will aim to track the supplier of the product and its sub-component starting from TIER I till the nth TIER supplier. When a product module is being outsourced by an OEM it can ask it's TIER I supplier to fill up a component supply chain chart (CSCC). CSCC enables to break the product module into minute details and capture the details of all the sub suppliers associated with the product module. This would enable the OEMs to manage all sub-suppliers and thereby ensure that the products delivered to them are in accordance to the green standards set by them. In this way the visibility of the supply chain across the entire TIER level suppliers involved with the product module including the OEM will be established.

A univocal logistics performance measurement method needs to be employed to measure the impact of the green practices employed by the suppliers. Currently the range of logistics performance metrics being employed by the companies within Dutch commercial vehicle industry varies from one another. This causes a lack of commonality as well as voice to monitor the progress. As the goal is to improve the logistics performance by harnessing the green supply chain best practices therefore it is imperative a common method to measure the logistics performance is being employed by the OEMs. In this regard a Balanced Scorecard based logistics performance metric is being suggested. The Balance scorecard is modified to incorporate sustainability dimension in the form of green practices being employed at various levels such as planning , sourcing, manufacturing and delivering a product to the OEMs by the sub suppliers. The idea behind the content of the balance scorecard is to create a univocal logistics performance measurement metrics to measure the impact of all these green supply chain practices being employed. The relationship between the green supply chain practices and the logistics performance measurement established in chapter five

is used as the basis for designing the content of the balance scorecard. The Balance Scorecard based logistics performance measure framework suggested would enable each of the sub suppliers to monitor the logistics performance measure right from the flow from raw materials to the final customer. This would enable OEMs to create one voice platform for communication of performance measures against green supply chain practices being deployed for each product and thereby enabling the improvement of logistics performance for oneself as well as of all the companies associated with it.

Based on the above results it is possible to conclude that the companies studied believe that the adoption of green supply chain best practices is important for a supply chain to be considered green. They all implement various types of green practices across their supply chain. They consider that some logistics performance measures reflect the influence of green supply chain best practices on logistics performance better than others. And they consider that some green practices have more influence on some the logistics performance measures than others.

Contents

1. CHAPTER ONE: INTRODUCTION

This chapter would first give a brief background on the research topic followed by detailing on research conceptual design and report structure. Research conceptual design will determine *what, why* and *how much* is going to be studied during the research and it consists of following four elements: research problem, research objective, research questions & conceptual framework and research significance & contributions. An insight on the scope of the research is also shared in this chapter in order to draw the research boundaries.

1.1 TOPIC BACKGROUND

In the recent decades industries are being compelled to react rapidly to increasing rate of change. The lifecycles of technology and product are getting shorter while their lead time is increasing. Increasing market competition is demanding quick changes in the design of products and services. Broader differentiation of products and services are sought to fulfill the customer demands. Under these circumstances, rather than competing as an isolated business entity, working in a network is proving to be beneficiary for the organizations (Min and Zhou, 2002, Stephan and Martin, 2008). In the network, supply chain along with its logistics function helps organizations to deliver with seven R's: right product, right quantity, right condition, right time, right place, right cost and right customer (Christopher, 2011) . The supply chain helps organizations to control, manage & improve the flow of materials, products, services and information, by using the logistics function from the point of origin to the final delivery point in order to fulfill the customer needs at a lower cost and by forming a network of interdependent organization (Lambert et al., 1998).

However, the supply chain and logistic activities among the network of organization faces a major issue related to the management of environmental risk and impacts. The increased pressure from environmentally conscious actors has lead to stringent environmental regulations. These regulations has pushed the industries to incorporate environmental management concerns into their corporate strategy and management practices (Rao and Holt, 2005, Paulraj, 2009) In order to overcome these issues, green supply chain management (GSCM) has emerged as the new organizational mantra. Implementation of GSCM has helped the organizations and their network of partners to minimize the environmental risks and impacts of its supply chain & logistical activities while improving their ecological efficiency (Zhu et al., 2008, Rao and Holt, 2005). Although the industries have adopted these green practices in their supply chain to meet legislative regulations. However, these practices are also considered by the organizations as measures to produce sustainable commercial advantage by enhancing their long term profitability(Paulraj, 2009).

GSCM has been an important research topic among the researchers for the last two decades. Great deal of empirical and theoretical researches has been carried out by researchers to understand the GSCM philosophy. In most of these researches macro variables were used to evaluate the connection between green SC practices and key performance indicators (Hervani et al., 2005, Susana et al., 2011). The effect of each green practice individually, however was not considered in most of these studies, nor is

the relationship between individual green practices and logistic performance taken into account (Hervani et al., 2005, McKinnon et al., 2010, Rao and Holt, 2005, Susana et al., 2011). Therefore, a research is aimed to bridge this gap by exploring and understanding the impact of various types of green SC practices on the performance of logistics of organizations within Dutch commercial vehicle industry covering the commercial vehicle manufacturer and their suppliers. The Dutch commercial vehicle industry is being chosen because of the availability of scope of GSCM, contacts with SC managers and knowledge of the industry environment.

1.2 BASIC DEFINITION OF KEY TERMS

Various definitions of Supply Chain and Logistics management have been introduced so far by various authors as well as concerned bodies. The definition introduced by *Council of Supply Chain Management Professionals* (CSCMP) is being widely used in both academics as well as in industries. The definitions are as following:

Supply Chain Management: "*Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies*" (CSCMP, 2011).

Boundaries and relationships of Supply Chain Management: "*Supply chain management is an integrating function with primary responsibility for linking major business functions and business processes within and across companies into a cohesive and high-performing business model. It includes all of the logistics management activities noted above, as well as manufacturing operations, and it drives coordination of processes and activities with and across marketing, sales, product design, finance, and information technology*" (CSCMP, 2011).

Logistics Management: *"Logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customer's requirements"* (CSCMP, 2011).

Boundaries and relationships of Logistics Management: *"Logistics management activities typically include inbound and outbound transportation management, fleet management, warehousing, materials handling, order fulfillment, logistics network design, inventory management, supply/demand planning, and management of third party logistics services providers. To varying degrees, the logistics function also includes sourcing and procurement, production planning and scheduling, packaging and assembly, and customer service. It is involved in all levels of planning and execution--strategic, operational and tactical. Logistics management is an integrating function, which coordinates and optimizes all logistics activities, as well as integrates logistics activities with other functions including marketing, sales manufacturing, finance, and information technology" (CSCMP, 2011) .*

In the context of this research planed the definitions of the terms used are as following:

- ***Supply Chain (SC):*** *"A supply chain is a network of partners who collectively convert a basic commodity (upstream) into a finished product (downstream) that is valued by end-customers, and who manage returns at each stage"* (Harrison and Hoek, 2008).

- ***Supply Chain Management (SCM)***: *"The management of upstream and downstream relationships with suppliers and customers in order to deliver superior customer value at less cost to the supply chain as a whole"* (Christopher, 2011).

- ***Green Supply Chain Management (GSCM):*** *"The process of integrating environmental thinking into SCM, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life"* (Srivastava, 2007).

- ***Logistics:*** *"Logistics refers to management of materials and information. Inbound logistics deals with links between the focal firm and its upstream ('buy side') suppliers, while outbound logistics refers to the links between the focal firm and its downstream ('sell side') end users"* (Harrison and Hoek, 2008).

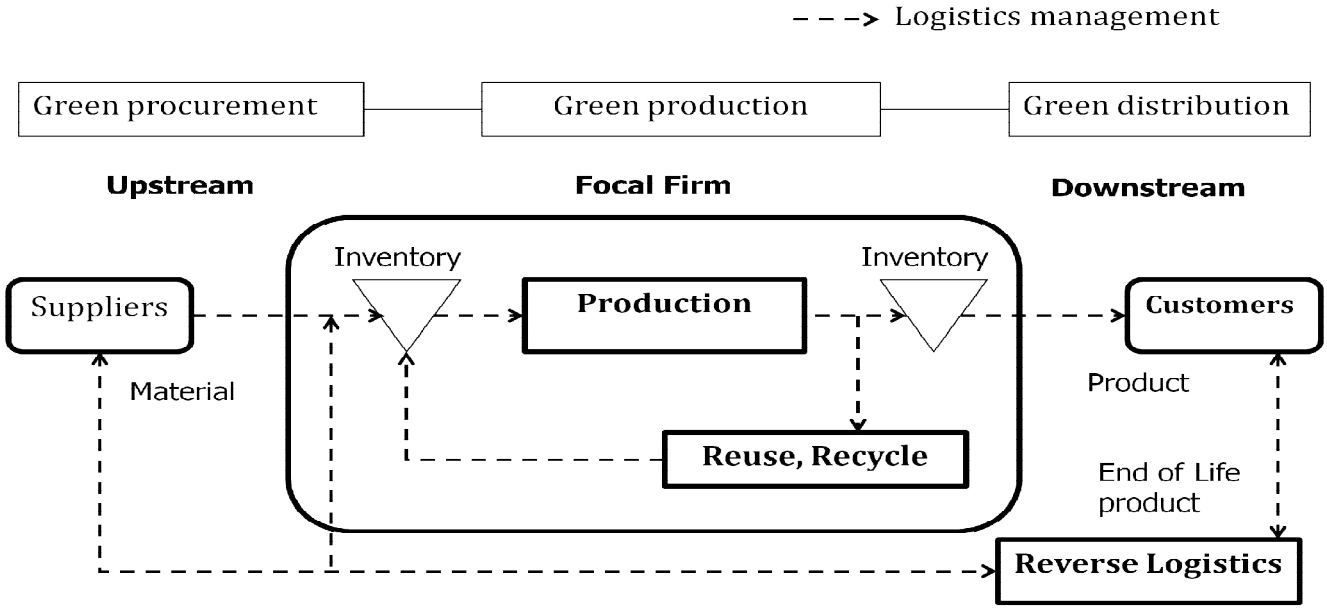


FIGURE 1: THE CONCEPT OF SC & LOGISTICS MANAGEMENT, ADAPTED FROM (HARRISON AND HOEK, 2008)

1.3 RESEARCH PROBLEM STATEMENT

Until the mid 1990s, just a handful of radical companies showed concern towards sustainable development. Environmental issues were however been kept in the constant public spotlight by the media, multi-party debate of governments, and various other Non-Governmental Environmental Organizations (Insight, 2008). Various environmental regulations concerning the industries such as REACH, WEEE, RoHS, European Union Emissions Trading Scheme (EU ETS) were introduced in Europe to create a sense of urgency towards sustainable development (Cobourn, 2008). Against this backdrop, environmental strategy became a new strategic imperative, which

companies must henceforth take on board in their development. Organizations interested in their environmental impacts in addition to regulatory compliance instructed their environmental professionals to identify ways of reducing emissions and wastes, in accordance to the various regulations set (Cash and Wilkerson, 2003).

By 2010, an inflection has clearly become apparent with the emergence of sustainable development departments within organizations (Cobourn, 2008). The rising consciousness of environmental issues among executive managements has enabled a better understanding of regulation mechanisms and their consequences. Environmental actions presently address new constraints and motives, which are more mature and integrated to company's decision processes. Consumers, governments, regulators and, increasingly, businesses are now seeing green. Technology companies are being forced by a growing wave of global environmentalism to produce greener products through greener processes (Loebich et al., 2011). The figure 2 & 3 below illustrates the rise of demand for green products across various segments.

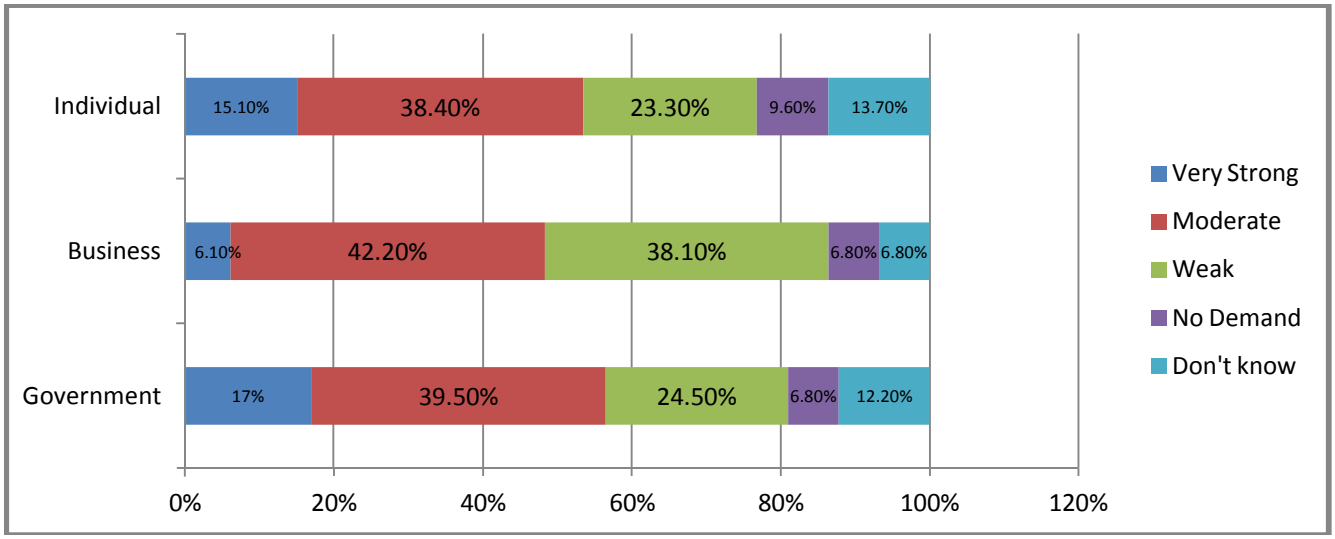


FIGURE 2: DEMAND OF GREEN PRODUCTS IN 2008-09 ACROSS GOVERNMENT, BUSINESS & INDIVIDUAL CUSTOMER SEGMENT (COBOURN, 2008)

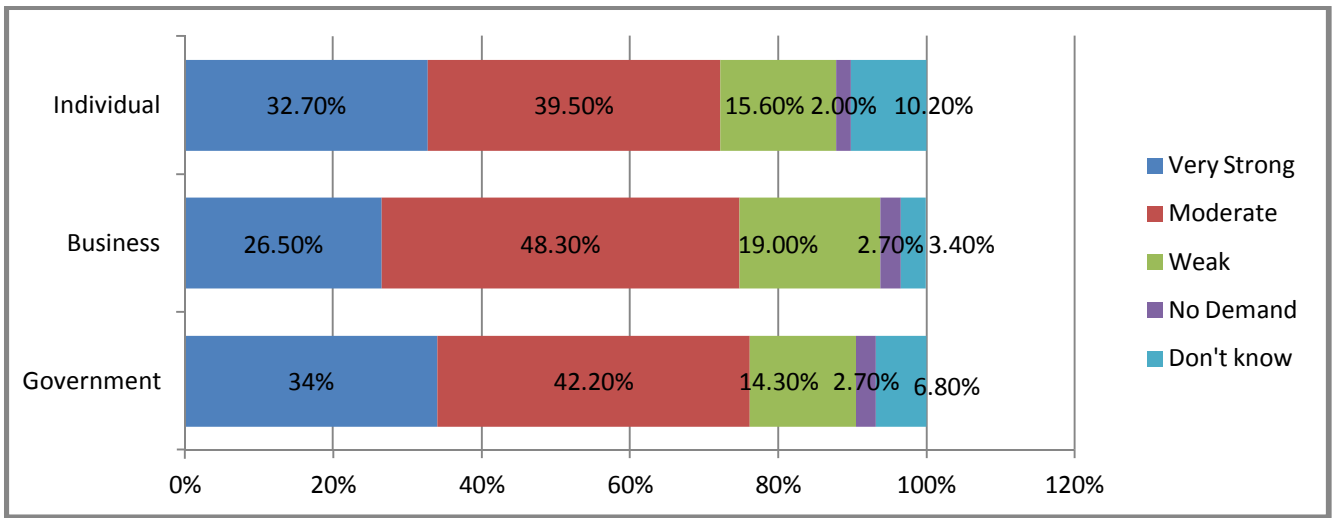


FIGURE 3: DEMAND EXPECTED OF GREEN PRODUCTS IN 2010-11 ACROSS GOVERNMENT, BUSINESS & INDIVIDUAL CUSTOMER SEGMENT (COBOURN, 2008)

Strangely, most firms implementing the green supply chain practices have not actually integrated environmental considerations into their supply chain management processes (SCC, 2010). The distinction is critical here because it is one thing to look at pieces of a supply chain and greening them and it is quite another to examine the decisions and actions that drive the entire supply chain (e.g., its management). The approach is generally driven by a need to "green" an existing industrial process or other aspect of the chain. The results can be quite positive from an environmental perspective; however, when those responsible for reviewing a firm's overall logistics performance make changes, the environmental aspects often are not considered. It is only after these changes have been implemented and their effects revealed that the idea of "greening" has the opportunity to emerge (Cash and SCC, 2008).

The disjointed nature of this process is not merely an intellectual concern (Cash and Wilkerson, 2003). Failure to integrate supply chain optimization efforts with green supply chain efforts results in a failure to realize potential financial and functional benefits and, in some cases, negates the benefits derived from any one area. Logistics manager may successfully increase revenue via a supply chain innovation while simultaneously increasing costs because their innovation increases energy use or creates a need for increased emissions management. In opposition, successful greening of a supply chain might lower regulatory costs but seriously reduce the organization's ability to satisfy customers. For the sake of the organization, synergy must be found between the two analyses (Cash and Wilkerson, 2003).

Unfortunately, most green supply chain efforts are initiated from outside the supply chain divisions, usually by the environmental, health, and safety division. Greening efforts will not be truly successful until the supply chain mangers themselves can identify the environmental effects of their decisions and initiate the coordination with the environmental professionals in their firms to reduce or avoid these impacts (Cash and Wilkerson, 2003). We can infer from this that organizations implement various types of green practices across the supply chain. These green supply chain practices have been adopted in various supply chain management context, but almost always separately and with little understanding of their influence on logistics performance. Logistics is an important entity for an organization to gain competitive advantage. Therefore, it is imperative for the managers to understand whether the applied green SC practices are going to have a positive or negative impact on the performance of the logistic function.

Problem statement:

*There is **no theory** or **model** in the existing scientific literature database which explores or establishes a relationship between Green supply chain practices with the logistics performance. There is **no theory** which can help the manager of an organization in selecting potential green SC practices in the context of enhancing firm's logistics performance.*

1.4 RESEARCH OBJECTIVE

The main objective of this practice oriented research would be to make a recommendation to the SC managers of Dutch commercial vehicle industry in rightful selection of green supply chain practices in the context of improving the performance of logistics of their organizations. This objective would be achieved by making analysis of the different types of green SC practices and logistic performance metric employed within various organizations of the Dutch commercial vehicle industry using the case study methodology. Inferences for recommendation would be derived by using the cross case data analysis technique. A relationship model would be derived to show the impact of the green SC practices on the logistics performance of an organization thereby establishing a relationship between green SC practices and logistics performance. This relationship however would be applicable only within the Dutch commercial vehicle industry. The results of this practice oriented research project will not comprise a new theory. However, it will contribute towards the theoretical discussion on this subject by bridging the knowledge gap and as a result towards the further development of science.

Objective:

The objective of this research is threefold:

- *To identify the potential Green SC practices and logistics performance metrics most widely used within SC of Dutch commercial vehicle industry.*
- *To explore the relationship between the Green SC best practices and the logistics performance metrics in the context of Dutch commercial vehicle industry.*
- *To make recommendations on how the logistics performance can be improved by the companies within the Dutch commercial vehicle industry by harnessing the Green SC chain best practices.*

1.5 RESEARCH FRAMEWORK & QUESTIONS

A research framework is a schematic representation of the research objective and includes the appropriate steps that need to be taken in order to achieve it. The framework for the research is formulated as following:

(a) By consulting relevant scientific literatures and exploring the various theories related to the field of green supply chain management practices and logistics performance measurement a theoretical framework would be derived. (b) By means of this theoretical framework, five to six organizations (research object) associated with automotive industry would be evaluated, (c) A confrontation of result of these evaluations carried in the various organizations concludes with,(d) recommendations on implementation of green supply chain practices in context of improving logistic function using a model. The figure 4 illustrates the schematic presentation of the research framework planned for the research.

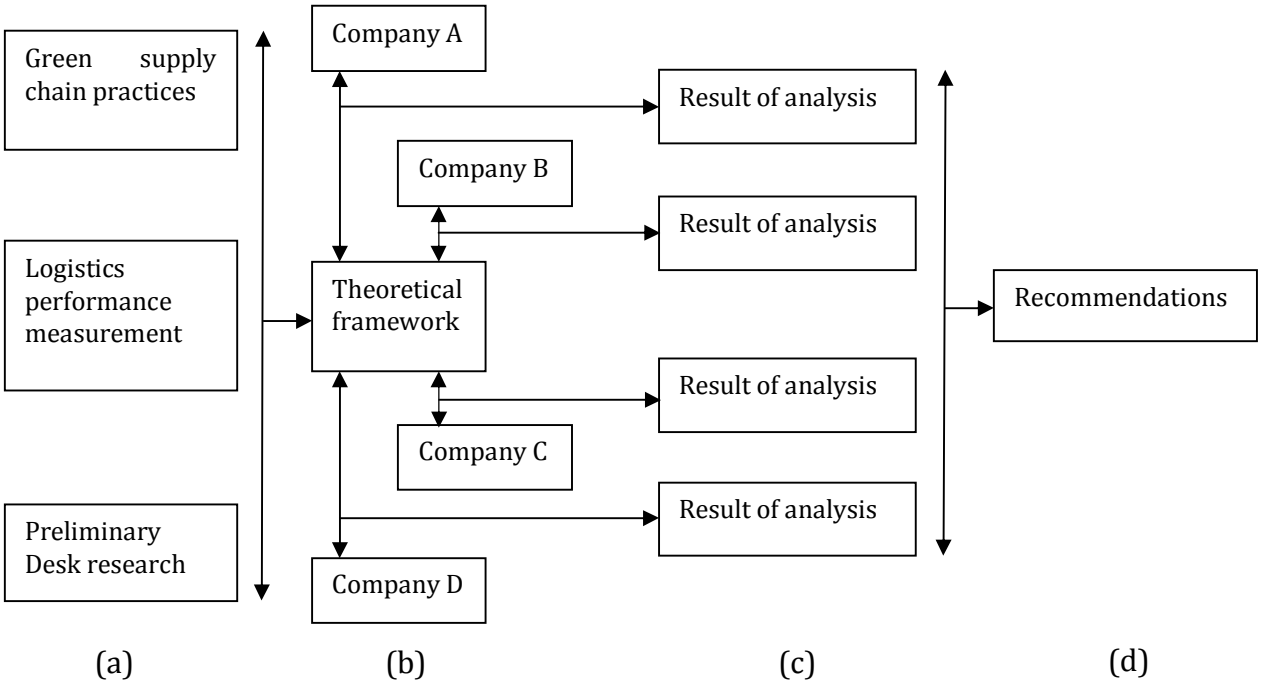


FIGURE 4: SCHEMATIC REPRESENTATION OF THE RESEARCH FRAMEWORK

The central research question for the research project is formulated as following:

"How can the SC managers of organizations within the Dutch Commercial Vehicle industry rightfully choose different types of green supply chain practices in order to improve the performance of logistics of their organization?"

In order to answer the central research question and gain a more in depth view in to the research problem a series of sub question is framed as following:

- What green SC practices are mentioned in the literatures that can be used by organizations across their SC to be considered green?
- Which green SC practices among the ones identified in literature are deployed mostly by the Dutch CV industry in practice across their supply chain?
- According to literature which logistics performance indicators can be used in the economic, environmental and social context of the organizations?
- Which logistics performance indicators identified in literature is used mostly to measure the performance of logistics by Dutch CV industry?

With respect to framing of the relationship model following questions needs to be answered:

- Which green SC practices identified in practice have most influence on the economic, environmental and social logistics performance metrics of an organization?

1.6 RESEARCH SIGNIFICANCE & CONTRIBUTIONS

Logistics supports competitiveness of the supply chain as a whole by meeting end-customer demand through supplying what is needed in the form it is needed, when it is needed, at a competitive cost. An organization seeks to create a plan for the flow of its products and information through its value chain using the logistics framework. SCM builds upon this framework and aims to create linkage and co-ordination between the various processes of other entities in the pipeline, i.e. suppliers, the organizations and the customers(Christopher, 2011) . Effective logistics and SC management can provide a major source of competitive advantage to any organization. Logistics performance is positively impacted by supply chain management strategy and directly impacts marketing performance which, in turn, impacts financial performance of an organization(Green Jr et al., 2008) . An enduring lead position over the competitors can be achieved in terms of customer services through better management of logistics and the supply chain practices.

The outcome of the research will be highly relevant for SC and Logistics managers associated with Dutch automotive industries. Primarily, the existing literature available on the relationship between the green SC practice and logistics performance is very limited. Hence, the research will provide manager of start up as well as matured organizations with a good insight into the dynamics of green supply chain practices. This will help them to avoid taking unreal assumptions or decisions regarding selection of green SC practices in the context of performance improvement of logistics and notify them with authentic assumptions. In addition, it will provide managers with a decision model to organize their companies within the supply chain in order to optimize the logistics performance across the network as a whole which will benefit the company on the long run. Therefore, it is recommended that a go ahead is given to pursue the research further as planned.

1.7 REPORT STRUCTURE

The thesis is organized as following: Chapter 2 focuses on the methodology, the nature of exploratory research, and the approach and data collection methods used to answer the research questions. Chapter 3 presents a review of the relevant literature. This focuses first on the review of the literature to identify the various green practices and logistics performance metrics being identified by the researchers in the context of green supply chain management. Later in the chapter a framework is developed based on the literature to describe the supply chain best practices employed in green supply chain management based on the GSCOR model. A list of logistics performance metrics is also identified based on sustainability dimension in order to measure the impact of the green supply chain best practices. Chapter 4 presents the description of the six case studies of companies with an emphasis on how they organize their supply chain operations. The within case analysis result is presented in Chapter 5 which identifies the various GSCOR process, green supply chain best practices and the logistics performance measurement metrics being used by the chosen companies. In addition cross case analysis results are also presented in this chapter which was performed to identify the most commonly used green supply chain practices and logistics performance metrics being employed by the organization within the Dutch commercial vehicle industry. In addition the relationship between the green supply chain metrics and logistics performance metrics is also established in this chapter. The final

conclusions which answer the main research questions and agenda for future research are presented in Chapter 6. The judgment on the quality of the research based on validity and reliability test are presented in Chapter 7. In Chapter 8 discussions for future research in presented followed by the reflection on the thesis in Chapter 9.

2. CHAPTER TWO: RESEARCH TECHNICAL DESIGN

In this chapter the research technical design is explained covering decisions concerning *how, where* and *when* the research is being carried in order to answer the research questions. This involves the research strategy i.e. the method used to carry out the research; research material i.e. data gathering method and research analysis i.e. how the collected data are being analyzed to answer the research questions. In addition, the limitation of the research is also shared in this chapter.

2.1 RESEARCH STRATEGY

As stated the objective of the research is to explore and understand the relationship of green supply chain practices with the logistics performance. Due to limited empirical evidence it is too early to develop testable hypotheses therefore this research is exploratory in nature. Therefore a ***qualitative analysis*** is employed to get a better insight of the research topic. The research strategy chosen for the thesis is a combination of "***desk research***" and "***case study***".

Literature survey variant of the desk research is employed in the initial phase of the thesis to map out the theories pertaining to the subject of GSCM and Logistics performance measurement. A quick survey of a large number of works on these subjects was carried in order to find as many different definitions and concepts of both the subject. Then by comparing them all and assessing them on their merits a theoretical framework relevant to the research was derived. The main advantage of the desk research strategy is that it enabled to collect large amount of relevant data on the subject quickly, without employing any extensive data collection technique(Verschuren and Doorewaard, 2010).

Case study method was applied to evaluate the research questions framed in the context of the chosen organizations within the Dutch commercial vehicle industry. According to Yin (2003), case study approach is applicable when the boundaries of a phenomenon are not clear. In this research the boundaries i.e. green SC practices which may impact the logistics performance is relatively unclear. Furthermore, at this early stage of the research, it was better to cover different tiers within a supply chain of Dutch commercial vehicle industry so that the role of green SC practices on logistics performance can be identified comprehensively. Thus multiple case study approach was adopted. The strategic sample for the cases was selected in such a way that there was not much of difference between the cases. The idea was to select the cases from the same industry i.e. Dutch commercial vehicle industry but from different tiers.

2.2 RESEARCH MATERIAL

Scientific literature in the form of scientific articles and journals was used as the source of both data and knowledge. Various popular journals pertaining to the subject like: *International journal of Supply chain, International journal of Logistics management, International journal of Management reviews, International journal of Operations & Production management, International journal of Production economies, Logistics Information management* were referred. The selections of journals were done based on the number of citations, information given in abstract and conclusion drawn. These

journals were referred basically to get the theoretical insight and find how the connection between the concept of GSCM and Logistics performance measurement can be established. Various theories and theoretical concepts obtained from the journals were compared to develop the theoretical framework. The advantage of using scientific literature as knowledge source is that profound insight on the subject can be acquired from it quickly, eliminating the necessity to start all over again. The advantage of using scientific literature as a data source is that it eliminates the need to go to great lengths to gather all the relevant material (Verschuren and Doorewaard, 2010).

Another method that was employed to collect data from the relevant sources was by questioning using the interview technique. Individual interviews were characterized by a limited degree of pre – structuring and a semi-open style of question. By pre-structuring it is meant that before the questioning session takes place the questions were consistently and precisely defined in an orderly form like which questions are to be asked and how and in which order they will be asked. The semi-open style of questioning means that respondent was given partial freedom in answering few questions and for few he was asked to rate on a scale of one through five given against the question. The respondent for the interview were selected of managerial position from the chosen companies within Dutch commercial vehicle industry. The face-to-face variant of interviewing was used wherever possible and in case where it became a constraint, then the telephone variant was employed. Both variants of interviews when conducted were being recorded if permitted by the interviewee to ensure that all the information is captured.

2.3 SAMPLE SELECTION

In addition to defining the theoretical part of the research framework, the practical part of selecting and approaching the actual respondents is of equal importance. Therefore, a systematic approach is employed for this process as well. The most important part in this direction is to carefully set the criteria of this selection. It is noted that this selection refers to the respondents of the semi-structured interviews.

The *first* criterion was to choose the respondents who are connected with the main component of this research, i.e. GSCM and Logistics. It was necessary for the respondents to be familiar with the functions and philosophy of these two components of the research so as to understand the topics discussed and contribute substantially in their confrontation. Therefore, it was decided to choose only senior level SC and Logistics managers for interviewing.

The *second* criterion employed was to choose only those companies which were associated with the Dutch commercial vehicle industry. As the focus of the research is towards commercial vehicle industry so it was important to choose the companies associated with it in order to ensure compliance with the research theme.

The *third* criterion was to choose the companies from various levels of the supply chain of Dutch commercial vehicle industry in order to ensure that the role of green SC practices on logistics performance can be identified comprehensively. For this reason the companies were chosen from OEM till TIER II level of the supply chain.

2.4 RESEARCH ANALYSIS

The theoretical framework derived from the desk research was used as guide to extract the information from the research objects. The comparative case study variant of case study was used to analyze the data. The comparison was carried out using the hierarchic method. The method involved two steps: 1) each cases are examined independently as if they belong to a series of single case studies. When analyzing these cases and describing the results, care was taken that the cases are studied based on an established pattern; 2) result obtain from the first step were used as input for the comparative analysis of the coherent body of all the cases that were part of the study (Verschuren and Doorewaard, 2010). By doing so, explanations for the similarities and differences between the various cases that emerged from the first step were explored. The advantage of using the case study based research strategy was that it offered flexibility thereby making it easier to change course during the thesis by delimiting the research to manageable proportions. It also raised the possibility of obtaining significant results in spite of the lack of thorough methodological knowledge and training (Verschuren and Doorewaard, 2010, Yin, 2003). A possible disadvantage of the case study strategy is that the external validity of the results is often under pressure. As fewer cases are studied for achieving in depth knowledge, the more difficult it becomes to apply the results to a broader population of interest (Yin, 2003).

2.5 RESEARCH LIMITATIONS

The limitations of the research are being presented here which is based on some assumptions and is framed by a number of constraints that affect the magnitude of its impact. Whether this affect is major or minor, this needs to be decided individually, by the actual reader. The rationale is to identify and enlist these limitations, so as to declare understanding of their existence and, thereby, reduce their effect.

Limitations	Mitigation strategy
Knowledge produced might not generalize to other industry or other settings	Select greater number of cases for case analysis to achieve in depth knowledge for the hypotheses development.
Research decisions (sample selection criteria, sample size, appropriateness of respondents, ability of the researcher)	Refer various literatures corresponding with the research theme and objective.
Research context (qualitative research: time and budget constraints)	Good planning, dedicated work and careful selection of boundaries for the research.

TABLE 1: RESEARCH LIMITATIONS AND MITIGATION STRATEGIES

Due to qualitative nature of the research, possibilities are there that the knowledge produced might not be generalizable to other industry or other settings. In order to mitigate this limitation care is taken to choose large sample size in order to gain in depth knowledge and hypotheses development.

Another possible limitation is that the research decisions towards sample selection, size and appropriateness of the respondents may not be in line to the research theme. To

mitigate this limitation various literatures are assessed and referred to in line with the research theme in order to generate good inventory of data before taking the research decisions.

The context of the qualitative research in terms of time and budget also act as limitation. So to mitigate this limitation good planning of the research project was constructed ab initio which was supported by continuous dedication and timely reporting to mentors in order to ensure the progress as planned.

3. CHAPTER THREE: THEORETICAL FRAMEWORK

In this chapter a brief overview on the state of the art in the form of literature review is shared on the topics like green supply chain practices, logistics performance, EU commercial vehicle industry and the regulations concerning the commercial vehicle industry. The theoretical framework of the research is also elaborated in this chapter based on which the case study interviews are being conducted at the chosen companies within the Dutch commercial vehicle industry.

3.1 LITERATURE REVIEW

This section elaborates on the state of art related to the green supply chain practices, logistics performance and GSCOR process available in the literature. Additionally information about the commercial vehicle industry in Europe and the regulations meant for them is also analyzed in order to build an inventory of information for the theoretical framework.

Green Supply Chain Practices

Stringent regulations set by concerned government bodies to meet the issues of global warming and climate change are driving the industries to reduce the carbon footprint across their value chain (Insight, 2008, Susana et al., 2011) Supply chain being the most dominant entity in the value chain of an organization is most vulnerable to environmental exploitations. So, it has become imperative to integrate the green or sustainable management practices into the SC in order to reduce its carbon footprint and maintain competitive advantage (Rao and Holt, 2005, Klassen et al., 2007). GSCM is defined as the process of *"integrating environmental thinking into SCM, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life"* (Srivastava, 2007). GSCM includes SC activities ranging from green purchasing to the integration of life cycle management, all the way through the supplier, manufacturer and customer, to closing the SC loop with reverse logistics (Rao and Holt, 2005) Supply chain management (SCM) is defined as "*management of upstream and downstream relationships with suppliers and customers in order to deliver superior customer value at less cost to the supply chain as a whole*" (Christopher, 2011). Many green practices at the various level in the supply chain are described in the literature, including green design (Klassen et al., 2007, Zhu et al., 2008); green sourcing (Hu and Hsu, 2006, Holt and Ghobadian, 2009, Paulraj, 2009); green manufacturing (Paulraj, 2009, Hu and Hsu, 2006, Holt and Ghobadian, 2009, Gonzalez et al., 2008) and green logistics (Gonzalez et al., 2008, Hu and Hsu, 2006, Zhu et al., 2008, Paulraj, 2009, Srivastava, 2007). An overview of the main methods of GSCM practices found in the literature is presented in table 1. GSCM practices in the context of this paper are considered as those activities which are performed across the SC to reduce its negative environmental impact. Therefore, the GSCM practices that are identified in table 1 are at three levels according to the definition of the SCM: (i) GSC practices deployed in upstream of the SC; these GSC practices involve the minimization of environmental concerns which are associated directly with interactions between the focal Company And their suppliers; (ii) GSC practices deployed inside the focal company; these GSC

practices involve the minimization of carbon footprint from the focal company's daily internal operations; and (iii) GSC practices deployed in downstream of the SC; these GSC practices are those which include minimization of environmental concerns related to the focal Company And their delivery partners.

Green practices	References
Upstream: Supplier -> Focal company	
• Communicating to suppliers about environmental and/or ethical criteria for goods and services	(Hu and Hsu, 2006); (Zhu et al., 2008);(Gonzalez et al., 2008)
• Using green purchasing or logistics guideline	(Hu and Hsu, 2006); (Holt and Ghobadian, 2009)
• Promoting ISO 14000 certification of suppliers	(Zhu et al., 2008)
• Periodic supplier evaluation of environmentally friendly practices	(Hu and Hsu, 2006);(Zhu et al., 2008);(Holt and Ghobadian, 2009)
• Working with suppliers to reduce and eliminate product environmental impacts	(Zhu et al., 2008); (Paulraj, 2009); (Holt and Ghobadian, 2009)
Focal company: Internal operation	
• Decreasing the consumption of hazardous and toxic materials	(Vachon, 2007)
• Minimizing waste	(Paulraj, 2009); (Rao.P and Holt.D, 2005)
• Reducing energy consumption	(Rao.P and Holt.D, 2005); (Gonzalez et al., 2008); (Holt and Ghobadian, 2009); (Paulraj, 2009)
• Obtaining ISO 14001 certification	(Vachon, 2007);(Holt and Ghobadian, 2009); (Rao.P and Holt.D, 2005)
• Integrating total quality environmental management (TQEM) into planning and operation processes	(Zhu et al., 2008); (Holt and Ghobadian, 2009)
• Implementing environmental management system (EMS)	(Vachon, 2007);(Holt and Ghobadian, 2009); (Rao.P and Holt.D, 2005)
• Reusing/recycling materials and packaging	(Vachon, 2007)
• Internal recycling of materials within the production phase	

Downstream: Focal company -> Customers	
• Planning vehicle routes for reduced environmental impacts	(Zhu et al., 2008); (Holt and Ghobadian, 2009);(Paulraj, 2009)
• Environmentally friendly packaging (green packaging)	(Rao.P and Holt.D, 2005); (Zhu et al., 2008)
• Using environmentally friendly transportation	(Holt and Ghobadian, 2009); (Rao.P and Holt.D, 2005)
• Reverse Logistics	(Rao.P and Holt.D, 2005); (Hu and Hsu, 2006); (Vachon, 2007)
• Eco- labeling	(Rao.P and Holt.D, 2005)

FIGURE 5: GREEN PRACTICES IDENTIFIED IN VARIOUS LITERATURES

Logistics performance

Logistics management is defined as "*the process of strategically managing the procurement, movement and storage of materials, parts and finished inventory (and the related information flows) through the organization and its marketing channels in such a way that current and future profitability are maximized through the cost-effective fulfillment of orders*" (Christopher, 2011). An organization seeks to create a plan for the flow of its products and information through its value chain using the logistics framework. SCM builds upon this framework and aims to create linkage and co-ordination between the various processes of other entities in the pipeline, i.e. suppliers, the organizations and the customers. Effective logistics and SC management can provide a major source of competitive advantage to any organization. An enduring lead position over the competitors can be achieved in terms of customer preference through better management of logistics and the supply chain (Christopher, 2011). Conceptually, logistics performance may be viewed as a subset of the larger view of the organizational performance. Traditionally, one way of measuring the logistics performance in an organization was by measuring its effectiveness, efficiency and changeability. Effectiveness is related to satisfaction of customer needs, efficiency is associated with economic and optimal use of enterprise resources and changeability is the ability to deal with the strategic awareness to handle changes (Moseng and Bredurp, 1993). According to (Keebler and Plank, 2009) the lack of appropriate logistics performance metrics may compromise customer satisfaction, leading to poor performance by the organization and possibly resulting in losing opportunities to improve the performance of the logistics function of an organization. For better functioning of the logistics entity, performance measurement is important as it facilitates understanding and integration among the network of organizations in the supply chain while enlightening the strategies and potential opportunities in the SCM (Hervani et al., 2005). (Keebler and Plank, 2009) categorized logistics performance into five categories namely: effectiveness measures involving suppliers, effectiveness measures having an internal focus of the firm, and efficiency measures covering the cost, productivity, and utilization focus. Each of these is hard measure of logistics performance of a firm and depending on the nature of the information system of the firm across the supply chain can be readily measured. (Chow et al., 1994) suggested a logistics performance measurement system

comprised of the following measures: Raw financial statistics for e.g. net income, gross sales; Cost statistics for e.g. transport cost, standard labor costs; Input/output measures or "performance indicators" for e.g. number of shipments/ efficiency and effectiveness vehicle hour; and Quality measures for e.g. order cycle time. (Andersson et al., 1989) proposed an holistic logistics performance measurement metric which includes: (i) supplier performance towards the company covering measures like quality, reliability, lead time and price; (ii) firms internal performance within the various units like materials management, production, distribution and covering measurements like logistics costs, inventory value, capital cost, turnover rate, productivity, internal lead times etc; (iii) firms external performance between the different units covering measurements like lead time and/or service level, reliability including quality and timing and (iv) external performance for the entire company towards the customers covering measurements like customer service elements for e.g. availability, reliability, lead times, etc. and turnover. An overview of the main measures and metrics of measuring Logistics performance found in the literature is presented in table 2. Logistics performance measurements in the context of this research paper are identified at three levels: (i) economic; (ii) operational; (iii) environmental across whole supply chain. The idea is to support managers in the decision making process and to provide monitoring capability of the influence of green practices on logistics performance in an integrated way. The three levels of performance measures are considered from the company perspective, to assess its contribution to the overall performance of the SC.

Measures	Metrics	References
SC Level = Upstream		
Economic		
Cost	Inventory turnover ratio, Cost of environmentally friendly product	(Fawcett and Cooper, 1998)
Efficiency	Perfect order, Order fulfillment	(Keebler and Plank, 2009)
Operational		
Quality	Percentage of good parts delivered	(Keebler and Plank, 2009)
Deliveries	Rate of timely deliveries, Back orders	(Andersson et al., 1989)
Environmental		
Emissions	Inbound logistics amount of CO_2 emission	(Susana et al., 2011)
Waste management	Percentage of material reused or recycled	(Fawcett and Cooper, 1998)

SC Level = Firm		
Economic		
Cost	Inventory carrying cost, Outbound and inbound freight cost, Inventory carrying cost	(Keebler and Plank, 2009)
Efficiency	Finished goods inventory turn, Order fill	(Fawcett and Cooper, 1998)
Operational		
Quality	Percentage of good parts delivered	(Keebler and Plank, 2009)
Deliveries	Rate of timely deliveries, Back orders	(Andersson et al., 1989)
Environmental		
Emissions	Outbound logistics amount of CO_2 emission	(Susana et al., 2011)
Waste management	Percentage of material reused or recycled	(Fawcett and Cooper, 1998)
SC Level = Downstream		
Economic		
Cost	Customer or segment profitability, Total cost (logistics)	(Fawcett and Cooper, 1998)
Efficiency	Complete orders	(Keebler and Plank, 2009)
Operational		
Quality	Customer complaints, Number of customer returns,	(Andersson et al., 1989)
Deliveries	Delivery consistency, Picking/shipping accuracy	(Fawcett and Cooper, 1998)
Environmental		
Emissions	Green house gas emissions, Air emissions	(Fawcett and Cooper, 1998)
Waste management	Percentage of materials remanufactured, Percentage of materials recycled or reused	(Keebler and Plank, 2009)

FIGURE 6: VARIOUS LOGISTICS METRICS IDENTIFIED IN VARIOUS LITERATURES

Previous researches have studied the impact of the green supply chain practices in various organizational contexts. Studies have examined the greening of supply chains within contexts like product design, process design, manufacturing practices , purchasing, supply chain performance and a broad mixture of these elements (Susana et al., 2011, Srivastava, 2007, Hervani et al., 2005). However, in terms of logistics performance measurement context very little research studies have been undertaken so far by the researchers. As a result a void in theory exists when these two terms are considered. Logistics function being an important part of the supply chain of an organization is crucial for the success of an organization. Therefore, the knowledge on impact of green supply chain practices on the performance of logistic function is imperative for the organization's success. Moreover due to absence of an adequate model, manager of firms find it difficult to make decisions on selection of green practices in an integrated way when the logistics performance of organizations becomes main rationale (McKinnon et al., 2010). The body of knowledge on supply chains in relation to logistics exists but there has been a lack of explicit determination of the impact uncertainty, such as on logistics performance, using either economic,

operational and environmental criteria (McKinnon et al., 2010). Most supply chain research considered the material producers, or suppliers as the key players. However, recent research on the logistics triad sees that third-party logistics provider as a core element of the supply chain (Fawcett S.E and Cooper M.B, 1998). Therefore, it is necessary to determine the impact of the relationship between all members of the triad and how various partnership arrangements may impact on logistics performance (McKinnon et al., 2010).

3.2 SCOR MODEL

The Supply Chain Operations Reference model is a process model developed by the Supply-Chain Council in an effort to develop a standard tool for evaluating, measuring, and improving supply chain performance. The SCOR breaks down the supply chain processes into six categories (SCC, 2010):

- Plan = Processes associated with planning, scheduling, and coordinating supply chain activities.
- Source = Processes associated with procuring material, physically receiving material, and storing raw materials.
- Make = Processes associated with transforming raw material into a finished product.
- Deliver = Processes associated with storing, packaging, and delivering finished products to the customer.
- Return = Processes associated with delivering and receiving material from a customer to a supplier, commonly called reverse logistics.
- Enable = Processes that facilitate the movement of materials (e.g., business rules, data management, performance management, contract management, asset management, and compliance management).

