Green Logistics -
key elements for a well-functioning sustainable logistics system.

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Abstract

A growing awareness of the modern society about the direct relationship between a growing global community with increasing total industrial activities on one hand and various environmental problems and a natural limitation of natural resources on the other hand set the base for sustainable or “green” approaches within the supply chain. This paper therefore will look at the issue of “Green Logistics” which seeks to reduce the environmental impact of logistics activities by taking into account functions such as recycling, waste and carbon emission reduction and the use of alternative sources of energy.

In order to analyze how these approaches and ideas are being perceived by the system as a whole two models from the area of prospective and scenario planning are being used and described to identify the main drivers and tendencies within the system in order to create feasible hypothesis. Using the URCA/CHIVAS model allows us to identify the driver variables out of a high number of variables that best describe the system “Green Logistics”. Followed by the analysis of the actor’s strategies in the system with the Mactor model it is possible to reduce the complexity of a completely holistic system to a few key drivers that can be analyzed further on.

Here the implications of URCA/CHIVAS and Mactor are being used to formulate hypotheses about the perception of Green Logistics and its successful implementation among logistics decision makers by an online survey.

This research seeks to demonstrate the usefulness of scenario planning to a highly complex system observing it from all angles and extracting information about the relevant factors of it. The results of this demonstration indicate that there are drivers much beyond the factory walls that need to be considered when implementing successfully a system such as Green Logistics.
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<td>3PL</td>
<td>Third Party Logistics</td>
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<td>BCM</td>
<td>Bromochloromethane (CH2BrCl)</td>
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<tr>
<td>CFC</td>
<td>Chlorofluorocarbon</td>
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<tr>
<td>CO₂</td>
<td>Carbon Dioxide</td>
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<td>EU</td>
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<td>GDP</td>
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<td>Greenhouse Gas</td>
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<td>NASA</td>
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OECD - Organization for Economic Co-operation and Development

OPEC - Organization of the Petroleum Exporting Countries

SPSS - Statistical Package for the Social Sciences (Microsoft Software)

TBL – Triple Bottom Line

UN – The United Nations

WTI – West Texas Intermediate

WTO – World Trade Organization

WWF - World Wide Fund for Nature
1. Introduction

With the UN World Conference on Environment and Development in June 1992 in Rio de Janeiro, the words “Sustainable Development” became a global ruling principal for the 21st century. Sustainable development stands here for development that takes into consideration the needs of present generations without impacting prospects of future generations ((WCED), 1987). In 2001, the UN established the so called Millennium Development Goals (UN Web Services Section) which should bring the more or less vague ideas and concepts into a framework with clear missions, goals and the indicators needed to measure them. Along with those goals came a various number of indicators in order to measure the forecasted progress until the defined date of achievement, the year 2015.

The protection of Biodiversity, the protection of natural resources, employment and social solidarity in combination with economic growth and social development are just a few words that express how important it is for corporations and their strategies to implement systems that guarantee exactly that in the long run. The growing global demand of goods and the decrease of natural resources to feed it, leads the industry to simply add sustainability to their major goals. The historic conflict between rising efficiency on one hand and sustainability on the other does not exist in this manner any longer.

Companies have to seek a way to guarantee economic circles that are not just in themselves efficient and sustainable but also to the world outside of the factory walls. Sustainable Logistics and so-called Green Supply Chains, which are Supply Chains that consider not just economic factors but also ecological and social ones, are already major headlines in the logistics world in regions like Europe and the United States and it is most likely that those tendencies are going to spread globally sooner or later.

The aim of this research is to demonstrate how methods of scenario planning like URCA/CHIVAS and Mactor can be used to reveal key success elements for the establishment of a well-functioning and long-term oriented Green Logistics system including economic, social and ecological mindsets. Moreover, this paper seeks to explain the tools and ideas of Green Logistics as a new approach on how to pass
goods and services from one step to another within the supply chain with less environmental impact of logistics.

1.1. An overview of global warming, social issues and economic data

When talking about sustainability one is usually relating to ecologic issues such as global warming and melting pole caps. As we all know our beloved planet earth is a very complex system. Just in the last decades we got to see that it is not just complex but also very fragile.

The so called greenhouse effect has been a part of the natural circle since its beginning. Carbon dioxide (CO₂), the most known greenhouse-gas, and methane allow sunlight to reach the earth, but prevent some of the resulting heat from radiating back out into space.

The NASA comments that “the main human activities that contribute to global warming are the burning of fossil fuels (coal, oil, and natural gas) and the clearing of land. Most of the burning occurs in automobiles, in factories, and in electric power plants that provide energy for houses and office buildings. The burning of fossil fuels creates carbon dioxide, whose chemical formula is CO₂. CO₂ is a greenhouse gas that slows the escape of heat into space.”¹

A world without the natural warming due to the greenhouse effect would simply not exist the way we know it, and most of all the way it allows mankind to live. Since the industrial revolution in the middle of the 18th century much larger amounts of carbon dioxide have been released to the atmosphere. Along with the constant development of industrial economies since then and especially after the 2nd World War, the atmosphere has grown warmer at an accelerating rate: “Since 1970, temperatures have gone up at nearly three times the average for the 20th century.”²

The graphic below illustrates the expected raise in global temperature until the year 2100. “Due to uncertainties about future emissions and concentrations of

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¹ http://www.nasa.gov/worldbook/global_warming_worldbook.html (Date of access: 20th of June 2010)
greenhouse gases, the net warming effect in the atmosphere, and the response of the climate system, estimates of future temperature change are uncertain.  

Figure 1 Projections of future global warming

The Intergovernmental Panel on Climate Change (IPCC) made the projections of future warming, projected by Figure 1.

The IPCC used therefore 4 different scenarios, scenario B1 which has a relatively low increase of CO₂ emissions, Scenario A1B with a moderate growth, scenario A2 with a relatively high growth and the scenario of relatively constant emissions of CO₂. Despite the fact that this graphic can only be used as a vague estimation since scientific projections all over the world are changing almost every day, it clearly illustrates the trend towards a rise in global temperature. This rise will result not just simply in a higher sea level but it will also have an impact on water resources and natural disasters, agriculture, human health, plants and animals (IPCC, 2007).

http://www.epa.gov/climatechange/science/futuretc.html (Date of access: 23rd of June 2010)
Scenario planning, scenario thinking and scenario analysis, in general, are going to be major elements of this dissertation because they are very suitable methods to make flexible long-term plans. It can be best described as a method for learning about the future by understanding the nature and impact of the most uncertain and important driving forces affecting our world. This process encourages a knowledge exchange and a development of mutual deeper understanding of central issues important to the future of a certain field of interest (van der Heijden, 2005).

The goal is to craft a number of diverging stories by extrapolating uncertain and heavily influencing driving forces. Moreover the results and tendencies I am talking about during this dissertation are mostly based on scenarios due to the fact that we simply do not know what is going to happen in the future, neither in 2 nor in 20 years. Scenarios therefore can demonstrate possible trends and will be a very useful tool in this dissertation for strategic and successful guidance to possible future situations and the path, which lead to this future situation.

Even though it is not undoubtedly proven that human behaviour causes this rise in temperature, a survey conducted by the University of Illinois at Chicago in 2009 states: “A group of 3,146 earth scientists surveyed around the world overwhelmingly agree that in the past 200-plus years, mean global temperatures have been rising, and that human activity is a significant contributing factor in changing mean global temperatures.”

The addition of 80 million people each year to an already overcrowded globe by itself is exacerbating the problems of underemployment, pollution, waste-disposal, epidemics, water-shortages, famine, over-fishing of oceans, deforestation, desertification, and depletion of non-renewable resources (CIA).

In December 2009 the world witnessed the great failure of the long overdue and highly desired United Nations World Climate Change Conference that took place in Denmark’s beautiful capital city Copenhagen (UN Web Services). Unfortunately, the global community was not able to reach a compulsory agreement which allowed to tackle ecological issues that already exist nowadays and will most likely become more challenging in the future.

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Also, it is highly expectable that continued global warming will have damaging effects such as changing weather patterns, floods, draughts and damaging storms that will harm not only mankind but also plants and animals. Global warming could melt enough polar ice to raise the sea level in an alarmingly amount. This would also lead to the spread of human disease and declining crop yields that would result in poverty, chaos and migration.

As mentioned above the corresponding paradigm to sustainable development has three key elements, those of economic, social and ecological sustainability. Breaking those key elements down we talk about economic sustainability that encompasses growth, stability, productivity and trickle-down effects; environmental sustainability includes ecosystem integrity and attention to carrying capacity and biodiversity while social sustainability mainly deals with equity, empowerment, accessibility and participation (Kraemer L., 2000).

After the global financial crisis, the world economy now faces a major new challenge, together with several long-standing ones such as poverty, deforestation, global warming, lack of education and poor women’s rights in certain regions of the world among others (CIA).

There are various definitions of what can be called an economy; I chose to explain it as an entire network of producers, distributors, and consumers of goods and services in a local, regional, national or global community (Auspitz, 1992). Economic sustainability therefore seeks the best possible combination of growth and stability; production and consumption in order to guarantee the same or even better economic opportunities for further generations. An economy consists of microeconomic aspects that deal with individual parts of the economy and macroeconomic aspects that rather focus on concepts that deal with an entire economy. Both of them influence the other so that small changes in economic behaviour can cause big changes in broad measures and obviously vice versa broad economic changes can influence the habits of each individual within. In order to explain economic dimensions in a global aspect we usually refer to indicators such as the Gross Domestic Product (GDP), GDP per capita, Consumer Price Index, unemployment rates, stock market indexes just to name a few. All of them give useful information about the economic situation and can be misleading when focussing only on a few.
The most used indicator is probably the GDP per capita which is the widely accepted measure for the overall output of a country with a positive correlation with the standard of living.

Figure 2 below shows the development of the global GDP per capita from the beginnings of industrialization until a projected value for the year 2100.

![Figure 2 Development of global GDP per capita](http://www.futuretimeline.net/22ndcentury/images/world_gdp_2100.jpg) (Date of access: 18th of August 2010)

A clear tendency to an overall growth of the World GDP per capita due to a more and more industrialized world and more regions with access to what and to the industry itself can be observed. Even big economic crisis like the one we saw in 2008 and 2009 will not slow down the ongoing overall rise in the long run. Emerging economies, or countries that are at the moment defined as less-developed but took the opportunities to re-think their economic patterns to boost the growth of their GDP such as China, India, Malaysia, Brazil, Russia or Indonesia can be seen as the big
drivers for the growing world economy but are still far away from reaching economic levels of Europe, Japan or the United States (Pelle, 2007).

A shift in economic power from the traditional world leaders such as the United States, Japan and Europe towards the highly growing emerging BRIC\(^5\) countries (Brazil, Russia, India and China) can be clearly monitored. A consumption growth forecast made by GoldmanSachs foresees that, by 2010, the BRIC’s will contribute to almost half of global consumption growth. Moreover the BRIC countries are showing constant independent growth scenarios (compare Figure 3 below). It happened even during the latest financial crisis when the performances were relatively constant, except from Russia.

\[
\begin{array}{c}
\text{BRICs Real GDP Growth} \\
\text{\% yoy} \\
\end{array}
\]

\[\begin{array}{cccc}
\text{Brazil} & \text{Russia} & \text{India} & \text{China} \\
\end{array}\]

\[\begin{array}{cccc}
95 & 96 & 97 & 98 \\
99 & 00 & 01 & 02 \\
03 & 04 & 05 & 06 \\
07 & 08 & 09 \\
\end{array}\]

\[\begin{array}{cccc}
-15 & -10 & -5 & 0 \\
5 & 10 & 15 & 20 \\
\end{array}\]

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{BRICs_real_GDP_growth.png}
\caption{BRIC’s real GDP growth}
\label{fig:BRICs_real_GDP_growth}
\end{figure}

Source: http://www2.goldmansachs.com/ideas/brics/drivers-of-global-consumption-doc.pdf (Date of access: 6th of June 2010)

\(^5\) The acronym BRIC is a synonym for the four biggest and most important emerging markets that are predicted to have an extensive ongoing economic growth in the close and medium-term future eventually becoming four of the six largest global economies and therefore gain massive overall importance. PELLE, S.; “Understanding Emerging Markets: Building Business Bric by Brick”, Sage Publications Pvt. Ltd, 2007, p.22
It can be stated that these economies were hit much less in comparison to the so-called G3 states USA, Japan and the European Union which used to be the benchmark for decades.