These processes are further broken down to form three process levels. Level 1 defines the scope of the supply chain and is used to evaluate competitive performance of the entire chain. Level 2 configures the supply chain into three primary types: Make to stock, Make to order & Engineer to order (SCC, 2010). The figure below illustrates the various levels as described.

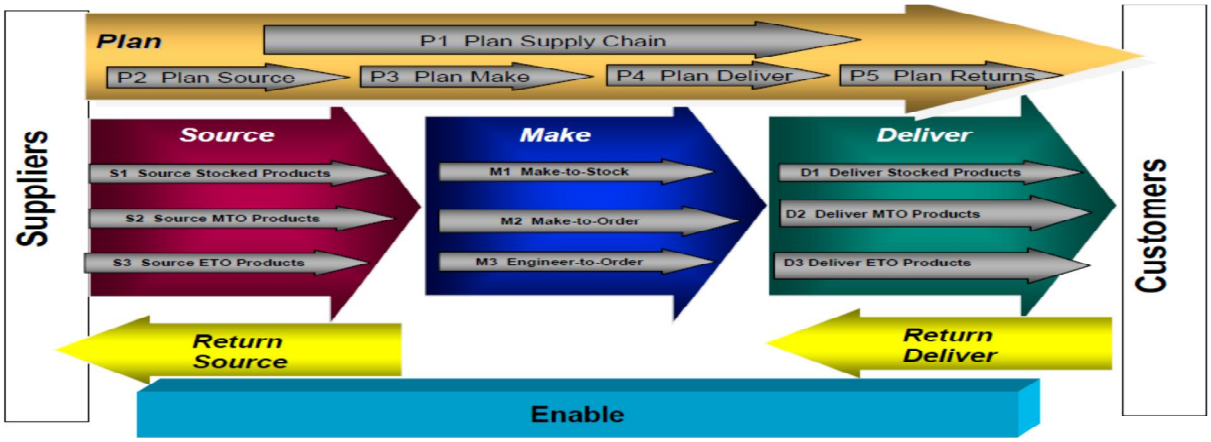


FIGURE 7: SCOR PROCESS LEVELS (SCC, 2010)

SCOR processes can be replicated to model supplier and customer interactions across the supply chain (SCC, 2010). In this way, a user can use the same six high-level processes to model an entire supply chain's operations, as shown in the figure below.

FIGURE 8: SCOR PROCESS MODEL (SCC, 2010)

3.3 ENVIRONMENTAL LIFECYCLE ANALYSIS

Environmental life-cycle assessments evaluate the environmental impacts that result from an organization's processes associated with a specific product or service. The scope goes beyond the manufacturing stage and looks both upstream and downstream from a process (Cash and Wilkerson, 2003). Thus environmental impacts are identified— from the moment of raw material extraction to final disposal (i.e., the entire life cycle of the product or service) as shown in the figure below.

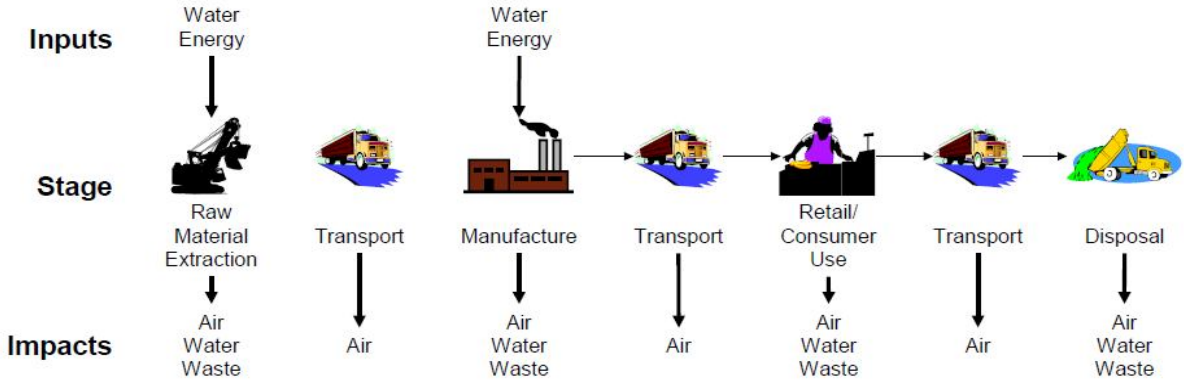


FIGURE 9: ENVIRONMENTAL LIFE CYCLE ANALYSIS OF SUPPLY CHAIN (CASH AND SCC, 2008)

3.4 GREEN SUPPLY CHAIN CONCEPT

The findings from environmental life cycle analysis led many firms to examine the logistical aspects of the development of their product or service. There was increased scrutiny of what items are purchased for use in various processes, the effects of manufacturing processes, and how products are packaged and delivered. The effort to reduce the impact of these activities on the environment is referred to as green supply chain management (Cash and Wilkerson, 2003). Thus green supply chain management integrates environmental management and supply chain management as shown below. Green SCM recognizes the disproportionate environmental impact of supply chain

processes in an organization. Green SCM leverages the role of the environment in SC value creation (Cash and Wilkerson, 2003).

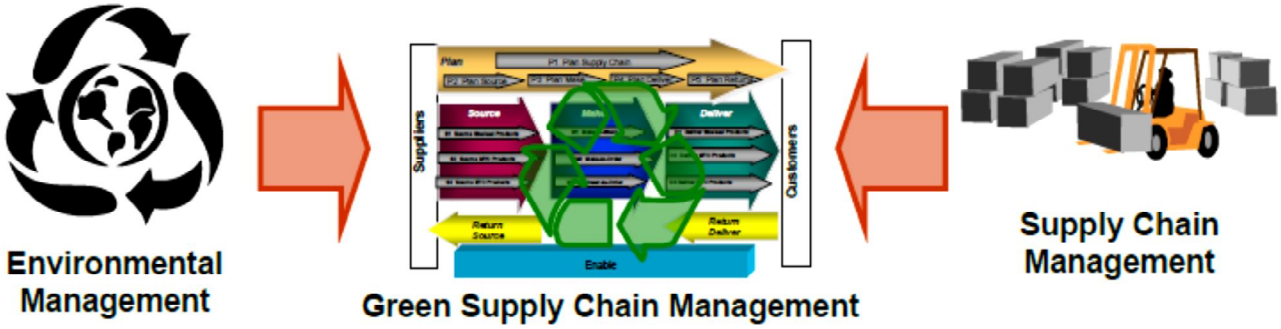


FIGURE 10: GREEN SUPPLY CHAIN CONCEPT (CASH AND WILKERSON, 2003)

3.4.1 GAPS IN GREEN SUPPLY CHAIN CONCEPT

Oddly, most firms implementing green supply chain practices have not actually integrated environmental considerations into their supply chain management processes. The distinction is critical: It is one thing to look at pieces of a supply chain and green them; it is quite another to examine the decisions and actions that drive the entire supply chain (e.g., its management).

Traditional green supply chain analysis occurs apart from standard supply chain analysis. The approach is generally driven by a need to "green" an existing industrial process or other aspect of the chain. The results can be quite positive from an environmental perspective; however, when those responsible for reviewing a firm's overall logistics performance make changes, the environmental aspects often are not considered. It is only after these changes have been implemented and their effects revealed that the idea of "greening" has the opportunity to emerge.

The disjointed nature of this process is not merely an intellectual concern (Cash and Wilkerson, 2003). Failure to integrate supply chain optimization efforts with green supply chain efforts results in a failure to realize potential financial and functional benefits and, in some cases, negates the benefits derived from any one area.

Logistics manager may successfully increase revenue via a supply chain innovation while simultaneously increasing costs because their innovation increases energy use or creates a need for increased emissions management. In opposition, successful greening of a supply chain might lower regulatory costs but seriously reduce the organization's ability to satisfy customers. For the sake of the organization, synergy must be found between the two analyses (Cash and Wilkerson, 2003).

Unfortunately, most green supply chain efforts are initiated from outside the supply chain divisions, usually by the environmental, health, and safety division. Greening efforts will not be truly successful until the supply chain mangers themselves can identify the environmental effects of their decisions and initiate the coordination with the environmental professionals in their firms to reduce or avoid these impacts (Cash and Wilkerson, 2003).

3.4.2 GREEN SCOR MODEL

To address the gaps in green supply chain management, a tool in the form of Green SCOR model was developed for implementing green supply chain management. Green SCOR is a modification of the SCOR model that includes environmental elements. Green

SCOR modifies the existing SCOR structure to include environmental processes, best practices and metrics. The figure below illustrates the Green SCM mapping (Cash and SCC, 2008).
Green Processes: Standard descriptions of management processes and a framework of process relationships. Green Best Practices: Management practices that produce best-in-class environmental performance of the supply chain.

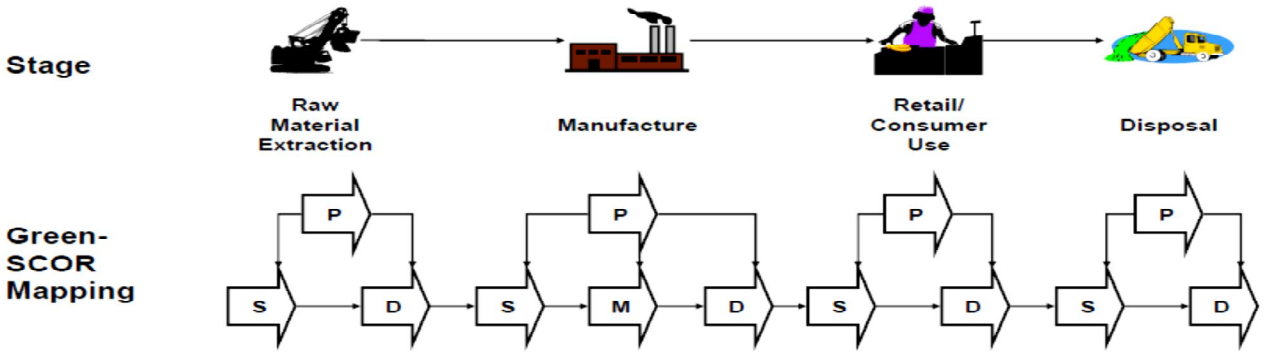


FIGURE 11: GREEN SCOR MAPPING (CASH AND SCC, 2008)

Green SCOR Process	Green SCOR best practices
PLAN	• Plan to minimize energy consumption and hazardous material usage • Plan the handling and storage of hazardous materials • Plan to collaborate with supply chain partners on environmental issues
SOURCE	• Select suppliers with EMS system in place • Select materials with environmentally friendly content • Specify design specifications to suppliers that include environmental requirements • Specify packaging & delivery requirements to minimize transportation and handling requirements
MAKE	• Schedule production to minimize energy consumption • Manage waste generated during the make process • Manage emissions (air and water) from the Make process
DELIVERY	• Minimize use of packaging materials • Schedule shipments to minimize fuel consumption • Retrieve packaging material for re-use
RETURN	• Do not physically return product beyond economic repair • Take back product for recycling • Schedule transportation and aggregate shipments to minimize fuel consumption

TABLE 2: LIST OF GREEN SC BEST PRACTICES (SCC, 2010, CASH AND WILKERSON, 2003, CASH AND SCC, 2008)

3.5 LOGISTICS PERFORMANCE METRIC

The logistics performance in the context of the Green SCOR is proposed in this section. The proposed metric is prepared by taking into account three essential aspect of sustainability namely: economic, environmental and social in the logistics performance context (Cetinkaya et al., 2011).

Economic performance is a pillar of Company Activities. There is no doubt that a company should be profitable in order to be sustainable in the long-term. Practices which are named as "green" and "sustainable" but are not profitable in the long term cannot be considered as sustainable over time. Within the economic impact we can include: operational, efficiency and responsiveness attributes as they are necessary to be profitable in the long term. The quality of logistics services and customer satisfaction are key issues to generating long term profits. Responsiveness dimension reflects how a company can respond to customer needs and a changing environment. In many ways it is related to the quality of service. The efficiency dimension is the most familiar dimension for all managers. It is about cutting costs, increasing resource utilization, and process time reduction (Cetinkaya et al., 2011).

The environmental group of metrics focuses on lowering the negative impact of transport and other Company Activities on the natural environment. The environmental dimension includes three sub-groups: emissions, natural resources utilization, waste and recycling. Until recently, environmental aspects in typical measurement systems used by companies have been largely ignored. Thus, there is lack of commonly accepted measurement norms and standards. CO_2 measurement is at the development stage (Cetinkaya et al., 2011). Apart from CO2, other categories of emissions should also be captured. Waste and recycling is another category related to the impact on environment. This can be reflected by the percentage of waste, and different categories of waste, sent to landfill in relation to waste which was recycled.

Traditionally the social dimension is still not commonly incorporated directly into organizational performance measurement systems. However, people and their skills and their impact on society are key issues in sustainability. Health and safety incorporates metrics such as: The number and type of work related accidents. Employment can be measured at different levels, as overall job creation or reduction, and at the company level reflecting working conditions and employee's morale. Noise emission was also included into the social dimension, as it is less important in purely industrial areas. Noise emission is most disturbing in residential areas (Cetinkaya et al., 2011).

	Attributes	Measurable	KPI	KPI Operationalization
Economic	Operational	Quality of products	% of good products	(Total supply – defectives) / total supply quantity
		Customer service level	On-time delivery	No. of shipments delivered within promised delivery time / total no. of shipments
		Product availability	% demand met	Orders fulfilled / total demand
		Transportation	Transit time (TT) variability	(Maximum TT – Minimum TT)/ Average TT

	Efficiency	Utilization	Capacity utilization	Capacity utilized or gross production / Optimum capacity or production level
		Productivity	Inventory turnover ratio	Cost of goods sold / average inventory investment
		Cost reduction	Total Logistics cost	Supply logistics cost + production log. cost + inventory log. cost + warehouse log. cost + transportation log. cost + log. cost of returns from customers + customer response logistics cost
	Responsiveness	Response to customer needs	Order fulfillment lead time	Actual lead time for orders shipped / total numbers of orders shipped
		Flexibility	Supply Chain Response Time	Order fulfillment lead time + source cycle time
Environmental	Emissions	Carbon dioxide	Carbon emissions	Total CO2 emissions in tons
		Air pollutant	Air pollutant emissions	Emissions of major air pollutants (NOx, SOx, Volatile Organics (VOC) and Particulate) in tons
	Resource utilization	Fuel	Fuel consumption	% Reduction of fuel utilization.
		Energy	Energy consumption	% Reduction in energy utilization per warehouse
		Water	Water consumption	% Reduction of water utilization
	Waste & recycling	Waste	% recycled waste	Waste created per production phase in %
		Materials/products recycle	% of packaging recyclable	Packaging reused in %
Social	Health & Safety	Toxic, hazardous emissions	Amount of unwanted emissions	Reduction of spillages and leakages (chemical substances) in %
		Accidents	Accident occurrence	No. of serious or fatal accidents/ year occurred
	Noise	Volume	Noise reduction	% Noise reduction from warehousing operation
	Employees	Employment	Recruitment for GSCM	No. of jobs created
		Training	Training on GSCM	% of staff trained

TABLE 3: SUSTAINBALE LOGISTICS PERFORMANCE METRICS (CETINKAYA ET AL., 2011)

3.6 EUROPEAN COMMERCIAL VEHICLE (CV) INDUSTRY

The commercial vehicle industry is vital to Europe's economic and social functioning, both as an enabler of business, commerce and social life and as a direct source of economic activity and employment in its own right. Commercial vehicle manufacturing is a significant generator of both employment and revenue in Europe and the €70 billion industry is an important industrial asset (ACEA, 2007). Freight transport and distribution is a €250 billion business, with commercial vehicles carrying 72.5% of all inland freight transported in Europe, while coaches and buses carry 8.5 % of all passengers annually (ACEA, 2007). To ensure that Europe's commercial vehicle industry maintains its technological lead, manufacturers and suppliers invest some 4% of their turnover in research and development (R&D) each year. The European automotive industry as a whole spends over €20 billion a year on R&D, of which an important share goes towards research and development in the commercial vehicle sector (ACEA, 2007). Commercial vehicle manufacturing is closely linked with other sectors suppliers which include electronics, mechanical and electrical engineering, information technology, steel, chemicals, plastics, metals, and rubber.

Freight transport and distribution is a €250 billion/year business in Europe and road haulage is the preferred mode. This is because trucks can be adapted to the customer's precise production rhythm, delivery schedule and cargo requirements. They can get the goods directly to where they are needed, without depending on rail track or inland waterway infrastructure (ACEA, 2007). Trucks are now completely integrated into the modern production process, at the heart of sophisticated logistics systems. Modern manufacturing methods require the delivery of components to manufacturers without delay, and road transport is the preferred method of delivery because of its reliability, versatility and flexibility.

Moreover, trucks function as part of an integrated infrastructure whose components also include inland waterway shipping, air and rail transport. While separately, each has its own inherent advantages, together they combine to form a more efficient, integrated system. Each, also, depends on trucks to transfer freight to and from depots or ports. Thus, not only do trucks remain the most flexible, responsive and economical mode of transport for the vast majority of goods and freight, they are also essential to the functioning of the larger, integrated transport infrastructure across Europe (ACEA, 2007).

EU25 Transport activity growth (2000-2020)	
Truck	**55%**
Rail	**13%**
Inland navigation	**28%**

FIGURE 12: TRANSPORT ACTIVITY GROWTH (ACEA, 2007)

In 2005, trucks carried little over 72% of all goods transported in the EU25, compared to 16.5% for trains, 5.4% for boats and barges on inland waterways, and 5.5% carried in pipelines. The EU Commission forecasts that the share of freight carried by road in the EU25 will continue to grow, while rail's share is expected to decrease.

3.6.1 DUTCH COMMERCIAL VEHICLE INDUSTRY

Overall, the automotive industry is one of the main industries in Netherlands. The main drivers of the Dutch economy are sectors like transport/logistics, trading and services. Manufacturing industries are less dominant within Netherlands compared to other European countries. Within the manufacturing industries, automotive is one of the main industries (Automotive, 2007).

The prospects for Dutch vehicle manufacturers are good. The production of trucks and buses has increased every year since 1997. DAF Trucks has seen strong growth in volume and market share in recent years, becoming one of the top European heavy-duty truck manufacturers (>14% market share in EU). In The Netherlands DAF Trucks develops designs and assembles complete trucks, including engines, for markets all over the world. Moreover, the Netherlands is home to Company A's largest assembly plant. Two more niche manufacturers produce customized heavy-duty trucks mainly for the Dutch market: Ginaf and Terberg (Automotive, 2007). There are also many trailer manufacturers in The Netherlands (eg. Nooteboom, Broshuis, Jumbo).

3.6.2 SUPPLY CHAIN STRUCTURE OF DUTCH CV INDUSTRY

The Dutch Commercial vehicle industry has a 'tiered' supply chain structure which is best illustrated by way of the diagram shown below. Upstream from the commercial vehicle manufacturer or OEM (Original Equipment manufacturer) are the Tier 1 suppliers, these companies will typically supply some of the largest components or sub-systems for the commercial vehicles, for example a suspension assembly or gear box. Moving downstream the Tier 2 suppliers typically provide components to the Tier 1 suppliers and these could for example be pump units, electric motors or bearing assemblies. Then further downstream we have the Tier 3-x suppliers who will provide the Tier 2 suppliers with anything from brackets, seals through to machined components etc.

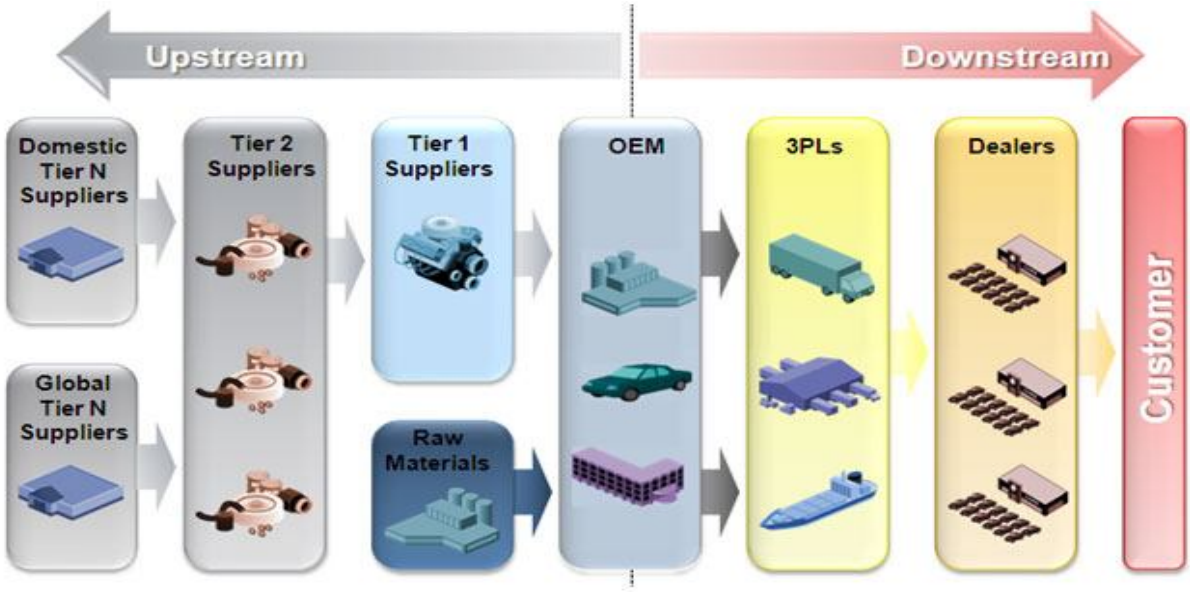


FIGURE 13: SUPPLY CHAIN STRUCTURE OF DUTCH COMMERCIAL VEHICLE INDUSTRY (AUTOMOTIVE, 2007)

As the Tier1 suppliers are the most important to the commercial vehicle manufacturers they will typically have a plant close to the commercial vehicle manufacturers to support Just-In-Time type production processes. Tier2 – x suppliers could be based anywhere in the world and many companies in this particular sector have established a manufacturing presence in low cost countries around the world, for example China and India (Automotive, 2007). In addition to the tiered suppliers there are also raw material providers such as the steel manufacturers who will provide sheet products directly to the commercial vehicle manufacturers. Downstream from the OEMs the third party logistics (3PL) providers will distribute finished vehicles to storage compounds and vehicle distribution hubs located around the world. These will then get shipped to the dealer networks as and when required.

3.6.3 GOING GREEN

Diminishing oil reserves and escalating global demand have combined to increase the volatility of fuel prices. The EU's transportation sector is 98 percent dependent on fossil fuels and is currently responsible for approximately 21 percent of the EU's harmful greenhouse gas (GHG) emissions, with more than half of those emissions produced by commercial vehicles (Stevenson, 2009).

Technological progress is transforming the automotive industry from a traditional manufacturing-based sector into an increasingly knowledge-based one. The opening of global markets and the increase and diversity in the movement of capital worldwide are altering the environment in which the commercial vehicle industry operates (Stevenson, 2009).

Combined, these circumstances have created a situation where the EU's commercial vehicle industry faces new dilemmas, responsibilities, and opportunities. To address these challenges, the European Union is taking concrete action to help fight climate change, reduce fuel costs, and increase European competitiveness. EU regulations will further reduce the amount of GHG emissions produced by automobiles by mandating better fuel economy in commercial vehicles, and vehicle manufacturers have responded by developing new models that are cleaner and more fuel efficient. The EU also supports the development of alternative fuels, including sustainable bio-fuels (Skorich, 2010, Stevenson, 2009).

3.6.4 REGULATIONS INFLUENCING COMMERCIAL VEHICLE INDUSTRY

A. REACH

The Registration, Evaluation, Authorization (and Restriction) of Chemicals (REACH) Regulation (EC) No 1907/2006 entered into force on 1 June 2007 and affects all industries. REACH aims to ensure a "high level of protection of human health and the environment, including the promotion of alternative methods for assessment of hazards of substances, as well as the free circulation of substances within the internal market while enhancing competitiveness and innovation". The main objectives of REACH are therefore: 1) to reduce the risk from chemicals to humans and the environment and to reduce animal testing; 2) to encourage substitution of specific dangerous substances; 3) to require authorization for use or restriction of the substances.

Under REACH, manufacturers and importers have a duty to register, for each legal entity, substances on their own, or in mixtures that they produce or import in quantities over 1 ton per year (per legal entity), unless the substance is exempt from registration. Registration requirements also apply to substance(s) intended to be released from articles under certain conditions, in which case the article producer/importer is responsible for ensuring that the substances are registered. To fulfill these obligations, the entire supply chain needs to communicate (data, uses, quantities, control measures for safe use, etc.) (Union, 2011). The key realities of REACH regulation is as following:

• Companies that do not comply with REACH will have no market. REACH poses a threat to any company doing business in the EEA (and businesses with customers or suppliers who do business in the EEA).
• Business continuity can be adversely impacted by REACH and supply chains can be disrupted.
• Companies that understand the business implications and impacts of REACH and develop strategic action plans will gain competitive edge over those that do not.
• Substitutions need to be phased-in with product development programs to minimize cost.

B. EU ETS

European Union emissions trading scheme is a market based approach to control pollution. The objective of the EU emissions trading system (ETS) is to "promote greenhouse gas (GHG) reductions in a cost-effective and economically efficient manner". The EU ETS is a 'cap-and-trade' system. That is to say it caps, through legislation and enforcement, the overall level of emissions allowed, but within that limit, participants in the system can buy and sell allowances as required. These allowances, sometimes referred to as permits, are the common trading currency at the heart of the system. One allowance gives the holder the right to emit one ton of CO_2 or the equivalent amount of another greenhouse gas. The overall cap on the total number of allowances creates scarcity in the market and provides environmental integrity in the system. The EU ETS applies to the 27 Member States of the European Union, and also Norway, Iceland and Liechtenstein. It covers around 50% of EU CO2 emissions and about 40% of total EU greenhouse gas emissions. Legislation dictates that emissions under the EU ETS will decline 21% from 2005 by 2020. Any company failing to comply with obligations under the EU ETS and failing to submit sufficient permits incurs a penalty of €100 / ton of CO2 and is still required to submit permits for the outstanding emissions. Member States may impose further penalties depending on the nature of the offence (Skorich, 2010).

C. WEEE

The European Union (EU) Directive on WEEE (waste from electrical and electronic equipment) is intended to protect the quality of the environment and human health through the prudent use of natural resources and the adoption of waste management strategies that focus on recycling and reuse. EU legislation restricting the use of hazardous substances in electrical and electronic equipment (Directive 2002/95/EC) and promoting the collection and recycling of such equipment (Directive 2002/96/EC) has been in force since February 2003. The legislation provides for the creation of collection schemes where consumers return their used e-waste free of charge. The objective of these schemes is to increase the recycling and/or re-use of such products. It also requires heavy metals such as lead, mercury, cadmium, and hexavalent chromium

and flame retardants such as polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE) to be substituted by safer alternatives. Producer's responsibility includes meeting labeling requirements, providing information to end-users and treatment facilities, ensuring the availability of collection infrastructure, submitting sales and recovery data, and financing WEEE costs (EU, 2011).

3.6.5 ENVIRONMENTAL MANAGEMENT TOOLS FOR ORGANIZATIONS

A. ISO 14000 standards

The ISO 14000 family addresses various aspects of environmental management. The very first two standards, ISO 14001:2004 and ISO 14004:2004 deal with environmental management systems (EMS). ISO 14001:2004 provides the requirements for an EMS and ISO 14004:2004 gives general EMS guidelines. The other standards and guidelines in the family address specific environmental aspects, including: labeling, performance evaluation, life cycle analysis, communication and auditing.

B. ISO 14001:2004-based EMS

An EMS meeting the requirements of ISO 14001:2004 is a management tool enabling an organization of any size or type to (ISO, 2011):

- Identify and control the environmental impact of its activities, products or services,
- Improve its environmental performance continually,
- Implement a systematic approach to setting environmental objectives and targets, to achieving these and to demonstrating that they have been achieved.

4. CHAPTER FOUR: INTRODUCTION TO RESEARCH CASES

This section presents the interview results of the semi structured interview carried out for the research. The goal of the qualitative interview was twofold:

1) To understand the green SCOR process using the first layer of green SCOR model and identify the green SCOR best practices being followed in the organizations.

2) To know the logistics performance indicators used by the organizations in practice and its relationship with the green SCOR best practices within the respective organizations.

The interview questions, derived from the literature, are answered, on the basis of the qualitative interview framework. The questions for the interview were characterized by a limited degree of pre-structuring and open style of questions. By pre-structuring it is meant that before the questioning session took place, the questions were consistently and precisely defined in an orderly form, like which questions are to be asked and how and in which order they will be asked. Open style of questioning mean that the respondent was given full freedom in answering the questions. The outlook of the questionnaire can be found in appendix A. Additionally a relationship matrix between the green supply chain practices and the logistics indicators chosen from the literature was also being asked to fill by the interviewees as shown in appendix B.

Before starting the citation of the results, it is necessary to provide some information with respect to the selected respondents. Overall six organizations associated with the Dutch commercial vehicle (Trucks) industry were chosen for case study. Supply chain managers of each organization were contacted for data collection. An appointment for interview was sought through company websites contact form. Upon getting a positive response, an e-mail with a brief introduction about the context and goal of the interview was shared. A detailing about the key themes and the possible sequence of the questionnaire was given to help the interviewees get an insight of the research topic. The date and time of the interview was fixed in accordance with the convenience of the interviewee. All the interviews were being conducted when the interviewee was at their office and the environment was very silent and suitable during the interview phase. The interview transcripts of all the companies can be found in appendix C.

Company Name	SC Position	Interviewee Designation	Mode
Company A	OEM	Director, SCM	Telephonic
Company D	TIER I	Manager, Logistics	Face-to-face
Company F	TIER I	Manager, Logistics	Face-to-face
Company B	TIER II	Manager, SC	Face-to-face
Company C	TIER II	Demand Manager	Face-to-face
Company E	TIER I	VP, Trade & Logistics	Face-to-face

TABLE 4: DETAILS OF THE ORGANIZATIONS & INTERVIEWEES

4.1 COMPANY A CASE DESCRIPTION

Company A manufactures various types of trucks like long-haulage trucks, distribution trucks, construction trucks and special purpose trucks. In addition, they also manufacture complete range of buses and coaches for public transport operators and coach companies and a complete range of industrial and marine engines. Company A is headquartered in Sweden and had production facilities in Sweden, France, Netherlands, Argentina, Brazil, Poland and Russia. Company A holds OEM position in the supply chain of automotive industry and their customer lies in B2B segment. Total workforce of the organization is around 38,000 and the company operates in about 100 countries.

Supply Chain of COMPANY A

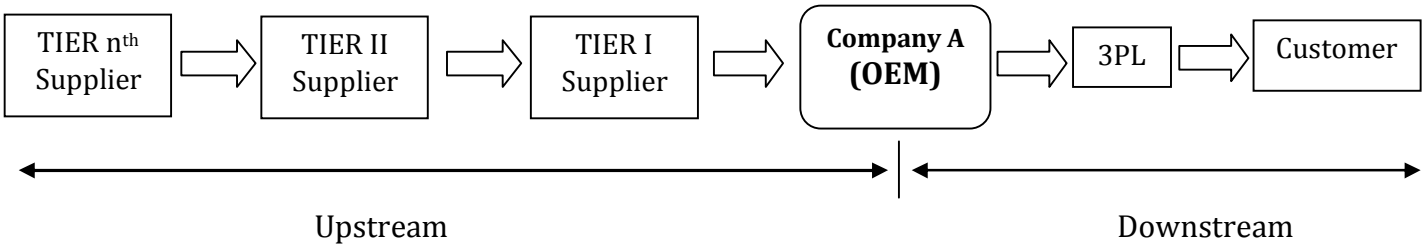


FIGURE 14: SUPPLY CHAIN OF COMPANY A

Mapping the Supply chain of Company A using GSCOR model

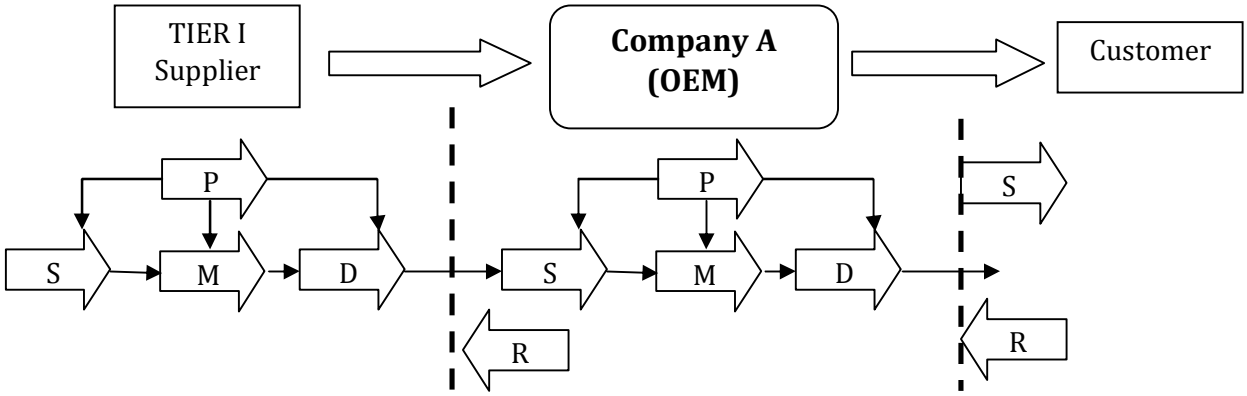


FIGURE 15: GSCOR MAPPING OF COMPANY A

Green SCOR Plan Process & Practices

Environmental policy is integrated in the DNA of the organization. At Company A the focus of their sustainability work is on the issues which are most relevant to their business. Being an ISO certified organization and following global reporting index to report its contribution towards sustainability is helping it to move itself in the right direction. To keep up to speed with a rapidly changing competitive environment they continuously monitor trends, and adjust long-term strategic direction for the Company A from top down. This includes evaluating sustainability risks and opportunities arising from climate change, constrained resources, urbanization, regulation and emerging market growth.

Abiding by the regulations is the bottom line for the organization. Regulations like REACH, EU ETS and WEEE are closely adopted in the processes and products. Strict environmental legislation does not pose major risks for Company A, as they see environmental excellence as a competitive advantage and a spur for further development, provided it is technology-neutral and allows sufficient lead time for adaptation.

Improving Company A's environmental footprint has been an important goal of the organization since a decade. Product efficiency, recycling of material based on the principle of 3R (Reduce, Reuse & Recycle), minimizing energy consumption, CO2 footprint of both product and process are some of the key opportunities they seek by improving company's environmental footprint. The Environmental Policy sets the tone for how Company A is to manage its negative impacts on the environment and enhance its contributions. The policy underlines the importance of responsibility.

End of life issues of the products are addressed right from the design to recycling stage. They have a modular design strategy for their products which enables them to maintain minimum number of parts in their product as a whole. Company A trucks are 95 percent commercially recyclable. When recycling a vehicle, the windshield and plastics are the most common items sent to landfill. The truck consists mainly of steel and cast iron with high residual value and there are many opportunities to efficiently reuse, recycle and recover for energy. Addressing end of life issues for their product is voluntarily undertaken by Company A in order to make business profitable for their customers. For their customer in B2B segment cost/km or cost of fuel consumption or life cycle cost are bottom lines in the competitive perspective.

Green SCOR Source Process & Practices

Almost 70% of the parts of Company A trucks are purchased thereby making suppliers a key stakeholder in their products. Suppliers are very important part of their organization and Company A seek to have a long term business policy with them and therefore selecting them is based on certain stringent book rules set by Company A management. ISO 9001/ ISO 14001/ TS 16949 are the minimum requirement that they need to fulfill apart from few other key parameters. All Company A suppliers shall comply with the EU legislation Registration, Evaluation, Authorization and regulation of Chemicals (REACH) (EC) 1907/2006 which came into force on the 1st of June 2007.

In order to avoid amongst others the environmental issues in products of their suppliers, Company A audit their process on a regular basis. These audits help them to check and monitor their activities as well in creating action plans in case of seeing any deviations or concerns. Company A's production system is focused towards the continuous improvement philosophy and they encourage their suppliers to adopt the same philosophy in their work culture.

Product lifecycle methodology is the foundation for Company A's R&D policy: underlining the importance of understanding and alleviating their impacts at the vehicle's every phase, yet placing their greatest efforts on addressing the areas of highest potential impact. More than half of Company A's R&D budget is spent on environmental improvements. Legislation has made great ideas developed in the

laboratory rolled out to market faster. European vehicle standards for environmental performance are the toughest in the world. At Company A, they took on the challenge and introduced their Euro 6 engine two years ahead of regulatory deadlines.

Company A's upstream packaging is basically designed based on the principal of maximum space occupancy by product and minimum vacant space in the package. The idea is to reduce the amount of air transport and utilize space efficiently. They have returnable packaging policy at upstream and use foldable type of bins to transport the parts from our supplier and all the packaging are designed by Company A.

Company A continuously strives to improve their transportation methods to reduce fuel consumption on a regular basis. Optimizing transport routes on a monthly basis, travel kilometer reduction per cost are some of the basic methods that they adopt to reduce fuel consumption. Company A is working with a logistics partner to optimize transport from all European suppliers to our production sites. All goods are collected in strategically placed hubs, which increase the filling rate of each truck. Moreover, Company A tailor the type of transport mode to each assignment such as increasing the load factor for goods shipments and using different types of transport and packaging to accommodate the volumes of various types of goods. Company A uses the best mode of transport best suited to their goal of efficiency, be it truck, rail or boat (and only in exceptional cases, air cargo).

Green SCOR Make Process & Practices

Company A is an ISO 14001 certified organization. The certification has helped them to streamline their efforts towards attaining full scale sustainability throughout the organization efficiently. It has enabled them to use a common language to communicate throughout the organization on the sustainability issues. It is an important pillar of their production system.

Company A constantly works to achieve more efficient resource utilization and safe, healthy workplaces in their service and production operations. The production of a truck generates about 0.5 percent (or 0.94 tons of carbon dioxide emissions) for every vehicle. It also consumes approximately 8 MWh of energy and 6.5 m^3 of water. Their focus on environmental management lies especially in reducing waste, water, hazardous substances and energy. Keen attention on process has helped the company reduce energy, water and chemicals use, with a seven percent increase in production volumes since 2007. Company A also tries to use closed production processes in order to avoid resource-intensive clean-up measures.

At Company A, the aim is always to use all resources wisely. It is an integral part of their quest for quality. Over the past decade they have achieved real reductions in the use of materials, hazardous chemicals and emissions, lessening the amount of waste generated in the process. Company A's strive towards continuous improvement helps them to get cleaner in their production processes, avoiding superfluous waste created by making unnecessary mistakes. As the amount of material use goes down, however, it is becoming more challenging for them to find ways to increase the rates of recycling. In last five years, Company A has reduced their material use per vehicle by six percent. Through dialogue with waste management suppliers, they aim to optimize their recycling processes further. During 2011, Company A accumulated a total of 83,200 tons

of waste, 85 percent of which was recycled or recovered as energy. Over the past three years, their recycling rate has remained stable. The next challenge for them is to take reductions to the next level while still continually reducing material use.

Company A manages its water use in two ways: firstly, they reduce its use in their operations. And secondly, through closed-loop systems in manufacturing and service workshops, they are also containing any possible emissions and ensuring that they don't discharge substances to the water system. This approach also allows them to reuse processed water. In fact, the same water has been circulating in their systems for up to three years, continually being cleaned and reused. Company A believes that their greatest potential to reduce greenhouse gas emissions (GHG) lies with reducing energy use. That's why every production operation at Company A is mandated to set targets and action plans in regard to improving energy efficiency.

Green SCOR Delivery and Return Process & Practices

A truck doesn't need any special packaging to deliver. They strive to deliver the trucks to their customers with minimum damages and transportation costs. Aftermarket parts are always delivered in returnable packaging or packing that can be recycled. Company A Transport Laboratory, a wholly owned Company A subsidiary, is their window into the challenges and solutions facing the customers every day. It tests and evaluates vehicle properties and performance in commercial road haulage. To reduce the carbon impact of goods transport within Transport Laboratory, Company A is switching their eight in-house transport trucks servicing Sodertalje operations to bio-ethanol driven vehicles in 2012. This promises to reduce the transported goods' carbon impact by 70 percent.

Furthermore they use rail and boat transport where suitable and possible. Reverse logistics plays an important role in upstream of their supply chain. The returning of empty bins and boxes to the respective suppliers helps them to create a balance between the inbound and outbound flow of goods in the upstream of supply chain and thereby minimizing energy consumptions and reducing wastes.

Logistics performance

Logistics is an important entity of Company A's business. They rely heavily on it to be productive and efficient. Delivery reliability is an important aspect of their business both at upstream as well as downstream of the supply chain. Green practices across the supply chain are incorporated with the goal of improving product and process quality, improve efficiency and reduce cost. This goals once achieved directly influences the positivity of their logistics function like delivery, flexibility and total logistics cost. Some of the key performance indicators used by Company A to measure its logistics function are: *quality of products, total logistics cost, on-time delivery rate, supply chain response rate, $C0_2$ emission, air pollutant emissions, fuel consumption, energy and water consumption, percentage of waste recycled, percentage of packaging recycled, reduction in hazardous emissions, occurrence of serious accidents.* Out of these KPIs the ones which best reflect the influences of green practice according to company A are: *Total logistics cost, $C0_2$ emission, air pollutant emissions, energy and water consumption, percentage of waste recycled, percentage of packaging recycled, fuel consumption, reduction in hazardous emissions and occurrence of serious accidents.*

Company A chooses green practices with the rational of enhancing organizations efficiency and reducing operating costs. Their green policies are adopted holistically across the entire value chain which has helped them to improve the overall logistics performance in return. For example, by specifying the packaging design from their end has helped them to reduce use of packaging material, reduce waste and also save logistic cost by complete filling of the bins instead of transporting just air. Company A has also realized that when a green practice is being adopted based on the rational of enhancing a particular entity of the value chain it has always backfired. For example, if they chose to improve transportation performance without taking into account packaging and adequate training of truck drivers they have never achieved the goal. So, the green practices which are being adopted with the rational of enhancing one particular element of value chain have often proven to backfire.

Company A emits about as much carbon dioxide through its logistics system as is emitted through energy use from factories and offices. To reduce this further, they're now switching their eight in-house transport trucks servicing Södertälje operations to bioethanol-driven vehicles in 2012. They are raising expectations on other logistics suppliers, too. And through logistics hubs and choosing the most suitable mode of transport for the assignment be it rail, road, ship or air cargo they're trying to optimize transport further. According to Company A, the selection of green practices must be done in a holistic way by taking into account the entire value chain of the product. Logistics is being used throughout the value chain of the product and therefore it's imperative that a 360 degree overview is taken into account when the rationale of implementing a green supply chain practices is to improve the logistics performance.

4.2 COMPANY B CASE DESCRIPTION

Company B is the largest global paints & coatings manufacturing Company and also a major producer of specialty chemicals. Their business area is divided into three units namely: Specialty Chemicals, Performance coatings and Decorative coatings. They hold Tier II position in the supply chain of automotive industry and their customers lies in B2B aftermarket segment covering dealer shops, body and repair shops. Total workforce of the organization is around 55,000 and the company operates in about 80 countries across the globe.

Supply Chain of Company B

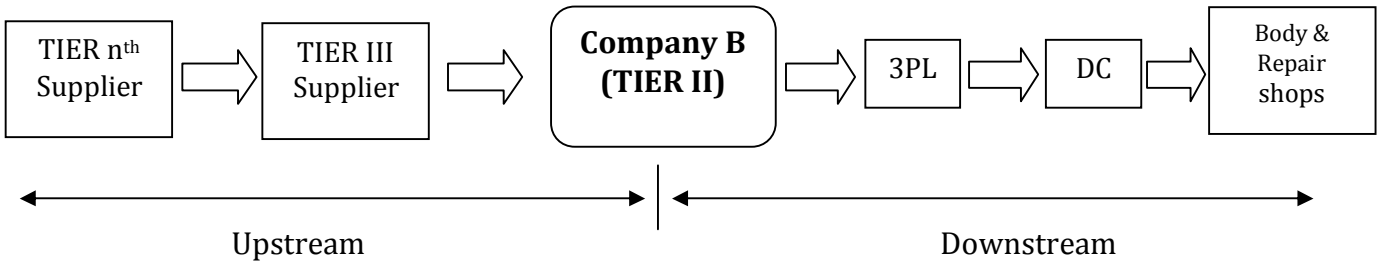


FIGURE 16: SUPPLY CHAIN OF COMPANY B

Mapping the Supply chain of Company B using GSCOR model

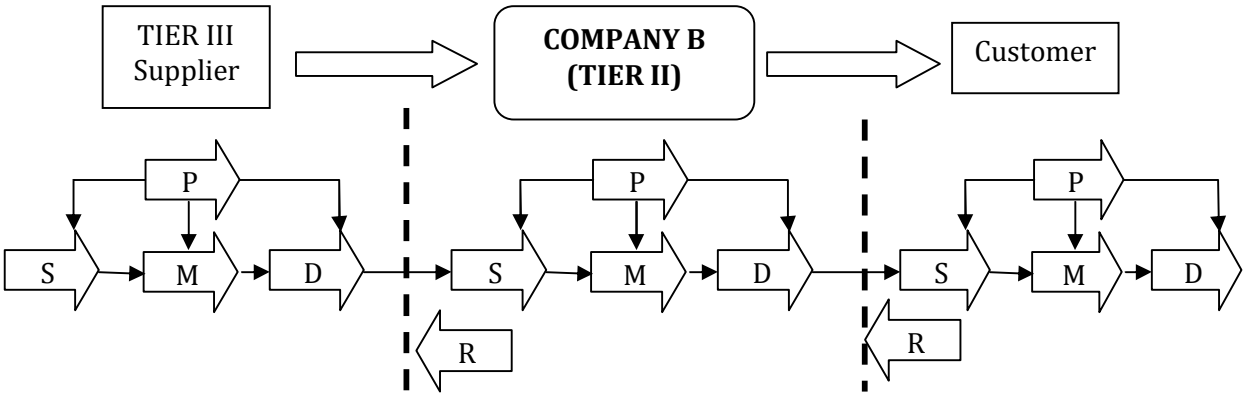


FIGURE 17: GSCOR MAPPING OF COMPANY B

Green SCOR Plan Process & Practices

Company B is committed to reducing their impact on the planet and delivering more sustainable products and solutions to their customers. In 2008, management of Company B issued a new environmental policy statement on Health, Safety, Environment and Security, which is fully aligned with their commitment to meeting all of their stakeholders' expectations in running a profitable and sustainable business, while at the same time meeting all of their commitments to society and the environment. Over the last few years sustainability has become firmly anchored in Company B's regular business processes. Sustainability is fully integrated in their strategy and management tools. Company B's sustainability strategy and development can be depicted as a three-level framework (Invent, Manage and Improve). Each of these levels includes environmental, economic and social aspects, which together map out their journey towards sustainability.