Moreover 2009 marked the first year in the post-World War II era that the global output - and per capita income – declined. Global trade plummeted nearly 25% from 2008's level, the largest single year drop since World War II. Among major countries, the biggest GDP losses occurred in Russia (-7.9%), Mexico (-6.5%), Japan (-5.7%), Italy (-5.0%), and Germany (-5.0%), while China (+8.4%), India (+6.1%), and Indonesia (+4.4%) recorded the biggest gains (CIA). In 2009, global per capita income fell about 2% to US$10,500, as global unemployment rose from just over 7% in 2008 to nearly 9% in 2009 - underemployment, especially in the developing world, remained much higher (CIA).

Despite these challenges, the world economy also shows great promise. Technology has made possible further advances in all fields, from agriculture to medicine, to alternative energy, metallurgy, and transportation. Improved global communications have greatly reduced the costs of international trade, helping the world gain from the international division of labour, raise living standards, and reduce income disparities among nations (CIA). These tendencies of an overall growth of economies worldwide and the rising living standards of great parts of the world community clearly have a significant impact on the amount of goods transported throughout the world. Reducing the consequences of exactly that is one of the main ideas of Green Logistics.

When talking about social issues we are also facing the consequences of the global financial crisis. Ban-Ki Moon, Secretary General of the United Nations describes the status quo like this:

“The numbers of people going hungry and living in extreme poverty are much larger than they would have been had progress continued uninterrupted. Economic hardship has pushed tens of millions of people into vulnerable employment and increased the number of those who, though employed, do not earn enough for themselves and their families to rise above the poverty line of $1.25 a day.”

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Throughout the world we are facing problems of poverty and hunger, lack of education, health and equality.

The most recent estimate of the United Nations Food and Agriculture Organization (FAO), released on October 14, 2009 by FAO, says that 1.02 billion people are undernourished, a sizable increase from its 2006 estimate of 854 million people. This increase has been due to mostly three factors:

1) neglect of agriculture relevant to very poor people by governments and international agencies; 2) the current worldwide economic crisis, and 3) the significant increase of food prices in the last several years which has been devastating to those with only a few dollars a day to spend: 1.02 billion people is 15 per cent of the estimated world population of 6.8 billion ((FAO), 2009). Nearly all of the undernourished are in a developing country, which also shows that there is a big gap between rich countries and poor countries as figure 4 shows below.

These remarks should remind the reader of the complexity of logistics actions which are highly related to economic, ecological and as a consequence of those two also to social issues such as hunger and poverty.

**Figure 4 Number of undernourished people in 2009**
Source: *The state of Food and agriculture*, FAO report 2009. p 116
The problem of global poverty and hunger is used here as an example of social issues the world is facing and is going to face in the close future.

1.2. Problem discussion

In today’s business environment, organizations are under increased pressure to provide customers with environmentally friendly logistics services, which can be described as the process of planning, controlling and implementing the effective flow and storage of goods, services and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements (Branch, 2008). Not only the emissions from transporting goods are the most visible contributors to air quality problems in urban areas, but there are also high influential interest groups such as NGO’s, governments and, last but not least, the customer itself that directly or indirectly manifests the need for Sustainable and more ecological approaches such as Green Logistics (Emmett, 2010).

Behind this new Green Wave lie two interlocking sources of pressure:

“First, the limits of the natural world could constrain business operations, realign markets, and perhaps even threaten the planet’s well-being. Second, companies face a growing spectrum of stakeholders who are concerned about the environment. Global warming, water scarcity, extinction of species (or loss of “biodiversity”), growing signs of toxic chemicals in humans and animals—these issues and many others increasingly affect how companies and society function. Those who best meet and find solutions to these challenges will lead the competitive pack.”

As stated above the problems that we face today consist mostly of three different dimensions: social, ecological and environmental. These dimensions interact and influence each other simultaneously. In other words, for a company to be successful in the long run, it is crucial to invest not only in economically reasonable projects but also in socially and ecologically reasonable ones. Those investments in social and

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ESTY, D.; WINSTON, A.; “Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage”, 2009, p. 8
environmental projects shall, at the same time, automatically lead to economic advantages.

According to the issues stated above it is necessary to implement management tools that are not simply economically efficient but also environmentally friendly and socially sustainable such as Green Logistics or Fair Trade\(^8\). Customers are becoming more and more aware of where their products come from, how they were produced and by whom. Environmental management activities are already part of the International Organization for Standardization (ISO) standards of the 14000-family and their influence is going to rise.

Moreover the social pressure of Non-Governmental Organizations like Greenpeace or the World Wild Fund for Nature (WWF) - an international NGO working on issues like conservation and restoration of the environment - on corporate actions can have meaningful impacts on the reputation of a product, a company or complete industry sectors.

This research will be useful to governmental agencies as a way to describe a complex system and its most influential indicators by using two methods that help to reduce complexity. Here it will be demonstrated on the example of Green Logistics as an important issue of our times but the ideas behind it can be adapted to other complex issues as well. Furthermore NGO’s can be addressed when talking about the environmental impacts of growing world trade and how to overcome them. It can be also useful for corporations by giving them an insight on how their activities first impact and second can help to overcome crucial problems of our society caused by extensive industrial activity such as pollution, diseases and climate change e.g. and how to use the positive image of green logistics and green strategies in general to increase brand or market value (Seghal, 2009).

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\(^8\) Fair Trade has two basic components: the first is to provide a working model of international trade that makes a difference to the producers and consumers that engage in it, and to do so in such a way that social objectives are met and the second, and more radical component is to challenge orthodoxy in business practices and to encourage business toward more social ends.

RAYNALDS; “Fair Trade: The Challenges of Transforming Globalization”, 2007, p.53
1.3. Motivation

As stated above, it is absolutely necessary for contemporary governments and corporations to implement environmental friendly policies as well as tackling the environmental challenges we face now and in future generations by holistic and, most of all, sustainable approaches.

This research tries to show that there is the possibility of a better market penetration, compared to a conventional approach, of a corporation when applying sustainable business approaches that seek to understand the needs of the involved variables and actors. The basic idea is to analyse the driving factors for a successful implementation of a Green Logistics system to establish long-term strategic advantages simply by understanding the system as a whole and draw the right conclusions out of it.

Sustainable Logistics not only creates more productive processes but also builds a basic step towards the need of fewer natural resources as an input factor. This strategy not only saves companies money, but also creates a certain attitude and image that can be used as a marketing tool in the short run and as part of the corporate strategy in the long run.