In order to meet the legal obligations, Company B continues to devote considerable resources to ensure that all substances and products can be manufactured and marketed in all countries where we operate. A number of substances have been registered with the European Chemicals Agency as defined by the first phase of the EU REACH regulations. To date, they have achieved the required submissions according to the specified requirements.

Improving company's environmental footprint has been an important goal of the organization since last few years. Product Stewardship, the ongoing performance improvement of products in terms of safety, health and environmental impact is an important part of their value chain approach to sustainability.

Company B's Eco-premium solutions program, which focuses on the development of products with lower toxicity; improved energy efficiency; use of natural resources/ raw materials, reduced emissions waste, land use and risks (e.g. of accidents) is the next step in product stewardship.

Green SCOR Source Process & Practices

Company B has developed a comprehensive policy on its way to world class sourcing with a focus on sustainability creation for both Company B and its key suppliers. The policy ensures that suppliers endorse their environmental and social standards as formulated in their code of conduct by asking them to sign a Vendor policy declaration. In a gradual process of building sustainable relationships with their key suppliers all Company B businesses have established a program of on-site visits to their critical suppliers in emerging countries. The objective of these "Supplier Support Visits" is to identify and nurture the critical suppliers as sustainable business partners.

Company B continually tracked the work of their key raw materials suppliers and in a few cases has also taken special steps to ensure continued availability. The impact from supplier's environmental issues would be huge to their organization and therefore sustainability focus areas have been defined for sourcing products or services that offer significant opportunity for reducing their ecological footprint. The focus areas include logistics & travel, waste management, packaging, carbon management, renewable raw materials etc. Company B doesn't require their supplier to have an ISO certification. Instead they have started a key Supplier Management Program where they cooperate with suppliers to enhance Eco-premium Solutions for their customers. In the key supplier meetings they are looking for a mutual understanding. Company B needs their suppliers to put effort in delivering innovations where they need them. During the meetings they communicate their future needs to make sure they continue to align and improve the fit with their supplier. Their suppliers need to help them to become the winners of tomorrow and by doing so, so will they.

Company B is adequately weighting concerns such as product energy consumption, hazardous material content or end-of-life issues in the R&D phase. Typical of current focus areas of their R&D are: VOC reduction in coatings products and Eco-efficient resource utilization. Low VOC and solvent-free products, whose performance match and often exceed those of solvent-based predecessors, are being developed by their performance coatings businesses. Bio-renewable materials in general, and saccharides, oils and fats in particular, are providing a rich vein of sustainable raw materials which have the potential to not only serve as alternative building blocks to petrochemical-based feed stocks, but also to help create products with new properties and applications.

The packaging methods of Company B vary from country to country. For example an agreement with a local raw material supplier to reuse steel drums, together with improved drum emptying procedures, saved a coatings site in China more than €33,000 in four months. They have reduced waste by 14 tons and recovered more than eight tons of raw materials. Even the transportation methods depend on the products like for binders they use full truck loads and for resins they buy from their brother and sister organizations located in Spain. Most products they buy from regional suppliers and apply milk run principle and use road mode mostly. Train mode is mostly used in inter country transportation due to speed, cost and delivery competitiveness.

Green SCOR Make Process & Practices

Company B see improving operational eco-efficiency as a fundamental element of manufacturing excellence which is helping them to achieve cost reduction, environmental protection and more effective use of raw materials and natural resources. In January 2010, Company B initiated an operational Eco-Efficiency program to achieve a step change in the environmental footprint of their operations. The main indicators were energy consumption, greenhouse gas emissions, waste produced, fresh water intake and VOC emissions. Quick scan reviews to identify improvement opportunities were conducted at 75 production sites, which represent approximately 75 percent of the whole company. A more extensive, comprehensive diagnostic toolkit for waste and energy consumption has been developed which has been applied at selected sites. Reducing Carbon Emissions from their manufacturing operations, in line with the Company B Carbon Policy, they continue to focus on improving the energy efficiency and managing the fuel mix of their energy intensive businesses to reduce greenhouse gas emissions and potential carbon costs.

Effective waste management has helped Company B to increase their raw material efficiency in manufacturing operations, reduces their environmental footprint and reduces costs. Their focus is on reducing total waste and eliminating hazardous waste to landfill. Total waste per ton of production generated and leaving their sites is down 11 percent to 13.1kg/ton (2009: 14.7kg/ton). Hazardous waste to landfill per ton of production is down 17 percent to 0.24kg/ton (2009: 0.29kg/ton) and the total figure is down to 4.7 kilotons (2009: 4.9 kilotons) down 4 percent.

Company B is concerned with the sustainable use and the conservation of water resources worldwide. They are aiming to achieve sustainable fresh water management at their production sites by 2015, as they recognized that water supply is essential to life and to the sustainability of their business. Company B rely on water for raw materials production, product formulation and manufacturing, power generation, cooling, cleaning, transporting and for effective use of some products. They are currently defining an integrated, company-wide Water Program, including expert resource support for improvements, which has included benchmarking their efforts with the leaders in the water initiatives.

Green SCOR Delivery and Return Process & Practices

Company B's end products are vulnerable to heat and cold and therefore have safety issues associated with delivery of it. They have standard packaging policies towards every customer and depending on the country they are supplying, different types of packaging strategies are being adopted. Basically they use tin cans of capacity around 1-5 L which can't be reuse.

The vehicle routing systems to customers are chosen with ideology of minimal impact on environment as well as reducing accidents. Company B mostly used train mode to transport the end products across countries within same continents. They have regional distribution systems which are supported by local manufacturing hubs and they try to minimize intercontinental transportation.

Logistics performance

Logistics plays an important role in Company B's business. Throughout the product value chain the organization relies heavily on its logistic entity. Logistic is one of the core areas of their business process which is most vulnerable to environmental, economic and social exploitation. Therefore, various green practices are being adopted by them to minimize these exploitations and improve their green image. Some of the key performance indicators used by Company B to measure its logistics function are: *cost, reliability, speed, quality of transportation, fuel consumption, safety, CO2 emissions*. According to SC manager of company B, they find it very difficult to choose logistics KPI indicating the influence of green practices. Until now carbon footprint is most commonly used for logistics performance in Company B. *Quality, cost* and *safety* are other key indicators which at times are also used to measure influence of green practices.

When asked about his opinion about how the green practices should be chosen with rationale of logistics performance improvement he replied by saying that "*it is difficult to define what the green aspects are within sustainability and how to apply that on logistics. We haven't done that and we are starting it in our organization. In his opinion a model like SCOR model would help them to create a one voice for the sustainability aspect in the logistics and try to improve its performance*".

4.3 COMPANY C CASE DESCRIPTION

COMPANY C is composed of six business units, each headed by an executive Vice President. These are: Chemicals, Polymers, Performance Chemicals, Fertilizers, Metals and Innovative Plastics. Company C's innovative plastic unit holds TIER II position in the supply chain of automotive industry and their customer lies in the B2B segment. Company C has a global workforce of over 33,000 individuals and has operations in over 40 countries across the globe.

Supply Chain of Company C

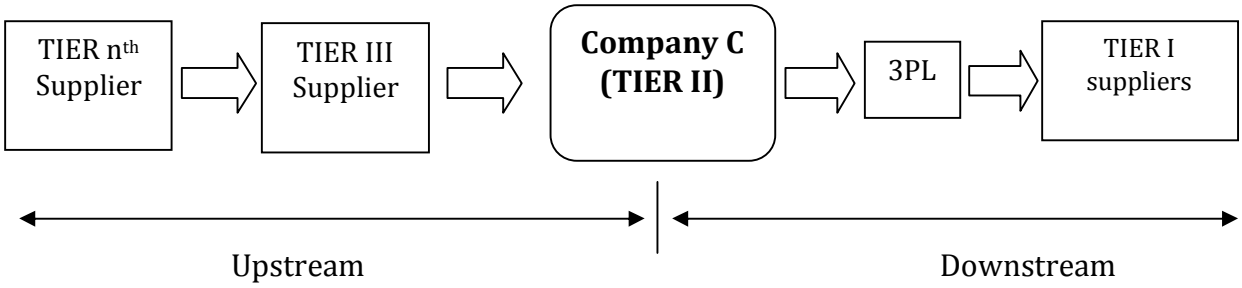


FIGURE 18: SUPPLY CHAIN OF COMPANY C

Mapping the Supply chain of Company C using GSCOR model

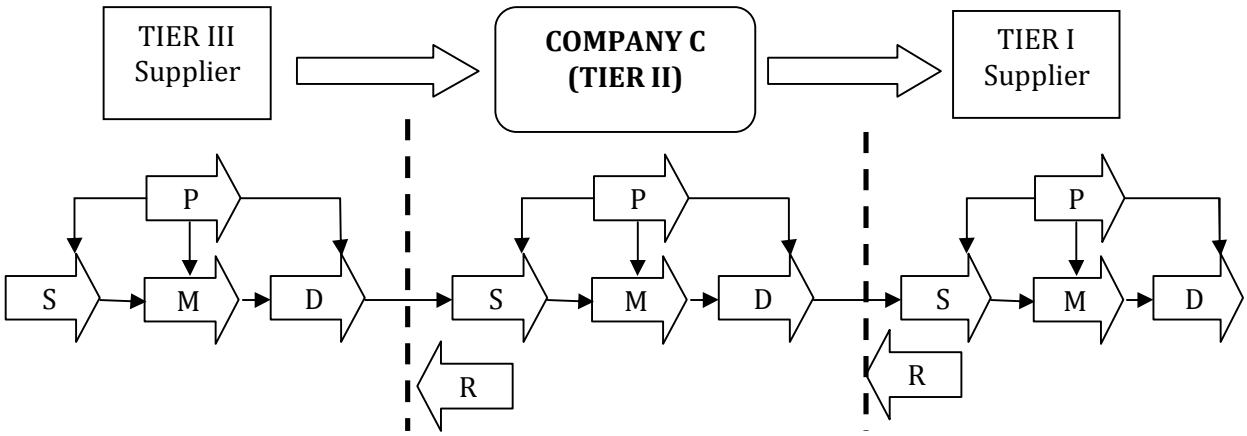


FIGURE 19: GSCOR MAPPING OF COMPANY C

Green SCOR Plan Process & Practices

Company C has implemented a global environmental management system (EMS) at all of its manufacturing facilities that meets the requirements of ISO 14001. More than 95 percent of their manufacturing facilities are ISO 14001 certified. Modifications in their existing global environmental manual and management system have been made to incorporate the modifications established by the ISO 14001:2004 standard. Innovative Plastics catering the automotive industry has implemented world-class Environmental, Health, Safety & Security (EHSS) programs at all of its manufacturing facilities globally. Innovative Plastics became part of Company C in August 2007, and is now proceeding to modify its systems and standards to comply with its Health and Environmental Management Standards (SHEMs). The SHEMs seek to establish a world-class approach to ensuring excellence in EHSS performance.

Company C is committed to compliance with all applicable chemical and product regulations and they have allocated resources to ensure that company-tailored product stewardship and toxicology business practices are in place. Company C has successfully registered all required chemical substances in 2010 and received REACH registration numbers from ECHA.

Company C sees two fold opportunity by improving its environmental footprint. The first prime focus is on reducing the intensity of their global operational footprint, including carbon intensity, energy and water use, and material efficiency – benefits that ultimately also flow to their customers. Second, they are committed to share their expertise by working even more closely with the customers to develop products, applications and solutions that respond to their sustainability needs. For example, Company C has expanded the Sustainability Solutions portfolio to help customers easily choose high-performance materials that advance their specific environmental goals and contribute to their business success.

All products of Company C in the Sustainability Solutions portfolio meet a widely recognized third-party standard or, where no recognized standard exists, pass a review evaluating environmental benefits using a rigorous Sustainable Product Scorecard process based on Life Cycle Assessment (LCA) methodologies. Company C continually

reviews its database of approved raw materials and identifies the use of any of these candidate substances as a raw material to produce finished goods within the EU or to produce finished goods which Innovative Plastics brings into the EU as importer of record. If they were to determine that a substance of very high concern (SVHC) is used, all attempts are made to eliminate the material and/or find a substitute.

Green SCOR Source Process & Practices

Company C has administered a rigorous supplier qualification program since 1998 with special focus on suppliers from emerging countries and contract manufacturers. This program is designed to evaluate the Environmental Health & Safety, Security and Labor Practices performance of these suppliers. All suppliers and service providers are expected to:

- Provide safe working conditions for all employees and prevent workplace injuries, illnesses and violence
- Maintain compliance with applicable regulations for Fair Labor Practices with regards to minimum age, discrimination, wages, overtime and freedom of association
- Design and operate their manufacturing facilities with effective process safety programs to minimize safety risk
- Comply with applicable EHS&S regulations and maintain required management system
- Ensure safe transportation of all materials into and out of their facilities

All suppliers and service providers are initially screened to determine potential risk of non-compliance with their expectations. Any potential arrangement deemed a risk of adherence to these expectations must complete a questionnaire or submit to an on-site audit. Since 1998, more than 2700 supplier arrangements have been evaluated including manufacturers from over 50 countries. In addition, more than 700 on-site compliance audits have been completed.

Company C uses Sustainable Product Scorecard to weigh concerns such as product energy consumption, hazardous material content or end-of-life issues. This scorecard has two components:

- ***Life Cycle Assessment:*** LCA and Life Cycle Inventory (LCI) methodologies, based on the ISO 14040 and ISO 14044 standards, are used to build the first component of the scorecard. The carbon and energy footprints of the products or applications are estimated across the life cycle. The results of the assessment are summarized in the Environmental Product Data Sheet.
- ***Green Chemistry Screen (GCS):*** This component of the scorecard guides the assessment of the chemical composition of the product, including impurities, byproducts and catalysts, against well-established toxicological, regulatory and industry standard criteria.

Green SCOR Make Process & Practices

More than 95 percent of Company C's manufacturing facilities are ISO 14001 certified. Company C has implemented numerous projects in order to improve the energy

efficiency of their operations and thereby reduce their GHG emissions. The overall efficiency of their chemical operations is significantly increased by cogeneration facilities co-located with four of their largest sites. Between 2010 and 2011, over 80 energy efficiency and GHG reduction projects were implemented with a combined reduction of more than 360,000 GJ and 24,000 metric tons of GHG emissions (CO2 equivalents). In the recent past, the business has shifted focus to driver fewer, but much larger, more strategic energy reduction projects at the manufacturing sites. These projects often have longer payback times and reflect the long term commitment the business has in reducing its energy footprint.

All Company C's sites are encouraged to follow waste minimization practices. Typical practices include:

- Milling and reuse of compounding drools
- Sale of scrap plastic that formerly went to landfills
- Thermal oxidation of high caloric value waste streams, resulting in steam generation and reduction in fossil fuel usage.
- Sale of intermediate products to other users

Company C's water program includes systems to assure that all effluent streams are properly permitted and maintain a very high level of compliance with discharge limitations. Water treatment processes focus on upstream contaminant reduction in addition to effluent treatment. All sites are expected to have storm water pollution programs in place. The plans contain preventive steps such as secondary containment, inspections and spill prevention. Company C's air emission compliance program is based on identification and location of emission sources and implementation of emissions reduction steps. Processes are continuously monitored as part of an overall program to ensure that air emissions remain below permissible limits.

Green SCOR Delivery and Return Process & Practices

Company C delivers most of its products to its customers using Octabin and bags. Recycling of these packaging wood and cardboard and reuse of wood pallets for raw materials are some of the green policies being adopted by Company C which has helped them to reduce the packaging cost.

Vehicle routing is usually done on the basis of full truck load principle in order to avoid transport of air. The logistics is being outsourced to 3PL on a contract basis therefore it is their responsibility to select the transportation mode which is cost as well as environmentally efficient.

Logistics Performance

Logistic is an important entity for Company C. It's the nerve line of their supply chain therefore relies heavily on it for overall efficiency of the supply chain. Green practices helps Company C to reduce its logistics cost as well as help in optimizing it.

The key logistics KPI commonly used by Company C are: *percentage of good products, on-time delivery, percentage of demand met, total logistics cost, flexibility, CO_2 emissions, air pollutant emissions, fuel consumption, energy consumption, water consumption, percentage waste recycled, amount of hazardous and toxic emissions, accident occurrence*

and *customer service index*. Out of these KPIs the ones which best reflect the influences of green practice according to company C are: *Total logistics cost, CO_2 emission, air pollutant emissions, energy and water consumption, percentage of waste recycled, percentage of packaging recycled, fuel consumption, reduction in hazardous emissions and occurrence of serious accidents.*

4.4 COMPANY D CASE DESCRIPTION

Company D manufactures various types of tyres for the automotive industry. They manufacture tyres for summer, winter and the ever-more popular all season tyre. They hold TIER 1 position in the supply chain of automotive industry and their customers lie in B2B (OEMs) as well as B2C (Aftermarket) segment. In 2009, it was bought by a global tyre company so their global work force now is around 12,000 employees of which 1700 people work in the Vredestein Enschede plant.

Supply Chain of Company D

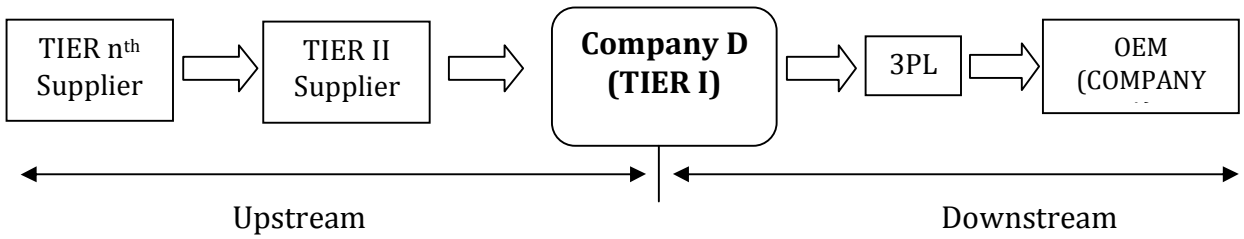


FIGURE 20: SUPPLY CHAIN ON COMPANY D

Mapping the Supply chain of Company D using GSCOR model

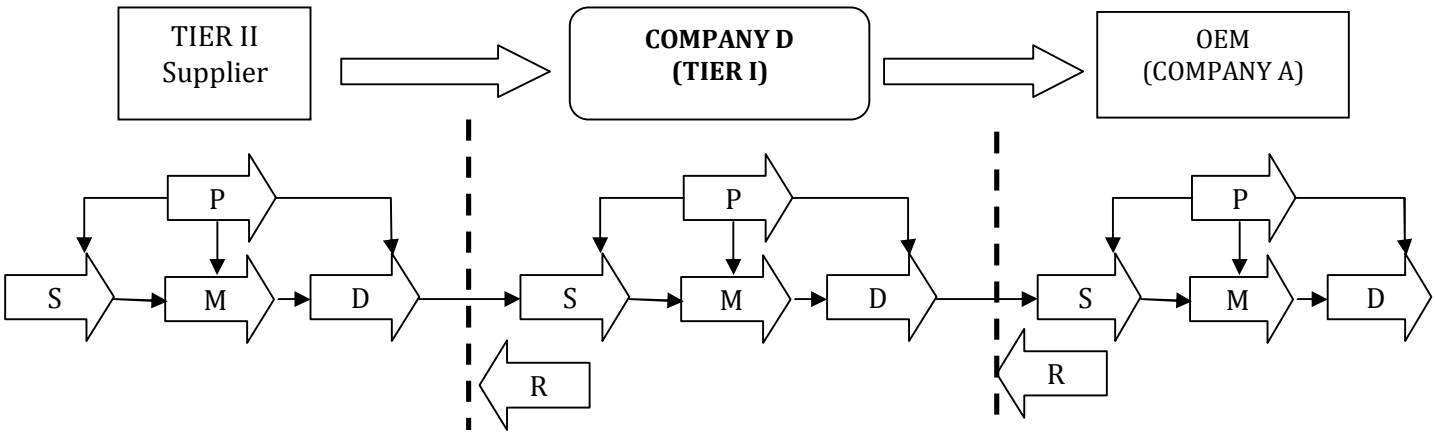


FIGURE 21: GSCOR MAPPING OF COMPANY D

Green SCOR Plan Process & Practices

Company D is an ISO 14001 certified organization therefore environmental policies are embedded and followed throughout the organization's system. The environmental strategies are articulated by top management and are therefore followed on top down basis. Top management articulates the reporting structure for economic and environmental data which are closely followed and updated by the operations team of Company D at plant label on a daily and monthly basis. Company D has a global

reporting index installed to monitor and update the progress and achievements in the sustainability field on a yearly basis.

REACH regulations are closely followed in product and process of Company D. Since the rubber compounding involves uses of various types of fillers and chemicals, utmost care is taken that REACH regulations are followed in the recipe formulation. EU ETS is at present not important but in years to come by Company D would be adopting it in their process. In addition Company D has signed mutual agreements with local governmental bodies to minimize its negative impact on environment by optimizing its energy usage.

The biggest opportunities which Company D sees in improving the company's environmental footprint are energy efficiency, material recyclability and waste management. A new eco-labeling is being introduced in Europe in 2012 focusing particularly on the tyres based on the same principles as of electronic appliances which elaborate on the efficiency label covering the rolling resistance, wet grip performance and noise level of the tyre. At present Company D is trying to achieve a rank B in the eco labeling for its product.

Company D uses the life cycle analysis to assess the environmental impacts associated with all the stages of product's end of life cycle i.e. from cradle-to-grave. Right from raw material extraction (cradle) through materials processing, manufacture, distribution, use and disposal or recycling (grave) issues are addressed to minimize the environmental impact. Life cycle analysis assists Company D to understand the full range environmental effects attributable to products and services. It is used to improve products and processes and provides Company D with a sound basis for substantiated decisions based on the People, Planet & Profit Philosophy.

Green SCOR Source Process & Practices

Company D emphasizes its suppliers to be ISO 14001 certified. This enables Company D to know about their commitment towards environment and ensures that suppliers have a system in place to handle their practices. In addition to this all the raw material suppliers of Company D shall comply with the EU legislation Registration, Evaluation, Authorization and regulation of Chemicals (REACH) (EC) 1907/2006 which came into force on the 1st of June 2007.

Most of the raw materials used by them are supplied by their chemical suppliers so any environmental concern would greatly influence their organization. Therefore, fulfilling the REACH regulation is a must for the supplier which ensures the reliability of the materials received from them. In addition to this regular audits on monthly and bi-monthly basis are conducted by the quality and procurement department of Company D in order to monitor and control adverse effects at threshold phase itself.

Company D pays a great attention in the R&D of the tyres. Minimizing the use of hazardous material and product energy consumption including end-of-life issues are being addressed at the R&D phase of the tyre itself. The emphasis is more towards usage of clean materials as for example the increasing the usage of chlorobutyl instead of regular butyl for tube manufacturing has resulted in a cleaner manufacturing process. In addition emphasis is also made towards reducing the rolling resistance, noise and debris over the entire life cycle of the tyre.

The packaging that is being used for the raw materials are used multiple times. The natural rubbers are usually being transported in crates. Carbon blacks are transported through silo trucks. All efforts are being taken to use wood free or reusable packaging at the upstream. Transportation of the materials from supplier is in full truck load and the process is being handled by 3PL under the guidance of Company D. Milk run is adopted if full truck load is not attainable in certain circumstances. Currently the inbound and outbound functions are handled independently. The focus towards sustainability in the inbound section is not very critically examined currently and usually Company D relies on 3PL service to be effective. Being green or sustainable for Company D is to be low cost.

Green SCOR Make Process & Practices

Being an ISO 14001 organization has helped Company D in being systematic. It acts as a watchdog in controlling the practices towards full scale attainment of sustainability across the organization. Environmental data are audited within the ISO 14001 standards on a yearly basis.

At Company D the most important aspects in the yearly Environmental plan are energy, air, soil, waste and safety. In order to continuously improve on all the considered subjects a vast number of data are monitored in graphs. Graphs are being used to record the emissions, use of hazardous materials, use of water and energy, waste and safety. Company D has incorporated various measures across its manufacturing facility to reduce energy consumption. For example, use of natural lighting provision in factory through roof improvement of transparent sheet has enabled Company D to save good amount of electricity usage for lighting the manufacturing process during day time. Company D has managed to reduce its power consumption by almost 20 % in a span of around seven years. In addition to this Company D has also focused on increasing the usage of renewable and clean energy technologies such as wind and solar energy across its production plant.

Waste minimization during production is an important goal of Company D sustainability policy. Wastes are categorized in to three categories namely: hazardous waste, non hazardous waste and recyclable waste. Each of these waste have waste bin color coding and waste collection points. Responsibility is assigned to concerned shop floor supervisors to maintain the separation of waste as per categorization during the make process. E-campaigns emphasizing on 3Rs: Reduce, Reuse and Recycle are conducted on monthly basis in order to build consensus among operators and production people to incorporate the practices adequately.

Similarly Company D is also putting efforts to reduce and control its air and water emission through continuous improvement plans. Global reporting index incorporated across the whole organization to have a common language for sustainability is playing a major role towards this attainment. Value stream mapping is employed to measure the current state of the carbon emissions and water footprint. Based on the mapping output year on year % reduction of carbon and water footprint are being targeted.

Green SCOR Delivery and Return Process & Practices

Company D products don't need any special packaging. Tyres are delivered without any packaging and only for tubes packaging is being used. Foldable racks are being used mostly between warehouses and local destinations.

Vehicle routing is usually done on the basis of full truck load principle in order to avoid transport of air. The logistics is being outsourced to 3PL on a contract basis therefore responsibility to select the transportation mode which is cost as well as environmentally efficient depends on the 3PL, however the guidance or planning is being done by Company D. Reverse logistics is basically being employed at both upstream and downstream of the supply chain. In upstream the plastics bins and crates are transported back to the suppliers whereas in downstream the foldable racks are transported on a regular basis. Tyres meant for recycling are collected on a regular basis using the reverse logistics mode.

Logistics Performance

Logistics is important for Company D as it gives Company D an edge over its competitors. Logistics is considered an important entity during both planning and execution phase. Few of the green practices have direct impact on the logistics performance, for example the use of foldable racks have greatly helped in reducing transportation cost per tyre. The key KPI used for measuring logistics performance of Company D are: *On-time delivery, percentage of demand met, total logistics cost, inventory turnover ratio, percentage of waste recycled, carbon emissions, air pollutant emissions, energy consumption*. Out of these KPIs the ones which best reflect the influences of green practice according to company D are: *total logistics cost, percentage of waste recycled, carbon emissions, air pollutant emissions and energy consumption*. Right container balancing of inbound and outbound using inland terminal is a practice which has greatly helped Company D to improve the logistics performance of the organization. Company D also tries to optimize the lead or the transit time by regularly monitoring the outbound logistics.

According to SC manager, the green practices incorporated with improving logistics performance as rationale needs to have commitment from customer. They must be ready to invest for the cost incurred. In addition a holistic approach needs to be adopted to optimize the performance of logistics.

4.5 COMPANY E CASE DESCRIPTION

Company E manufactures various types of fasteners for the automotive industry and its suppliers. The fasteners division of Company E has a market share of approximately 15% in the Western European automotive industry, making Company E one of the largest players in the European market. They hold TIER I position in the supply chain of the automotive industry and their customers lies in the B2B segment covering mostly the OEMs. The company employs about 1500 employees and operates in more than 12 countries.

Supply Chain of Company E

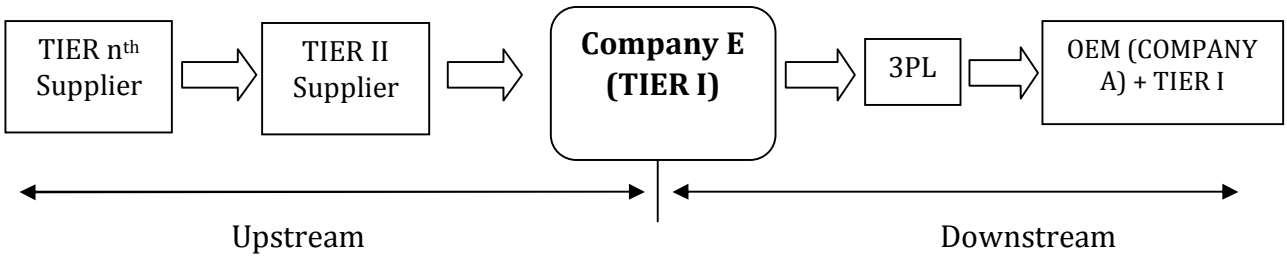


FIGURE 22: SUPPLY CHAIN OF COMPANY E

Mapping the Supply chain of Company E using GSCOR model

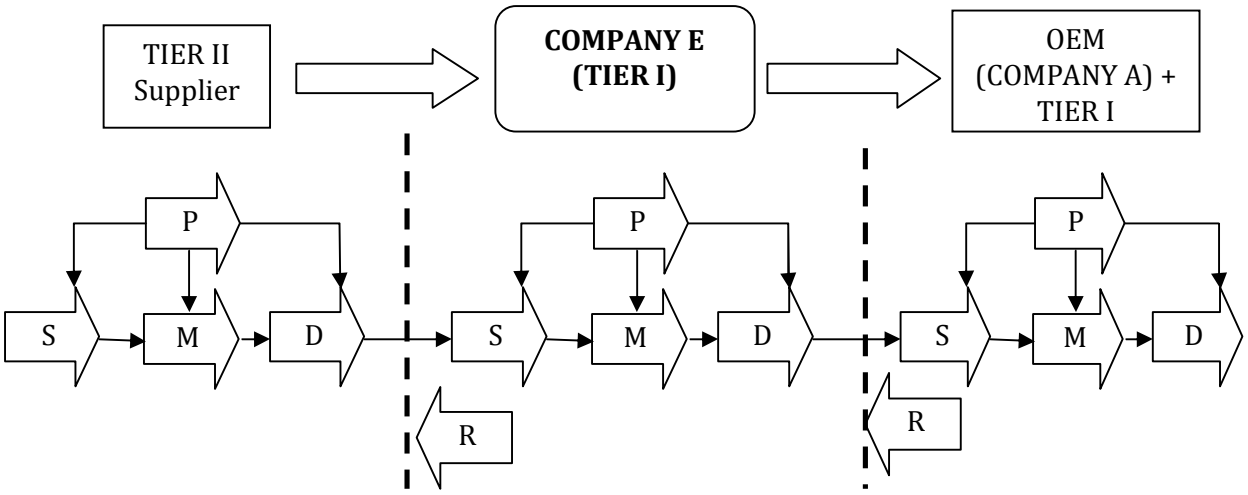


FIGURE 23: GSCOR MAPPING OF COMPANY E

Green SCOR Plan Process & Practices

Company E is an ISO 14001 certified organization which has enabled them to integrate a formal environmental policy for the organization. The environmental strategies based on ISO principles are set by the top management but it is the responsibility of the line managers to incorporate them in the organization adequately. So the policies are set in top down fashion whereas the implication is approached in bottom up way.

Company E basically outsource the coating of the fasteners to the third party and therefore doesn't bind by regulations like REACH. However they ensure that the coating of the fasteners at the supplier end is in accordance to REACH regulations.

Company E doesn't see any big opportunity in improving the company's environmental footprint. Recyclability of the material is one option that the company mostly concentrates upon as an opportunity to improve itself.

Almost 99% of the fasteners constitute of the same material therefore end of life issues are not a big concern for the organization. Even the customers are not very determined to apply the end of life principle in the fasteners therefore Company E doesn't see a need for any incorporation of it in its products.

Green SCOR Source Process & Practices

To be a supplier of Company E they must have a TS 16494 and ISO 14001certification. This ensures Company E about the supplier's environmental impact or commitment to environmental sustainability.

For coating of the fasteners Company E is highly dependent on its supplier and if any violation of REACH regulation happens at suppliers end then it would directly impact upon Company E. In order to avoid such incidents Company E audits their suppliers every six months to ensure that the process followed at the supplier end is in accordance with the agreed one and in case of any violation; improvement plans are drawn to overcome it along with the suppliers.

The product that Company E deals with doesn't give them any opportunity to weigh the product energy consumption or end of life issues at the R&D phase. During the R&D phase the focus is mostly on the functionality and dimension alignment in accordance with customer requirements.

The raw material that is being used by Company E is steel which is being delivered to them in log size. Therefore there is not much of scope for them to employ any environmental packaging method in the upstream. Apart from the steel rods, oil in cans is received from suppliers in returnable cans. The transportation is based on full truck load in order to avoid large number of trips and maximize the utilization of space in the trucks.

Green SCOR Make Process & Practices

The ISO certification has enabled Company E towards full scale attainment of sustainability across its business process. Company E has always attached great importance to the concept of 'people, planet and profit'. In line with this philosophy, the company devotes a lot of attention to the theme of sustainable enterprise. Policy with respect to the people dimension is targeted at the training, personal development and motivation of employees on the one hand, and safety, health and welfare on the other. With respect to the 'planet' dimension, an active environmental policy and quality assurance are important aspects of business management, particularly for the production companies. The environmental policy encompasses an environmental care system and preventive measures designed to monitor environmental risks and ensure they remain within acceptable levels within the organization. Company E ensures that they have the up-to-date required environmental permits for each of its production facilities. The quality systems of most production companies are certified according to ISO/TS 16949.

Heat treatment is a process that consumes maximum energy during the make process of Company E's product. In order to reduce the impact of the heat treatment on the production of the products new and innovative ways of heat treatment has been adopted by Company E which has resulted in remarkable decrease in the energy consumption and has also increased the overall equipment efficiency of the process. Company E supplies a product that has little if any negative impact on the environment.

The waste is recycled and constant efforts are made to reduce the burden on the environment caused by business activities. All efforts are being taken to use the recyclable steel in the products again subjected to the condition that the required properties of the product are not being disturbed by this incorporation.

A regular check on air and water emission is being maintained at all the production facilities. Continuous improvement plans are drawn on regular basis to minimize the use of water and prevent the release of toxic chemicals and gases to environment.

Green SCOR Delivery and Return Process & Practices

The fasteners are delivered in returnable bins loaded in wooden pallets. The emphasis is always on reusing the plastic pallets and the wooden pallets to the maximum possible times. The routing of vehicle is mostly done on the basis of full truck load.

The logistic activity is being outsourced to 3PL so the emphasis is on motivating them to deliver and receive the products at possible low cost. Reverse logistics plays an important role in the return of the bins and pallets. Usually milk run is employed to collect and return the empty bins and pallets.

Logistics performance

Logistics is an important backbone of Company E. It is one of the major areas where Company E is eyeing to improve itself further with the aim of increasing its profitability. Being a supplier of automotive OEM solely it is very important that logistics is being harnessed by the organization efficiently in order to reach break even. The logistics performance indicators used by Company E are: *reliability, flexibility, order fulfillment, warehouse stock, inventory turnover, on-time delivery, carbon emissions, air pollutant emissions, fuel consumption, energy consumption and total cost per unit. O*ut of these KPIs the ones which best reflect the influences of green practice according to company E are: *$C0_2$ emission, air pollutant emissions, energy and water consumption and fuel consumption.*
The green practice in past which has helped them to improve the logistics performance is by proper vehicle routing. The green practices when chose with the rationale of logistics performance then Company E would prefer to use small areas of improvement rather than taking a holistic one. The customers are the ones who are driving Company E's strategies towards sustainability so it is imperative that practices are chosen in quantum forms in order to minimize chances of any major loss just in case incorporation of a green practice backfired.

4.6 COMPANY F CASE DESCRIPTION

Company F produces and sells parabolic springs, air suspension systems, special axles and related articles for manufactures of trailers, trucks and buses. The company holds TIER I position in the supply chain of commercial vehicle industry and their customers mostly lies in the B2B segment covering the OEMs. The company employs around 145 employees and covers various countries across Europe.

Supply Chain of Company F

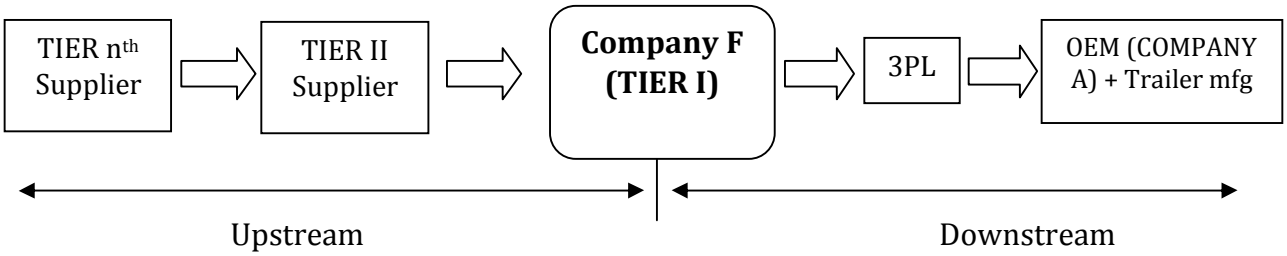


FIGURE 24: SUPPLY CHAIN OF COMPANY F

Mapping the Supply chain of Company F using GSCOR model

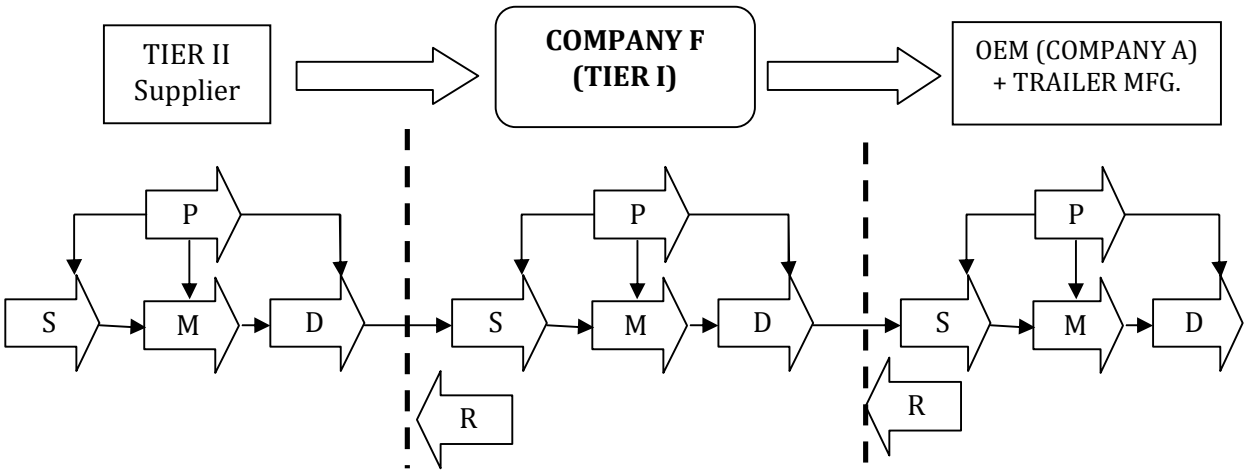


FIGURE 25: GSCOR MAPPING OF COMPANY F

Company F's Green SCOR Plan Process and Practices

Company F doesn't have an ISO certification or an environmental policy as such across the organization. Although they try to be best in class but they don't have a concrete policy to attain it. The process of attaining ISO certification is under process which is expected to be attained in another year's time.

The materials basically used are alloys of steel to manufacture the axles and air suspension system and every effort is being taken in order to avoid the use of hazardous material in the recipe using the design system installed. REACH regulations are not being followed closely yet but in next few months plans are there to incorporate the regulation in the production system. A new production facility is under construction with completely new state of the art process and technologies in order to maximize the benefits by being energy efficient and sustainable organization. End-of-life is not applicable to the products because there is no scope of recycling in any of the products being designed and developed by Company F.

Company F's Green SCOR Source Process and Practices

Currently not much of emphasis is put by Company F on the environmental impact or commitment of the suppliers towards environmental sustainability. The emphasis is

mostly on the quality standard of the supplier. But for certain suppliers located in developing countries they are thoroughly examined in terms of capability and efficiency before awarding any new business. Risks from environmental issues of the suppliers are minimal for Company F so not much of emphasis is put towards it.

The products developed by Company F are more technically challenging then environmentally. Therefore the effort for weighing concerns like product energy consumption, hazardous material content and end-of –issues are not very important and not taken into consideration during the R&D phase. The packaging used for transporting the material from the suppliers is usually in recyclable bins and pallets. However, transportation optimization to reduce fuel consumption is not yet taken into consideration during sourcing phase at present.

Company F's Green SCOR Make Process and Practices

Company F systems are robust and deliver reliability and cost-effective operation for on-highway applications as well as in the most demanding operating environments. In order to reduce the energy consumption during the make process, the energy usage per machine is monitored using SCADA system and continuous improvement plans are derived based on the data on a monthly basis.

Waste generated during the production process does not give much scope of recyclability. The cost of returning the waste generated during the production to the suppliers is much higher than the benefit of recycling it. Therefore not much of efforts are made to recycle the wastes rather efforts are made towards making the process more efficient to minimize the generation of wastes. The water and air emissions are being tried to control by Weweler on a regular basis. The heat generated by the production process is being used recycle and used to heat the office areas.

Company F's Green SCOR Delivery & Return Process and Practices

Returnable packaging is used to deliver to the customers. The packaging received from the suppliers is often used to forward the product to the customers. The packaging from customers is returned at every delivery step and it is being reused to deliver next consignment again. Packaging recyclability is a big scope of cost saving is being vied by Company F. Full truck load as well as milk run is employed in the transportation to optimize the cost. Depending on the customer location various methods are employed to optimize the fuel consumption. Road is the most preferred mode for transporting the products to the customer.

Logistics performance

Logistics manager sets the KPI and informs about it to the management about it and logistics plays an important role in the organizations working principles. Green practices are not playing a major role in the logistics performance of the organization for Company F. However packaging at times have influence the cost of logistics and efforts are being used to harmonize it and maximize the benefits out of it. The key performance indicators being used are: *delivery reliability, customer complaint, quality issues,* and *total logistics cost*. The performance indicator which best reflects the

influence of green practices on logistics performance for Company F is cost. Packaging is a practice which has greatly helped them in improving its logistics cost.

Green practices should be chosen with rationale of logistics performance in a holistic way. When incorporating a certain green practices both suppliers as well as customers needs to be invited to discussion table so that each of them is aware of the benefits that is being looked at by incorporation of the green practice.

5. CHAPTER FIVE: CASE ANALYSIS

In this chapter each of the case studies are first analyzed individually and then against each other. The rationale behind the within case analysis is to understand the perspective of each companies towards the green practices and the process where they focus more in implementing them. The perspectives towards logistics performance of each of the companies are also analyzed and the various logistics metrics used by the companies is also explored. The cross case analysis is performed to identify the most commonly used green supply chain practices as well as the logistics metrics by the companies of the Dutch commercial vehicle industry. The relationship between the green supply chain practices and logistics performance metrics are also established in this chapter.

5.1 THEMATIC NODES & CODING SCHEME

The qualitative interviews helped to generate plethora of information on the research topic from the chosen cases. In order to extract the important information it is imperative that the data collected is being categorized into thematic *nodes* and subsequent *coding* within it (Yin, 2003, Strauss, 2003). A node can be defined as a collection of references about a specific theme, place, person or other area of interest. Coding the sources is a way of gathering all the references to a specific topic, theme, person or other entity (Miles and Huberman, 1994). For the research the *thematic nodes* that were considered are:

Green SCOR Plan: Under this thematic node the data collected from the six cases about their green planning processes within the organization are being collected.

Green SCOR Source: Under this thematic node the data collected from the six cases about their green sourcing processes within the organization are being collected.

Green SCOR Make: Under this thematic node the data collected from the six cases about their green manufacturing processes within the organization are being collected.

Green SCOR Delivery & Return: Under this thematic node the data collected from the six cases about their green delivery & return processes within the organization are being collected.

Logistics metrics: Under this thematic node the data collected from the six cases about the logistics performance metrics used within the organization are being collected.

Within these thematic nodes there are specific topics which this research aims to explore. So in order to gather all the relevant topics existing within the thematic nodes following codlings were used: Environmental policies, Environmental regulations, Opportunities, End-of-life issues, Supplier selection, Supplier environmental commitment, Product R&D, Environmental packaging, Environmental transportation, Environmental certifications, Energy control, Emission control, Waste recycling, Green packaging, Green transportation, Economic, Environmental and Social. The thematic node & coding scheme presented in table 5 illustrates the coding scheme being used within the thematic nodes including its description.

Thematic Nodes	Coding	Description
Green SCOR Plan	Env_policies	Company's environmental policies
	Env_regulations	Regulations followed by the company
	Opportunites	Opportunities seeked from environmental policies
	End-of-life issues	Importance of End-of-life issues
Thematic Nodes	**Coding**	**Description**
Green SCOR Source	Supplier Selection	Supplier selection criteria
	Supplier Env commit	Importance of suppliers environment commitment
	Product R&D	Sustainability concerns weighed during R&D
	Env Packaging	Packaging methods use to minimise waste
	Env Transportation	Transport method use to minimise fuel consumption
Thematic Nodes	**Coding**	**Description**
Green SCOR Make	Environmental cert	Environment certification obtain for production plant
	Energy control	Effort taken to reduce energy consumption
	Waste recycling	Effort taken to reduce waste generation and recycling
	Emission control	Effort taken to reduce air and water pollution
Thematic Nodes	**Coding**	**Description**
Green SCOR Delivery & Return	Green packaging	Packaging policies followed in downstream
	Green transportation	Transportation policies followed in downstream
Thematic Nodes	**Coding**	**Description**
Logistics metrics	Economic	Economic metrics used to measure attributes like operation, efficiency & responsiveness.
	Environmental	Environmental metrics used to measure attributes like emissions, resource utilisation & waste recycling.
	Social	Social metrics used to measure attributes like health & safety, noise and employees

TABLE 5: THEMATIC NODES & CODING SCHEME

5.2 COMPUTER ASSISTED QUALITATIVE DATA ANALYSIS SOFTWARE

The data obtain from the case study interviews were partially structured and mostly included pure qualitative data. In order to analyze these qualitative data help of computer assisted qualitative data analysis software namely NVivo 9 was taken in this research. NVivo is software that helps researchers to manage, analyze and report unstructured data (NVivo, 2012). It doesn't do the thinking for the researcher but it provides a workspace and tools to enable researchers to easily work through the collected information. With purpose built tools for classifying, sorting and arranging information, NVivo gives time to analyze the materials, identify themes, glean insight and develop meaningful conclusions (NVivo, 2012).

Exploring perception

In order to explore the perception of the interviewees through the interview data collected, the qualitative data collected was transcribed in semi structured forms. Following is the protocol being employed to explore the perceptions of each company towards the research topic using the NVivo software.

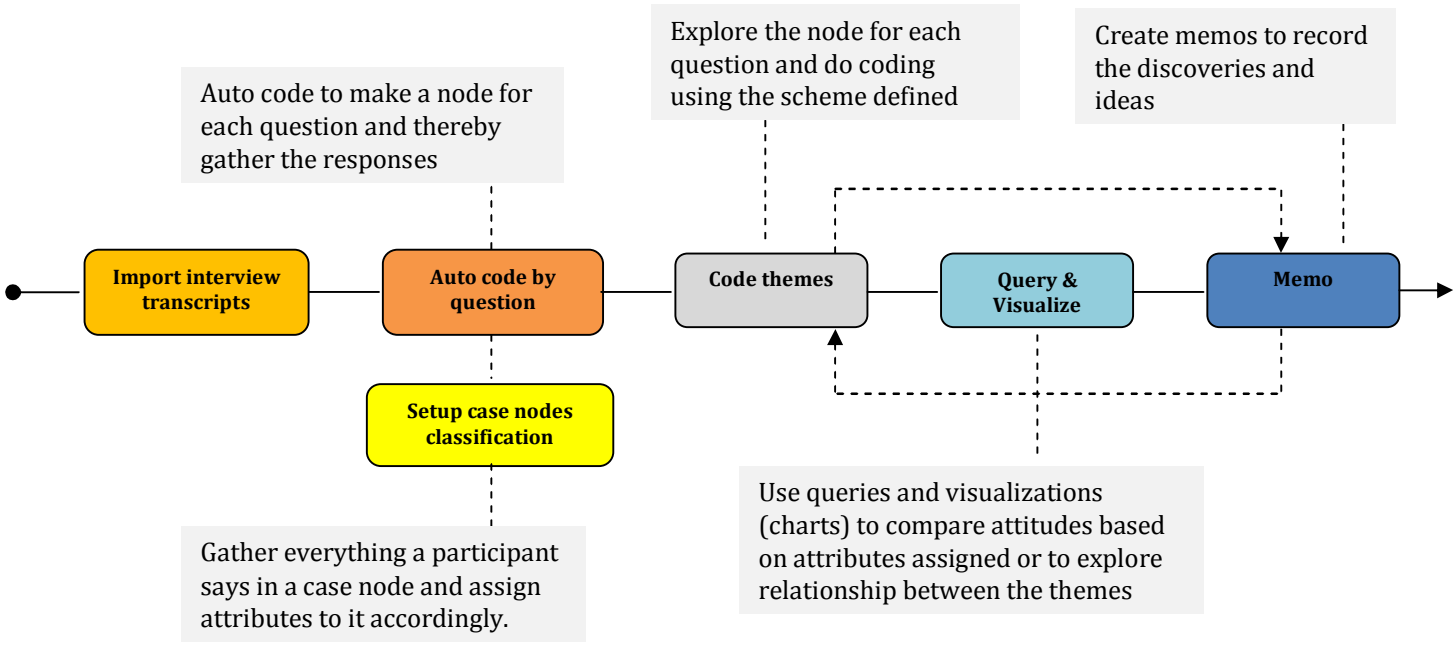


FIGURE 26: EXPLORING PERCEPTION USING NVIVO SOFTWARE (NVIVO, 2012)

The visualization technique in the form of chart is used for this particular research to present the data. Following are the chart types being used (NVivo, 2012):

Chart type	Description	Chart is used to find out
Coding by attribute value for a node	Displays how a particular node is matched against one or two attributes and their corresponding combinations of attribute values	for one selected attribute, which attribute value: - has the most/least percentage coverage
Coding by attribute value for a source	Displays how a particular source is coded against one or two attributes and their corresponding combinations of attribute values	for one selected attribute, which attribute value: - has the most/least percentage coverage

The percentage cover indicates how much of the number of characters not words as a percentage of the total source matches or covers within a particular thematic node within a reference.

5.3 WITHIN CASE ANALYSIS

In the within case analysis each Company Are evaluated in terms of the following aspects:

- The Green SCOR process level which is most dominant in the organization
- The Green SCOR best practices which are mostly used in the planning phase
- The Green SCOR best practices which are mostly used in the sourcing phase
- The Green SCOR best practices which are mostly used in the making phase
- The Green SCOR practices which are mostly used in the delivery and return phase
- The Logistics metrics which are mostly used by the Company Across its supply chain

Based on this evaluation, for each Company A compliance rating is also made for the list of green SCOR best practices and the logistics metrics articulated in the theoretical framework of the research. The compliance is codified on a scale from 1 (not implemented, if the green SC practice or logistics metrics is not part of a company's operations) to 5 (totally implemented, when the green SC practice or logistics metrics is fully implemented and is embedded in the company processes).

5.3.1 COMPANY A CASE ANALYSIS

Based on the response of the interviewee and the coding scheme used, Company A's overall response summary can be presented as following:

1. The Green SCOR process which is most dominant within the Company A organization is presented in figure 30. From the figure it can be inferred that Green Source process and Green Make process almost gets an equal weight followed by the Green Plan process. The Green Delivery & Return process scores low in the overall priority list.

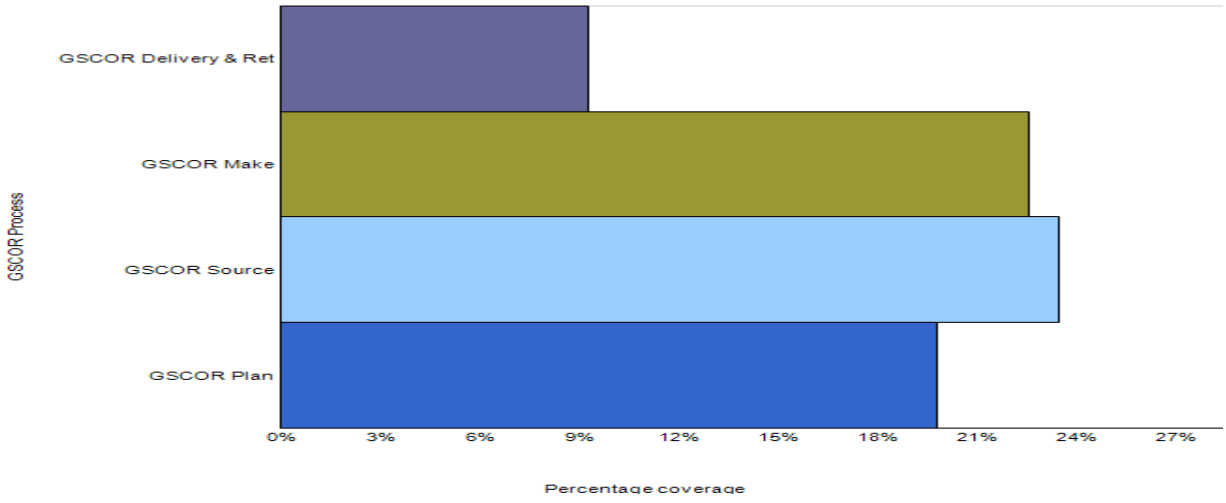


FIGURE 27: COMPANY A GSCOR PROCESS DOMINANCE

2. The green supply chain practices which are most widely used across the Green SCOR plan process is illustrated in figure 31. From the figure it can be inferred that practices emphasizing the end-of-life issues of the product are high on agenda. The practices confining with introduction of environmental policies across the organization comes second followed by the practices which helps in achieving the opportunities looked up by being green. The practices pertaining to environmental regulations are currently low in the agenda list.

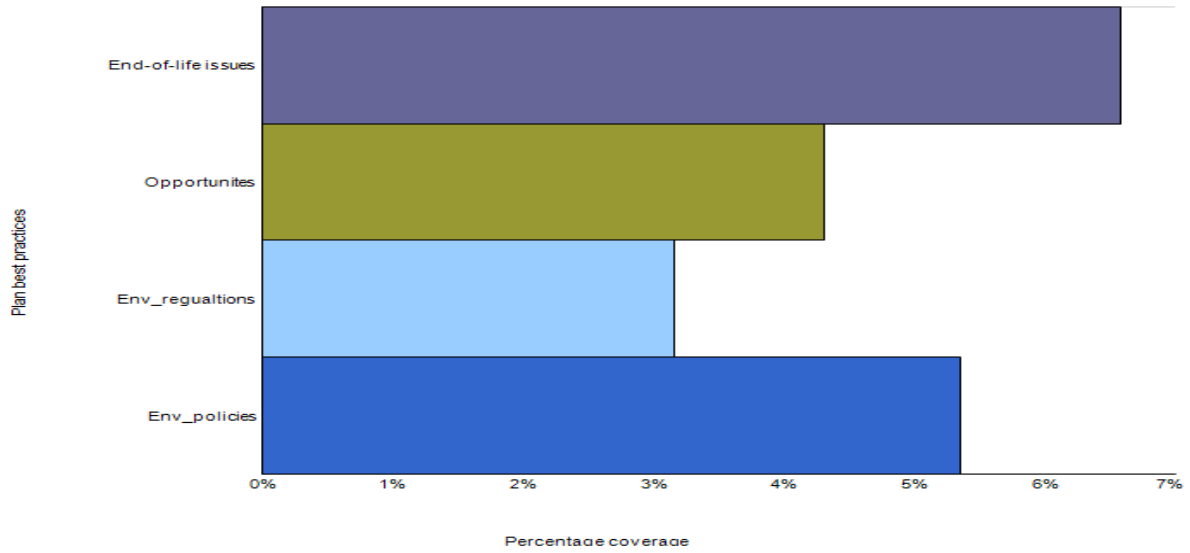


FIGURE 28: GSCOR BEST PRACTICES WITHIN THE GSCOR PLAN PROCESS

3. The green supply chain practices which are most widely used across the Green SCOR sourcing process is illustrated in figure 32. From the figure it can be inferred that practices emphasizing the environmental friendly transportation of the product are high on agenda. The practices confining with selection of suppliers and product R&D stressing on product energy consumption, hazardous material content comes second. These practices are followed by the practices pertaining to the supplier's environmental commitments and environmental packaging in the upstream of the supply chain.

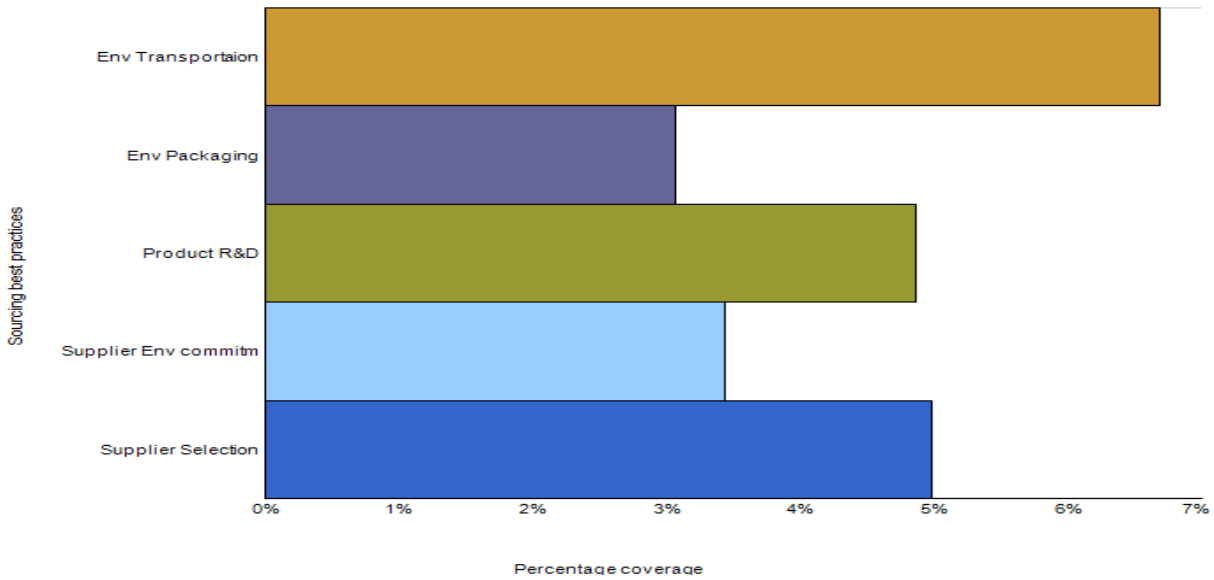


FIGURE 29: GSCOR BEST PRACTICES WITHIN THE GSCOR SOURCE PROCESS

4. The green supply chain practices which are most widely used across the Green SCOR making process in Company A is illustrated in figure 33. From the figure it can be inferred that practices emphasizing minimization and recycling of wastes are ranked high on agenda. The practices confining with emission and energy control comes second in the priority list. The practices pertaining to attainment of environmental certifications is not very ranked high in the importance list.

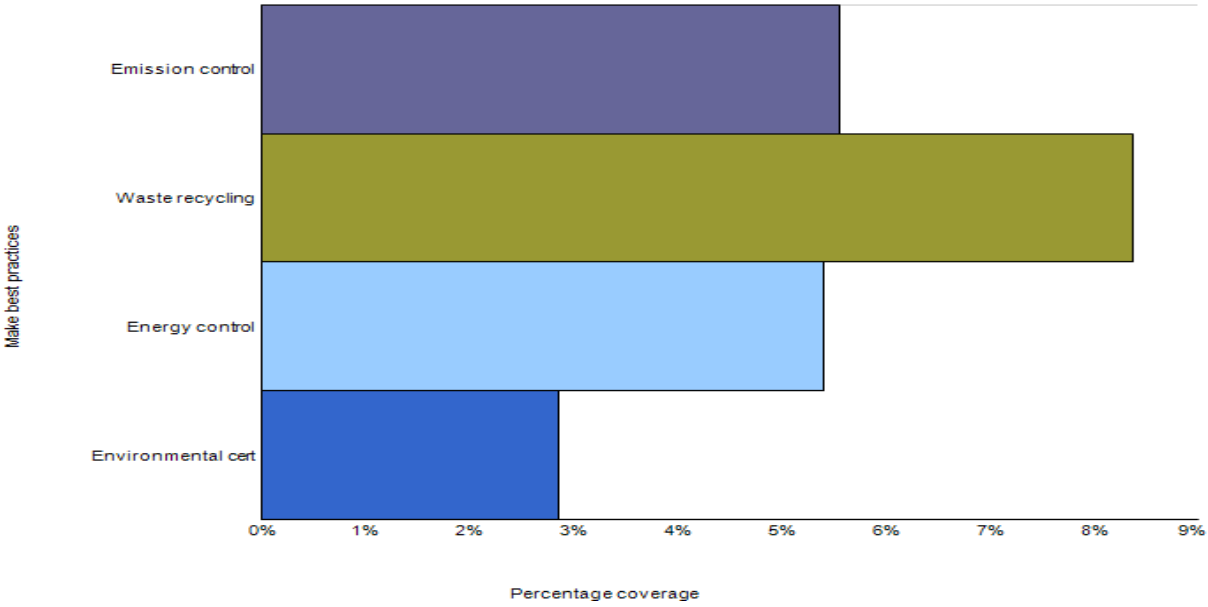


FIGURE 30: GSCOR BEST PRACTICES WITHIN THE GSCOR MAKE PROCESS

5. The green supply chain practices which are most widely used across the Green SCOR delivery and return process in Company A is illustrated in figure 34. From the figure it can be inferred that practices emphasizing green packaging are ranked high on agenda. The practices confining with green transportation at downstream of the supply chain comes second in the priority list.

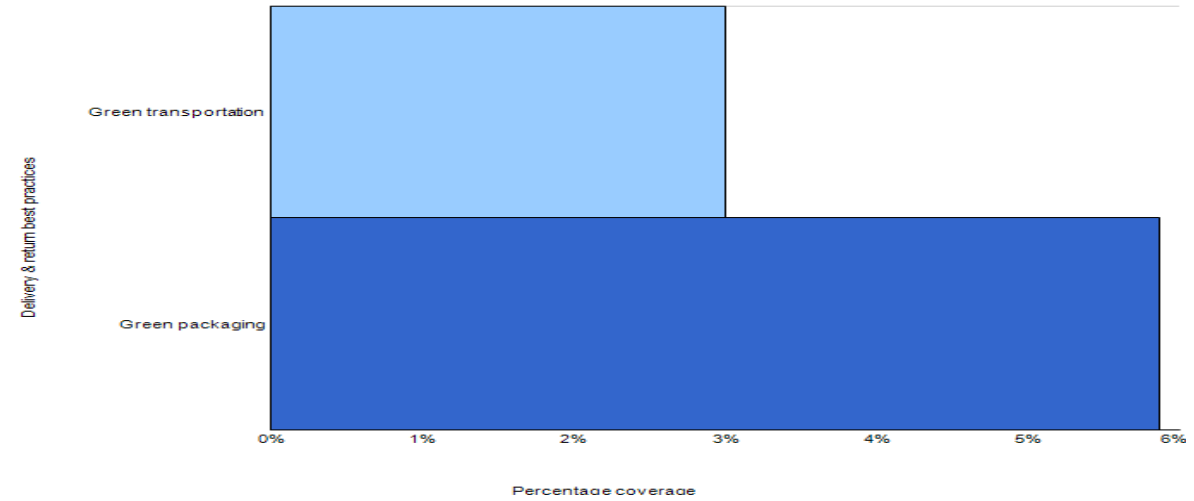


FIGURE 31: GSCOR BEST PRACTICES WITHIN THE GSCOR DELIVERY & RETURN PROCESS

6. The logistics metrics which are most widely used across the supply chain of Company A is illustrated in figure 35. From the figure it can be inferred that environmental attributes like emissions, resource utilization, waste & recycling covering measurable entities such as carbon emissions, air pollutant emissions, fuel, energy and water

consumption, percentage of waste and packaging recycled are most widely used by Company A. These metrics are followed by the economic attributes like operation, efficiency and responsiveness covering measurable entities like quality of products, customer service level, cost reduction, flexibility comes next in the logistics metric list. The social metrics doesn't have a very priority in the metric list and only health & safety related attribute such as toxic and hazardous emission control along with the number of any fatal accident occurrence are usually measured to determine efficiency of logistics.

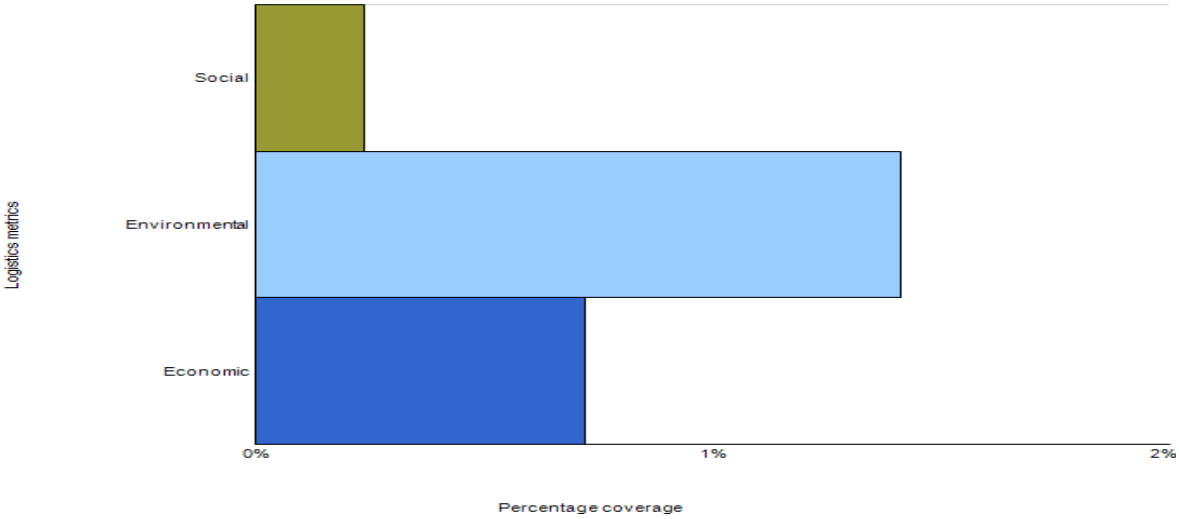


FIGURE 32: LOGISTICS METRICS USED BY COMPANY A

7. The table below illustrates the compliance of the various green SCOR best practices and logistics metrics shortlisted from the literature across the Company A organization.

Green SCOR Process	Green SCOR best practices	Compliance Rating
Plan	Minimize energy consumption & hazardous material	**5**
	Strive for establishing univocal environmental policies	**4**
	Proper handling and storage of hazardous material	**4**
	Collaborate with SC partners on environmental issues	**5**
Source	Select suppliers with EMS in place	**4**
	Suppliers supplying environmentally friendly content	**5**
	Specify design specification including environmental req.	**5**
	Specify packaging and delivery requirements	**4**
Make	Schedule production to minimize energy consumption	**5**
	Manage waste generated during the production process	**5**
	Manage emissions (air and water) from production	**4**
Deliver	Minimize use of packaging materials	**5**
	Schedule shipments to minimize fuel consumption	**4**
	Retrieve packaging material for re-use	**4**
Return	Don't physically return product beyond economic repair	**4**
	Aggregate return shipments to minimize fuel consumption	**3**

TABLE 6: GREEN SCOR PRACTICE IMPLEMENTATION RATING FOR COMPANY A

	Measurable	KPI	Compliance Rating
Economic	Quality of products	% of good products	**5**
	Customer service level	On-time delivery	**5**
	Product availability	% demand met	**1**
	Transportation	Transit time (TT) variability	**1**
	Utilization	Capacity utilization	**1**
	Productivity	Inventory turnover ratio	**1**
	Cost reduction	Total Logistics cost	**5**
	Response to customer needs	Order fulfillment lead time	**5**
	Flexibility	Supply Chain Response Time	**5**
Environmental	Carbon dioxide	Carbon emissions	**5**
	Air pollutant	Air pollutant emissions	**5**
	Fuel	Fuel consumption	**5**
	Energy	Energy consumption	**5**
	Water	Water consumption	**5**
	Waste	% recycled waste	**5**
	Materials/products recycle	% of packaging recyclable	**5**
Social	Toxic, hazardous emissions	Amount of unwanted emissions	**5**
	Accidents	Accident occurrence	**5**
	Noise volume	Noise reduction	**1**
	Employment	Recruitment for GSCM	**1**
	Training	Training on GSCM	**1**

TABLE 7: LOGISTICS METRICS COMPLIANCE RATING FOR COMPANY A

5.3.2 COMPANY D CASE ANALYSIS

Based on the response of the interviewee and the coding scheme used, Company D's overall response summary can be presented as following:

1. The Green SCOR process which is most dominant within the Company D organization is presented in figure 36. From figure it can be inferred that almost equal weight is given to all the process namely Green Source, Make & Plan process. However, the Green Delivery & Return process scores low in the overall priority list.

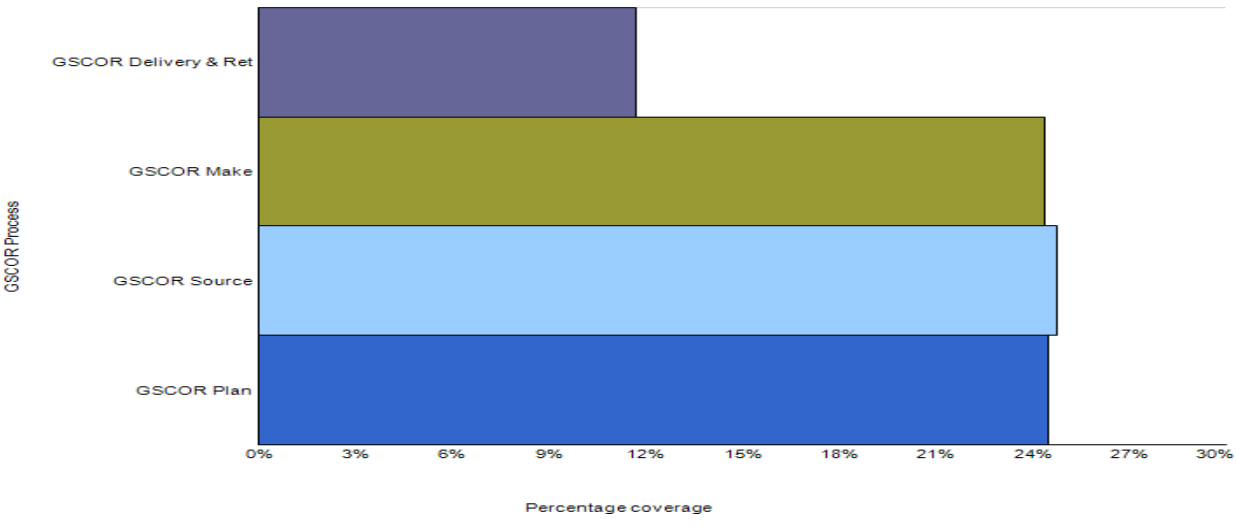


FIGURE 33: COMPANY D GSCOR PROCESS DOMINANCE

2. The green supply chain practices which are most widely used across the Green SCOR plan process is illustrated in figure 37. From the figure it can be inferred that practices emphasizing the end-of-life issues of the product are high on agenda. The practices confining with introduction of environmental policies across the organization comes second followed by the practices which helps in achieving the opportunities looked up by implementing or being green. The practices pertaining to environmental regulations come last in the agenda list.

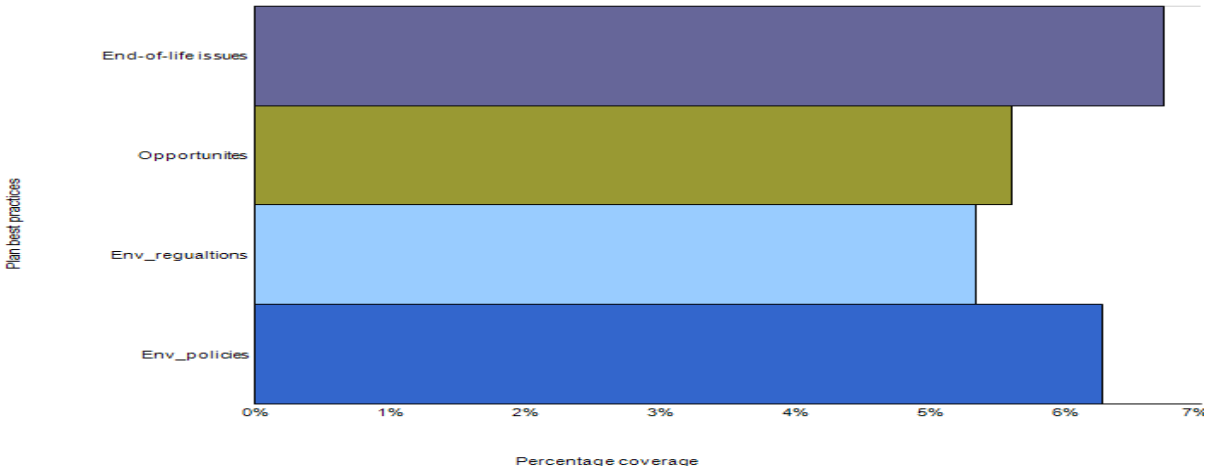


FIGURE 34: GSCOR BEST PRACTICES WITHIN THE GSCOR PLAN PROCESS

3. The green supply chain practices which are most widely used across the Green SCOR sourcing process is illustrated in figure 38. From the figure it can be inferred that practices emphasizing the product R&D stressing on product energy consumption, hazardous material content comes first on priority list. The environmental friendly transportation of the product is next on the agenda. The practices confining with selection of suppliers and supplier's environmental commitments lies third in the list. The practices pertaining to environmental friendly packaging ranks low in the priority list of Company D.

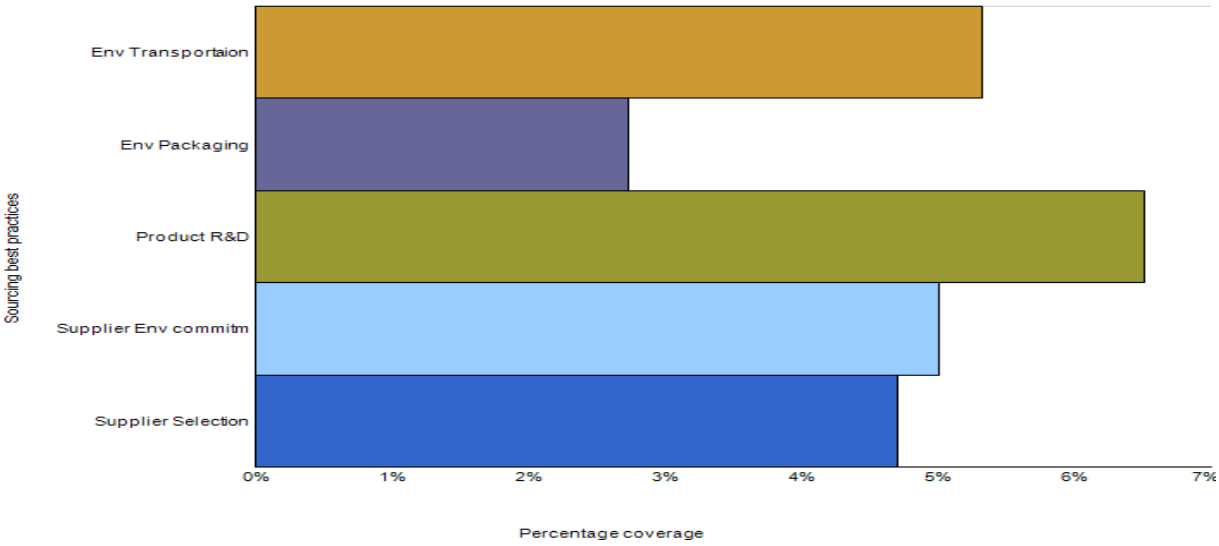


FIGURE 35: GSCOR BEST PRACTICES WITHIN THE GSCOR SOURCE PROCESS

4. The green supply chain practices which are most widely used across the Green SCOR making process in Company A is illustrated in figure 39. From the figure it can be inferred that practices emphasizing energy control are ranked high on agenda. The practices confining with emission and waste minimization & recycling comes second in the priority list. The practices pertaining to attainment of environmental certifications is not very ranked high in the importance list.

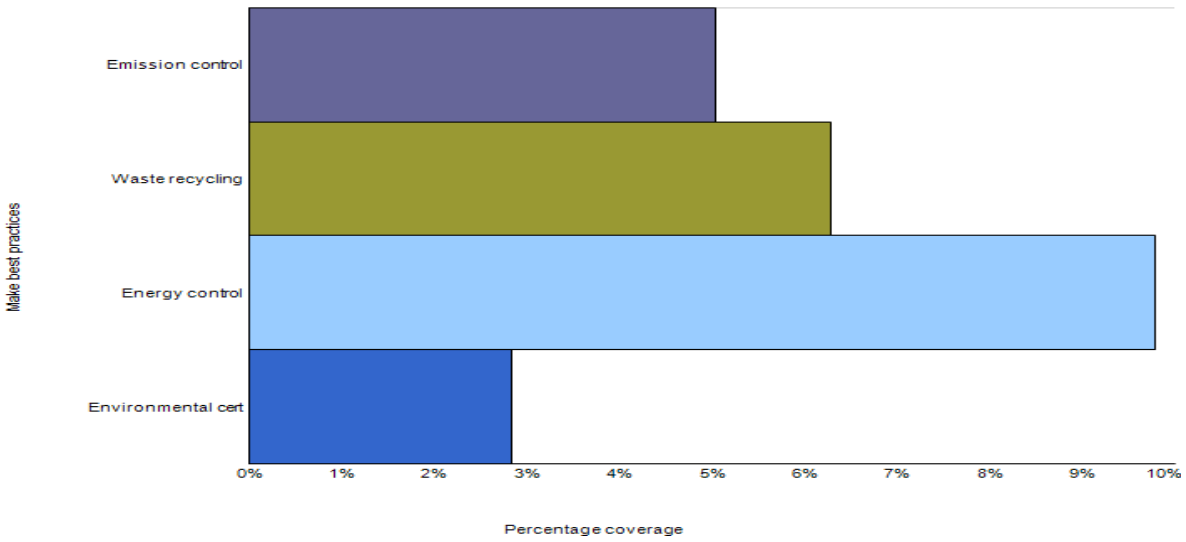


FIGURE 36: GSCOR BEST PRACTICES WITHIN THE GSCOR MAKE PROCESS

5. The green supply chain practices which are most widely used across the Green SCOR delivery and return process in Company A is illustrated in figure 40. From the figure it can be inferred that practices emphasizing green transportation are ranked high on agenda. The practices confining with green packaging at downstream of the supply chain comes second in the priority list.

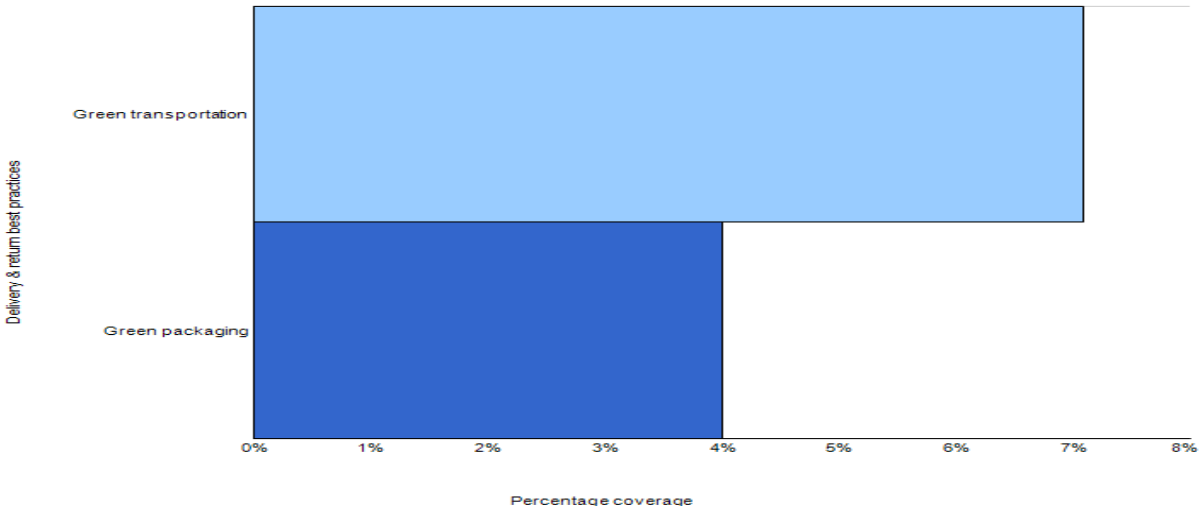


FIGURE 37: GSCOR BEST PRACTICES WITHIN THE GSCOR DELIVERY & RETURN PROCESS

6. The logistics metrics which are most widely used across the supply chain of Company D is illustrated in figure 41. From the figure it can be inferred that environmental attributes and economic attributes are most commonly used logistics metrics. No form of social metrics is used by Company D to determine efficiency of logistics.

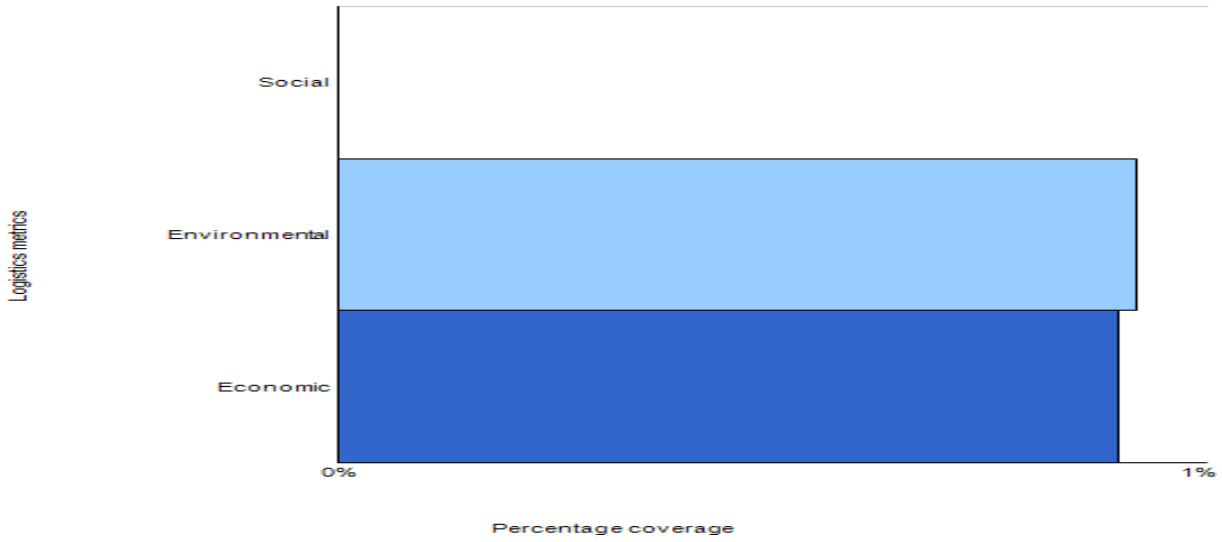


FIGURE 38: LOGISTICS METRICS USED BY COMPANY D

7. The table below illustrates the compliance of the various green SCOR best practices and logistics metrics shortlisted from the literature across the Company D.

Green SCOR Process	Green SCOR best practices	Compliance Rating
Plan	Minimize energy consumption & hazardous material	**4**
	Strive for establishing univocal environmental policies	**3**
	Proper handling and storage of hazardous material	**4**
	Collaborate with SC partners on environmental issues	**5**
Source	Select suppliers with EMS in place	**4**
	Suppliers supplying environmentally friendly content	**4**
	Specify design specification including environmental req.	**4**
	Specify packaging and delivery requirements	**5**
Make	Schedule production to minimize energy consumption	**4**
	Manage waste generated during the production process	**4**
	Manage emissions (air and water) from production	**4**
Deliver	Minimize use of packaging materials	**4**
	Schedule shipments to minimize fuel consumption	**3**
	Retrieve packaging material for re-use	**4**
Return	Don't physically return product beyond economic repair	**5**
	Aggregate return shipments to minimize fuel consumption	**4**

TABLE 8: GREEN SCOR PRACTICE IMPLEMENTATION RATING FOR COMPANY D

	Measurable	KPI	Compliance Rating
Economic	Quality of products	% of good products	**5**
	Customer service level	On-time delivery	**5**
	Product availability	% demand met	**5**
	Transportation	Transit time (TT) variability	**5**
	Utilization	Capacity utilization	**1**
	Productivity	Inventory turnover ratio	**1**
	Cost reduction	Total Logistics cost	**5**
	Response to customer needs	Order fulfillment lead time	**5**
	Flexibility	Supply Chain Response Time	**5**
Environmental	Carbon dioxide	Carbon emissions	**5**
	Air pollutant	Air pollutant emissions	**5**
	Fuel	Fuel consumption	**1**
	Energy	Energy consumption	**5**
	Water	Water consumption	**5**
	Waste	% recycled waste	**5**
	Materials/products recycle	% of packaging recyclable	**5**
Social	Toxic, hazardous emissions	Amount of unwanted emissions	**1**
	Accidents	Accident occurrence	**1**
	Noise volume	Noise reduction	**1**
	Employment	Recruitment for GSCM	**1**
	Training	Training on GSCM	**1**

TABLE 9: LOGISTICS METRICS COMPLIANCE RATING FOR COMPANY D

5.3.3 COMPANY E CASE ANALYSIS

Based on the response of the interviewee and the coding scheme used, Company E's overall response summary can be presented as following:

1. The Green SCOR process which is most dominant within the Company E organization is presented in figure 42. From the figure it can deduced that Green Make process gets the maximum weight among all the processes. Next to this Green Source and Plan process ranks in the priority list. The Green Delivery & Return process scores low in the overall priority list.

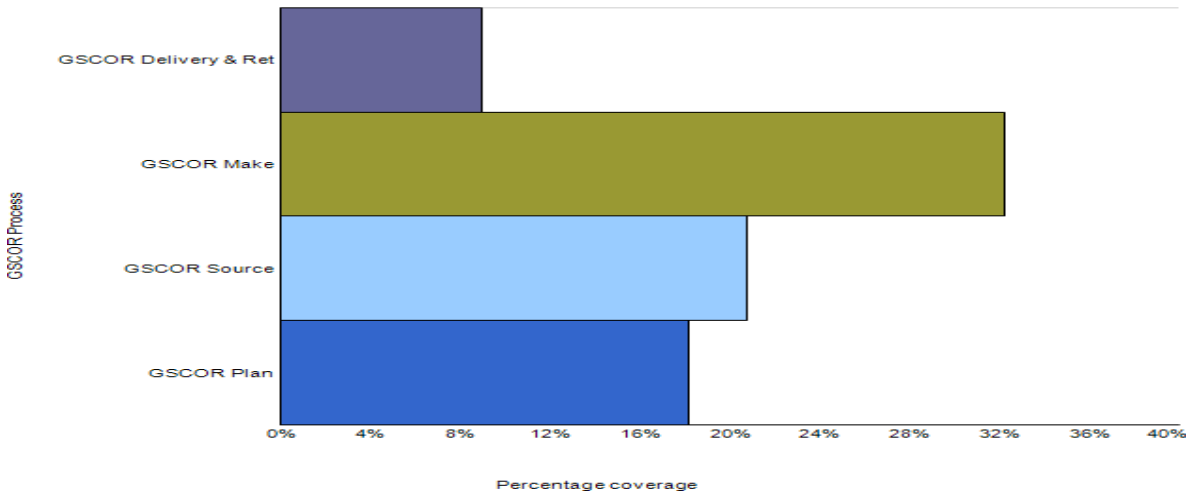


FIGURE 39: COMPANY E GSCOR PROCESS DOMINANCE

2. The green supply chain practices which are most widely used across the Green SCOR plan process is illustrated in figure 43. From the figure it can be inferred that practices emphasizing the environmental policies are high on agenda. The practices confining with end-of-life issues of the product is second followed by the practices pertaining to environmental regulations. The practices which help in achieving the opportunities looked up by being green come last in the agenda list.

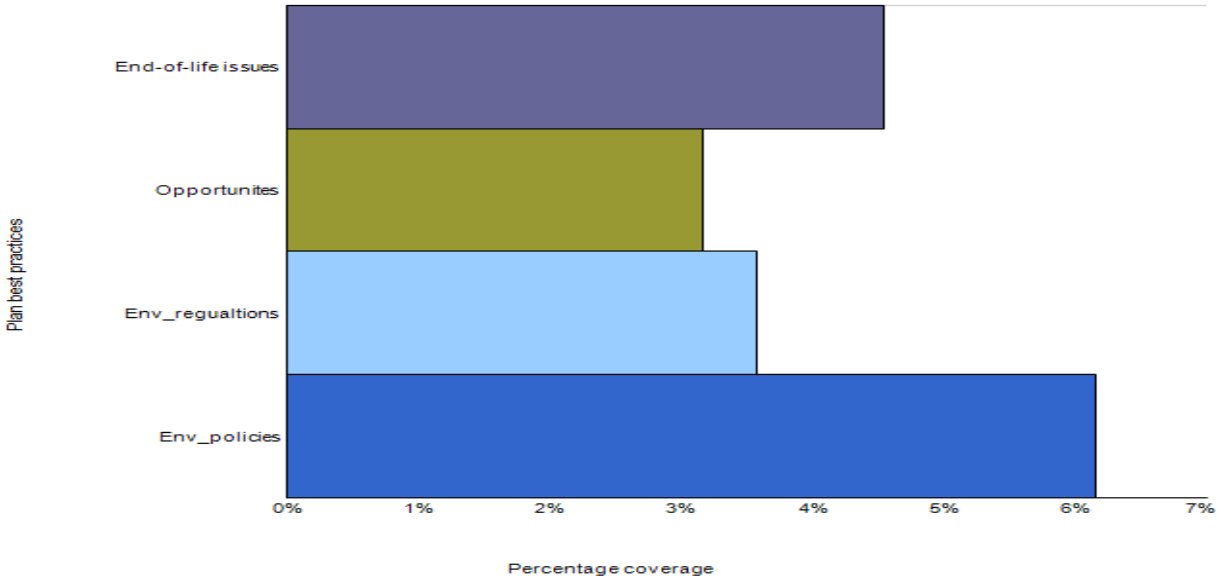


FIGURE 40: GSCOR BEST PRACTICES WITHIN THE GSCOR PLAN PROCESS

3. The green supply chain practices which are most widely used across the Green SCOR sourcing process is illustrated in figure 44. From the figure it can be deduced that practices emphasizing the supplier's environmental commitments come first on priority list. The practices pertaining to environmental friendly packaging ranks second in the priority list of Company E. Practices emphasizing the product R&D stressing on product energy consumption, hazardous material content comes third on priority list followed by supplier selections and environmental friendly transportation of the product.