Logistical functions such as information management, transport, warehousing, inventory management, material handling and packaging are everywhere in a business structure and play an extensive role within every corporation. They can have a huge impact on how a company performs economically.

By analysing the key elements of a well-functioning Green Logistics system, I will demonstrate a different approach to identify what is actually necessary for this system to perform efficiently, taking into consideration the most important objectives or variables presented in chapter 3.2 and all actors involved, such as companies, governments, international institutions and NGO’s.
1.4. Research Purpose and goal

The aim of this work is to identify crucial elements for a well-functioning Green Logistics system presenting methods of scenario planning (URCA/CHIVAS, Mactor) in order to give useful implications for logistics decision makers on how to run a Green Logistics initiative successfully. I also intend to identify which aspects need to be observed intensively considering the entire system with all its complexity. The basic idea behind URCA/CHIVAS and Mactor is to capture the entire complexity of the system and reducing it to the most influential parameters in order to give valuable information about the driving forces within the system.

The research questions of this paper are 1) which elements within the system Green Logistics actually make the system work efficiently and 2) which ones minimize the resistance of the involved actors against its establishment.

To answer these questions, I will first identify variables related to green and sustainable logistics. They are divided into economic, cultural, technological, social, environmental, political, demographic, and legal dimensions in order to capture its diverse background. To evaluate which of those variables have the highest influence on all the other variables, I will run a structural analysis, by using the URCA/Chivas model, which will be explained in detail in chapter 2.3. This model also gives a hierarchical order of the crucial variables, ranked by their motricity within the system.

By using the MACTOR model afterwards, which will be explained in chapter 2.4., the relevant actors and their strategies will be identified. Moreover, the crucial variables identified by the structural analysis will give me the objectives of the system “Green Logistics”.

Out of the results of URCA/Chivas and MACTOR, I will formulate hypothesis about the identified key elements of the Green Logistics system. To test these hypotheses, a questionnaire will be sent out to logistics decision-makers in Germany and Brazil. The answers will be analysed and with these results it should be possible to conclude if the models used can be used to create reasonable preceptions about driving forces within a highly complex system.
2. Literature Review

2.1. Sustainable and Green Logistics and Supply Chain Management

Currently, society has become increasingly dependent on their transport systems to support a wide variety of activities ranging from commuting, to supplying energy needs, to distributing parts between factories. A quite frequent challenge is to develop transport systems that satisfy mobility needs as well as support economic development. Moreover, it became quite crucial for transportation in general to consider ecological and social issues. Transportation itself is a major part of our day-to-day routine in order to overcome space which is shaped by a great variety of human and physical constraints. The most common ones are time, distance, administrative divisions and/or topography. The goal of transportation is thus to transform the geographical attributes of freight, people or information, from an origin to a destination conferring them an added value in the process. In doing so, social, ecological and obviously economic aspects of transportation have to be considered (Rodrique, J-P., 2009).

As stated above, the complexity of the term sustainable or green logistics is quite difficult to grasp, because there exist numerous definitions, frameworks and theories. Some use the term “sustainable logistics”, others prefer calling it “green logistics’ and others again simply refer to it as “reverse logistics”. Each of these terms can be distinguished by details or different approaches even though their main principle is identical. For this paper, I will continue using them interchangeably according to the context. Don Wilson for example, president of the Wilson Group, describes Green Logistics as “using less energy (which also means fewer emissions) to deliver finished products to a retail point of purchase while retaining enough profit margin to keep the doors open” (Wilson, 2009). Even though this is quite a straight forward statement, it describes pretty well what is and should be important to a company seeking to implement green logistics tools, fewer input with still efficient output.

Before getting deeper into what green logistics and its similar terms actually are, it might be interesting to explore what a supply chain and logistics itself are.

A supply chain can be seen as a system of organizations, people, technology, information and resources involved in moving a product or service from the
supplier to the customer. A customer can be internal, i.e., within one organization, or external, beyond the walls of one’s organization. Supply chain activities usually transform natural resources, raw materials, and components into a finished product that is delivered to the final customer. A major part of managing a supply chain is not only the flow of materials, but the management of channel intermediaries with the supply chain (Wood, D., 1998). In our study, supply chain systems are more sophisticated and used products re-enter the supply chain at any point where residual value is recyclable. Supply chains usually link the value chain, which means that the value of the good transported increases from each step to the next step on the very same chain.

For freight transportation, for example, all the components of a supply chain require movements of raw materials, parts and finished products on modes such as trucks, rail, or containerships. Thus, transportation is directly the outcome of the functions of production, manufacturing, and consumption (Rodrigue, J-P., 2009).

Govil and Proth created a very adequate definition when they describe logistics as a global network of organizations that cooperate to improve the flows of material and information between suppliers and customers at the lowest cost and the highest speed with the objective of customer satisfaction (Govil, 2002). Here also the term “global” is introduced. The growing internationalization of the industry during the last two decades does not allow leaving out that term. Almost every good we use nowadays passes through various locations on the globe from the point of origin of each raw material involved to the home’s of the final customer throughout the world.

Moreover figure 5 shall give a visual overview of what a supply chain is.
The most suitable definition of logistics in my view is the one Andreas Kannt uses when he describes it as “the part of the supply chain that plans, implements and controls the efficient, effective flow and storage of goods, services and related information from the point of origin to the point of consumption in order to meet customers’ requirements.” In other words, logistics is involved in every process from bringing an item from location to location within the supply chain, while at the same time keeping track of it and maximizing the efficiency of each movement.

As we can see, both terms are interrelated in many ways and need to be addressed simultaneously. In other words logistics are necessary for a well working supply chain and a well-organized and cooperative supply chain is crucial for efficient logistics.

Figure 6 therefore illustrates that interrelation already including aspects of sustainable logistics.

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KANNT, A; “Supply Chain Management and Design at Global Companies”, 2002, p. 5
The first sustainable or green approach on logistics rose in the mid 1990’s due to the great awareness of environmental aspects. This awareness emerged out of a growing customer preference which was then followed by legal requirements. Countries like Germany e.g. passed laws already in the early 1990’s mandating that all packaging be returnable from customer to retailer, from retailer to wholesaler and from wholesaler to manufacturer (Wood, D., 1998). Even though this movement was growing much faster in Europe and Japan the global logistics world is simply unthinkable without sustainable aspects. Moreover the tendency to fewer raw materials in general and a strong dependency on fuel prices for the logistics industry in particular gave another incentive to develop “greener” strategies.