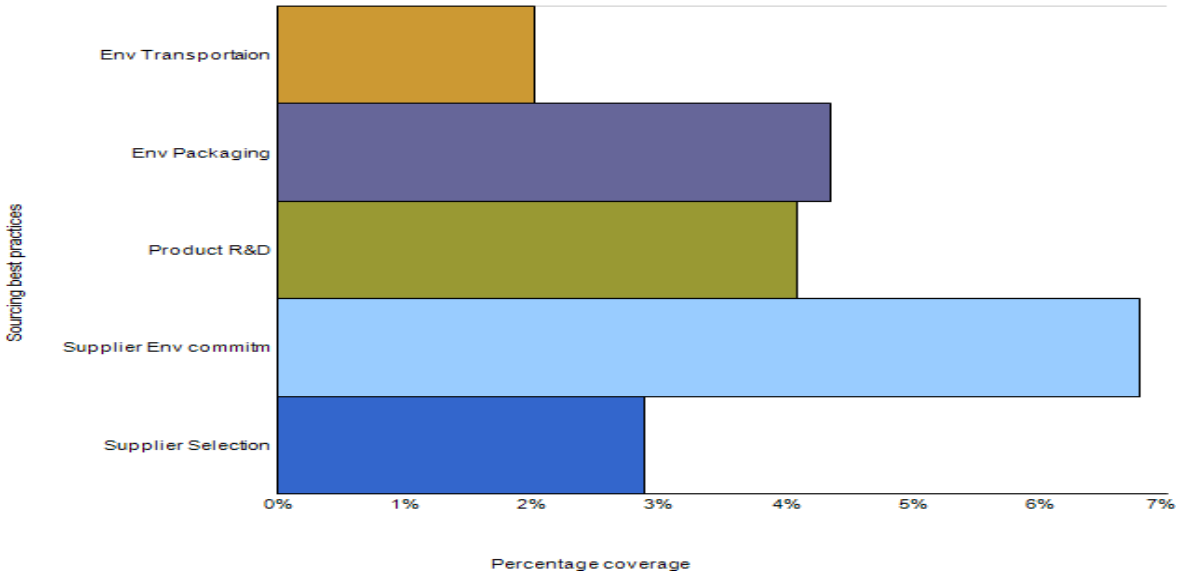


FIGURE 41: GSCOR BEST PRACTICES WITHIN THE GSCOR SOURCE PROCESS

4. The green supply chain practices which are most widely used across the Green SCOR making process in Company E is illustrated in figure 45. From the figure it can be inferred that practices emphasizing environmental certification ranks high on the agenda. The practices confining with energy control and waste minimization & recycling comes second in the priority list. The practices pertaining to emission control not very ranked high in the importance list.

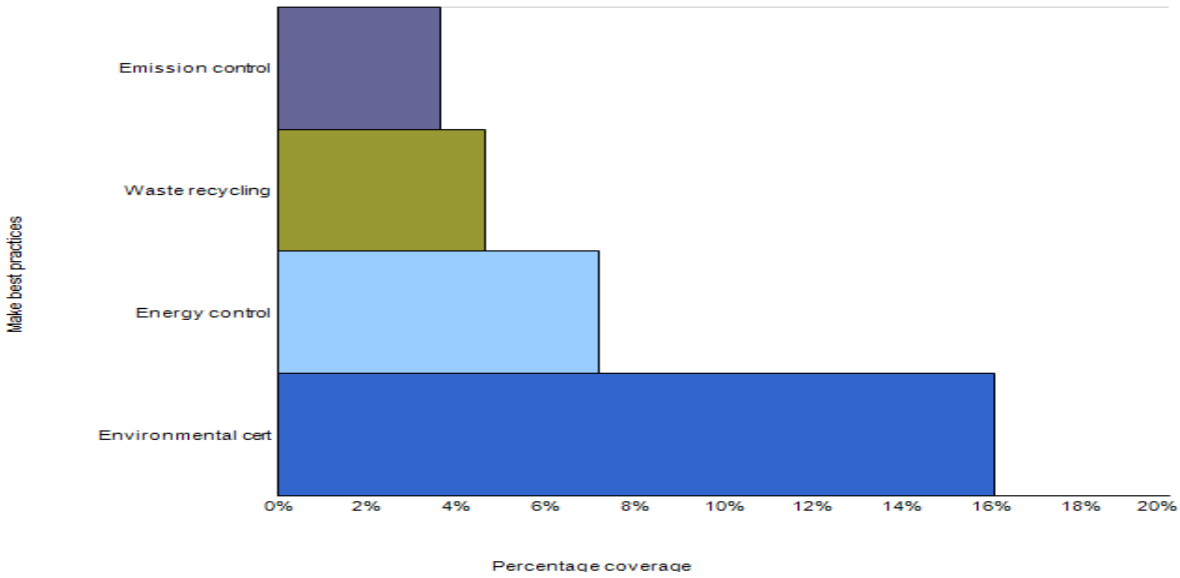


FIGURE 42: GSCOR BEST PRACTICES WITHIN THE GSCOR MAKE PROCESS

5. The green supply chain practices which are most widely used across the Green SCOR delivery and return process in Company E is illustrated in figure 46. From the figure it can be inferred that practices emphasizing green transportation are ranked high on agenda. The practices confining with green packaging at downstream of the supply chain comes second in the priority list.

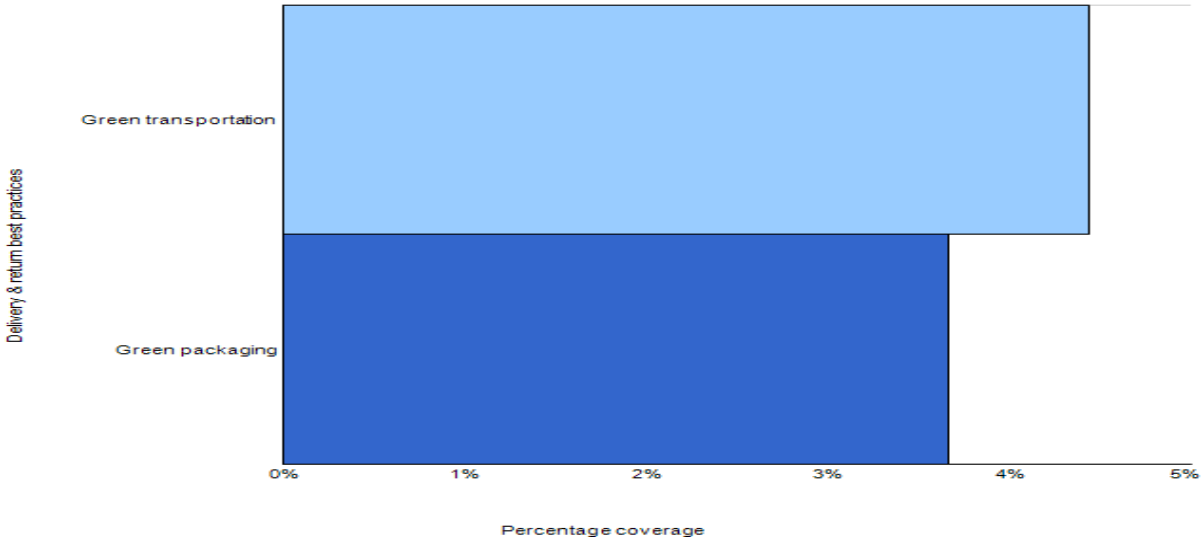


FIGURE 43: GSCOR BEST PRACTICES WITHIN THE GSCOR DELIVERY & RETURN PROCESS

6. The logistics metrics which are most widely used across the supply chain of Company E is illustrated in figure 47. From the figure it can be inferred that economic and

environmental attributes are most commonly used logistics metrics. No form of social metrics is used to determine efficiency of logistics.

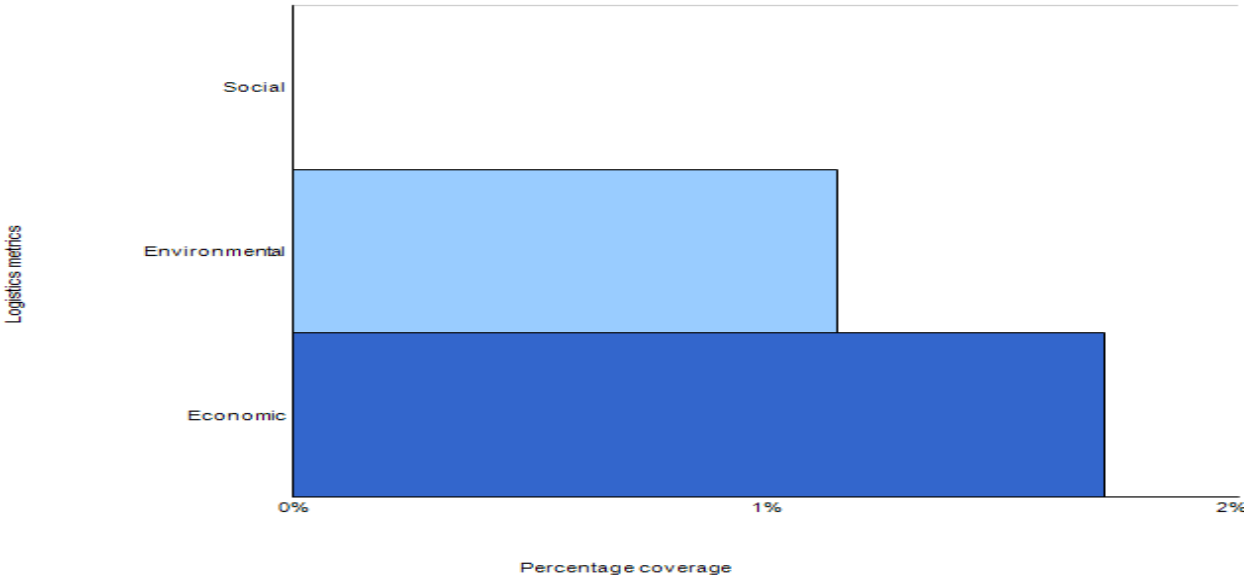


FIGURE 44: LOGISTICS METRICS USED BY COMPANY E

7. The table below illustrates the compliance of the various green SCOR best practices and logistics metrics shortlisted from the literature across the Company E.

Green SCOR Process	Green SCOR best practices	Compliance Rating
Plan	Minimize energy consumption & hazardous material	**4**
	Strive for establishing univocal environmental policies	**3**
	Proper handling and storage of hazardous material	**4**
	Collaborate with SC partners on environmental issues	**4**
Source	Select suppliers with EMS in place	**3**
	Suppliers supplying environmentally friendly content	**4**
	Specify design specification including environmental req.	**3**
	Specify packaging and delivery requirements	**3**
Make	Schedule production to minimize energy consumption	**3**
	Manage waste generated during the production process	**3**
	Manage emissions (air and water) from production	**3**
Deliver	Minimize use of packaging materials	**4**
	Schedule shipments to minimize fuel consumption	**3**
	Retrieve packaging material for re-use	**2**
Return	Don't physically return product beyond economic repair	**2**
	Aggregate return shipments to minimize fuel consumption	**2**

TABLE 10: GREEN SCOR PRACTICE IMPLEMENTATION RATING FOR COMPANY E

	Measurable	KPI	Compliance Rating
Economic	Quality of products	% of good products	**5**
	Customer service level	On-time delivery	**5**
	Product availability	% demand met	**1**
	Transportation	Transit time (TT) variability	**5**
	Utilization	Capacity utilization	**1**
	Productivity	Inventory turnover ratio	**1**
	Cost reduction	Total Logistics cost	**5**
	Response to customer needs	Order fulfillment lead time	**5**
	Flexibility	Supply Chain Response Time	**5**
Environmental	Carbon dioxide	Carbon emissions	**1**
	Air pollutant	Air pollutant emissions	**5**
	Fuel	Fuel consumption	**1**
	Energy	Energy consumption	**5**
	Water	Water consumption	**5**
	Waste	% recycled waste	**5**
	Materials/products recycle	% of packaging recyclable	**1**
Social	Toxic, hazardous emissions	Amount of unwanted emissions	**1**
	Accidents	Accident occurrence	**1**
	Noise volume	Noise reduction	**1**
	Employment	Recruitment for GSCM	**1**
	Training	Training on GSCM	**1**

TABLE 11: LOGISTICS METRICS COMPLIANCE RATING FOR COMPANY E

5.3.4 COMPANY F CASE ANALYSIS

Based on the response of the interviewee and the coding scheme used, Company F's overall response summary can be presented as following:

1. The Green SCOR process which is most dominant within the Company E organization is presented in figure 48. From the figure it can be deduced that Green Plan process gets the maximum weight among all the processes. Next to this Green Source and Make process ranks in the priority list. The Green Delivery & Return process scores low in the overall priority list.

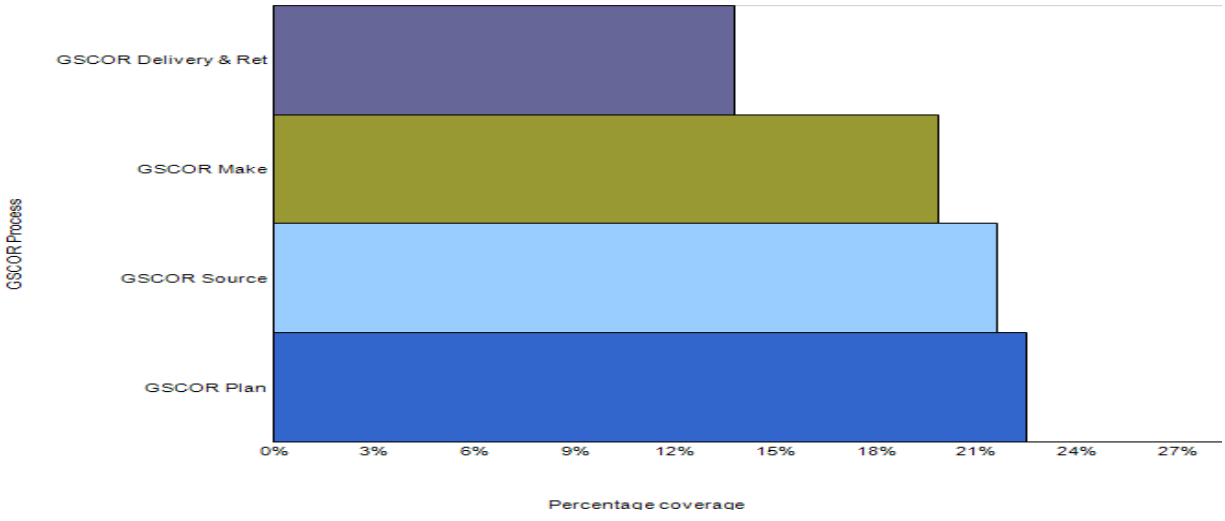


FIGURE 45: COMPANY F GSCOR PROCESS DOMINANCE

2. The green supply chain practices which are most widely used across the Green SCOR plan process is illustrated in figure 49. From the figure it can be inferred that practices emphasizing the environmental regulations are important for Company F. The practices confining with environmental policies is second followed by the practices which help in achieving the opportunities looked up by being green. The practices pertaining to product end-of-life issues come last in the agenda list.

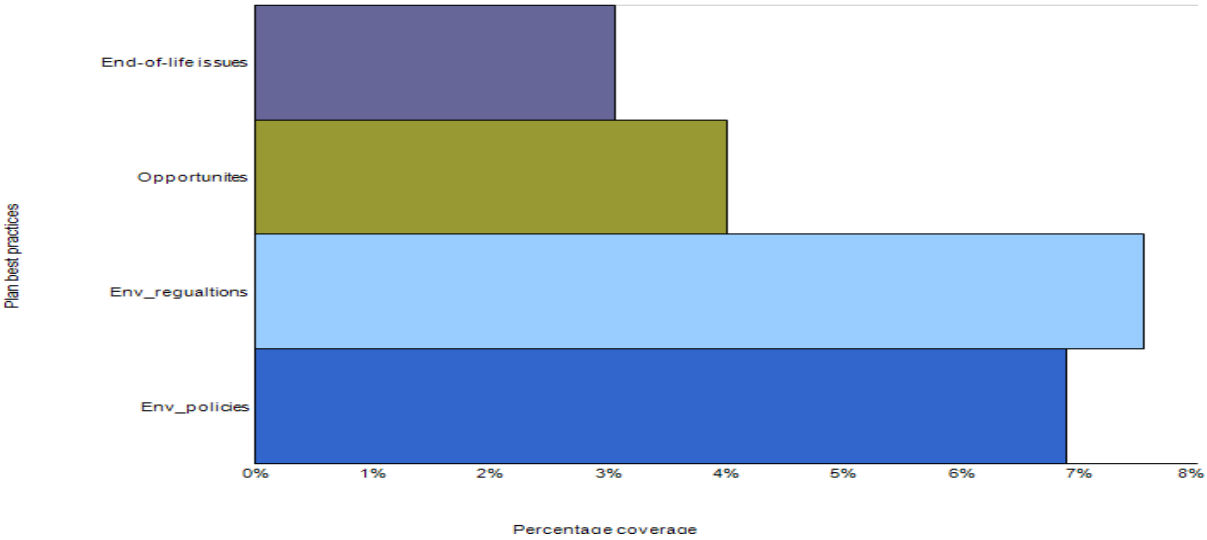


FIGURE 46: GSCOR BEST PRACTICES WITHIN THE GSCOR PLAN PROCESS

3. The green supply chain practices which are most widely used across the Green SCOR sourcing process is illustrated in figure 50. From the figure it can be inferred that practices emphasizing the product R&D stressing on product energy consumption, hazardous material content comes first on priority list. The supplier's environmental commitments lie next on the agenda followed by practices confining with selection of suppliers. The practices pertaining to environmental friendly transportation of the product and environmental friendly packaging, ranks low in the priority list of Company F.

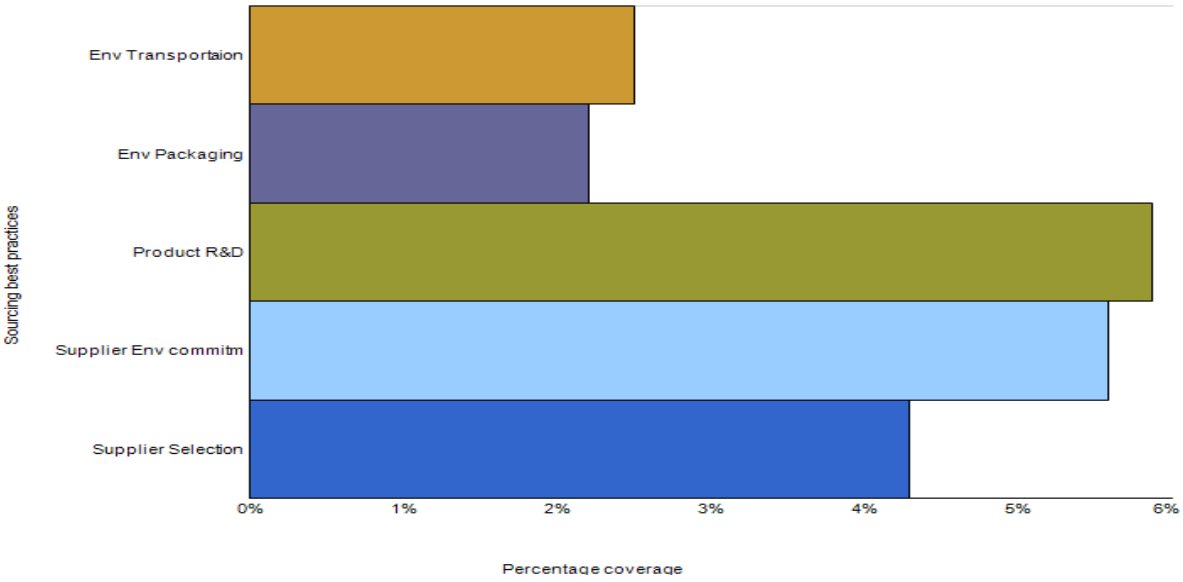


FIGURE 47: GSCOR BEST PRACTICES WITHIN THE GSCOR SOURCE PROCESS

4. The green supply chain practices which are most widely used across the Green SCOR making process in Company F is illustrated in figure 51. From the figure it can be inferred that practices emphasizing waste recycling and energy control are ranked high on agenda. The practices confining with emission control comes second in the priority list. The practices pertaining to attainment of environmental certifications is not at all looked upon in the existing phase.

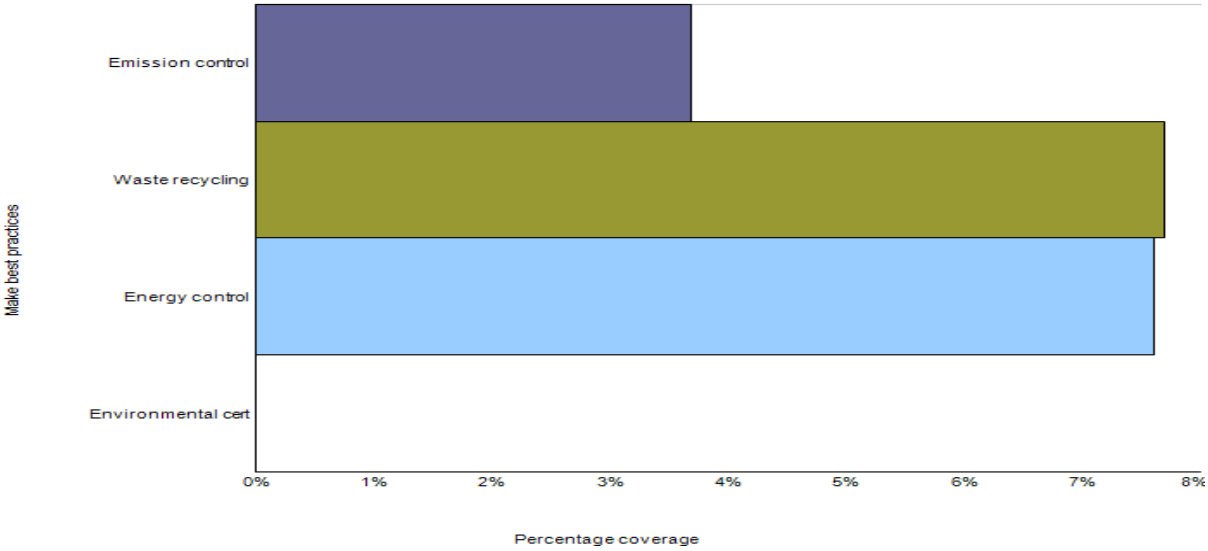


FIGURE 48: GSCOR BEST PRACTICES WITHIN THE GSCOR MAKE PROCESS

5. The green supply chain practices which are most widely used across the Green SCOR delivery and return process in Company F is illustrated in figure 52. From the figure it can be inferred that practices emphasizing green packaging are ranked high on agenda. The practices confining with green transportation at downstream of the supply chain comes second in the priority list.

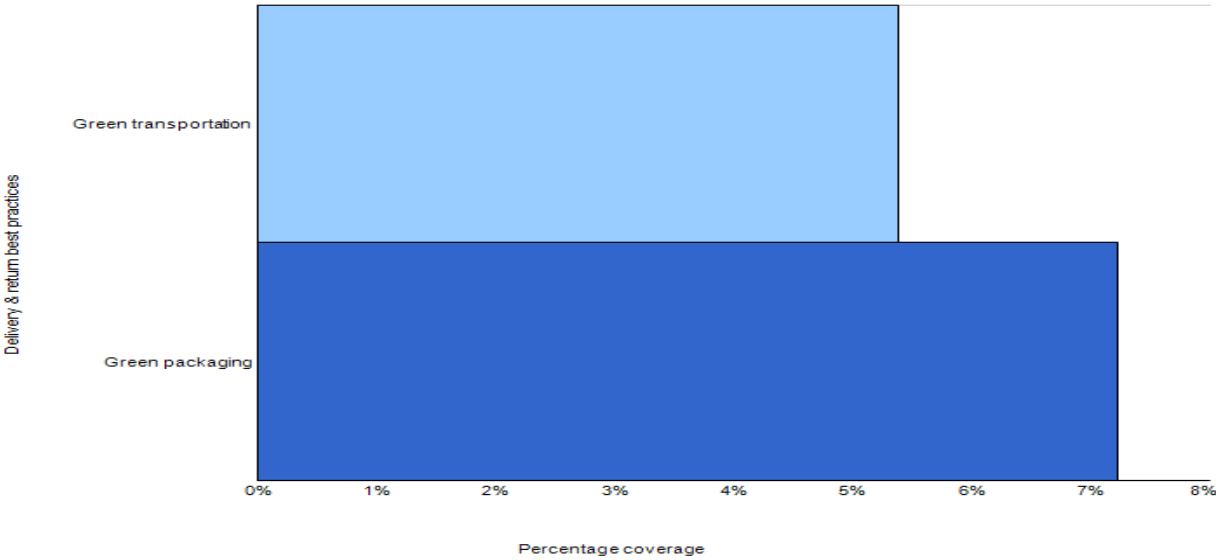


FIGURE 49: GSCOR BEST PRACTICES WITHIN THE GSCOR DELIVERY & RETURN PROCESS

6. The logistics metrics which are most widely used across the supply chain of Company E is illustrated in figure 53. From the figure it can be inferred that only economic attributes are most commonly used logistics metrics. No forms of social or environmental metrics are being used to determine efficiency of logistics.

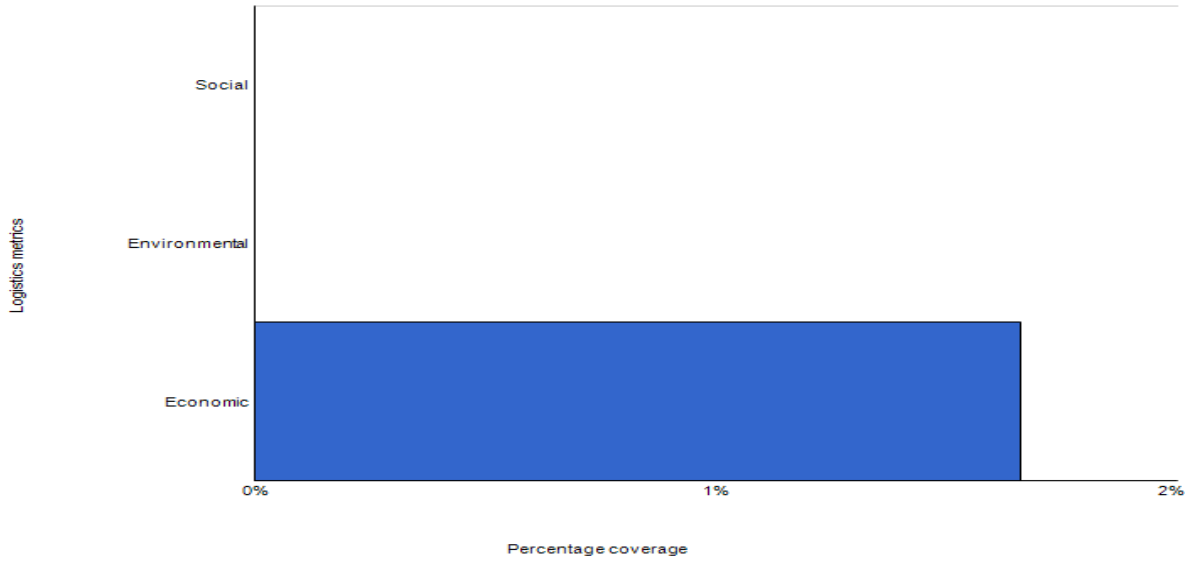


FIGURE 50: LOGISTICS METRICS USED BY COMPANY F

7. The table below illustrates the compliance of the various green SCOR best practices and logistics metrics shortlisted from the literature across the Company F.

Green SCOR Process	Green SCOR best practices	Compliance Rating
Plan	Minimize energy consumption & hazardous material	**4**
	Strive for establishing univocal environmental policies	**3**
	Proper handling and storage of hazardous material	**2**
	Collaborate with SC partners on environmental issues	**2**
Source	Select suppliers with EMS in place	**3**
	Suppliers supplying environmentally friendly content	**4**
	Specify design specification including environmental req.	**4**
	Specify packaging and delivery requirements	**3**
Make	Schedule production to minimize energy consumption	**2**
	Manage waste generated during the production process	**3**
	Manage emissions (air and water) from production	**4**
Deliver	Minimize use of packaging materials	**2**
	Schedule shipments to minimize fuel consumption	**3**
	Retrieve packaging material for re-use	**2**
Return	Don't physically return product beyond economic repair	**1**
	Aggregate return shipments to minimize fuel consumption	**2**

TABLE 12: GREEN SCOR PRACTICE IMPLEMENTATION RATING FOR COMPANY F

	Measurable	KPI	Compliance Rating
Economic	Quality of products	% of good products	**5**
	Customer service level	On-time delivery	**5**
	Product availability	% demand met	**1**
	Transportation	Transit time (TT) variability	**5**
	Utilization	Capacity utilization	**1**
	Productivity	Inventory turnover ratio	**5**
	Cost reduction	Total Logistics cost	**5**
	Response to customer needs	Order fulfillment lead time	**5**
	Flexibility	Supply Chain Response Time	**5**
Environmental	Carbon dioxide	Carbon emissions	**1**
	Air pollutant	Air pollutant emissions	**1**
	Fuel	Fuel consumption	**1**
	Energy	Energy consumption	**1**
	Water	Water consumption	**1**
	Waste	% recycled waste	**1**
	Materials/products recycle	% of packaging recyclable	**1**
Social	Toxic, hazardous emissions	Amount of unwanted emissions	**1**
	Accidents	Accident occurrence	**1**
	Noise volume	Noise reduction	**1**
	Employment	Recruitment for GSCM	**1**
	Training	Training on GSCM	**1**

TABLE 13: LOGISTICS METRICS COMPLIANCE RATING FOR COMPANY F

5.3.5 COMPANY B CASE ANALYSIS

Based on the response of the interviewee and the coding scheme used, Company B's overall response summary can be presented as following:

1. The Green SCOR process which is most dominant within the Company B organization is presented in figure 54. From the figure it can be deduced that Green Source process gets the maximum weight among all the processes. Next to this Green Make which is followed by Green Plan process in the priority list. The Green Delivery & Return process scores low in the overall priority list.

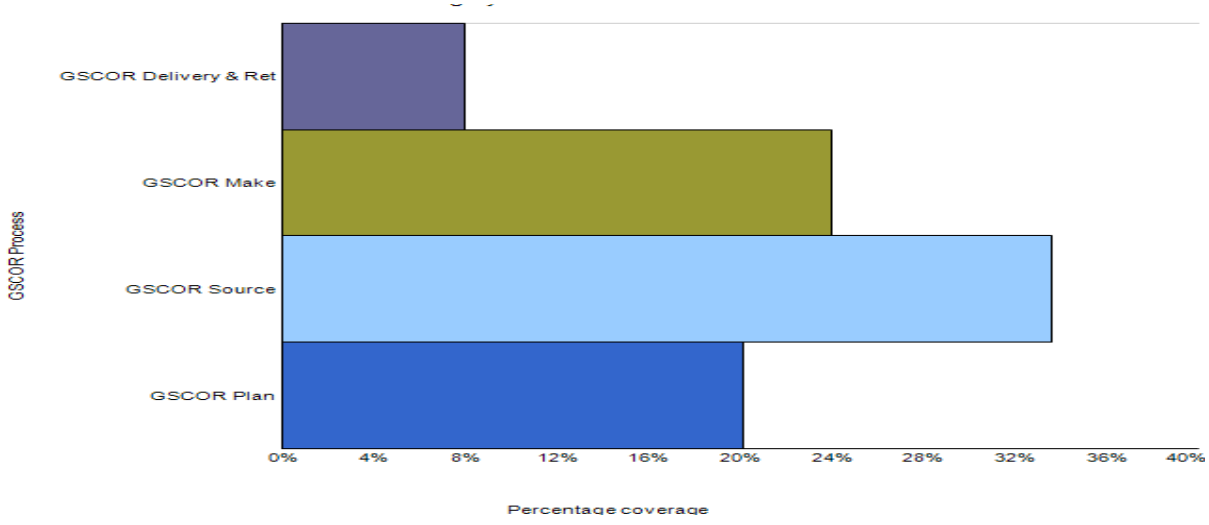


FIGURE 51: COMPANY B GSCOR PROCESS DOMINANCE

2. The green supply chain practices which are most widely used across the Green SCOR plan process is illustrated in figure 55. From the figure it can be inferred that practices emphasizing the environmental policies are important for Company B. The practices confining with environmental regulations is second followed by the practices which help in achieving the opportunities looked up by being green. The practices pertaining to product end-of-life issues come last in the agenda list.

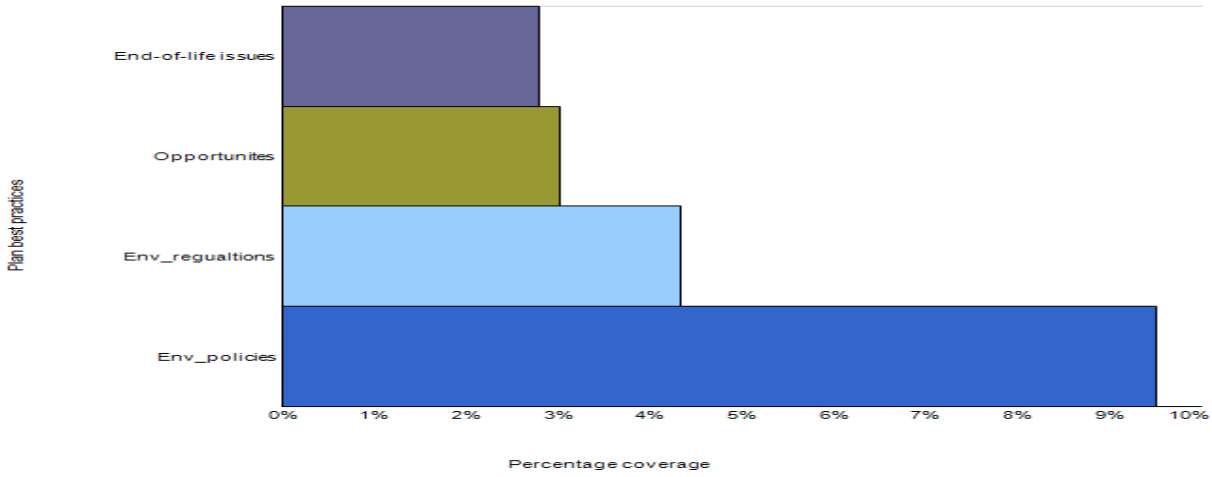


FIGURE 52: GSCOR BEST PRACTICES WITHIN THE GSCOR PLAN PROCESS

3. The green supply chain practices which are most widely used across the Green SCOR sourcing process is illustrated in figure 56. From the figure it can be deduced that practices emphasizing the supplier's environmental commitments come first on priority list. Practices emphasizing the product R&D stressing on product energy consumption, hazardous material content comes second on priority list followed by supplier selection practices. The practices pertaining to environmental friendly transportation & and environmental friendly packaging ranks low in the list.

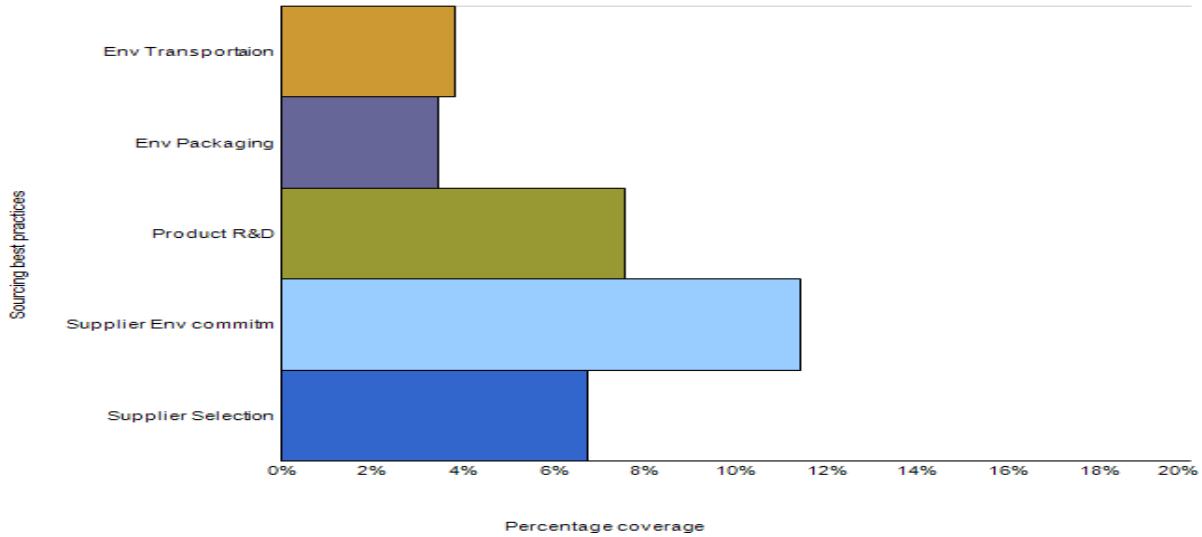


FIGURE 53: GSCOR BEST PRACTICES WITHIN THE GSCOR SOURCE PROCESS

4. The green supply chain practices which are most widely used across the Green SCOR making process in Company B is illustrated in figure 57. From the figure it can be inferred that practices emphasizing energy and emission control are ranked high on agenda. The practices confining with waste recycling comes next in the priority list. The

practices pertaining to attainment of environmental certifications for the manufacturing plant is not at all looked in the current phase.

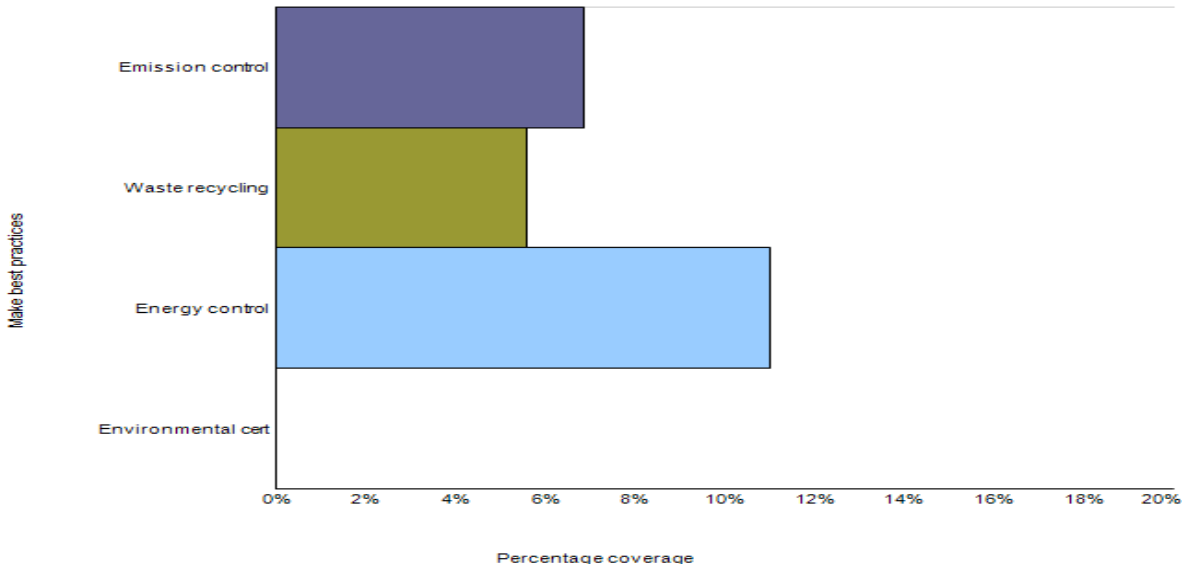


FIGURE 54: GSCOR BEST PRACTICES WITHIN THE GSCOR MAKE PROCESS

5. The green supply chain practices which are most widely used across the Green SCOR delivery and return process in Company E is illustrated in figure 58. From the figure it can be inferred that practices emphasizing green transportation are ranked high on agenda. The practices confining with green packaging at downstream of the supply chain comes second in the priority list.

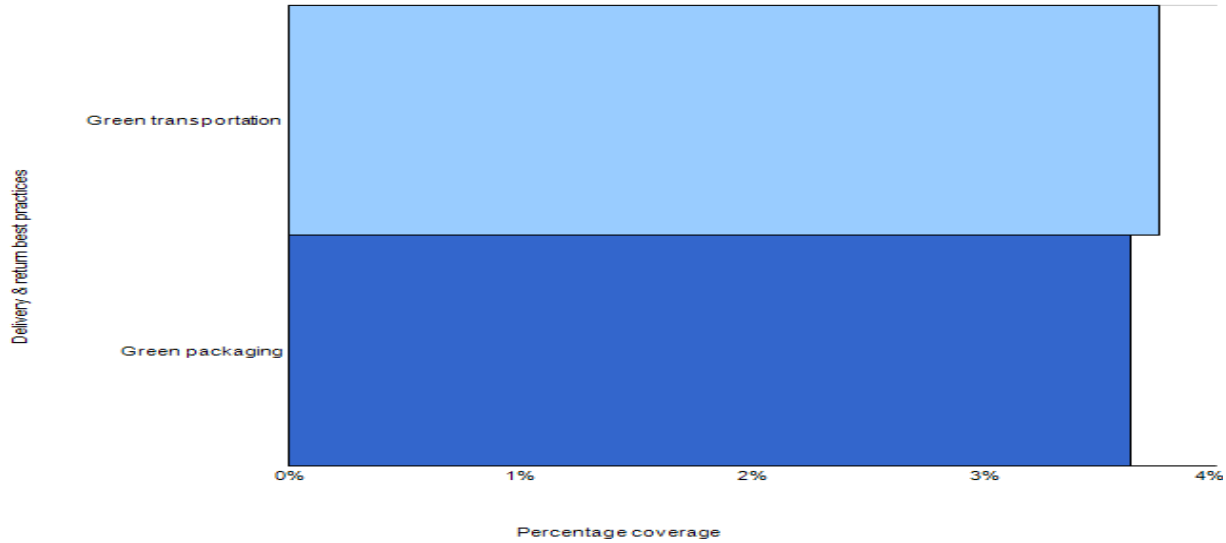


FIGURE 55: GSCOR BEST PRACTICES WITHIN THE GSCOR DELIVERY & RETURN PROCESS

6. The logistics metrics which are most widely used across the supply chain of Company B is illustrated in figure 59. From the figure it can be inferred that economic attributes are most widely used by Company B to measure its logistics performance. The environmental attributes comes next in the logistics metric list. The social metrics doesn't have a very priority in the metric list and only health & safety related attribute such as toxic and hazardous emission control along with the number of any fatal accident occurrence are usually measured to determine efficiency of logistics.

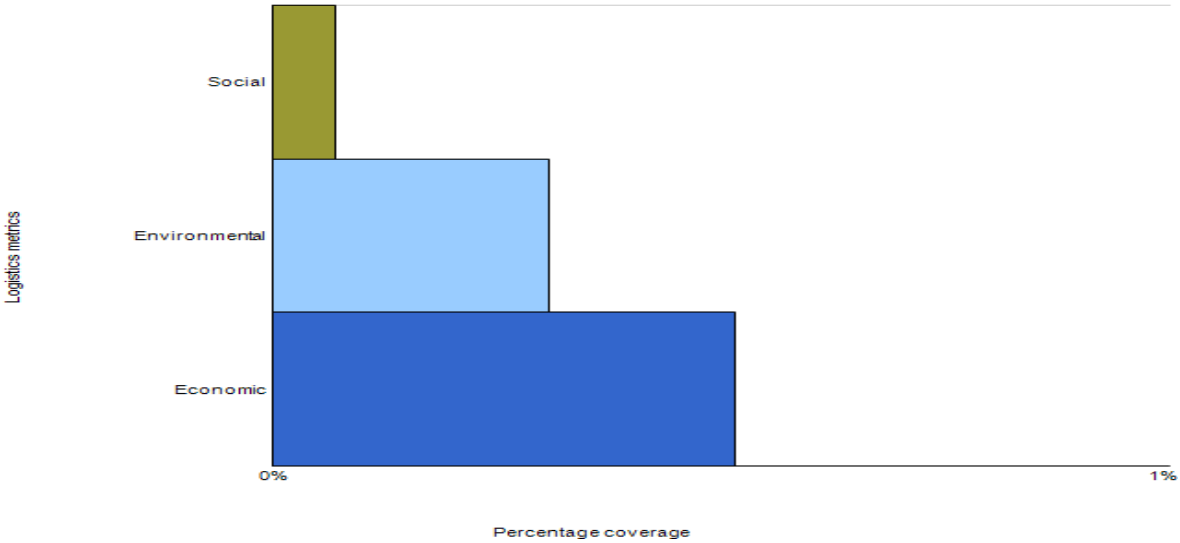


FIGURE 56: LOGISTICS METRICS USED BY COMPANY B

7. The table below illustrates the compliance of the various green SCOR best practices and logistics metrics shortlisted from the literature across the Company B.