Moreover Srivastava created a very suitable map that visualizes the interrelations between Green Supply Chain Management and Green Operations such as Waste.
Management, Reverse Logistics and Green Manufacturing as an additional issue to the already highly complex system and mind-sets (Srivastava, 2007).

![Green Supply Chain Management Diagram]

**Figure 7 Classification based on problem context in supply chain design**  
Source: (Srivastava, 2007)

Out of these tendencies two main dimensions of green logistics arose. First, the aim of making the own global supply chains of companies more energy efficient and less environmentally harmful. And second, the need of bringing a company’s products into compliance with foreign government regulations (IOMA, 2007).

As mentioned above, still the main impetus for greening the supply chain stems from customers who continue to push more to environmentally friendly products and services, and retailers who continue to demand better recycling solutions (Lopata, November 2009).

It grew out of the growing awareness of environmental problems, and in particular with well-publicized issues such as acid rain and climate change. Furthermore the World Commission on Environment and Development Report (1987), with its establishment of environmental sustainability as a goal for international action, gave green issues a significant boost in political and economic arenas.
The transportation industry is undeniably a major contributor to environmental issues through its modes, infrastructures and traffics. The developing field of sustainable logistics and all its various characteristics can be seen as an opportunity for the transportation industry to present a more environmentally friendly face. While traditional logistics seeks to organize forward distribution, which is mostly the transport, warehousing, packaging and inventory management from the producer to the consumer, environmental considerations opened up markets for recycling and disposal, and led to an entire new sub-sector: reverse logistics (Rodrigue, J-P., 2009).

The conventional forward distribution channel in freight distribution usually deals with raw materials, parts and finished goods flowing from suppliers to producers, distributors and, finally, to consumers. In many cases, there is also a reverse channel where wastes, packages, and defective/obsolete products are flowing back up the supply chain again. In some cases, distributors will take back the merchandises, but in many others, a specialized segment of the distribution industry aims at collecting and then recycling goods and parts. Thus, reverse logistics is concerned about the movements of previously shipped goods from customers back to manufacturers or distribution centres due to repairs, recycling or returns (Dyckhoff, 2010).

Figure 8 shall give a visual overview of the idea of reverse logistics.
As concern for the environment rises, companies need to take more account of the external costs of logistics associated mainly with climate change, air pollution, noise, vibration and accidents. Examining ways of reducing these externalities and achieving a more sustainable balance between economic, environmental and social objectives is a main aspect of green logistics.

Green Logistics, on the other hand, as explained before, is mostly concerned with producing and distributing goods in a sustainable way, or in other words, taking into account environmental and social issues. Furthermore the objectives are not only concerned with the economic impact of logistics policies on the observed company, but also with wider effects on society, such as the effects of pollution on the environment. Activities on Green Logistics also include measuring the environmental impact of different distribution strategies, reducing the energy usage in logistics activities, and reducing waste and managing its treatment (Sbihi, 2007).

In doing so, Green Logistics also uses the so called Triple Bottom Line Approach (TBL) which is a metric for a corporation’s social, environmental, and economic performance. It seeks to describe business involvement in sustainability. TBL is all about dropping the financial bottom line as a meaningful indicator of where you stand in the market place and replacing it with a bottom line that properly acknowledges the interplay of the social, economic and environmental dimensions of our lives (Norman & MacDonald, Vol. 14, No.2, 2004).

Green or sustainable Logistics clearly explains that approach as figure 8 shows.
2.1.1. The 4 dimensions of Transportation

Transport represents one of the most important human activities and is an indispensable component of the economy. It creates valuable links between regions and economic activities, between people and the rest of the world. It is a four-dimensional activity whose importance is:

1. **Social.**
   Transport modes facilitate access to healthcare, welfare, and cultural or artistic events, thus performing a social service. They shape social interactions by favoring or inhibiting the mobility of people. Moreover it supports and may even shape social structures.

2. **Political.**
   Governments play a critical role in transport as sources of investment and as regulators. The political role of transportation is undeniable as governments often...
subsidize the mobility of their populations (highways, public transit, etc.). While most transport demand relates to economic imperatives, many communication corridors have been constructed for political reasons such as national accessibility or job creation.

3. Economic.
Transport has always naturally been linked to economic development. It is an industry in its own right (car manufacturing, air transport companies, etc.). It also is an economic factor in the production of goods and services. It contributes to the value-added of economic activities, facilitates economies of scale, influences land (real estate) value and the geographic specialization of regions (Rodrigue, J-P., 2009). It can surely be stated that transport is both a factor shaping economic activities, and is also shaped by them.

4. Environmental.
Despite the various advantages of transport, its environmental consequences are also significant. They include air and water quality, noise level and public health. Therefore a common trend, as stated above, is relating decisions to transport, taking into account its corresponding environmental costs. Transportation is a dominant factor in contemporary environmental issues. Substantial empirical evidence indicates that the importance of transportation is growing (Rodrigue, J-P., 2009).

The following contemporary trends can be identified regarding the issue:

- **Growth of the global demand.** The twentieth century, more than any other, has seen a considerable growth of the transport demand related to individual (mostly passengers) as well as freight mobility. This growth can partly be seen as the result of larger quantities of passengers and freight being moved, but also the longer distances over which they are carried (Rodrigue, J-P., 2009).
- **Cost reduction.** Even if several transportation modes are very expensive to own and operate (ships and planes for instance), costs per unit transported have dropped significantly over the last decades. This also has made it possible to
overcome larger distances and further exploit the comparative advantages of space (Gangophady, 2009).

2.1.2. Examples of Industry initiatives and tools on Sustainable Logistics

During the last decades various initiatives have been made once through governmental incentives and also directly by the involved industry in order not only to benefit from a better public standing but also from its long-term economic benefits. Still, environmental programmes or initiatives need to involve agreements and partnerships between public and private operators, in order to take concerted action to tackle some of the most pressing environmental problems. These innovative public/private programmes are designed to encourage voluntary adoption of technologies and strategies that save fuel and reduce greenhouse gases in the freight sector. Most of these programmes and initiatives are not specifically related to transport and logistics. Nevertheless, as the role of transport in Green House Gas emissions is constantly increasing, it seems worthwhile to consider all these programmes in order to have a complete overview.

The programme that looks most pertinent to the logistics world is the EPA SmartWay programme, which has sister programmes active in Mexico and Canada. As described below, several European countries have taken similar initiatives to promote best practices in the area of sustainable public, commercial and industrial transportation.

EPA US SmartWay programme (USA)

Launched in 2004, EPA SmartWay, is an innovative brand that represents environmentally cleaner, more fuel efficient transport options. In its simplest form, the SmartWay brand identifies products and services that reduce transport-related emissions. However, the impact of the brand is much greater as the SmartWay brand signifies a partnership between government, business and consumers to protect the environment, reduce fuel consumption, and improve air quality for future generations. All EPA SmartWay transport programmes result in significant, measurable air quality and/or greenhouse gas improvements while maintaining or improving current levels
of other emissions and/or pollutants (United States Environmental Protection Agency, 2010).

The Energy Saving Trust and others (United Kingdom)
Current programmes are the Energy Saving Trust, Safe and Fuel Efficient Driving (SAFED) and Freight Best Practices. The Energy Saving Trust conducts green fleet reviews for fleets of more than 50 vehicles, as well as providing advice to smaller fleets, to help them cut costs and emissions (Energy Saving Trust, 2009). The Safe and Fuel Efficient Driving (UK Road Safety Ltd., 2005) programme includes ecodriving for van and heavy goods vehicle drivers. This programme teaches road skills to help industry increase safety as well as reduce fuel costs and emissions. A new working group has been created in conjunction with the freight and logistics industry to develop a consistent carbon measurement and reporting method standard for the logistics transport supply chain. The objective is to develop a basis that can be used for a future reward structure – such as a voluntary recognition scheme – which industry, or potentially government, could develop. Freight Best Practice is funded by the Department for Transport to promote operational efficiency within freight operations and offers free essential information for truck operators covering a wide range of topics (UK Road Safety Ltd., 2005).

Green Distribution Partnership and others (Japan)
An experimental domestic Emission Trading Scheme and Domestic Credit System are part of a voluntary action plan. Under this scheme, large businesses provide funds or technology to small and medium-sized enterprises and use certified emission reductions in joint projects with these companies to achieve the voluntary action plan targets. The Green Distribution Partnership conference was established in 2005 to promote cooperation between shippers and carriers. This partnership includes the promotion of best practices, the establishment of a calculation method for CO2 emissions and recognition of efforts. It also funds advanced logistics models and freight consolidation projects (Green Partnership, 2010).
Objectif CO2. (France)

In 2008, the French Ministry of Ecology and Sustainable Development and Spatial Planning (MEEDDAT) and the French Environment and Energy Management Agency (ADEME), together with the main French road transport and logistics associations, launched “Objectif CO2 - Les transporteurs s'engagent”. This voluntary public-private programme to reduce CO2 emissions in the transport sector provides a framework for transport companies to commit to reducing their fuel consumption and CO2 reduction. Twenty-five large transport companies in France are already participating and this number was expected to be around 100 at the end of 2009. The programme includes a CO2 diagnosis (baseline), identification of company specific environmental performance indicators, emission reduction goals to be realised within three years, and action plans (French Environment and Energy Management Agency, 2009).

EU Emission Trading Scheme

In January 2005, the European Union Greenhouse Gas Emission Trading Scheme (EU ETS) commenced operation as the largest multi-country, multi-sector Greenhouse Gas Emissions trading System in the world. The scheme is based on Directive 2003/87/EC, which entered into force on 25 October 2003. Since 2005, some 10 000 large industrial plants in the EU have been required to buy and sell permits to release carbon dioxide into the atmosphere. An emission trading scheme enables companies that exceed individual CO2 emissions targets to buy allowances from ‘greener’ ones to help reach the targets for the EU under the Kyoto Protocol (European Commission, 2010).

The Carbon Trust

The mission of the Carbon Trust is to accelerate the move to a low carbon economy, by working with organisations to reduce carbon emissions now and develop commercial low carbon technologies for the future. Its key focus is to help businesses and public sector organisations to reduce their greenhouse gas emissions, and to act as a catalyst to accelerate the move to a low carbon economy (Carbon Trust, 2010).
The Greenhouse Gas Protocol

The Greenhouse Gas Protocol (GHG Protocol) is the most widely used international accounting tool for government and business leaders to understand, quantify, and manage greenhouse gas emissions. The GHG Protocol works with businesses, governments, and environmental groups around the world to build a new generation of credible and effective programmes for tackling climate change. The GHG Protocol was jointly convened in 1998 by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI) (Greenhouse Gas Protocol Initiative, 2011).

International Carbon Action Partnership

In October 2007, leaders of more than 15 governments met in Lisbon to establish the International Carbon Action Partnership (ICAP). ICAP is made up of countries and regions that have implemented or are actively pursuing the implementation of carbon markets through mandatory cap and trade systems. The partnership provides a forum for sharing experiences and knowledge. Sharing and evaluating best practices will help ICAP members determine the extent to which their respective programmes can be supported by, and/or benefit from, the ICAP process (International Carbon Action Partnership, 2011).

2.2. Methodology: Structural analysis with URCA/Chivas

In order to project the influence of Green Logistics on the MDG, this thesis is going to use the method of Structural Analysis. “Structural analysis is a tool that structures the pooling of ideas. This form of analysis describes a system using a matrix which combines the constituent components of the system. This method identifies the main variables which are both influential and dependent: those which are essential to the evolution of the system.”10

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Structural analysis is, aside the method of scenarios, one of the most used tools in future studies. Claiming to have its inspiration in the systemic approach, structural analysis experienced a real boost no sooner than in the late 1960's. Jay Forrester who worked on models of industrial dynamics, and then urban dynamics (1961), can be seen as one of the initiators of the first justifications of structural analysis. At the same time, the necessity to take into account multiple and homogeneous, qualitative and quantitative variables, induced the pioneers of structural analysis to use other modes of representation based on matrix and charts.

Structural analysis is a tool designed to link up ideas. It allows describing the system thanks to a matrix which links up all its constitutive elements. The method enables, by studying these relations, to underline the variables that are essential to the system's evolution. It has the advantage of stimulating reflection within a group, and leading it to think about certain aspects, which are sometimes counterintuitive. It applies to the qualitative study of extremely different systems.

The system composes a group of interrelated elements. These elements' interrelations web, or in other words its structure, constitutes the key of its dynamics and remains quite permanent. Structural analysis, which aims at bringing this structure to light, takes place in usually three stages:

1. the inventory of variables / factors
2. the description of relationships between variables where the interrelations between the elements or variables are being described
3. the identification of essential variables where the essential variables and key factors to the system's global dynamics are being identified.