Green SCOR Process	Green SCOR best practices	Compliance Rating
Plan	Minimize energy consumption & hazardous material	**5**
	Strive for establishing univocal environmental policies	**4**
	Proper handling and storage of hazardous material	**4**
	Collaborate with SC partners on environmental issues	**3**
Source	Select suppliers with EMS in place	**3**
	Suppliers supplying environmentally friendly content	**4**
	Specify design specification including environmental req.	**4**
	Specify packaging and delivery requirements	**5**
Make	Schedule production to minimize energy consumption	**4**
	Manage waste generated during the production process	**4**
	Manage emissions (air and water) from production	**3**
Deliver	Minimize use of packaging materials	**3**
	Schedule shipments to minimize fuel consumption	**2**
	Retrieve packaging material for re-use	**3**
Return	Don't physically return product beyond economic repair	**3**
	Aggregate return shipments to minimize fuel consumption	**3**

TABLE 14: GREEN SCOR PRACTICE IMPLEMENTATION RATING FOR COMPANY B

	Measurable	KPI	Compliance Rating
Economic	Quality of products	% of good products	**5**
	Customer service level	On-time delivery	**5**
	Product availability	% demand met	**1**
	Transportation	Transit time (TT) variability	**1**
	Utilization	Capacity utilization	**1**
	Productivity	Inventory turnover ratio	**1**
	Cost reduction	Total Logistics cost	**5**
	Response to customer needs	Order fulfillment lead time	**5**
	Flexibility	Supply Chain Response Time	**5**
Environmental	Carbon dioxide	Carbon emissions	**5**
	Air pollutant	Air pollutant emissions	**1**
	Fuel	Fuel consumption	**5**
	Energy	Energy consumption	**1**
	Water	Water consumption	**5**
	Waste	% recycled waste	**1**
	Materials/products recycle	% of packaging recyclable	**1**
Social	Toxic, hazardous emissions	Amount of unwanted emissions	**1**
	Accidents	Accident occurrence	**5**
	Noise volume	Noise reduction	**1**
	Employment	Recruitment for GSCM	**1**
	Training	Training on GSCM	**1**

TABLE 15: LOGISTICS METRICS COMPLIANCE RATING FOR COMPANY B

5.3.6 COMPANY C CASE ANALYSIS

Based on the response of the interviewee and the coding scheme used, Company C's overall response summary can be presented as following:

1. The Green SCOR process which is most dominant within the Company C organization is presented in figure 60. From the figure it can be deduced that Green Plan process gets the maximum weight among all the processes. Next to this Green Source process which is followed by Green Make process in the priority list. The Green Delivery & Return process scores low in the overall priority list.

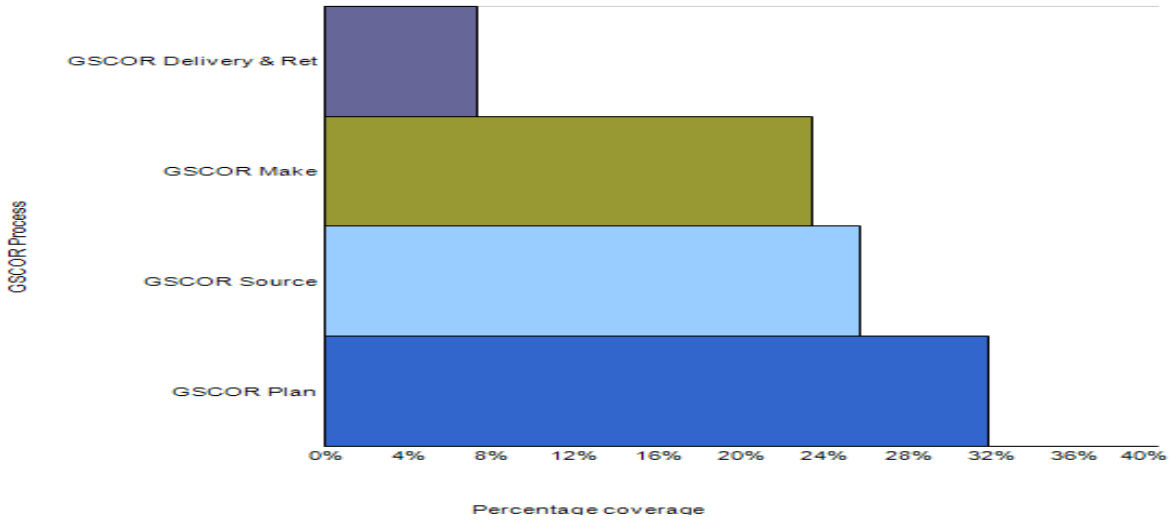


FIGURE 57: COMPANY C GSCOR PROCESS DOMINANCE

2. The green supply chain practices which are most widely used across the Green SCOR plan process is illustrated in figure 61. From the figure it can be inferred that practices emphasizing the environmental policies are high on agenda. The practices confining with end-of-life issues of the product is second followed by the practices pertaining to the opportunities looked up by being green. The practices related to environmental regulations ranks low in the priority list.

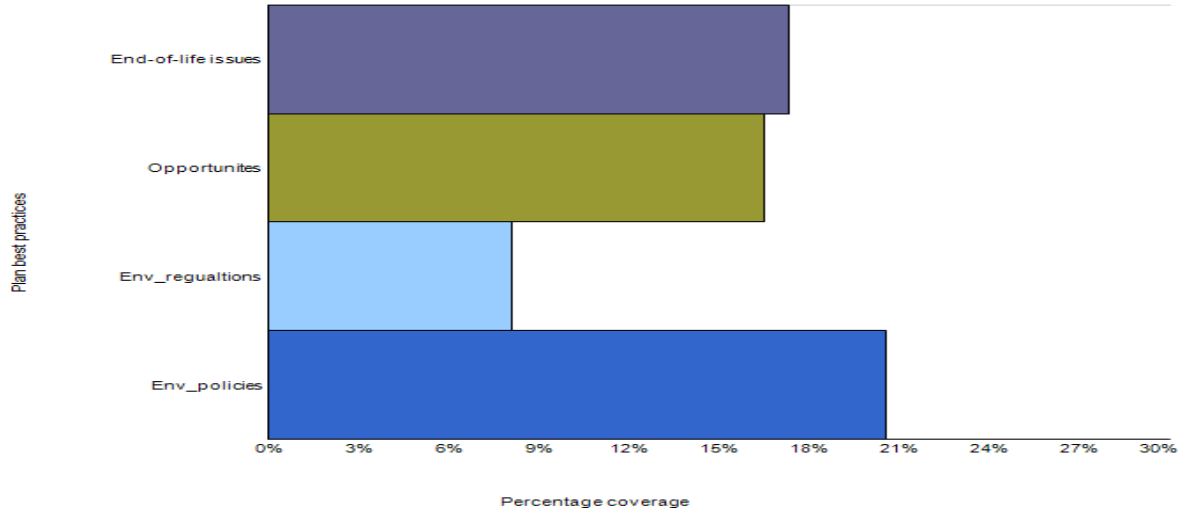


FIGURE 58: GSCOR BEST PRACTICES WITHIN THE GSCOR PLAN PROCESS

3. The green supply chain practices which are most widely used across the Green SCOR sourcing process is illustrated in figure 62. From the figure it can be inferred that practices confine with selection of suppliers and product R&D stressing on product energy consumption, hazardous material content is ranked high on important list. These practices are followed by the practices pertaining to the supplier's environmental commitments, however emphasis on environmental packaging and transportation is null in the upstream of the supply chain of Company C.

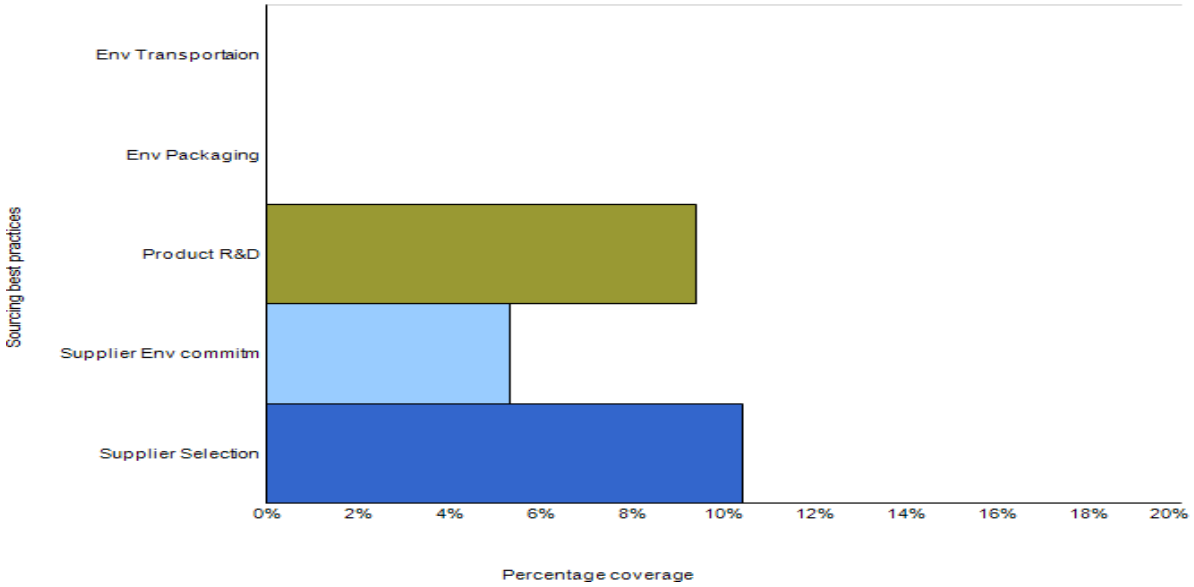


FIGURE 59: GSCOR BEST PRACTICES WITHIN THE GSCOR SOURCE PROCESS

4. The green supply chain practices which are most widely used across the Green SCOR making process in Company A is illustrated in figure 63. From the figure it can be inferred that practices emphasizing energy control are ranked high on agenda. The practices confining with emission and waste minimization & recycling comes second in the priority list. The practices pertaining to attainment of environmental certifications is not very ranked high in the importance list.

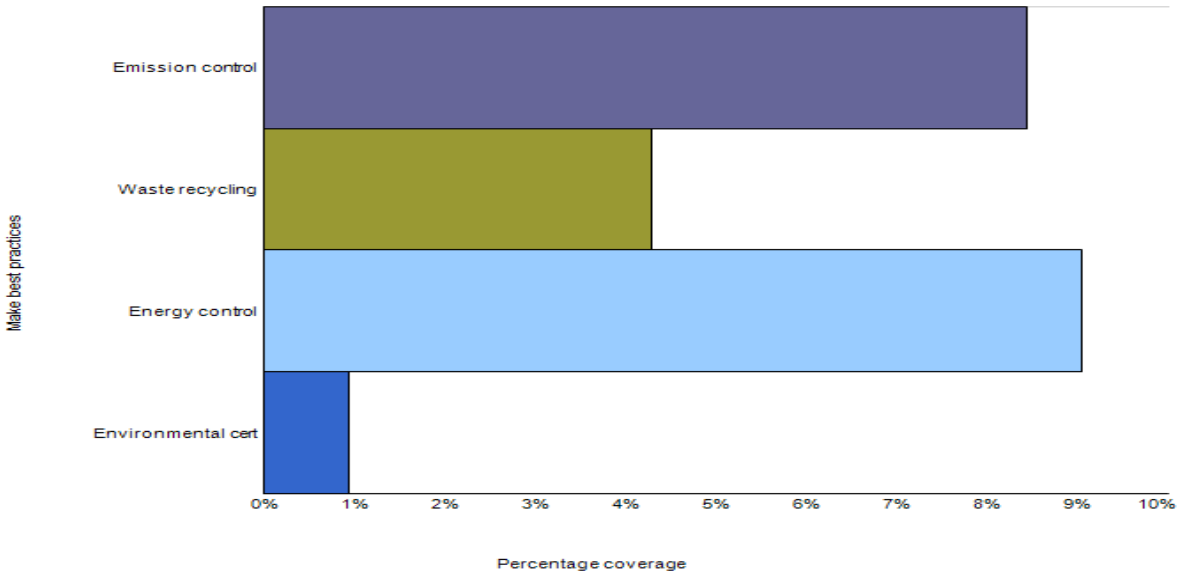


FIGURE 60: GSCOR BEST PRACTICES WITHIN THE GSCOR MAKE PROCESS

5. The green supply chain practices which are most widely used across the Green SCOR delivery and return process in Company C is illustrated in figure 64. From the figure it can be inferred that practices emphasizing green transportation are ranked high on agenda. The practices confining with green packaging at downstream of the supply chain comes second in the priority list.

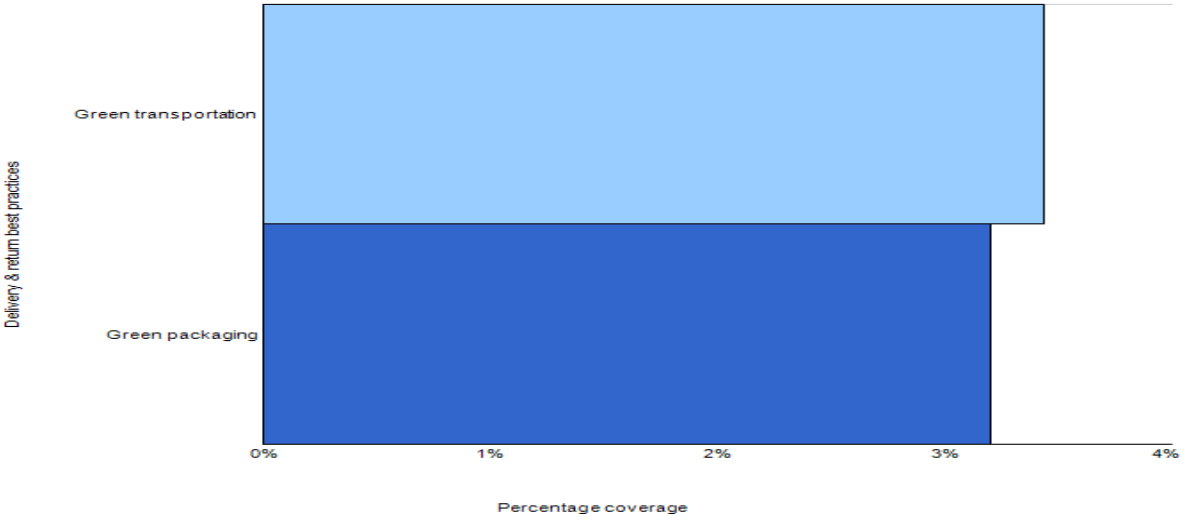


FIGURE 61: GSCOR BEST PRACTICES WITHIN THE GSCOR DELIVERY & RETURN PROCESS

6. The logistics metrics which are most widely used across the supply chain of Company C is illustrated in figure 65. From the figure it can be inferred that environmental attributes are most widely used by Company C to measure its logistics performance. The

economic attributes comes next in the logistics metric list. The social metrics doesn't have a very priority in the metric list and only health & safety related attribute such as toxic and hazardous emission control along with the number of any fatal accident occurrence are usually measured to determine efficiency of logistics.

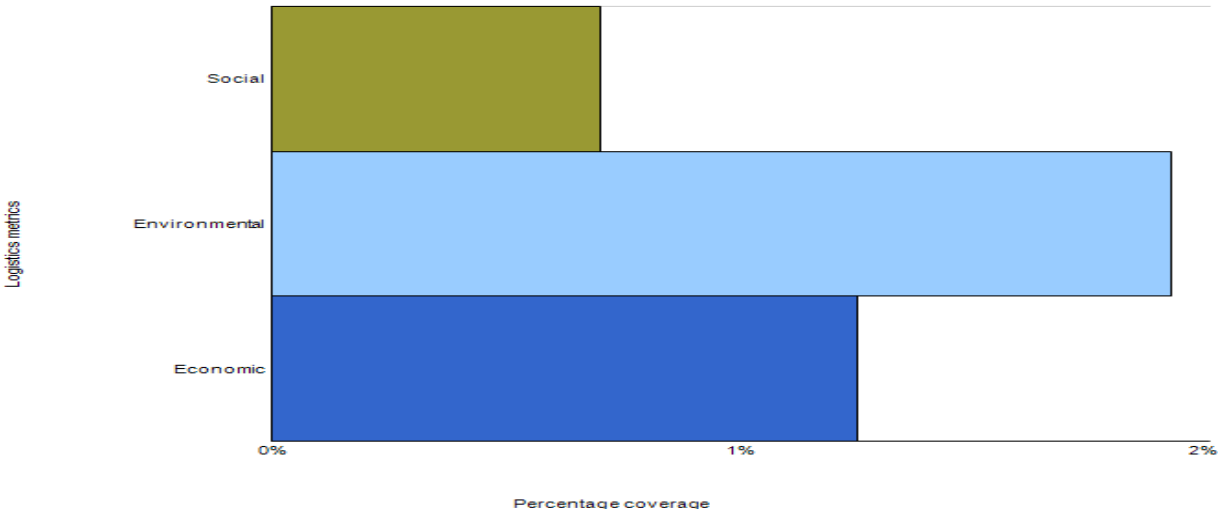


FIGURE 62: LOGISTICS METRICS USED BY COMPANY C

7. The table below illustrates the compliance of the various green SCOR best practices and logistics metrics shortlisted from the literature across the Company C.

Green SCOR Process	Green SCOR best practices	Compliance Rating
Plan	Minimize energy consumption & hazardous material	**4**
	Strive for establishing univocal environmental policies	**4**
	Proper handling and storage of hazardous material	**4**
	Collaborate with SC partners on environmental issues	**3**
Source	Select suppliers with EMS in place	**4**
	Suppliers supplying environmentally friendly content	**3**
	Specify design specification including environmental req.	**4**
	Specify packaging and delivery requirements	**5**
Make	Schedule production to minimize energy consumption	**4**
	Manage waste generated during the production process	**4**
	Manage emissions (air and water) from production	**3**
Deliver	Minimize use of packaging materials	**4**
	Schedule shipments to minimize fuel consumption	**4**
	Retrieve packaging material for re-use	**3**
Return	Don't physically return product beyond economic repair	**3**
	Aggregate return shipments to minimize fuel consumption	**3**

TABLE 16: GREEN SCOR PRACTICE IMPLEMENTATION RATING FOR COMPANY C

	Measurable	KPI	Compliance Rating
Economic	Quality of products	% of good products	**5**
	Customer service level	On-time delivery	**1**
	Product availability	% demand met	**1**
	Transportation	Transit time (TT) variability	**1**
	Utilization	Capacity utilization	**1**
	Productivity	Inventory turnover ratio	**1**
	Cost reduction	Total Logistics cost	**5**
	Response to customer needs	Order fulfillment lead time	**5**
	Flexibility	Supply Chain Response Time	**5**
Environmental	Carbon dioxide	Carbon emissions	**5**
	Air pollutant	Air pollutant emissions	**5**
	Fuel	Fuel consumption	**5**
	Energy	Energy consumption	**5**
	Water	Water consumption	**5**
	Waste	% recycled waste	**5**
	Materials/products recycle	% of packaging recyclable	**5**
Social	Toxic, hazardous emissions	Amount of unwanted emissions	**5**
	Accidents	Accident occurrence	**5**
	Noise volume	Noise reduction	**1**
	Employment	Recruitment for GSCM	**1**
	Training	Training on GSCM	**1**

TABLE 17: LOGISTICS METRICS COMPLIANCE RATING FOR COMPANY C

5.4 CROSS CASE ANALYSIS

The cross case analysis is being performed in order to diagnose and extract following key things from the data collected and the within case analysis performed.

- The green supply chain practices which are mostly used by the companies.
- The logistics metrics which are most widely used by the companies.
- The relationship between the green practices with the economic, environmental and social logistics performance measure metrics.

In the research design, six case studies (p = 1, 2... 6) were used to collect data concerning 16 green practices (k = 1, 2. . . 16) and 21 logistics performance measures (w = 1, 2, . . . , 21) according to the proposed theoretical framework. The pure interview data is being used to attribute weights (from 1 to 5) to the research variables according to the following notation:

- $\mathbf{L_{kp}}$ is the importance of green practice k to achieve a greener SC in case study p.
- $\mathbf{X_{kp}}$ is the level of implementation of green practice k in the case study p.
- $\mathbf{Z_{wp}}$ is the accuracy with which performance measure w reflects the influence of green practices on the SC in the case study p.
- $\mathbf{Y_{wp}}$ is the level of implementation of performance measure w in the case study p.
- $\mathbf{(X_k; Y_w)_p}$ is the weighting for the relationship between green practice k and performance measure w in the case study p.

5.4.1 GREEN SC PRACTICES MOST COMMONLY USED

In this section the answer to sub research question namely "*Which green SC practices among the ones identified in literature are deployed mostly by the Dutch CV industry in practice across their supply chain?*" is being explored. In order to find the answer the inputs of the within case analysis is summarized as shown in table 18. The table presents the green supply chain practices which are being mostly implemented by the companies across their supply chain.

In this paper green behavior indicates how extensively the green practices are implemented by the organizations, depending on the level of implementation of a set of green practices. Therefore, two scores are proposed, as shown below. In each case study the individual green practice implementation score ($IGPrac\_score_p$) is the cumulative score for the level of implementation of 16 green practices, as in

$$IGPrac\_score_p = \sum_{k=1}^{16} X\ kp$$

This equation is developed so that the overall level of green behavior on the part of the company can be assessed as the by sum of the implementation level of each individual green practice. The assumption was made that all green practices contribute equally to the overall score and that, if green practices are implemented, the company will behave in a green way. The company with the highest green score is the one with the highest total implementation level of green practices.

Cross-case analysis allows the identification of leading variables among all case studies. From the analysis it is possible to identify the green practices that companies consider most important within the commercial vehicle SC. One assumption is that all companies assign importance levels on the same scale. Each variable is examined in turn, and a score is calculated, based on the weighting allocated in the individual case-study analysis. The scores are taken forward in the cross-case analysis to provide an indication of the variables of importance for the five companies. The equation below defines a cross-case score that is used to assess the importance of each green practice in achieving a greener SC ($GPrac\_score_p$).

$$GPrac\_score_p = \sum_{p=1}^{6} L\ kp$$

Figure 66, illustrates the outcome of the cross case analysis performed by summarizing the most preferred green supply chain best practices in increasing order of preference when analyzed from top of the graph.

5.4.2 LOGISTICS METRICS MOST COMMONLY USED

In this section the answer to sub research question namely "*Which logistics performance metrics identified in literature are used mostly to measure the performance of logistics by Dutch CV industry?*" is being explored. In order to find the answer the inputs of the within case analysis is summarized as shown in table 19. The table presents the logistics performance metrics which are being mostly implemented by the companies across their supply chain in order to measure the impact of the green supply chain practices. The individual logistics performance measure implementation score in each case study

($ILPM\_score_p$) is the sum of the twenty one performance measures implementation level in each case study, as shown in

$$ILPM\_score_p = \sum_{k=1}^{16} Y\ wp$$

The above equation was developed so that higher overall performance measures implementation is associated with more effective company performance, and this level of performance will be used in evaluating the impact of green behavior.

The aggregate score based on cross case analysis to measure the logistics performance which is used widely by the companies to reflect the impact of green practices; (LPM_score_w) is obtained from the following equation

$$LPM\_score_w = \sum_{p=1}^{6} Z\ wp$$

Figure 67, illustrates the outcome of the cross case analysis performed by summarizing the logistics performance metrics which widely reflects the impact of green supply chain practices in decreasing order of preference when analyzed from top of the graph.

Green SCOR best practices	Company A	Company D	Company E	Company F	Company B	Company C	Total (GPrac_Score)
Minimize energy consumption & hazardous material	5	4	4	4	5	4	26
Proper handling and storage of hazardous material	4	3	3	3	4	4	21
Strive for establishing univocal environmental policies	4	4	4	2	4	4	22
Collaborate with SC partners on environmental issues	5	5	4	2	3	3	22
Select suppliers with EMS in place	4	4	3	3	3	4	21
Suppliers supplying environmentally friendly content	5	4	4	4	4	3	24
Specify design specification including environmental req.	5	4	3	4	4	4	24
Specify packaging and delivery requirements	4	5	3	3	5	5	25
Schedule production to minimize energy consumption	5	4	3	2	4	4	22
Manage waste generated during the production process	5	4	3	3	4	4	23
Manage emissions (air and water) from production	4	4	3	4	3	3	21
Minimize use of packaging materials	5	4	4	2	3	4	22
Schedule shipments to minimize fuel consumption	4	3	3	3	2	4	19
Retrieve packaging material for re-use	4	4	2	2	3	3	18
Don't physically return product beyond economic repair	4	5	2	1	3	3	18
Aggregate return shipments to minimize fuel consumption	3	4	2	2	3	3	17
Sum total company wise (IGPrac_Score)	70	65	50	44	57	59	

TABLE 18: CROSS CASE COMPARISON OF GSCOR BEST PRACTICES IMPORTANCE

FIGURE 63: CROSS CASE RANKING OF GSCOR BEST PRACTICES

Logistics measurable	Company A	Company D	Company E	Company F	Company B	Company C	Total (LPM_score)
Quality of products	5	5	5	5	5	5	30
Customer service level	5	5	5	5	5	1	26
Product availability	1	5	1	1	1	1	10
Transportation	1	5	5	5	1	1	18
Utilization	1	1	1	1	1	1	6
Productivity	1	1	1	5	1	1	10
Cost reduction	5	5	5	5	5	5	30
Response to customer needs	5	5	5	5	5	5	30
Flexibility	5	5	5	5	5	5	30
Carbon dioxide	5	5	1	1	5	5	22
Air pollutant	5	5	5	1	1	5	22
Fuel	5	1	1	1	5	5	18
Energy	5	5	5	1	1	5	22
Water	5	5	5	1	5	5	26
Waste	5	5	5	1	1	5	22
Materials/products recycle	5	5	1	1	1	5	18
Toxic, hazardous emissions	5	1	1	1	1	5	14
Accidents	5	1	1	1	5	5	18
Noise volume	1	1	1	1	1	1	6
Employment	1	1	1	1	1	1	6
Training	1	1	1	1	1	1	6
Sum total company wise (ILPM_score)	77	73	61	49	57	73	

TABLE 19: CROSS CASE COMPARISON OF LOGISTICS METRICS IMPORTANCE

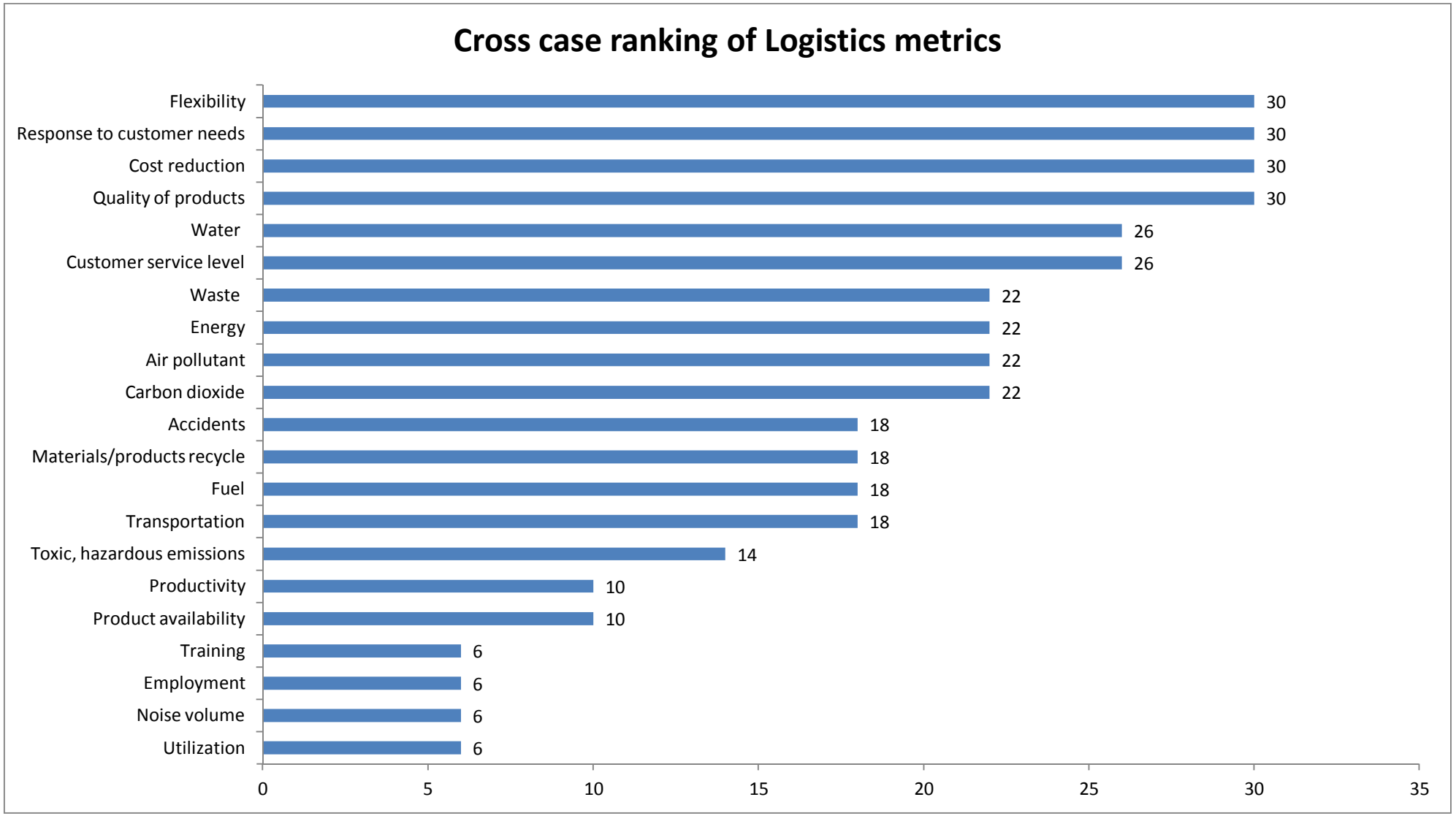


FIGURE 64: CROSS CASE RANKING OF LOGISTICS METRICS

5.4.3 RELATIONSHIP BETWEEN GSCOR BEST PRACTICES AND LOGISTICS METRICS

In this section the answer to sub research question namely "*Which green SC practices identified in practice have most influence on the economic, environmental and social logistics performance metrics of an organization?*" is being explored. The cross-case analysis is used to identify the main relationships between Green supply chain practices and Logistics performance measurement metrics. The data used to develop this analysis was gathered from the tables presented in Appendix D. Responses from two companies were not obtained. The relationships were classified as most influential, if the implementation of a green practice increases a measure overall value, or as less influential, if the implementation of a practice decrease a measure overall value. The intensity of the relationship was weighted using a scale from 1 (no relationship) to 5 (strong relationship). A cumulative score (RGPLM (k; w)) was computed to identify the significant relationships in all case studies using the following equation.

$$\text{RGPLM (k;w)} = \sum_{p=1}^{4} (\text{Xk; Yw})\text{p}$$

Table 20, 21, 22 and 23 illustrates the relationship being organized in matrix form. The logistics performance that are being chosen here all have preference value equal to three and above in the relationship weight age of the companies. The logistics metrics in the matrix are then counted on the number of frequency of repetition across the companies to derive the most important ones. Figure 68, 69 and 70 represents the relationship established between the green supply chain practices and economic, environmental and social logistics performance measurement metrics using the above equation.

TABLE 20: MATRIX REPRESENTING THE INFLUENCE OF GSCOR PLAN BEST PRACTICES ON LOGISTICS METRICS

Plan best practices / Organization	**Decrease energy consumption and hazardous material usage**	**Better handling and storage of hazardous materials**	**Environmental collaboration with suppliers**
Company A	Transportation, Utilization, Productivity, Cost reduction, Flexibility, Carbon emissions, Energy Consumption, Air emissions, Hazardous emissions	Transportation, Flexibility, Accidents	Transportation, Utilization, Productivity, Cost reduction, Flexibility
Company D	Hazardous emissions, Accidents	Hazardous emissions, Accidents	Packaging recycling
Company F	Productivity, Cost reduction, Energy Consumption, Water Consumption	Hazardous emissions	Cost reduction, Flexibility, Carbon emissions, Air emissions, Packaging recycling, Energy Consumption
Company E	Transportation, Utilization, Productivity, Cost reduction, Carbon emissions, Energy Consumption, Fuel consumption, Water consumption, Air emissions, Hazardous emissions, Accidents, Employment, Training	Air emissions, Waste recycling, Hazardous emissions, Accidents, Training	Customer service level, Product availability, Carbon emissions, Energy Consumption, Fuel consumption, Water consumption, Air emissions, Waste recycling, Packaging recycling, Accidents, Training

TABLE 21: MATRIX REPRESENTING THE INFLUENCE OF GSCOR SOURCE BEST PRACTICES ON LOGISTICS METRICS

Source best practices / Organizations	Selection of materials with environmental friendly content	Select suppliers with EMS system in place	Specify design specifications to suppliers that include environmental requirements	Specify green packaging & delivery requirements to suppliers
Company A	Packaging recycling	Quality of products, Customer service level, Cost reduction, Flexibility, Response to customer needs	Quality of products, Customer service level, Cost reduction, Utilization	Transportation, Utilization, Cost reduction
Company D	Air emissions, Hazardous emissions	Quality of products, Customer service level, Cost reduction	Quality of products, Cost reduction	Cost reduction, Packaging recycling
Company F	Quality of products, Product availability	Product availability	Product availability, Air emissions, Energy Consumption, Waste recycling	Transportation, Cost reduction, Packaging recycling
Company E	Quality of products, Customer service level, Carbon emissions, Air emissions, Packaging recycling, Accidents, Hazardous emissions	Quality of products, Carbon emissions, Energy Consumption, Fuel consumption, Water consumption, Air emissions, Hazardous emissions, Employment	Quality of products, Carbon emissions, Energy Consumption, Fuel consumption, Water consumption, Air emissions, Waste recycling, Packaging recycling, Hazardous emissions, Employment	Quality of products, Customer service level, Carbon emissions, Energy Consumption, Fuel consumption, Water consumption, Air emissions, Waste recycling, Packaging recycling, Hazardous emissions

TABLE 22: MATRIX REPRESENTING THE INFLUENCE OF GSCOR MAKES BEST PRACTICES ON LOGISTICS METRICS

Make best practices / Organization	Schedule production to minimize energy consumption	Manage waste generated during the make process	Manage emissions (air and water) from the Make process
Company A	Transportation, Utilization, Productivity, Cost reduction	Productivity, Waste recycling	Productivity, Carbon emissions, Air emissions
Company D	Product availability, Utilization, Productivity, Cost reduction, Fuel consumption, Waste recycling, Energy Consumption, Water Consumption	Utilization, Productivity, Fuel consumption, Waste recycling, Energy Consumption, Water Consumption	Carbon emissions, Air emissions, Fuel consumption, Energy Consumption, Water Consumption
Company F	Utilization, Cost reduction, Carbon emissions, Air emissions, Energy Consumption, Water Consumption	Productivity, Waste recycling	Carbon emissions, Air emissions
Company E	Quality of products, Customer service level, Utilization, Productivity, Carbon emissions, Energy Consumption, Fuel consumption, Water consumption, Air emissions, Waste recycling, Packaging recycling	Quality of products, Transportation, Product availability, Utilization, Productivity, Cost reduction, Flexibility, Response to customer needs, Carbon emissions, Air emissions, Waste recycling, Packaging recycling	Quality of products, Utilization, Productivity, Carbon emissions, Energy Consumption, Fuel consumption, Water consumption, Air emissions, Waste recycling, Packaging recycling, Hazardous emissions

TABLE 23: MATRIX REPRESENTING THE INFLUENCE OF GSCOR DELIVERY & RETURN BEST PRACTICES ON LOGISTICS METRICS

Delivery & Return best practices / Organization	Minimize use of packaging materials	Schedule shipments to minimize fuel consumption	Retrieve packaging material for re-use	Do not physically return product beyond economic repair	Schedule transportation and aggregate shipments to minimize fuel consumption
Company A	Transportation, Waste recycling, Packaging recycling, Cost reduction	Transportation, Cost reduction, Carbon emissions, Fuel consumption	Transportation, Waste recycling, Packaging recycling, Cost reduction		Transportation, Cost reduction, Carbon emissions, Fuel consumption
Company D	Response to customer needs	Transportation, Utilization, Productivity, Cost reduction, Flexibility, Carbon emissions, Air emissions, Fuel consumption, Energy Consumption, Hazardous emissions,		Carbon emissions, Air emissions, Fuel consumption, Energy Consumption, Waste recycling, Hazardous emissions	Cost reduction, Carbon emissions, Air emissions, Fuel consumption, Energy Consumption
Company F	Cost reduction, Packaging recycling, Waste recycling	Customer service level, Transportation, Cost reduction, Response to customer needs, Carbon emissions, Air emissions, Fuel consumption	Waste recycling, Packaging recycling, Cost reduction		
Company E	Fuel consumption, Waste recycling, Packaging recycling	Productivity, Cost reduction, Carbon emissions, Energy Consumption, Fuel consumption, Air emissions	Customer service level, Response to customer needs, Packaging recycling	Customer service level, Transportation, Cost reduction,	Transportation, Cost reduction, Fuel consumption, Energy Consumption

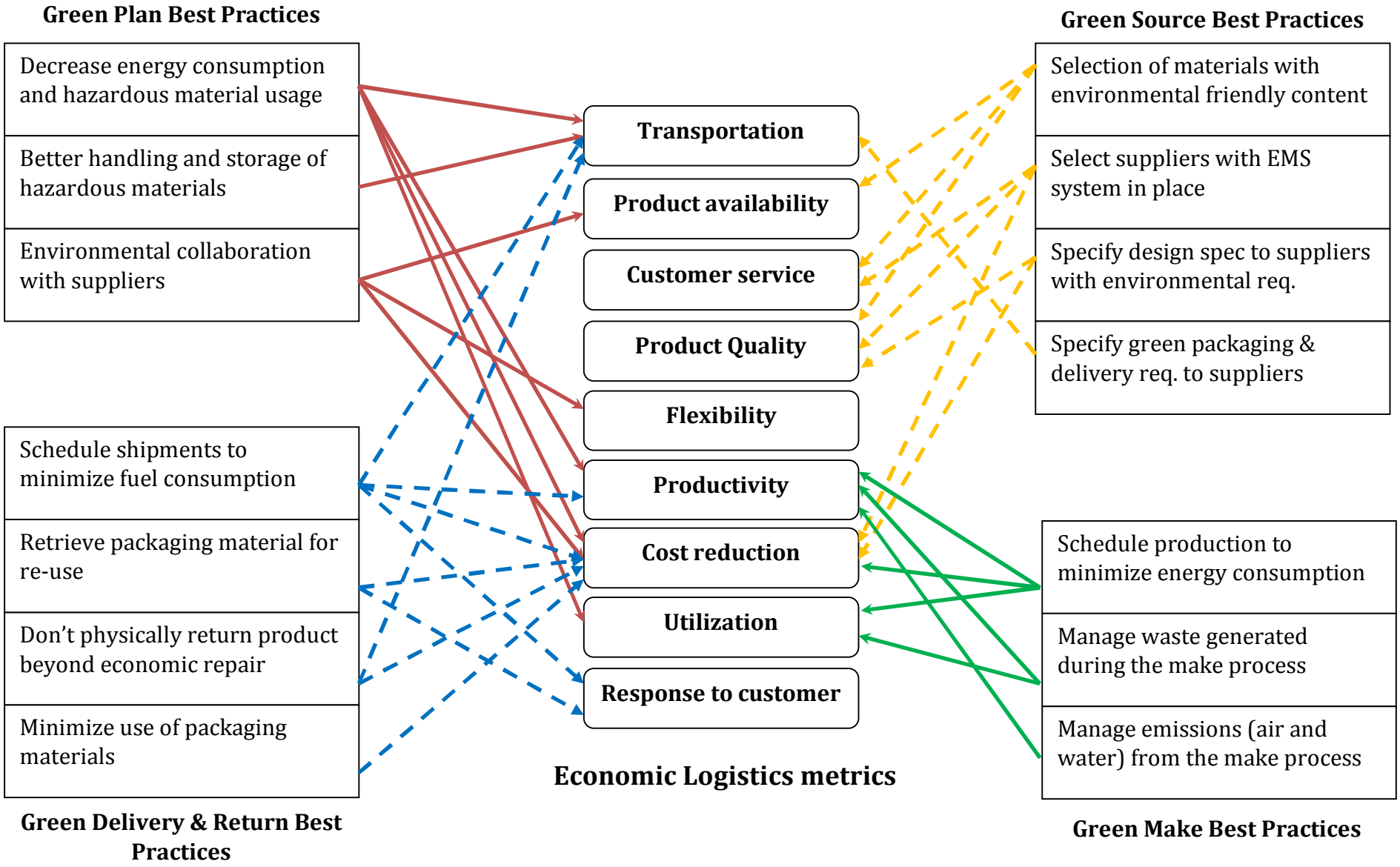


FIGURE 65: RELATIONSHIP BETWEEN GSCOR BEST PRACTICES AND ECONOMIC LOGISITCS METRICS

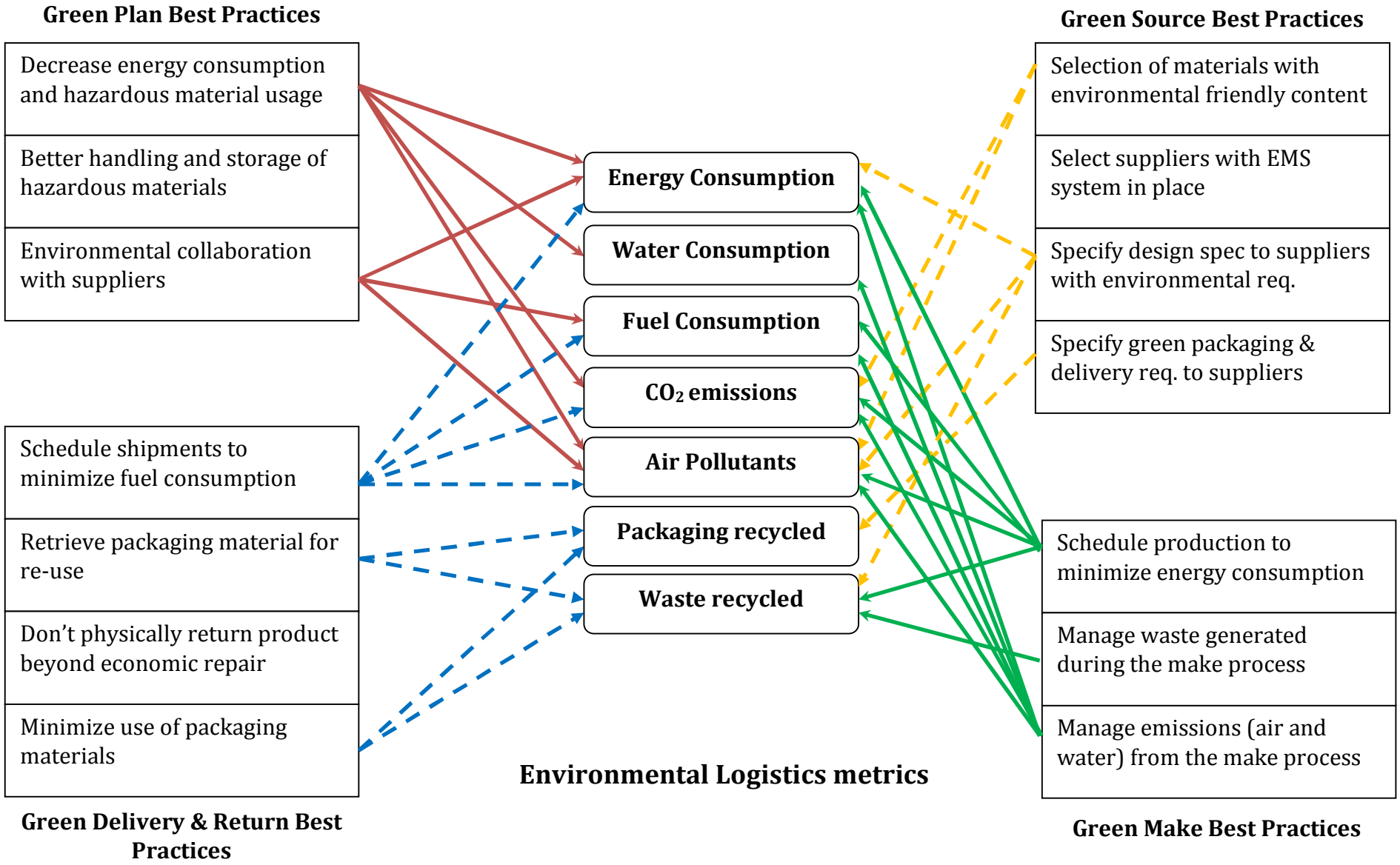


FIGURE 66: RELATIONSHIP BETWEEN GSCOR BEST PRACTICES AND ENVIRONMENTAL LOGISITCS METRICS

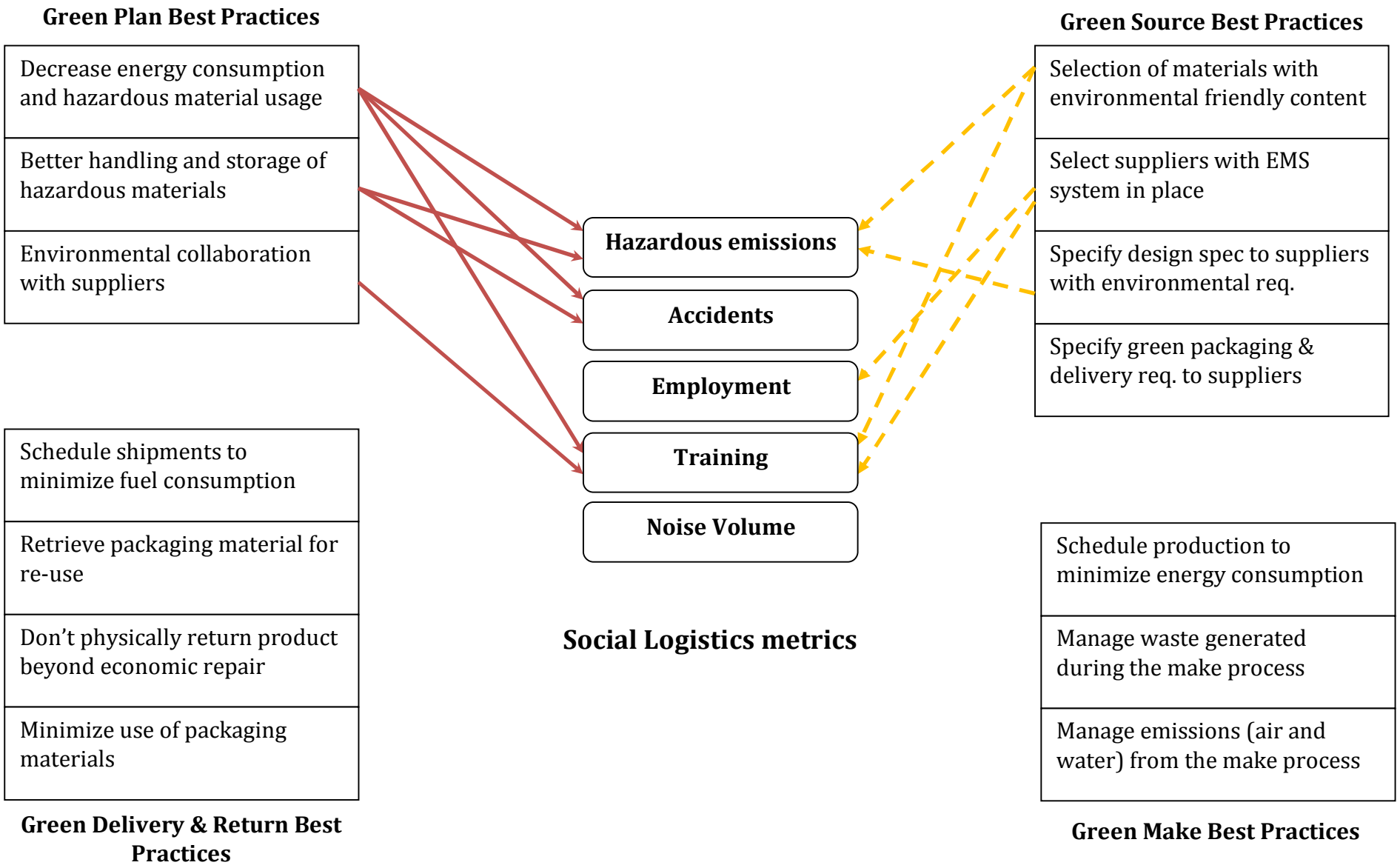


FIGURE 67: RELATIONSHIP BETWEEN GSCOR BEST PRACTICES AND SOCIAL LOGISITCS METRICS

5.5 IMPROVING LOGISTICS PERFORMANCE BY HARNESSING GREEN PRACTICES

The within case analysis reflected that the focus of companies towards implementation of green practices across the supply chain varies from one another. Company A being an OEM focus more on greening the source and make process. The TIER I company namely Company E however concentrate on greening its make process only. Company D the other TIER I supplier however very much matches with the greening ideology of Company A. The TIER II companies namely Company C and Company B completely differ in their perception from the TIER I companies as they mostly concentrate on greening the source process. One reason for the TIER II companies to behave differently maybe is that they are not purely automotive companies as in the case of TIER I companies. Not purely automotive means that they also cater other industries through their products. The figure below illustrates the claims made above regarding the difference in implementation of green supply chain practices by summarizing the percentage coverage of various GSCOR process within the chosen cases.