The URCA Matrix identifies which are the most influential and dependent variables. In order to define our key variables, we informed the matrix how each variable influenced the other variables. We classified the influence as being:

- **U** - Unidirectional Influence
- **R** - Reversal Influence
- **C** - Circular Influence
- **A** – No Influence
### Customer requirements
- Resistance to fossil fuels
- Preference for local products
- Environmental Consciousness
- Percentage Growth of Amount of Vehicles
- Moving Air to Surface route
- Approval and Demand for Sustainable Development Projects
- Amount of Greenhouse Gas Emissions (GHG)
- Investments in Train routes
- Investment in Energy Industry Development - alternative Energy Technology

### Average length
- Price of Land
- Length of Product Life Cycle
- Investments in Infrastructure (Ports, Aijorts, roads)
- Freight transport intensity (ratio of tonne-km to GDP)
- Modal split (% of goods moved by different modes)
- Inventory Management

### Future availability of the natural resource oil
- Percentage of empty containers
- Average length of haul
- Handling factor ratio
- Efficiency of Rail Management
- Inland freight cost
- Freight Cost

### Environmental
- Fuel efficiency (ratio of fuel consumption to vehicle-kms)
- Hybrid or Electric Vehicle usage
- Speed of Logistics

### Other
- Amount of waste disposal regulation
- Customs duties for imports and exports
- Sustainable Transport Policies
- Tax Incentives for Sustainable Technologies
- Port & terminal charges
- Strength and Effectiveness of Public-Private Partnerships
- Political stability
- Carbon Trade
- Number of transit countries crossed
- Working Conditions
- Amount of disease related to ecological issues
- Fair Trade Initiatives
- Green Material Usage
- Fuel efficiency ratio of fossil consumption to vehicle-kms
- Integration of IT in the supply chain
- Hybrid & Electric Vehicle usage
- Going Solar
- Product and package design
- Speed of Logistics

### Commands
-Tax Incentives for Sustainable Technologies
- Fuel efficiency (ratio of fuel consumption to vehicle-kms)
- Hybrid or Electric Vehicle usage
- Going Solar
- Product and package design
- Speed of Logistics

Comparing the hierarchy of variables in the various classifications is a rich source of information. It enables one to not only confirm the importance of certain variables, but also to affect the variables which, because of their indirect actions, play an important role despite not identifiable through direct classification.
The limitations concern the subjective nature of the list of variables drawn up during the first phase, similar to that of the relationship between the variables. This subjectivity comes from the well-known fact that structural analysis is not a reality but a means of looking at reality. This tool enables to find a method to pool ideas by reducing the inevitable biases. In fact, the results as well as the input data, list of variables and matrix, inform as much about the manner in which reality is perceived by the working group and therefore about the group itself, as about the system under observation. The CHIVAS method is used to calculate the hierarchization of variables in systems analysis. It derives from the interrelationships between variables, through the structural matrix constructed using the mentioned above URCA model. It was designed to facilitate filling out the structural matrix shown as an example in Graphic 10, reducing the number of questions and making it possible to work with only the part above the diagonal of the matrix in which the diagonal and the lower part are filled out automatically. The objective is to hierarchize the variables by their ability to influence the system as a whole. It computes the hierarchization through the receptivity of the variables to the influence of the system. Once the filling-out process is concluded, by explaining the interrelation of each variable to another using the URCA scheme, the CHIVAS-model automatically produces the result of the hierarchy of the variables, making it possible to select the most important variables thereby reducing the number to be dealt with in the scenario (Marques, 2009). Using the URCA/CHIVAS Model allows reducing the complexity of a system by simply identifying the most influential variables among all the involved variables. It is possible, therefore, to focus on a restricted number of factors while continuing the research. Graphic 10 gives an overview of the URCA table that is used to extract a certain hierarchy of importance among all variables. To explore that hierarchy, it is necessary to explain the relationship each variable has to one another. Filling up the matrix is usually done line by line. For variable number "i" (rank number "i") for example, one will systematically assess whether it acts directly on each of the other variables. This means, for a matrix with for example 50 variables, a total number of 1250 questions is being raised. Figure 10 is an example of how the model appears to the user. Those listed variables are not related to the research of that dissertation. The graphic shall only demonstrate how a certain amount of variables are listed in order to identify their relationship with each other variable in the list.
The basic logic behind the interrelations expressed in a structural analysis matrix is based on an algorithm that Arcade, Godet, Meunier and Roubleat describe as follows:

1. **Determination of variables/factors which receive no influence (empty columns in the structural analysis matrix)**
2. **Visual alignment of the variables concerned, which will constitute the peaks of the tree to be drawn**
3. **Removal of the variables concerned by barring rows and columns corresponding to them in the matrix**
4. **Repetition of the process until no variables are left**
5. **Transcription of direct influence relationships in the matrix in the form of arrows.**

The URCA/CHIVAS model computes all those steps automatically and gives a certain hierarchy of variables as a result. The calculation itself is based on counting the U´s, R´s, C´s and A´s per line and column filled in by the expert group describing the relationship between different variables. Each U for one variable in relation to another means an R for the very opposite combination expressed by either 1 or 0, while C´s create the same value (1) for both and A´s, which stand for no relationship at all can be expressed as 0´s. Summing up the rows gives a first hierarchy about the most influential variables while the sum of each column allow to draw a first conclusion about the most dependent variables. This first result already should give an idea about the hierarchy of the variables in terms of dependency and influence among the observed crucial variables of the system. Nevertheless the initial process of filling-out the URCA/CHIVAS matrix does not take into consideration indirect influences between the underlying variables nor does the initial hierarchy.

In order to include these indirect influences, the URCA/CHIVAS model multiplies the underlying matrix several times which can lead to changes within the hierarchy. Unfortunately it was not able to reveal the amount of times necessary for the matrix being multiplied until a reasonable result is produced.