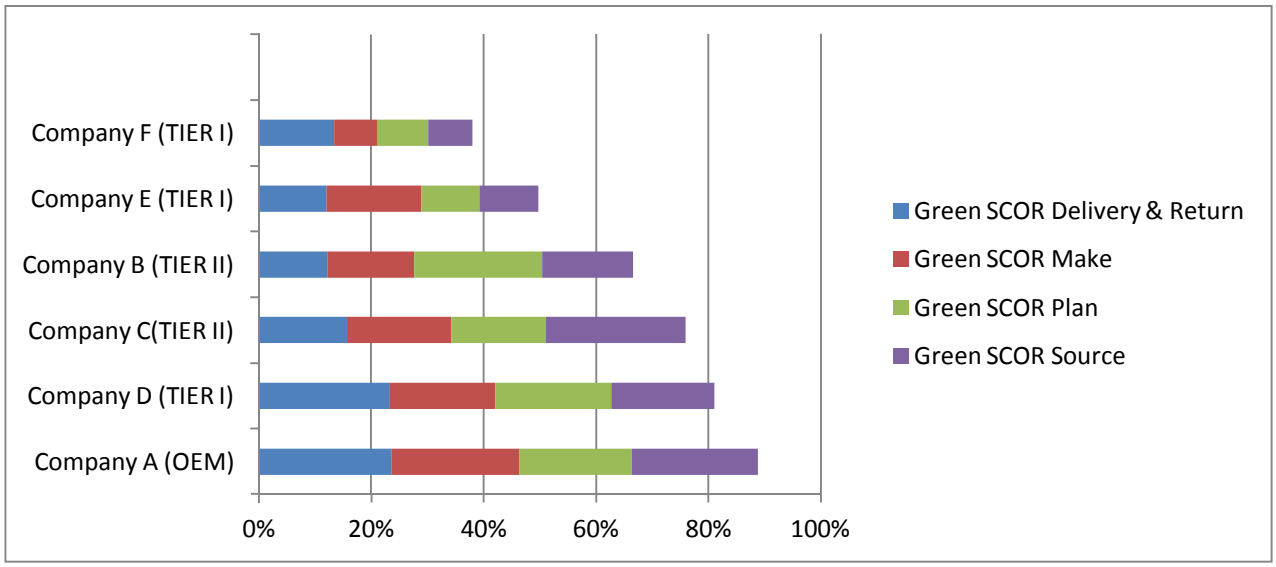


FIGURE 68: GREEN SCOR PROCESS IMPLEMENTATION VARIATION WITHIN THE VARIOUS ORGANIZATIONS

The within case analysis also helped to identify the various logistics performance measurement metrics used by the companies. Even the logistics metrics used by the companies varied across the supply chain similar to the green supply chain practices. Company A concentrated on both economic as well as environmental based metrics to measure its logistics performance. In comparison TIER I company such as Company F concentrated only on the economic based logistics metrics. The TIER II companies in contrast to TIER I companies however used different logistics metrics. Company C used more of environmental based logistics performance metrics whereas Company B used more of economical based logistics performance metrics.

The above analysis on the green supply chain practices and logistics performance measure metrics used by the chosen case study companies reflected the following three things:

1. The choice and rationale behind implementation of green supply chain practices implementation across the entire supply chain varies from company to company.
2. The choice of logistics performance metrics to measure the influence of the green supply chain practices varies from company to company.
3. The visibility of supply chain for the OEMs is limited to only TIER I companies as beyond that the suppliers are monitored by the subsequent TIER companies.

These findings can be summarized by the following diagram which is representing the supply chain of Company A and its supplier up to TIER II level.

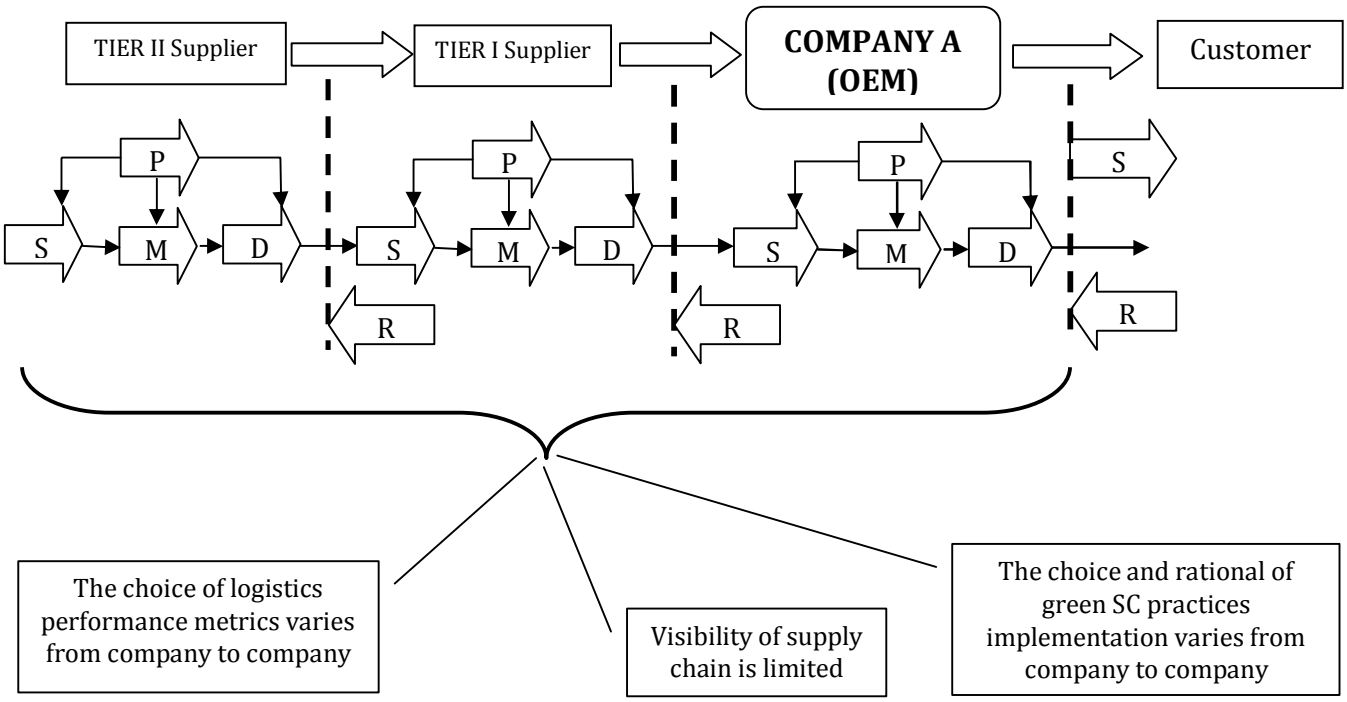


FIGURE 69: INFERENCE OUT OF THE WITHIN CASE ANAYSIS OF THE RESEARCH CASES

5.5.1 WHAT IS NEEDED?

In order to improve the logistics performance of the companies by harnessing the green practices it is imperative that a fully visible supply chain is being created by the OEMs and capture the impact of the green practices across the whole value chain (Cetinkaya et al., 2011). The management of Logistics performance, looking solely at outcomes is not enough since the logistics performance is influenced by two other interrelated elements namely: Process and Product (Cetinkaya et al., 2011) as shown in figure 73. A visible and transparent supply chain allows a company to consider the impact of every supply chain and every single member on sustainability. The impact is from both, products and processes. Product is the subject of the Supply Chain. Processes change the product, or support product delivery (Cetinkaya et al., 2011).

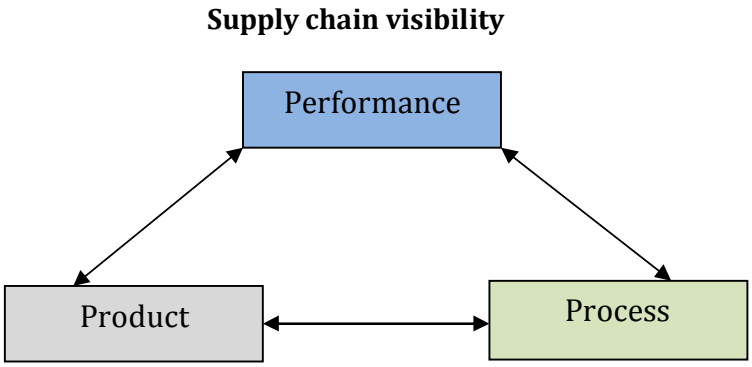


FIGURE 70: ELEMENTS OF VISIBLE SUPPLY CHAIN

From the case studies performed it was evident that the OEM although being the supreme commander of the supply chain limits its visibility only till TIER I suppliers. This is supported from the findings of the within case analysis which showed alignment of green practices and logistics performance measurement metrics only between the TIER I and OEM. The TIER II organizations are solely being left at the vicinity of the TIER I suppliers even though they are also part of the products being developed by the OEM.

Product impact on performance is related to sourcing, manufacturing, product flow monitoring and quality control. Only fully available information about products, processes and performance provides the ability to create a fully visible Supply Chain and capture the impact of the whole Supply Chain:

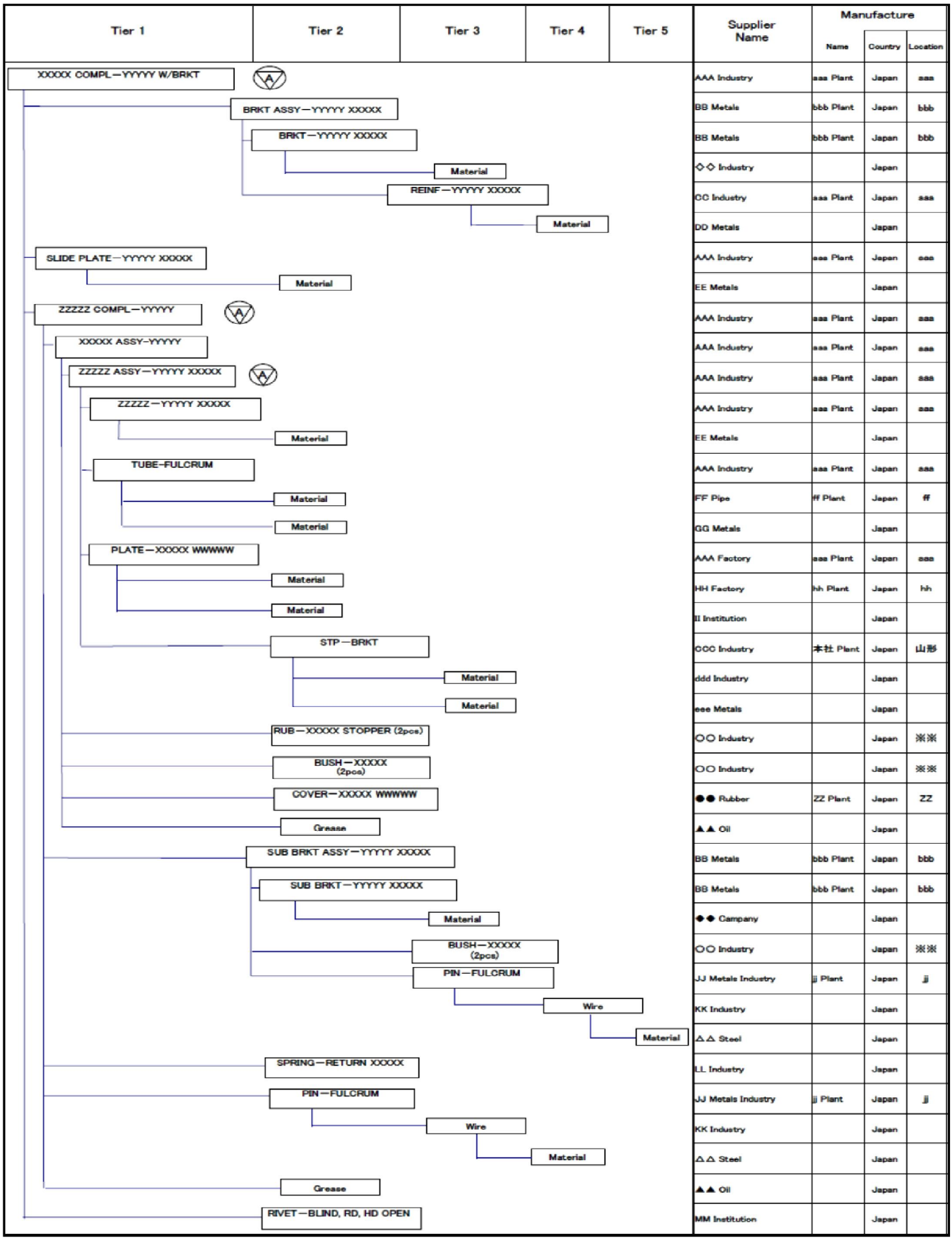
- Products – what is their origin, where they were treated?
- Processes – what was done to the products, how were the processes supported?
- Performance – what was the impact of both processes and products?

In order to improve the logistics performance by harnessing the green supply chain practices two things needs to be done by the OEMs. The action is directed only towards the OEMs because they are the engine of the value chain of Dutch commercial vehicle industry. It is the OEMs who drives the business of the TIER I suppliers by outsourcing their products and thereby giving them business opportunities. The two things that need to be done are:

1. Product oriented monitoring

The OEM in the case of this research Company A adopts modular product design. Modular product design means each components of the commercial vehicle being manufactured are in modules which are outsourced to TIER I or TIER II suppliers for manufacturing. All these modules are then collected from the respective suppliers and assembled at Company A's production plants to give the final shape of a commercial vehicle.

Product oriented monitoring aims to track the supplier of the product and its sub-component starting from TIER I till the nth TIER supplier. When a product module is being outsourced by an OEM it can ask it's TIER I supplier to fill up a component supply chain chart (CSCC). The components supply chain chart is a chart which would visualize the structure of the component supply chain as shown in figure 74.



Supplier Name	Manufacture		
	Name	Country	Location
AAA Industry	aaa Plant	Japan	aaa
BB Metals	bbb Plant	Japan	bbb
BB Metals	bbb Plant	Japan	bbb
◇◇ Industry		Japan	
CC Industry	aaa Plant	Japan	aaa
DD Metals		Japan	
AAA Industry	aaa Plant	Japan	aaa
EE Metals		Japan	
AAA Industry	aaa Plant	Japan	aaa
AAA Industry	aaa Plant	Japan	aaa
AAA Industry	aaa Plant	Japan	aaa
AAA Industry	aaa Plant	Japan	aaa
EE Metals		Japan	
AAA Industry	aaa Plant	Japan	aaa
FF Pipe	ff Plant	Japan	ff
GG Metals		Japan	
AAA Factory	aaa Plant	Japan	aaa
HH Factory	hh Plant	Japan	hh
II Institution		Japan	
CCC Industry	本社 Plant	Japan	山形
ddd Industry		Japan	
eee Metals		Japan	
○○ Industry		Japan	※※
○○ Industry		Japan	※※
●● Rubber	ZZ Plant	Japan	ZZ
▲▲ Oil		Japan	
BB Metals	bbb Plant	Japan	bbb
BB Metals	bbb Plant	Japan	bbb
◆◆ Campany		Japan	
○○ Industry		Japan	※※
JJ Metals Industry	jj Plant	Japan	jj
KK Industry		Japan	
△△ Steel		Japan	
LL Industry		Japan	
JJ Metals Industry	jj Plant	Japan	jj
KK Industry		Japan	
△△ Steel		Japan	
▲▲ Oil		Japan	
MM Institution		Japan	

FIGURE 71: COMPONENT SUPPLY CHAIN CHART

From the above figure it can inferred that the CSCC enables to break the product module into minute details and capture the details of all the sub suppliers associated with the product module. This would enable the OEMs to manage all sub-suppliers and thereby ensure that the products delivered to them are in accordance to the green standards set by them. Following are the steps that can be taken by the OEMs in successfully implementing the component supply chain chart concept.

- Identify all the sub-suppliers for the production phase and complete the CSCC (Component Supply Chain Chart) to understand the complete supply chain.
- Select and evaluate sub-suppliers based on their ability to supply products which satisfy green targets planned by the OEMs.
- Criteria for selection, evaluation, and re-evaluation shall be established based on the univocal logistics performance metrics set by the OEMs.
- Deploy a performance measurement method to ensure that sub-suppliers source, manufacture, delivers and returns a product in accordance with the green practices set by the OEMs.

Currently the CSCC is being used by the automotive giants such as TOYOTA, NISSAN and HONDA to monitor the quality, cost and delivery targets set for the product modules outsourced by them. A similar use of the CSCC is therefore advisable to the commercial vehicle manufacturers so that they can monitor the green practices employed and logistics performance metrics being used by the sub suppliers to monitor the impact of those practices.

2. Create a univocal logistics performance measurement method

It is essential that a univocal logistics performance measurement method needs to be employed to measure the impact of the green practices employed by the suppliers. Currently the range of logistics performance metrics being employed by the companies within Dutch commercial vehicle industry varies from one another. This causes a lack of commonality as well as voice to monitor the progress. As the goal is to improve the logistics performance by harnessing the green supply chain best practices therefore it is imperative a common method to measure the logistics performance is being employed by the OEMs. Again the OEMs are advised to adopt these because they are the one who can drive the sub suppliers since they are all obliged to the OEMs.

A wide range of methods have been developed, but only some of them are accepted by practitioners and implemented to measure Logistics performance, among them the SCOR model and the Balanced Scorecard are common (Cetinkaya et al., 2011). The SCOR model, which is presented in the Chapter three, includes a set of predefined metrics that can be used by a Company And is focused on the company point of view. However the implementation of SCOR may not be possible for all the sub suppliers as it needs certain criteria to fulfill before being implemented into operation. Therefore the Balance scorecard method is suggested as the univocal method that can be used to establish the logistics performance measurement scorecard. As the goal here is to establish the logistics performance metrics to monitor the impact of the green supply chain best practices therefore the performance metric is advised to build upon the following three main dimensions: social, economic and environmental, which are further sub-divided as shown in figure 75. This modular composition would allow

logistics performance to be analyzed in a flexible manner, and such an approach can be even used in the small companies, when precise data may not be available.

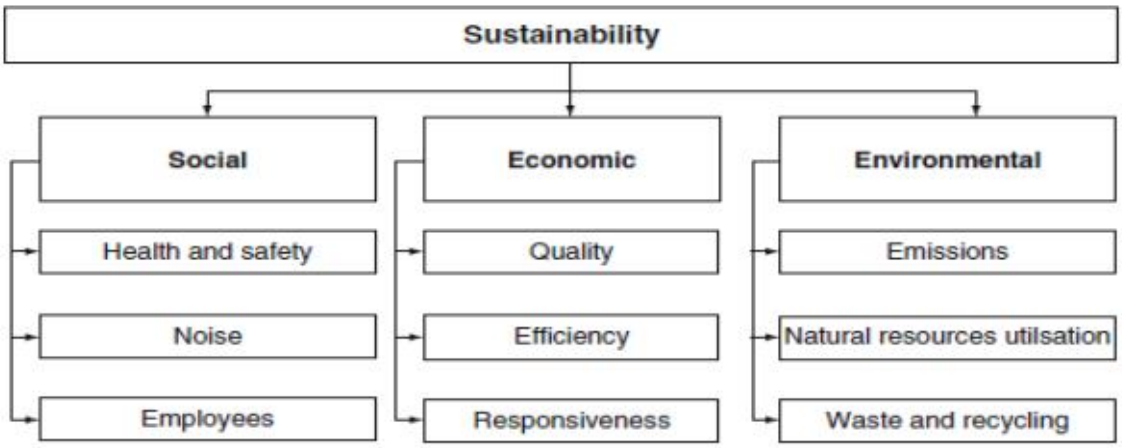


FIGURE 72: PERFORMANCE METRICS DIMENSIONS & SUB-DIMENSIONS (CETINKAYA ET AL., 2011)

Balance Scorecard looks beyond traditional economical performance measures. In the Balanced Scorecard, metrics are grouped into four perspectives: customer, financial, business processes, growth and learning. In practice, Balance Scorecard is a flexible tool, so it is often modified, and its perspectives are renamed or new perspectives are added (such as environmental dimension), to reflect a situation specific to the organization (Kaplan and Norton, 2000). In this case the Balanced Scorecard suggested is modified to incorporate sustainability dimension in the form of green practices being employed at various levels such as planning , sourcing, manufacturing and delivering a product to the OEMs by the sub suppliers. The idea behind the content of the balance scorecard is to create a univocal logistics performance measurement metrics to measure the impact of the green supply chain practices being employed. The relationship between the green supply chain practices and the logistics performance measurement established in chapter five is used as the basis for designing the content of the balance scorecard.

It is imperative that the logistics performance measure scorecard framework being established is being adopted by all the sub suppliers into their process. By analyzing the case studies it was found that some companies measure only their core processes, other are sharing metrics with business partners, while some organizations were able to look at their end-to-end supply chain. Another important inference that can be made from the case study was that the logistics performance measurement was concentrated in internal Company Activities, often limited to core operations. In the case of TIER I companies, achieving this level can be enough as their processes are easily visible and their performance can be easily captured without advanced performance systems. Other groups of companies particularly TIER II monitor all their processes, both core and supporting. Currently the logistics performance measures employed often includes only the nearest supply chain partners, such as suppliers and customers, and often only on the point of contact, or on the shared processes that link two companies – Supplier performance, or customer satisfaction are examples of such measures. Therefore an extended logistics performance measurement system is needed which looks beyond company borders.

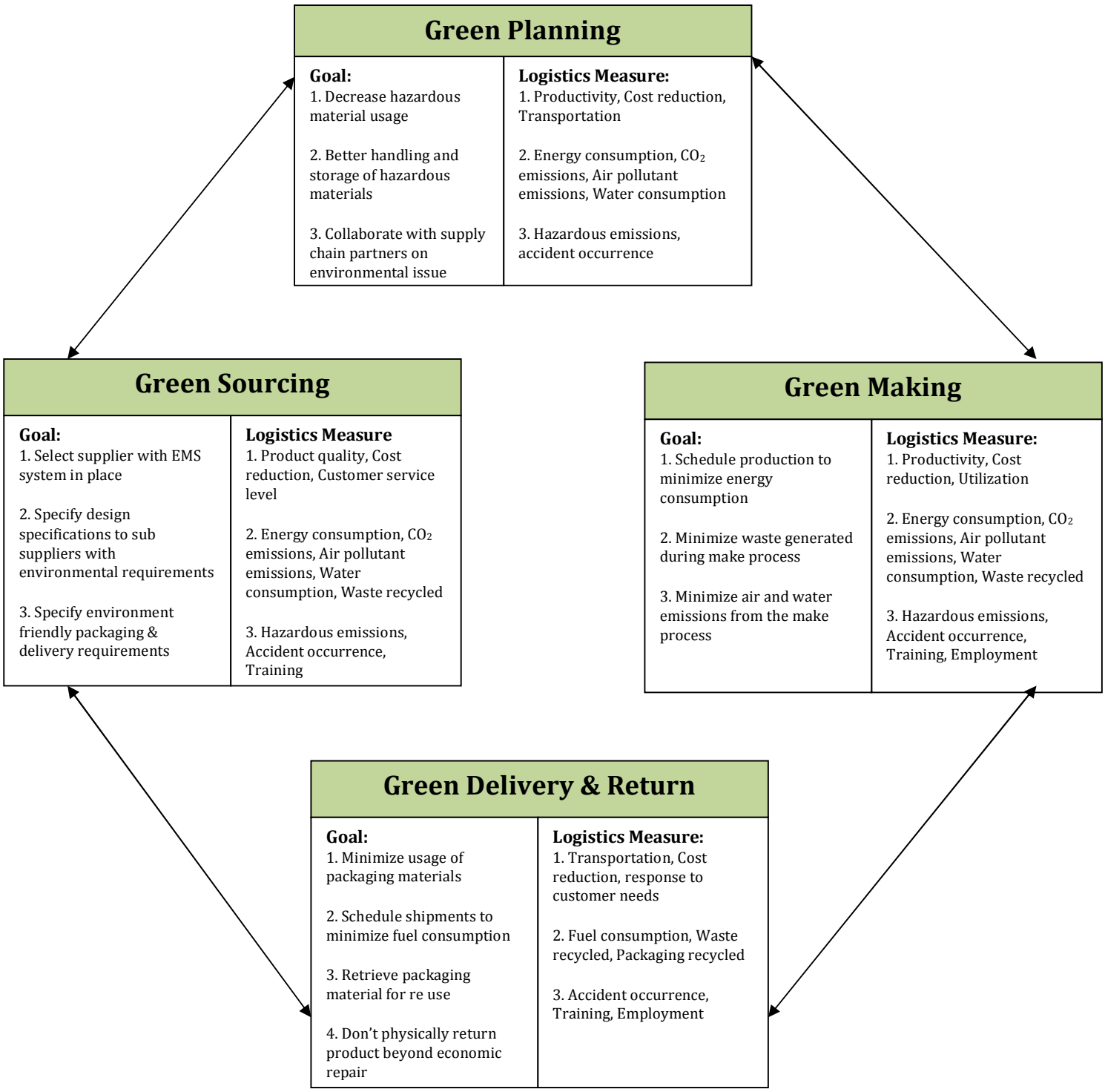


FIGURE 73: LOGISTICS PERFORMANCE MEASURE SCORECARD FRAMEWORK ADAPTED FROM (KAPLAN AND NORTON, 2000)

The Balance Scorecard based logistics performance measure framework suggested would enable each of the sub suppliers to monitor the logistics performance measure right from the flow from raw materials to the final customer. This would enable OEMs to create one voice platform for communication of performance measures against green supply chain practices being deployed for each product and thereby enabling the improvement of logistics performance for oneself as well as of all the companies associated with it.

5.5.2 HOW TO IMPLEMENT THE PROTOCOL?

In order to improve the logistics performance of Dutch commercial vehicle industry by means of harnessing the green supply chain practices a strategy involving product oriented monitoring and univocal logistics performance measurement method are suggested. Here it is now explained how these needs to be implemented in the process in the form of protocol in order to achieve the desired end results. The implementation protocol is elaborated using the 4W1H (Who, Where, When, What, How) ideology.

- **Where:** In the ESOW (Engineering statement of Work) or Advance Product Quality Planning (APQP) phase / Sustainability report / Supplier Contract.
- **When:** At the time of releasing RFQ or LOI to sub suppliers and during audits to monitor the progress of achievement of targets.
- **What:** The green practices to be implemented during plan, source, make and delivery & return of products and the logistics metrics to be used to monitor the impact of these practices.
- **Who:** Initiated by OEMs and implemented and exercised by the sub suppliers till the nth TIER.
- **How:** Monthly audits by sub sequent suppliers and reporting of the chosen logistics KPI from nth TIER till TIER I to the OEMs.

6. CHAPTER SIX: CONCLUSIONS & RECOMENDATIONS

This chapter provides a summary of the findings from the case studies and the case analysis in the previous chapter by addressing the main research question. The central research question which this research aimed to answer is:

"How can the SC managers of organizations within the Dutch Commercial Vehicle industry rightfully choose different types of green supply chain practices in order to improve the performance of logistics of their organization?"

There were two important areas meant to be explored before answering this question, those related to *green supply chain practices* and *logistics performance measurement*. The distinction between these two areas of exploration guided the entire research process, and has been the basic classification factor throughout the presentation of all the results. As a consequence, the same format will be followed in this section as well, with all the conclusions being classified under the Green supply chain practices and Logistics performance measurement.

Another important aspect to keep in mind while reading this section is the objective of this research which can be summarized as following:

- *To identify the potential Green SC practices and logistics performance measurement metrics most widely used within SC of Dutch commercial vehicle industry.*
- *To explore the relationship between the Green SC best practices and the logistics performance metrics in the context of Dutch commercial vehicle industry.*
- *To make recommendations based on the findings of case analysis of how the logistics performance can be improved by the companies within the Dutch commercial vehicle industry by harnessing the green practices.*

The objective of this research has been threefold. Regarding the first and second objective, it is satisfied by the derived conclusions from the case analysis, which primarily answer these objectives. Since the purpose of this research has been not only to identify and explore the green practices and logistics performance measurement metrics, but also to propose recommendations, therefore this third part of the research objective needs to be fulfilled as well. In this direction, a number of recommendations have been produced for individual companies as well the Dutch commercial vehicle industry as a whole, on the basis of the derived conclusions and of the author's critical thinking. In addition, recommendations for future research on the subject are also being suggested.

6.1 CONCLUSIONS

This research explored the relationships between green supply chain practices and logistics performance measurement metrics. It proposes a set of green practices which could be deployed in the context of Dutch Commercial Vehicle SC, as well as logistics

measurement systems which could be used to evaluate the influence of these practices on logistics performance. A comprehensive review of the literature to date was performed in order to identify the main green supply chain best practices within the GSCM paradigm. From several items of anecdotal and empirical evidence presented in the literature, a theoretical framework was constructed to represent the relationships among logistics performance metrics and green supply chain best practices.

A cross-case analysis was performed in order to assess the environmental behaviour of the commercial vehicle industry supply chain. Furthermore, the research found that the GSCOR level one processes that are considered critical for a supply chain to be considered green are ''GSCOR source,'' ''GSCOR make and ''GSCOR plan''. The focus on "GSCOR delivery and return" process is minimal within the Dutch commercial vehicle industry. The most widely adopted green supply chain best practices within the case study companies are ''Minimization of energy consumption and hazardous material usage,'' ''specification of packaging & delivery requirements,'' ''choosing suppliers supplying environmental friendly content,'' ''specifying design specification including environmental requirements" and "managing waste generated during make process" are few. Regarding the logistics performance measures, the ones highlighted by the case companies as the most important to reflect the influence of green supply chain practices on logistics performance are ''flexibility," ''cost reduction," ''response to customer needs," "quality of products" and ''water & energy emission control'' to be name few. Moreover, the sustainable logistics performance measures that were most extensively used in the case study companies are ''economic metrics'' and ''environmental metrics''. The "social metrics" are known and adopted by very few of the companies within the Dutch commercial vehicle industry.

Based on the survey result of four companies belonging to the Dutch commercial vehicle industry supply chain, it was found that the types of green supply chain best practices adopted influences the logistics performance of the organization. This paper supports, to a certain extent, the notion that there is a positive relationship between green supply chain best practice implementation and economic logistic measurable of organizations in terms of ''cost reduction,'' "productivity," "transportation," ''product quality'' and "customer service level". Green supply chain best practices also contribute to improved environmental logistics performance, since they have positive influence on ''energy consumption,'' "air pollutant emissions," "CO_2 emissions," "water & fuel consumption" and "waste & packaging recycled" thereby promoting its reduction. Social logistics performance is also improved, and consequently there is a positive relationship between green supply chain best practices and ''hazardous emissions'' & ''employee training''. These results confirm the findings of Rao and Holt (2005), who established a connection between greening the inbound, production and outbound SC processes and variables indicating competitiveness, namely efficiency, quality, productivity and cost savings. The empirical research of Zhu and Sarkis (2004) also showed a significant relationship between green supply chain management practices and environmental performance (emissions, waste, use of hazardous materials and frequency of environmental accidents) and economic performance (product availability, quality of products and flexibility).

However, certain relationships associated with the following variables were not confirmed by the analysis: ''better handling and storage of hazardous materials,'' ''select suppliers with EMS system in place'' and "don't physically return product beyond

economic repair". The relationship between environmental logistics metrics and these variables couldn't be established. In the case of social logistics metrics only relationship with "GSCOR Plan" and "GSCOR Source" best practices could be established.

Based on the within case and cross case analysis of the green supply chain best practices and logistics performance metrics being used by the case companies, three key inferences were drawn as following:

1. The choice and rationale behind implementation of green supply chain practices implementation across the entire supply chain varies from company to company.
2. The choice of logistics performance metrics to measure the influence of the green supply chain practices varies from company to company.
3. The visibility of supply chain for the OEMs is limited to only TIER I companies as beyond that the suppliers are monitored by the subsequent TIER companies.

These three inferences drawn acted as the basis for answering the main research question which is associated with finding the answer to improving the logistics performance metric by means of harnessing the green supply chain practices. In order to improve the logistics performance it is essential to increase the visibility across the supply chain of the product. This is because logistics performance is influenced by two other interrelated elements namely: Process and Product. The impact is from both, products and processes on the performance. Product is the subject of the Supply Chain. Processes change the product, or support product delivery. Therefore a twofold strategy is articulated as an answer to the main research question.

1. Product oriented monitoring
2. Creation of a univocal logistics performance measurement method

Product oriented monitoring will aim to track the supplier of the product and its sub-component starting from TIER I till the nth TIER supplier. When a product module is being outsourced by an OEM it can ask it's TIER I supplier to fill up a component supply chain chart (CSCC). CSCC enables to break the product module into minute details and capture the details of all the sub suppliers associated with the product module. This would enable the OEMs to manage all sub-suppliers and thereby ensure that the products delivered to them are in accordance to the green standards set by them. In this way the visibility of the supply chain across the entire TIER level suppliers involved with the product module including the OEM will be established.

A univocal logistics performance measurement method needs to be employed to measure the impact of the green practices employed by the suppliers. Currently the range of logistics performance metrics being employed by the companies within Dutch commercial vehicle industry varies from one another. This causes a lack of commonality as well as voice to monitor the progress. As the goal is to improve the logistics performance by harnessing the green supply chain best practices therefore it is imperative a common method to measure the logistics performance is being employed by the OEMs. In this regard a Balanced Scorecard based logistics performance metric is being suggested. The Balance scorecard is modified to incorporate sustainability dimension in the form of green practices being employed at various levels such as planning , sourcing, manufacturing and delivering a product to the OEMs by the sub suppliers. The idea behind the content of the balance scorecard is to create a univocal

logistics performance measurement metrics to measure the impact of all these green supply chain practices being employed. The relationship between the green supply chain practices and the logistics performance measurement established in chapter five is used as the basis for designing the content of the balance scorecard. The Balance Scorecard based logistics performance measure framework suggested would enable each of the sub suppliers to monitor the logistics performance measure right from the flow from raw materials to the final customer. This would enable OEMs to create one voice platform for communication of performance measures against green supply chain practices being deployed for each product and thereby enabling the improvement of logistics performance for oneself as well as of all the companies associated with it.

Based on the above results it is possible to conclude that the companies studied believe that the adoption of green supply chain best practices is important for a supply chain to be considered green. They all implement various types of green practices across their supply chain. They consider that some logistics performance measures reflect the influence of green supply chain best practices on logistics performance better than others. And they consider that some green practices have more influence on some the logistics performance measures than others.

6.2 RECOMMENDATIONS

In this section recommendations are made to the companies considered for the research. In addition, a small piece of advice is made to the Dutch Commercial vehicle industry followed by recommendation for further research.

6.2.1 INDIVIDUAL COMPANIES

Company A holds an important position in the supply chain of Dutch commercial vehicle industry by being an OEM. The arenas for action for Company A to enhance sustainability in supplier relations are multifaceted. A research being conducted by bestLog reveals two major action fields corresponding to the level of supply chain integration towards supplier for a sustainable supply chain (Cetinkaya et al., 2011). The two action fields are:

1. Compliance and transparency in supply chain processes
2. Product and service development and associated cost- and gain-sharing models

Compliance and transparency

Company A needs to be concerned with the activities of their suppliers and may also be in a sense responsible for their products and services – for example, for their social behavior in their manufacturing activities. So, Company A should aim to ensure all their suppliers compliance, at least with minimum standards and applicable laws. Measures to increase compliance and transparency in the supply chain (first- to n-tier) can be divided into two basic categories – reactive and proactive. The reactive approach requires that all the suppliers comply with national and international legislation and with regulatory and industry-specific environment and social standards, e.g. with regard to health and safety, social conditions, child labor, waste disposal, etc. The proactive approach requires that each

In order to attain compliance and transparency in the supply chain it is advisable for Company A and the other TIER level suppliers to:

- Maintain a global perspective and track developments, understand the differences between different regulatory requirements and standards, and gain knowledge of specific sustainable issues.

- Try to develop incentives and to motivate the subsequent suppliers to invest in complying with standards, especially the first-tier suppliers to implement the same compliance culture and awareness, and to extend it further to the second and subsequent tiers of the supply chain.

Product and service development and associated cost- and gain-sharing models

Company A has been from a long time involved with development of environmentally friendly and socially responsible products and services. Their sustainability measures with regard to logistics primarily involved (re-)designing of products, packaging, and logistics services aiming for higher utilization rates and safer handling processes in transport and warehousing. However, so far these efforts have not helped them to attain the benefits that they have sighted by incorporation of these measures. A research conducted by bestLog research shows that the measure reasons why projects fail in this area are not shortcomings in technical capabilities for (re-) designing products, packages or services. Rather the underlying cost- and gain-sharing models in supplier–customer relations were inappropriate and betrayed a lack of incentives for suppliers (Cetinkaya et al., 2011).

It is often seen that suppliers simply accept customer standards, as they usually have no other choice (Cetinkaya et al., 2011). But the feedback from practitioners shows that standards add real value to both sides, if the benefits are clearly communicated. Hence, Company A should try to quantify and communicate the benefits of their standards, in order to motivate their suppliers to accept, apply, and invest (e.g. in training) in these standards. Company A should also take care to evaluate whether their customers are willing to invest or share in cost savings. And if not, then they should evaluate potential costs and benefits which they can exploit for their own supply chain operations, e.g. through improved transport utilization.

6.2.2 DUTCH COMMERCIAL VEHICLE INDUSTRY

As an industry it is imperative that the focus of the Dutch Commercial vehicle industry should be towards the future sustainable supply chain. Sustainability is the ongoing as well as future mantra across every industry and commercial vehicle industry no different than them. So it is important that the commercial vehicle industry build up a scenario of the future sustainable supply chain ab-initio so that it doesn't become too late for the organizations within the commercial vehicle industry to cope with the future sustainable supply chain demand.

Scenario planning is a strategic management process used in the private, public and charitable sectors, as documented by (Van der Heijden, 2009). Scenarios are plausible yet challenging stories about the future that address a core issue of importance, such as

the future of supply chain management, for a particular set of stakeholders, including practitioners in a wide variety of circumstances and policy makers in different national contexts. By giving these diverse stakeholders a shared basis for discussion, scenarios enable creative thinking about how to shape the future of sustainable supply chain management. Scenarios also encourage the discussion of uncertain events. By making uncertainty explicit, preconceptions may be identified and help decision makers consider how they and others might react to the different ways in which the future may develop. Scenario building is primarily a qualitative activity, focused on generating challenging insights. The scenario process has eight steps as follows:

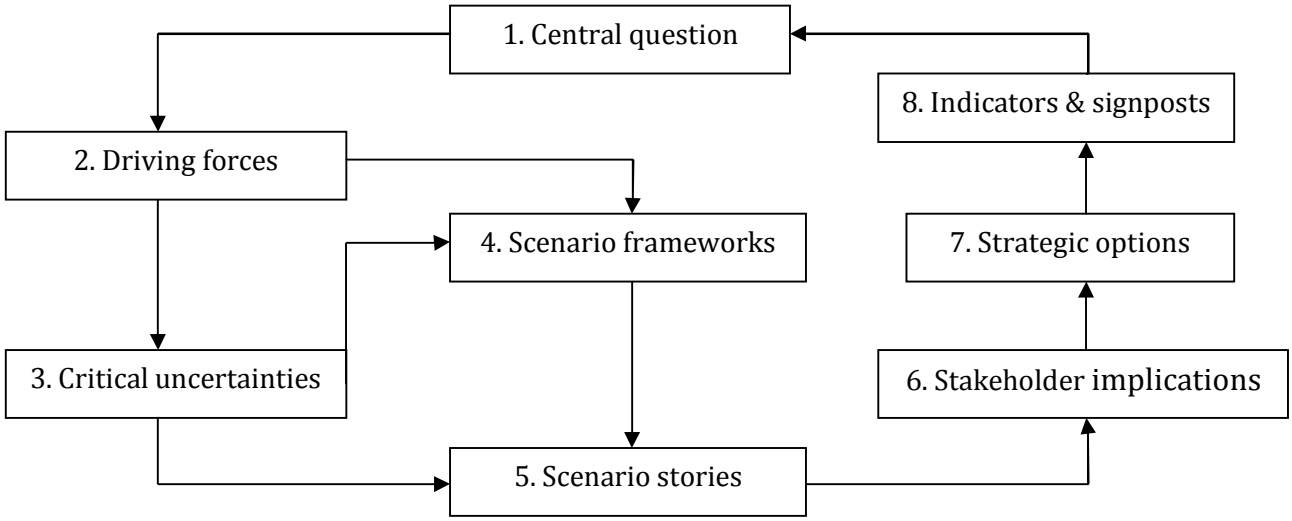


FIGURE 74: EIGHT STEP SCENARIO APPROACH (CETINKAYA ET AL., 2011)

The key questions for the future development of sustainable supply chains arise from the potential different scenarios that may develop due to the differing combinations of corporate decisions, both inside and outside the firm, as well as the role of public policy and the various standards bodies and third party influencers.

6.2.3 FURTHER ACADEMIC RESEARCH

This research paper explored the relationships between green supply chain practices and Logistics performance measurement metrics. It proposes a set of green practices which could be deployed in the context of Dutch Commercial Vehicle SC, as well as logistics measurement systems which could be used to evaluate the influence of these practices on logistics performance. A comprehensive review of the literature to date was performed in order to identify the main practices within the GSCM paradigm. From several items of anecdotal and empirical evidence presented in the literature, a theoretical framework was constructed to represent the relationships among logistics performance indicators and green supply chain best practices.

The research findings, however, must be tempered by several shortcomings. First, motivations and barriers regarding the reasons companies do or do not implement green supply chain best practices can be explored. Understanding such reasons can help SC managers to establish and promote more environmentally appropriate practices. Moreover, the results are derived from the analysis of six case studies from the Dutch

commercial vehicle industry. So the research has explored only the commercial vehicle SC, so the findings may not be universally applicable across different industries and in various countries. Because only one industry sector was analyzed in this study, the results cannot be extrapolated to other industries with other product and process specificities. There is a possibility that different sectors might have different factors (product and process characteristics or legislative requirements) which influence the supply chain environmental behavior as well as logistics performance. It would therefore be desirable to conduct research related to replication and cross-cultural/multi-national investigations in different industrial contexts so as to provide for generalization of these findings. Furthermore, the validity of the relationship model derived from the case studies can be tested empirically and more fully, and accordingly future research should collect large samples of empirical data on green supply chain best practices and logistics performance. The relationship derived between the green SCOR best practices and logistics metrics have given rise to many hypotheses which needs to be empirically proven using quantitative data sets. The reliability of the strategy suggested for improving the performance of the logistics performance by means of harnessing the green supply chain best practices can be empirically tested in a real time environment using real time data. This empirical test can be performed in a completely different industry or multi sector setting. This would help to further improve the content of the strategy in particular the balance scorecard suggested and make it more robust so that it can be employed in other organizations as well.

7. CHAPTER SEVEN: JUDGING THE QUALITY OF THE RESEARCH

The quality of a case study research can be judged based on four logical test (Yin, 2003). These four logical tests have been commonly used to establish the quality of any empirical social research. These four tests can be summarized as following (Yin, 2003):

- ***Construct validity:*** This validity confines with establishing correct operational measures for the concepts being studied.
- ***Internal validity***: This validity is usually applicable for explanatory or causal studies only and not for descriptive or exploratory studies. The validity confines with establishing a causal relationship whereby certain conditions are shown to lead to other conditions as distinguished from false relationships.
- ***External validity***: This test confines with establishing the domain to which a study's findings can be generalized
- ***Reliability:*** This test confines with demonstrating that the operations of a study such as the data collection procedures can be repeated, with the same results.

In order to perform these tests effectively certain tactics are being suggested by Yin, 2003 along with when in research phase those tactics needs to be used. The table below illustrates these tactics being employed in practice with reference to research being performed.

Tests	Case study tactic	Phase of research	In practice implication
Construct validity	Use of multiple sources of evidence	Data collection	Multiple sources like qualitative interviews, scientific literature and company yearly reports & websites were being used
	Establish chain of evidence	Data collection	All interview transcripts and survey data are shared in the appendix of the report
	Have key informant review draft case study	Composition	All interview transcripts are being verified by respective interviewees to confirm the content
Internal validity	Pattern matching	Data analysis	Patterns in each case sufficiently matched with the theoretical framework
	Explanation building	Data analysis	Reasons for patterns are being explored in the within and cross case analysis of the research
External validity	Use replication logic in multiple case studies	Research design	Multiple cases covering various TIER of the industry were chosen and both within & cross case synthesis were performed to arrive at the relationships and conclusions.
Reliability	Use case study protocol	Data collection	Case studies were performed as per the protocol defined by the experts. For each cases same protocol was being employed without any deviations
	Develop case study database	Data collection	Data collected from each case studies are well defined as case description (chapter four)

TABLE 24: CONFRONTING THE VALIDITY AND RELIABILITY ISSUES OF THE RESEARCH ADAPTED FROM (YIN, 2003)

The *construct validity* of the research is being very well covered using the case study tactics prescribed by Yin (2003). Multiple sources of evidence in the form of scientific literatures, qualitative interviews and company yearly reports and website was referred and used to collect the data for the research. The data collected from the interview and survey is well transcribed and shared in the appendix of the research report. This helped in establishing a chain of evidence of the research. The case description derived from the interview transcripts were sent to the interviewees for verification. This ensured that the key informant of the research are being reviewed and verified which further strengthens the construct validity of the research.

The *internal validity* of the research is covered well using the case study tactics identified by Yin (2003). Pattern matching tactic was being employed to understand the extent of implementation of green supply chain practices and logistics performance metrics within the chosen cases using the theoretical framework as the basis. The cross case analysis was used as a basis for deriving the relationship between green supply chain practices and logistics performance metrics. Explanation building tactic was used based on the finding of the within case and cross case studies to explain the ways to improve the logistics performance of the commercial vehicle industry. Both pattern matching as well as explanation building tactics being employed ensured the internal validity of the research.

The *external validity* of the research is being ensured by employing the replication logic tactic in the research design phase as identified by Yin (2003). Multiple cases are being chosen representing various TIER levels within the supply chain of Dutch commercial vehicle industry. Both within case and cross case synthesis is being employed to derive the relationships between the green supply chain best practices and logistics performance metrics as well the conclusion of the research.

The *reliability* of the research result is ensured by implication of the tactics namely use of the case study protocol and development of case study database as suggested by Yin (2003). The protocol that is being used to extract the information from each of the chosen case studies is according to the one defined by the experts. The research approach defined in chapter two of the report supports this claim. For each case same protocol was being used to extract information for the research. The data derived from the case studies are well documented in both transcripts as well as descriptions form. To ensure the existence of database the interview transcripts and survey report of all the interviews is shared in the appendix of this report.

8. CHAPTER EIGHT: DISCUSSIONS

There are three important things that the researcher would like to put forward for further discussion.

Firstly, the social logistics metrics that was being considered for the research was not very dynamic. The perception towards social logistics metrics varies from industry to industry, company to Company As well as from country to country. The researcher believes that the selection of the social metrics needs further insight which can be taken into account during future researches. The social metrics are not very commonly employed by the organizations which was evident from the within case analysis of the logistics performance metrics of this research. The choice of social logistics performance metrics for future research can incorporate the universal definition of sustainability into account and also inferences from scientific literatures if available on various social logistic metrics being used by organization in practice can be made.

Secondly, the external validity of this research is limited as the result can be generalized to only the Dutch commercial vehicle industry. In order to increase the external validity the researcher believes that further researches in these topic needs to include multi industry as well as multi country setting. Although doing this in a Master thesis project might be difficult but if supported by external organization this can be achieved. Thus the researches if carried out in future based on the platform of the finding of current project needs to incorporate the external validity context.

Thirdly, the content of the Balance scorecard card that has been derived based on the relationship established between the green supply chain best practices and logistics performance metric can be made robust. Current content is confined to Dutch commercial vehicle industry inputs. So the applicability might me in question for many when used in different industry setting. Future researches can focus on creating an inventory of green supply chain best practices and logistics performance metrics being used across various industries. Based on this findings relationship can be established between these two entities using qualitative or qualitative research strategy by collecting empirical data. Once the relationship is established then the content of the Balance scorecard can be amended accordingly.

9. CHAPTER NINE: REFLECTION

The long route being taken from the beginning of this research to the mining of the corresponding conclusions has finally come to an end. There have been numerous arguments expressed and various elements cited. This section takes a step backwards and looks over and beyond this research, so as to connect these diverse components and achieve an overall consensus that stresses 1) the *contribution* and 2) the *limitations* of this research project.

Research contribution

This study makes a significant academic contribution to the green supply chain and logistics literature. The research problem which this research aimed to address was that there is no theory or model in literature as well as in practice which the managers can used to improve the logistics performance of their organization. First, the research contributes, through an empirical investigation, to the adoption of GSCM practices in the Dutch commercial vehicle industry, by examining different companies at different SC levels. Second, relationships between the individual green supply chain best practices and logistics performance measurement metrics are examined and evaluated. Therefore, this paper contributes to the literature by exploring relationships between specific green supply chain best practices and specific logistics performance measurement metrics. Given such results, for individual companies and their SCs, managers can recognise how to improve their logistics performance and also gain operational and economic benefits through the adoption of certain GSCM practices suggested in the research.

Several managerial implications can be deduced from this study. The relationship model between the green supply chain best practices and economic, environmental & social logistics performance metrics is proposed, together with a set of green practices (at upstream, focal Company And at downstream level) and a logistics performance measurement system which could be deployed by SC managers to green their SCs and evaluate the influence of these practices on logistics performance. In addition, application of the model could encourage SC managers to think about why they consider some practices more important to their SCs, but in some cases do not implement them. The guidelines and protocols that have been derived for improving the logistics performance by means of harnessing the green supply chain practices is well explained for the SC managers. In other words, the contribution of this research is clear and straightforward. There is not much to be said in this direction. What should be, though, examined is the weight of this contribution, the actual importance of the final outcome. In this respect, the limitation of this research needs to be discussed in deep.

Research Limitations

The last topic that needs to be discussed is the limitations of this research and how they seem to impact the final output. As with any type of research, this research project also presents some limitations. These limitations have been already recognized at the beginning of the research technical design and certain mitigation strategies are also being employed. It has been declared ab initio that, whether these limitations have a major or minor impact on this research, this need to be decided individually, by the actual reader. The purpose of recognizing and enlisting these limitations is to declare the awareness of their existence and, thereby, reduce their effect.

Taking in to account the first limitation i.e. the qualitative nature of this research and how it affects the extraction of tangible solutions. It has been stated that a constructive and systematic research approach followed by a step-by-step confrontation of the research problem are considered sufficient. This is adequate enough to direct the collection, analysis and synthesis of research data in order to derive valuable conclusions and tangible solutions. Researcher has a firm believe that the adopted research protocol allies with the characteristics of qualitative research and manages to produce fruitful solutions and tangible guidelines. Whether now these are to be adjusted or not upon implementation, this is to be decided by the recognized clients of this research.

Another limitation that has been recognized is related with decisions that have been made during the research technical design. The research sample selection criteria, the sample size, the quality and suitability of the respondents, even the ability of the researcher to conduct the interviews can be seen as subduing factors. It has been claimed however under the research strategy section that when it comes to qualitative research, trustworthiness of the results is translated as trust on the ability of the researcher to run the research. There are no objectifiable criteria such as the reliability and validity in the case of quantitative research. The only relevant action that can be taken is the assessment of corresponding literature so as to gather and comply with already established approaches and practices. Amid the various decisions that have been made in this research design, the size of the sample is, perhaps, the only one that may be problematic and needs to be discussed. It has been found that, using a critical case/ criterion/ homogeneous/ convenience sampling strategy, a sample of six interviewees can be sufficient in this research context. On one hand, the fast convergence of the results supports and justifies this decision. On the same track, the successful implementation of the triangulation methodology, where data from different sources appears to point at the same direction, is also supporting.

On the other hand though, the assumption of homogeneous sample is somehow invalidated, since additional criteria appear to influence the opinions of the respondents, such as the industry their companies belong to and the organizational structure of their companies. In this respect, homogeneity might not be a valid assumption when looking backwards, and as a result there may have been needed more respondents to reassure qualified results. However, this argument is by no means sufficient to justify the invalidation of the entire research. The evidence supporting the derived conclusions is clear and, again, always sided by the other methods of the triangulation methodology. Overall, the opinion of the researcher is that the research project here is merely an initial attempt. Further research and quantitative results are necessary for the production of safe, concrete and specific solutions. Therefore, this research can be still and always used as an initial approach on the described subject, an approach that can be always furthered and supported by analogous attempts. After all, qualitative research is about the production of hypotheses.

The final issue found to be limiting the effectiveness of this research, is the overall context within which this research is performed. That is, as a master thesis, this research is acutely limited by time and budget constraints. Along with the unpredictable and hard to schedule nature of qualitative research, it was claimed that it might create problem during research phase. This is because of the need to establish contact with the

supply chain managers in order to collect data for the research. However, dedicated work and well-structured planning have been considered to be the mitigator which was believed sufficient to confront this limitation. Overall, it is the view of the researcher that this constraint has been effectively dealt with and that the final outcome is of high quality and beyond the limits of a master dissertation.

APPENDIX A – INTERVIEW QUESTIONAIRE

Basic Info about interviewee and organization:

1. What product does your organization manufacturers?
2. What position does your organization hold in the supply chain (tier level) of your industry?
3. What position do you hold in the organization and how many employees are there in your organization?

Questions on Green Supply Chain Practices

Environmental management system of the organization (GrSCOR Plan process)

4. Does your company have a formal environmental policy? Is it known and followed from the top down?
5. How deeply is your Company Affected by already existing environmental regulations like REACH, EU ETS and WEEE?
6. Where does the biggest opportunity lie for improving your company's environmental footprint (i.e., energy efficiency, recycled materials, etc.)?
7. Has your Company addressed end-of-life issue for your products? Do you need to? Have you determined whether your customers are willing to pay a higher price for greener products?

Upstream (GrSCOR Source Process)

8. How much do you know about your suppliers' environmental impact or commitment to environmental sustainability?
9. What extent might your organization is harmed by a supplier's environmental issues?
10. How does the ISO 14000 certification of your suppliers play role in the selection process?
11. Are you adequately weighting concerns such as product energy consumption, hazardous material content or end-of-life issues in the R&D phase?
12. What environmental packaging methods your organization has adopted at upstream to minimize waste?
13. What transportation methods are being adopted by your organization to reduce fuel consumption?

Focal firm (GrSCOR Make process)

14. Do you have an ISO 14000 certification for your organization? What benefits did it bring to your organization?
15. What effort does your company has taken so far to reduce energy consumption during production? Could you give some examples?
16. How do you manage and try to minimize the waste generated during the production process? To what extent does your organization recycled the wastes generated?
17. How do you control the emissions (air & water) during production? What control measures are taken so far to minimize these emissions?

Downstream (GrSCOR Delivery Process)

18. What green packaging policies are being adopted by your organization at downstream of your supply chain? How beneficial did it resulted in so far?
19. What role environmental impacts play in the vehicle routing system? What environmentally friendly transportation modes are being adopted by your organization at downstream?
20. What role reverse logistics plays as a strategy in your aim towards controlling environmental impact of your supply chain?

Questions on Logistics performance

21. How important is the logistics performance for your organization?
22. How are the green supply chain practices related to the logistics function?
23. Which performance indicators do you use to measure the performance of organization's logistic function?
24. Which among these practices best reflects the influence of green practices on the logistics performance?
25. Which green practices have enhanced organization's logistics performance?
26. Which green practices have deteriorated organization's logistics performance?
27. In your opinion how these green practices should be chosen with rationale of logistics performance improvement?

APPENDIX B – RELATIONSHIP BETWEEN GSC PRACTICES AND LOGISTICS METRICS

Relationship between Green SC practice and Economic Logistics metrics

Kindly fill up in a scale of "1" to "5", where "1" being less influential and "5" being most influential, the impact of various green supply chain practices on economic logistics metrics.

		Economic Logistics metrics								
		Operational				Efficiency			Responsiveness	
	Green Practices	*Quality of products*	*Customer service level*	*Product availability*	*Transportation*	*Utilisation*	*Productivity*	*Logistics Cost reduction*	*Response to customer needs*	*Flexibility*
Plan	Decrease energy consumption and hazardous material usage									
	Better handling and storage of hazardous materials									
	Environmental collaboration with suppliers									
Source	Selection of materials with environmentally friendly content									
	Select suppliers with EMS system in place									
	Specify design specifications to suppliers that include environmental requirements									
	Specify green packaging & delivery requirements to suppliers									
Make	Schedule production to minimize energy consumption									
	Manage waste generated during the make process									
	Manage emissions (air and water) from the Make process									
Delivery	Minimize use of packaging materials									
	Schedule shipments to minimize fuel consumption									
	Retrieve packaging material for re-use									
Return	Do not physically return product beyond economic repair									
	Take back product for recycling									
	Schedule transportation and aggregate shipments to minimize fuel consumption									

Relationship between Green SC practice and Environmental Logistics metrics

Kindly fill up in a scale of "1" to "5", where "1" being less influential and "5" being most influential, the impact of various green supply chain practices on environmental logistics metrics

		Environmental Logistics metrics						
		Emissions		Resource utilization			Waste & Recycling	
	Green Practices	*Carbon emissions*	*Air pollutant emissions*	*Fuel consumption*	*Energy consumption*	*Water consumption*	*Waste recycling*	*Packaging recycling*
Plan	Decrease energy consumption and hazardous material usage							
	Better handling and storage of hazardous materials							
	Environmental collaboration with suppliers							
Source	Selection of materials with environmentally friendly content							
	Select suppliers with EMS system in place							
	Specify design specifications to suppliers that include environmental requirements							
	Specify green packaging & delivery requirements to suppliers							
Make	Schedule production to minimize energy consumption							
	Manage waste generated during the make process							
	Manage emissions (air and water) from the Make process							
Delivery	Minimize use of packaging materials							
	Schedule shipments to minimize fuel consumption							
	Retrieve packaging material for re-use							
Return	Do not physically return product beyond economic repair							
	Take back product for recycling							
	Schedule transportation and aggregate shipments to minimize fuel consumption							

Relationship between Green SC practice and Social Logistics metrics

Kindly fill up in a scale of "1" to "5", where "1" being less influential and "5" being most influential, the impact of various green supply chain practices on social logistics metrics.

		Social Logistics metrics				
		Health & Safety		Noise	Employees	
	Green Practices	*Toxic, hazardous emissions*	*Accidents*	*Noise Volume*	*Employment*	*Training*
Plan	Decrease energy consumption and hazardous material usage					
	Better handling and storage of hazardous materials					
	Environmental collaboration with suppliers					
Source	Selection of materials with environmentally friendly content					
	Select suppliers with EMS system in place					
	Specify design specifications to suppliers that include environmental requirements					
	Specify green packaging & delivery requirements to suppliers					
Make	Schedule production to minimize energy consumption					
	Manage waste generated during the make process					
	Manage emissions (air and water) from the Make process					
Delivery	Minimize use of packaging materials					
	Schedule shipments to minimize fuel consumption					
	Retrieve packaging material for re-use					
Return	Do not physically return product beyond economic repair					
	Take back product for recycling					
	Schedule transportation and aggregate shipments to minimize fuel consumption					

APPENDIX C – INTERVIEW TRANSCRIPTS

COMPANY A; Interview date: 11th April, 2012; Interview mode: Telephonic; Interview time: 16:00hrs to 17:15 hrs

Basic Info about interviewee and organization:

1. What product does your organization manufacturers?
   Interviewee: *We manufacture various types of trucks like long-haulage trucks, distribution trucks, construction trucks and special purpose trucks. In addition, we also manufacture complete range of buses and coaches for public transport operators and coach companies and a complete range of industrial and marine engines.*

2. What position does your organization hold in the supply chain (tier level) of your industry?
   Interviewee: *We hold OEM position in the supply chain of automotive industry. Our customers lie in B2B segment.*

3. What position do you hold in the organization and how many employees are there in your organization?
   Interviewee: *I work to the capacity of Director Production Planning and Material Control and scope of my work is to plan the supply chain activities namely sourcing, manufacturing, delivering and returning. Total workforce of our organization is around 38,000 and we are operating in about 100 countries.*

Questions on Green Supply Chain Practices

Environmental management system of the organization (GrSCOR Plan process)

4. Does your company have a formal environmental policy? Is it known and followed from the top down?
   Interviewee: *Environmental policy is integrated in the DNA of our organization. At COMPANY A we focus our sustainability work on the issues which is most relevant to our business. To keep up to speed with a rapidly changing competitive environment we continuously monitor trends, and adjust long-term strategic direction for the COMPANY A Group from top down. This includes evaluating sustainability risks and opportunities arising from climate change, constrained resources, urbanization, regulation and emerging market growth.*

5. How deeply is your Company Affected by already existing environmental regulations like REACH, EU ETS and WEEE?
   Interviewee: *Abiding by the regulations is the bottom line for our organization. Regulations like REACH, EU ETS and WEEE are closely adopted in our processes and products. Strict environmental legislation does not pose major risks for Company A, as we see environmental excellence as a competitive advantage and a spur for further development, provided it is technology-neutral and allows sufficient lead time. For example, our Euro 6 engines are ready ahead of EU requirements and are well placed to give us prime-mover advantage in the market place. As an automotive company we try to follow the legislations and regulations established by concerned bodies in our organization as well in our products to the best possible extent.*

6. Where does the biggest opportunity lie for improving your company's environmental footprint?
   Interviewee: *Improving our company's environmental footprint has been an important goal of our organization since a decade. Product efficiency, recycling of material based on the principle of 3R (Reduce, Reuse & Recycle), minimizing energy consumption, CO2 footprint of both product and process are some of the key opportunities we seek by improving company's environmental footprint. The Environmental Policy sets the tone for how Company A is to manage its negative impacts on the environment and enhance its contributions. The policy underlines the importance of responsibility.*

7. Has your Company addressed end-of-life issues for your products? Do you need to? Have you determined whether your customers are willing to pay a higher price for greener products?
   Interviewee: *End of life issues of our product are addressed right from the design to recycling stage. We have a modular design strategy for our product which enables us to maintain minimum number of parts in our product as a whole. A truck is 95 percent commercially recyclable and the carbon impact is minimal. When recycling a vehicle, the windshield and plastics are the most common items sent to landfill. A truck consists mainly of steel and cast iron with high residual value and there are many opportunities to efficiently reuse, recycle and recover for energy. Addressing end of life issues for our product is voluntarily undertaken by us in order to make business profitable for our customer. For our customer as such in B2B segment cost/km or cost of fuel consumption or life cycle cost are bottom lines for in the customer's perspective.*

Upstream (GrSCOR Source Process)

8. How much do you know about your suppliers' environmental impact or commitment to environmental sustainability?
   Interviewee: *Almost 70% of our parts are purchased thereby making suppliers a key stakeholder of our products. Supplier is very important for us and we seek to have a long term business policy with them and therefore selecting them is based on certain stringent book rules set by COMPANY A management. ISO 9001/ ISO 14001/ TS 16949 are the minimum requirement that they need to fulfill apart from few other key parameters. A supplier being obliged to an environmental management system like ISO or TS helps us to check their commitment towards environmental sustainability.*

9. What extent might your organization is harmed by a supplier's environmental issues?
   Interviewee: *In order to avoid amongst others the environmental issues in products of our suppliers we audit their process on a regular basis. These audits help us to check and monitor their activities as well in creating action plans in case of seeing any deviations or concerns. Our company's production system is focused towards the continuous improvement philosophy and we encourage our suppliers to adopt the same philosophy in their work culture. One area for improvement is to further refine our product lifecycle approach, especially to improve our understanding of the impacts that occur during raw materials supply. We are involved in developing tools for emission calculations, including cooperation with*

the Network for Transport and Environment (NTM). Our carbon emissions calculations are based on the NTM methodology.

10. How does the ISO 14000 certification of your suppliers play role in the selection process?
    Interviewee: *ISO certification is an important certification that a supplier must poses in order to be our supplier. ISO certification of supplier helps us to analyse the internal environmental management system of our suppliers. A supplier being ISO certified ensures its commitment towards sustainability and having a proper documentation system in place.*

11. Are you adequately weighting concerns such as product energy consumption, hazardous material content or end-of-life issues in the R&D phase?
    Interviewee: *Product lifecycle methodology is the foundation for Company A's R&D policy: underlining the importance of understanding and alleviating our impacts at the vehicle's every phase, yet placing our greatest efforts on addressing the areas of highest potential impact. More than half of our R&D budget is spent on environmental improvements. Legislation has made great ideas developed in the laboratory rolled out to market faster. European vehicle standards for environmental performance are the toughest in the world. At Company A, we took on the challenge and introduced our Euro 6 engine two years ahead of regulatory deadlines.*

12. What environmental packaging methods your organization has adopted at upstream to minimise waste?
    Interviewee: *Our upstream packagings are basically designed based on the principal of maximum space occupancy by product and minimum vacant space in the package. The idea is to reduce the amount of air transport and utilize space efficiently. We have returnable packaging policy at our upstream and use foldable type of bins to transport the parts from our supplier. All packaging is today designed by Company A.*

13. What transportation methods are being adopted by your organization to reduce fuel consumption?
    Interviewee: *We continuously strive to improve our transportation methods to reduce fuel consumption on a regular basis. Optimizing transport routes on a monthly basis, travel kilometre reduction per cost are some of the basic methods we adopt to reduce fuel consumption. Also, Company A is working with a logistics partner to optimise transport from all European suppliers to our production sites. All goods are collected in strategically placed hubs, which increase the filling rate of each truck. Moreover, we tailor the type of transport mode to each assignment - increasing the load factor for goods shipments and using different types of transport and packaging to accommodate the volumes of various types of goods. We use the mode of transport best suited to our goal of efficiency, be it truck, rail or boat (and only in exceptional cases, air cargo).*

Focal firm (GrSCOR Make process)

14. Do you have an ISO 14000 certification for your organization? What benefits did it bring to your organization?

Interviewee: *Yes we are an ISO 14001 certified organization. The certification has helped us to streamline our efforts towards attaining full scale sustainability throughout our organization efficiently. It had enabled us to use a common language to communicate throughout our organization on the sustainability issues. It is an important pillar of our production system.*

15. What effort does your company has taken so far to reduce energy consumption during production? Could you give some examples?
    Interviewee: *Company A constantly works to achieve more efficient resource utilization and safe, healthy workplaces in our service and production operations. The production of a truck generates about 0.5 percent (or 0.94 tonnes of carbon dioxide emissions) for every vehicle. It also consumes approximately 8 MWh of energy and 6.5 m3 of water. Our focus on environmental management lies especially in reducing waste, water, hazardous substances and energy. Keen attention on process has helped our company reduce energy, water and chemicals use, with a seven percent increase in production volumes since 2007. Although all operations share energy efficiency as a high priority, efficiency levels of new buildings and equipment are expected to far exceed norms. We also try to use closed production processes in order to avoid resource-intensive clean-up measures. Closed-loop is currently applied in all European operations and is being implemented in Brazilian and Argentinean factories.*

16. How do you manage and try to minimise the waste generated during the production process? To what extent does your organization recycled the wastes generated?
    Interviewee: *At Company A, we aim to use all resources wisely. It is an integral part of our quest for quality. Over the past decade we have achieved real reductions in the use of materials, hazardous chemicals and emissions, lessening the amount of waste generated in the process. Our striving towards continuous improvement helps us get leaner in our production processes, avoiding superfluous waste created by making unnecessary mistakes. As the amount of material use goes down, however, it is becoming more challenging to find ways to increase the rates of recycling. In five years, we've reduced our material use per vehicle by six percent. Through dialogue with waste management suppliers, we aim to optimise our recycling processes further. During 2011, Company A accumulated a total of 83,200 tonnes of waste (excluding foundry sand), 85 percent of which was recycled or recovered as energy. Over the past three years, our recycling rate has remained stable. Our challenge is to take reductions to the next level while still continually reducing material use.*

17. How do you control the emissions (air & water) during production? What control measures are taken so far to minimize these emissions?
    Interviewee: *We manage water use in two ways: Firstly, we reduce its use in our operations. And secondly, through closed-loop systems in manufacturing and service workshops, we are also containing any possible emissions and ensuring that we don't discharge substances to the water system. This approach also allows us to reuse processed water. In fact, the same water has been circulating in our systems for up to three years, continually being cleaned and reused. Our greatest potential to reduce greenhouse gas emissions (GHG) lies with reducing energy use.*

That's why every production operation at Company A is mandated to set targets and action plans in regard to improving energy efficiency.

Downstream (GrSCOR Delivery Process)

18. What green packaging policies are being adopted by your organization at downstream of your supply chain? How beneficial did it resulted in so far?
    Interviewee: *Trucks doesn't need any special packaging. We strive to deliver the trucks to our customers with minimum damages and transportation costs. Parts delivered are always delivered in returnable packaging or packing that can be recycled.*

19. What role environmental impacts play in the vehicle routing system? What environmentally friendly transportation modes are being adopted by your organization at downstream?
    Interviewee: *As said earlier Environmental Policy sets the tone for how we manage our negative impacts on the environment and enhance its contributions. The policy underlines the importance of responsibility. Company A Transport Laboratory, a wholly owned Company A subsidiary, is our window into the challenges and solutions facing our customers every day. It tests and evaluates vehicle properties and performance in commercial road haulage. To reduce the carbon impact of goods transport within Transport Laboratory, we're switching our eight in-house transport trucks servicing Södertälje operations to bioethanol-driven vehicles in 2012. This promises to reduce the transported goods' carbon impact by 70 percent. Furthermore we use Rail- and boat transport where suitable and possible.*

20. What role reverse logistics plays as a strategy in your aim towards controlling environmental impact of your supply chain?
    Interviewee: *Reverse logistics plays an important role in upstream of our supply chain. The returning of empty bins and boxes to the respective suppliers helps us to create a balance between the inbound and outbound flow of goods in the upstream of supply chain and thereby minimising energy consumptions and reducing wastes.*

Questions on Logistics performance

21. How important is the logistics performance for your organization?
    Interviewee: *Logistics is an important entity of our business. We rely heavily on it to be productive and efficient. Delivery reliability is an important aspect of our business both at upstream as well as downstream of the supply chain.*

22. How are the green supply chain practices related to the logistics function?
    Interviewee: *Green practices across the supply chain are incorporated with the goal of improving product and process quality, improve efficiency and reduce cost. This all goals once achieved directly influences the positivity of our logistics function like delivery, flexibility and total logistics cost.*

23. Which performance indicators do you use to measure the performance of organization's logistic function?
    Interviewee: *Delivery reliability, logistics cost and CO2 footprint.*

24. Which among these practices best reflects the influence of green practices on the logistics performance?
    Interviewee: *All of these three helps us to monitor the influence.*

25. Which green practices have enhanced organization's logistics performance?
    Interviewee: *We choose green practices with the rational of enhancing organizations efficiency and reducing operating costs. Our green policies adopted holistically across the value chain have helped us to improve the logistics performance. For example: Specifying the packaging design from our end has helped us to reduce use of packaging material and also save logistic cost by complete filling of the bins instead of transporting just air.*

26. Which green practices have deteriorated organization's logistics performance?
    Interviewee: *We have realized that when a green practice is being adopted based on the rational of enhancing a particular entity of the value chain it has always backfired. For example if we chose to improve transportation performance without taking into account packaging and training to drivers we will never achieve the goal. So, the green practices which are being adopted with the rational of enhancing one particular element of value chain have often proven to backfire.*

27. In your opinion how these green practices should be chosen with rationale of logistics performance improvement?
    Interviewee: *Company A emits about as much carbon dioxide through its logistics system as is emitted through energy use from factories and offices. To reduce this further, we're switching our eight in-house transport trucks servicing Södertälje operations to bioethanol-driven vehicles in 2012. We're raising expectations on other logistics suppliers, too. And through logistics hubs and choosing the most suitable mode of transport for the assignment – be it rail, road, ship or air cargo – we're optimizing transport further. The green practices must be chosen in a holistic way by taking into account the entire value chain. Logistics is being used throughout the value chain of a product and therefore it's imperative that a 360 degree overview is taken to improve its performance.*

APPENDIX D –RELATIONSHIP MATRIX FILLED BY ORGANIZATIONS

Organization filled by: COMPANY A

		Economic Logistics KPI									Environmental Logistics KPI							Social Logistics metrics				
		Operational				Efficiency			Responsiveness		Emissions		Resource utilization			Waste & Recycling		Health & Safety		Noise	Employees	
	Green Practices	*Quality of products*	*Customer service level*	*Product availability*	*Transportation*	*Utilisation*	*Productivity*	*Logistics Cost reduction*	*Response to customer needs*	*Flexibility*	*Carbon emissions*	*Air pollutant emissions*	*Fuel consumption*	*Energy consumption*	*Water consumption*	*Waste recycling*	*Packaging recycling*	*Toxic, hazardous emissions*	*Accidents*	*Noise Volume*	*Employment*	*Training*
Plan	Decrease energy consumption and hazardous material usage	1	1	1	5	5	5	5	1	3	4	3	2	5	1	1	1	3	2	1	1	2
	Better handling and storage of hazardous materials	1	1	1	4	1	1	1	1	3	1	1	1	1	1	1	1	2	3	1	1	2
	Environmental collaboration with suppliers	1	1	1	4	4	3	4	1	3	1	1	1	1	1	1	1	1	1	1	1	2
Source	Selection of materials with environmentally friendly content	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1
	Select suppliers with EMS system in place	4	4	2	2	1	1	4	4	4	1	1	1	1	1	1	1	1	1	1	1	1
	Specify design specifications to suppliers that include environmental requirements	4	4	1	2	3	2	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Specify green packaging & delivery requirements to suppliers	1	1	1	5	3	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Make	Schedule production to minimize energy consumption	1	1	1	3	3	3	3	1	1	2	1	1	2	1	1	1	1	1	1	1	1
	Manage waste generated during the make process	1	1	1	1	1	3	1	1	1	1	1	1	2	1	3	1	1	1	1	1	1
	Manage emissions (air and water) from the Make process	1	1	1	1	1	3	1	1	1	4	4	1	1	1	1	1	1	1	1	1	1
Delivery	Minimize use of packaging materials	1	1	1	3	1	1	3	1	1	1	1	1	1	1	3	3	1	1	1	1	1
	Schedule shipments to minimize fuel consumption	1	1	1	4	1	1	4	1	1	3	2	3	1	1	1	1	1	1	1	1	1
	Retrieve packaging material for re-use	1	1	1	3	1	1	3	1	1	1	1	1	2	1	4	3	1	1	1	1	1
Return	Do not physically return product beyond economic repair																	1	1	1	1	1
	Take back product for recycling																	1	1	1	1	1
	Schedule transportation and aggregate shipments to minimize fuel consumption	1	1	2	4	1	1	4	1	1	3	2	3	1	1	1	1	1	1	1	1	1

Organization filled by: COMPANY E

		Economic Logistics KPI									Environmental Logistics KPI							Social Logistics metrics				
		Operational				Efficiency			Responsiveness		Emissions		Resource utilization			Waste & Recycling		Health & Safety		Noise	Employees	
	Green Practices	*Quality of products*	*Customer service level*	*Product availability*	*Transportation*	*Utilisation*	*Productivity*	*Logistics Cost reduction*	*Response to customer needs*	*Flexibility*	*Carbon emissions*	*Air pollutant emissions*	*Fuel consumption*	*Energy consumption*	*Water consumption*	*Waste recycling*	*Packaging recycling*	*Toxic, hazardous emissions*	*Accidents*	*Noise Volume*	*Employment*	*Training*
Plan	Decrease energy consumption and hazardous material usage	1	2	1	4	3	3	3	2	1	4	4	4	5	3	2	2	5	4	1	4	3
	Better handling and storage of hazardous materials	1	1	2	2	2	2	1	2	1	2	3	2	2	2	3	2	3	4	1	2	4
	Environmental collaboration with suppliers	2	3	3	1	2	1	1	1	1	3	3	3	3	3	4	4	2	3	1	2	3
Source	Selection of materials with environmentally friendly content	4	3	2	1	1	2	1	1	1	3	3	2	2	2	2	3	4	3	1	1	1
	Select suppliers with EMS system in place	4	2	2	1	1	1	1	1	2	3	3	3	3	3	2	2	3	2	1	3	2
	Specify design specifications to suppliers that include environmental requirements	4	2	2	1	1	1	1	1	2	3	3	3	3	3	4	4	3	2	1	3	2
	Specify green packaging & delivery requirements to suppliers	3	3	2	2	1	2	1	1	1	3	3	4	4	4	4	4	3	1	1	1	1
Make	Schedule production to minimize energy consumption	3	3	2	2	3	3	2	1	1	4	4	4	4	4	3	3	2	2	2	1	1
	Manage waste generated during the make process	4	2	4	3	4	4	3	4	3	3	3	2	2	2	4	3	2	2	1	1	1
	Manage emissions (air and water) from the Make process	3	2	2	2	3	3	2	1	1	4	5	3	4	3	3	3	3	1	2	1	1
Delivery	Minimize use of packaging materials	3	3	3	5	4	3	5	2	2	2	2	3	2	2	3	3	2	1	1	1	1
	Schedule shipments to minimize fuel consumption	1	1	1	1	2	4	5	2	2	3	3	3	3	2	2	2	1	1	1	1	1
	Retrieve packaging material for re-use	1	4	2	1	1	1	1	3	2	2	2	2	2	1	2	4	2	1	1	1	1
Return	Do not physically return product beyond economic repair	1	3	2	5	2	1	3	2	2	1	2	2	2	2	2	2	2	1	1	1	1
	Schedule transportation and aggregate shipments to minimize fuel consumption	2	1	1	4	2	1	5	1	1	2	2	3	3	2	1	2	2	2	1	1	1

Organization filled by: COMPANY D

		Economic Logistics KPI									Environmental Logistics KPI							Social Logistics metrics				
		Operational				Efficiency			Responsiveness		Emissions		Resource utilization			Waste & Recycling		Health & Safety		Noise	Employees	
	Green Practices	*Quality of products*	*Customer service level*	*Product availability*	*Transportation*	*Utilisation*	*Productivity*	*Logistics Cost reduction*	*Response to customer needs*	*Flexibility*	*Carbon emissions*	*Air pollutant emissions*	*Fuel consumption*	*Energy consumption*	*Water consumption*	*Waste recycling*	*Packaging recycling*	*Toxic, hazardous emissions*	*Accidents*	*Noise Volume*	*Employment*	*Training*
Plan	Decrease energy consumption and hazardous material usage	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1	1	5	5	1	1	5
	Better handling and storage of hazardous materials	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	5	1	1	5
	Environmental collaboration with suppliers	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	3	2	2	1	1	1
Source	Selection of materials with environmentally friendly content	1	1	1	1	1	1	1	1	1	2	3	1	1	1	1	2	5	2	1	1	1
	Select suppliers with EMS system in place	4	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	1
	Specify design specifications to suppliers that include environmental requirements	4	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Specify green packaging & delivery requirements to suppliers	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	5	1	1	1	1	1
Make	Schedule production to minimize energy consumption	1	1	3	1	4	5	3	1	2	2	2	4	4	3	4	1	1	1	1	1	1
	Manage waste generated during the make process	1	1	1	1	4	5	1	1	1	2	2	5	5	4	5	1	1	1	1	1	1
	Manage emissions (air and water) from the Make process	1	1	1	1	1	1	1	1	1	3	3	3	4	4	1	1	1	1	1	1	1
Delivery	Minimize use of packaging materials	1	1	1	2	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1
	Schedule shipments to minimize fuel consumption	1	1	2	5	4	4	5	2	3	4	4	5	5	1	1	1	3	1	1	1	2
	Retrieve packaging material for re-use	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Return	Do not physically return product beyond economic repair	1	1	1	1	1	1	1	1	1	3	3	3	3	1	4	1	3	1	1	1	1
	Schedule transportation and aggregate shipments to minimize fuel consumption	1	1	1	1	1	1	4	1	1	3	3	4	4	1	1	1	2	1	1	1	1

REFERENCES

ACEA 2007. Europe's Commercial Vehicle Industry : A Key Economic Asset. *ACEA: COMMERCIAL VEHICLES FACT SHEET.* Brussels: European Automobile Manufacturers Association.

ANDERSSON, P., ARONSSON, H. & STORHAGEN, N. G. 1989. Measuring Logistics performance. *Engineering Costs and Production Economics,* 17**,** pg.253-262.

AUTOMOTIVE, F. 2007. *Automotive Industry of the Netherlands* [Online]. Available: http://www.automotive-industry.nl/page/wb/automotive-industry-overview.php [Accessed March 25 2012].

CASH, R. & SCC. Year. Introduction to GreenSCOR- Introducing Environmental Considerations to the SCOR Model. *In:* Supply Chain World- North America Conference and Exposition, March 17-19 2008 Minneapolis. Supply Chain Council.

CASH, R. & WILKERSON, T. 2003. Green SCOR: Developing a Green Supply Chain Analytical Tool. McLean: Logistics Management Institute.

CETINKAYA , B., CUTHBERTSON, R., EWER, G., KLAAS-WISSING, T., PIOTROWICZ, W. & TYSSEN, C. 2011. *Sustainable Supply Chain Management: Practical Ideas for Moving Towards Best Practice,* Heidelberg, Dordrecht, London, New York, Springer.

CHOW, G., HEAVER, T. D. & HENRIKSSON, L. E. 1994. Logistics Performance: Definition and Measurement. *International Journal of Physical Distribution & Logistics Management,* 24**,** pg. 17-28.

CHRISTOPHER, M. 2011. *Logistics & Supply Chain Management*, Pearson Education Ltd.

COBOURN, B. 2008. Going green: Sustainable growth strategies. PricewaterhouseCoopers:Technology executive connections.

CSCMP. 2011. *CSCMP's Definition of Supply Chain and Logistics Management* [Online]. Available: http://cscmp.org/aboutcscmp/definitions.asp [Accessed 25th January 2012].

EU. 2011. *Recast of the WEEE Directive* [Online]. Available: http://ec.europa.eu/environment/waste/weee/index_en.htm [Accessed 22nd March 2012].

FAWCETT S.E & COOPER M.B 1998. Logistics Performance Measurement and Customer Success. *Industrial Marketing Management,* 27**,** pg. 341 - 357.

FAWCETT, S. E. & COOPER, M. B. 1998. Logistics Performance Measurement and Customer Success. *Industrial Marketing Management* 27**,** pg. 341 - 357.

GONZALEZ, P., SARKIS, J. & ADENSO, D. B. 2008. Environmental management system certification and its influence on corporate practices: evidence from the automotive industry. *International Journal of Operations and Production Management,* 28**,** pg. 1021–1041.

GREEN JR, K. W., WHITTEN, D. & INMAN, R. A. 2008. The impact of logistics performance on organizational performance in a supply chain context. *Supply Chain Management: An International Journal,* 13**,** 317-327.

HARRISON, A. & HOEK, R. V. 2008. *Logistics Management and Strategy: Competing through the supply chain,* Essex, Pearson Education Limited.

HERVANI, A. A., HELMS, M. M. & SARKIS, J. 2005. Performance measurement for green supply chain management. *Benchmarking: An International Journal, ,* 12**,** pp 330–353.

HOLT, D. & GHOBADIAN, A. 2009. An empirical study of green supply chain management practices amongst UK manufacturers. *Journal of Manufacturing Technology Management,* 20**,** pg. 933 -956.

HU, A. & HSU, C. 2006. Empirical study in the critical factors of green supply chain management (GSCM) practice in the Taiwanese electrical and electronics industries. *IEEE International Conference on Management of Innovation and Technology.*

INSIGHT 2008. How mature is the green supply chain. *Supply Chain Monitor.* Bearing Point Inc: Management and technology consulting services.

ISO. 2011. *ISO 14000 essentials* [Online]. International Standards for Business, Government and Society. Available: http://www.iso.org/iso/iso_14000_essentials [Accessed 22nd March 2012].

KAPLAN, R. S. & NORTON, D. P. 2000. The Balanced Scorecard— Measures that Drive Performance. *Harvard Business Review***,** Pg. 69-79.

KEEBLER, J. S. & PLANK, R. E. 2009. Logistics performance measurement in the supply chain: a benchmark. *Benchmarking: An International Journal of Operations Management,* 16**,** pg. 785-798.

KLASSEN, R., LINTON, J. D. & JAYARAMAN, V. 2007. Sustainable supply chains: an introduction. *Journal of Operations Management,* 25**,** pg. 1075–1082.

LAMBERT, D. M., STOCK, J. R. & ELLRAM, L. M. 1998. *Fundamentals of Logistics International Edition*, McGraw-Hill Publishing Co.

LOEBICH, M., YVON, D. & HOUOT, X. 2011. Green Supply Chain: from awareness to action. BearingPoint. Management & Technology Consultants.

MCKINNON, A., CULLINANE, S., BROWNE, M. & WHITEING, A., . (eds.) 2010. *Green Logistics: Improving the environmental sustainability of logistics,* United Kingdom: Kogan Page Limited.

MILES, M. B. & HUBERMAN, A. M. 1994. *Qualitative Data Analysis: An Expanded Sourcebook,* California, SAGE Publication Inc.

MIN, H. & ZHOU, G. 2002. Supply chain modeling: past, present and future. *Computers and Industrial Engineering,* 43**,** 231–249.

MOSENG, B. & BREDURP, H. 1993. A Methodology for Industrial Studies of Productivity Performance. *Journal of Production Planning and Control,* 4.

NVIVO. 2012. *What is NVivo?* [Online]. QSR International Pty Ltd Available: http://www.qsrinternational.com/products.aspx [Accessed 25th June 2012].

PAULRAJ, A. 2009. Environmental motivations: a classification scheme and its impact on environmental strategies and practices. *Business Strategy and the Environment,* 18**,** pg. 453–468.

RAO, P. & HOLT, D. 2005. Do green supply chains lead to competitiveness and economic performance? *International Journal of Operations & Production Management,* 25**,** pp 898–916.

RAO.P & HOLT.D 2005. Do green supply chains lead to competitiveness and economic performance? *International Journal of Operations and Production Management,* 25**,** pg. 898–916.

SCC 2010. Supply-Chain Operations Reference-model. *SCOR Overview.* Supply Chain Council.

SKORICH, J. 2010. The European Union emissions trading scheme: a cost-effective tool for addressing climate change. *In:* ZEALAND, D. O. T. E. U. T. A. A. N. (ed.) *EU Insight.* Australia.

SRIVASTAVA, S. 2007. Green supply-chain management: A state-of-the-art literature review. *International Journal of Management Reviews,* 9**,** pg. 53-81.

STEPHAN, S. & MARTIN, M. 2008. From literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production,* 16**,** pg. 1699 - 1710.

STEVENSON, M. 2009. EU Focus: Countering the Economic Downturn, Revitalizing the Industry. *In:* HOPE, S. (ed.) *The EU and the Automobile.* Washington: Delegation of the European Commission to the United States.

STRAUSS, A. L. 2003. *Qualitative analysis for social scientists,* Cambridge, Cambridge University Press.

SUSANA, G. A., HELENA, C. & MACHADO, V. C. 2011. The influence of green practices on supply chain performance: A case study approach. *Transportation Research Part E,* 47**,** pg. 850-871.

UNION, E. 2011. Automotive Industry Guideline on REACH. *Regulation (EC) No 1907/2006.*

VACHON, S. 2007. Green supply chain practices and the selection of environmental technologies. *International Journal of Production Research,* 45**,** pg. 4357–4379.

VAN DER HEIJDEN, K. 2009. *Scenarios: the art of strategic conversation*, John Wiley & Sons.

VERSCHUREN, P. & DOOREWAARD, H. 2010. *Designing a Research Project,* The Hague, Eleven International Publishing.

YIN, R. K. 2003. *Case Study Research: Design and Methods*, SAGE Publication.

ZHU, Q., SARKIS, J. & LAI, K. 2008. Confirmation of a measurement model for green supply chain management practices implementation. *International Journal of Production Economics,* 111**,** pg. 261–273.