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11 ARCADE, J.; GODET, M.; MEUNIER, F; ROUBELAT, F.; “Structural analysis with the MICMAC method & Actors’ strategy with MACTOR method”; AC/UNU Millennium Project, Futures Research Methodology, 2006, p. 10-15
2.2.1. List of relevant variables

In order to run the URCA/Chivas Model, it is necessary to define variables that may have an effect on the variable analyzed and rank their influences. The variables have been selected according to the prospective diamond (Figure 11) which is used in various aspects of organizational research (Cavalcanti, 2006). The system that is under research should be seen as a whole, which cannot be disassociated from its active elements and the meaning of which can only be fully perceived when analysed simultaneously with the set of the interrelationships involved (Marques, 2009). The variables that were identified significant in their influence on the system by the author are listed in figure 11 according to their classification as a cultural, demographic, ecological, economic, legal, social, political or technological variable. A total of 44 influential variables to the system Green Logistics were identified as listed below showing the prospective diamond with its eight dimensions and the variables representing them. All observed variables were chosen by the author according to his knowledge about the subject and personal perception of important aspects to the system.

![Prospective Diamond](image)

**Figure 11** The prospective diamond and the observed variables of the system

Source: Created by author based on (Cavalcanti, 2006)
2.3. The MACTOR model

We use the MACTOR method to analyze the balance of power between actors, that will be mapped in chapter 2.4.1 and studying their convergences and divergences when faced with a certain number of associated issues at stakes and objectives. It basically aims to assist in making decisions so that actors can implement their possible alliances and conflict policies. By analyzing and describing the inter-actor influence, MACTOR basically attempts to give a global vision of the importance and possible outcome of the different variables (identified prior by the structural analysis), as well as the expected actor’s strategies, relationship of power and potential alliances and conflicts (Bendahan, 2003). The MACTOR method brings to light the interplay of potential alliances and conflicts among actors. Therefore it helps formulating key questions for prospective and strategic recommendations. Actors are important to this study since they are key elements of the System that we are talking about. Actors usually have the potential to influence variables and moreover influence other actors as well. The result of the MACTOR model gives an insight of how the involved actors interact among each other and which are supposedly the most influential on the system “Green Logistics” as a whole. It usually comprises seven steps: the first step is the construction of the table of the actors’ strategies, which involves the actors who control the key variables generated from the structural analysis in chapter 2.3. The information gathered about the actors is set out in the way that at first, an identity card for all actors including their goals, projects, objectives, their motivations, constraints and internal means of action and their past strategic behaviour is made. After that, the means of action that actors have at their disposal to use on others to achieve their objectives is reviewed (Godet, 2010). The second step seeks to identify the strategic stakes and their associated objectives. The meeting of actors according to their goals, projects etc. brings out a certain number of strategic stakes on which actors naturally have convergent or divergent positions (Godet, Scenarios and Strategies; A toolbox for problem solving, 2004). In the third step, the actors are positioned in relation to objectives while their convergences and divergences are being identified. During this phase, the attitude of each actor in respect to each objective is being expressed in the actors versus objectives matrix by indicating an agreement using (+1), a disagreement using (-1) or neutrality with (0) (Godet, Scenarios and Strategies; A toolbox for
problem solving, 2004). In order to compile a list of sets of possible alliances and conflicts, the MACTOR method specifies the number and objectives over which the actors, in pairs, converge or diverge. In order to visualize the groups of actors that have convergences of interests and to identify those actors who are potentially the most threatened two complete diagrams of convergences followed by possible divergences are being made (Godet, La Prospect - Pour penser e agir autrement, 2010). In step four the objectives for each actor are ranked. The previously constructed diagrams stay elementary since they take into account only the number of convergences and divergences of objectives between actors, but to increase realism, one must also take into account the hierarchy of objectives for each actor. Furthermore in step five the balance of power between the various actors is evaluated. A matrix of direct influences between actors is constructed using a strategic table of actors by analysing each actor’s means of action. Balance of power is calculated by the MACTOR software package, taking both direct and indirect means of action into account, e.g., an actor being able to have an influence on another through a third person. An influence-dependence plan of the actors which visualizes the position of each actor within the system is then made. This plan gives an overview whether an actor is influential or dependent to the system under study. Analysis of the balance of power between actors represents the strengths and weaknesses of each actor, their blocking possibilities, etc just like graphic 12 illustrates.
In step six there is an integration of the balance of power into the analysis of convergences and divergences between actors. To say that an actor for instance has twice as much weight as another in overall balance of power implicitly gives double weight to his/her involvement in the objectives that interest him/her and so on. This stage seeks to incorporate all the actors' balances of power into the intensity of their positioning in relation to the objectives. New diagrams of possible convergences and divergences between all actors can thus be obtained. The comparison between the series of diagrams enables one to observe how potential alliances and conflicts are influenced by taking account of the hierarchy of objectives and the balance of power among actors.
Lastly in step seven strategic recommendations and key questions for the future are being formulated. One advantage of the MACTOR method is that it works for a wide range of strategies involving several actors using a series of stakes and associated objectives. In this, it is different from research coming from game theory which often results in the construction of models which can be applied but are not applicable. Nevertheless, significant progress may be made through a closer relationship between the concepts of game theory and the MACTOR method (Arcade, 2006). The MACTOR method contains a certain number of limitations concerning the gathering of necessary information. A certain reticence on the part of the actors may be observed when they are asked to reveal their strategic projects and external means of action. Representing an actor game on the basis of this method presupposes consistent behaviour on the part of each actor in relation to the outcome, which is often contradicted in reality. In terms of tools, MACTOR software currently requires only two tables of data from which several pages of result listing and diagrams can be obtained. Yet, this is the main danger that lies in wait for MACTOR’s users seduced, even carried away by the tide of results and comments generated, they forget that everything depends on the quality of the input data as well as the ability to pick out the most relevant results (Godet, Scenarios and Strategies; A toolbox for problem solving, 2004). Although the MACTOR method fits into the scenario method, where structural analysis, actors’ strategies, and probabilistic cross-impact matrices are commonly used it can also be used on its own, either for prospective purposes or for the analysis of a given strategic situation. In structural analysis, these impacts deal with variables, while the actors’ strategies concern actors and their characteristic objectives and probabilistic models combine events and hypotheses to create a certain scenario which are different from forecasts because they are based less on experiences of the past but on the experts opinion about actual developments.

2.3.1. Functioning and Output of the Mactor model

The method basically uses three main inputs, collected in three different matrixes. The first of them is the position of actors towards a certain issue - which are formulated upon the driver variables extracted from the structural analysis with
URCA/CHIVAS - stored in the position matrix (1MAO). The Position is treated as the opinion of each actor on each of the formulated issues, determining whether it stands positive (value of 1), negative (-1) or neutral (0) to a particular issue. The second relevant input is the weight and relevance that actors give to a certain issue, collected in the so-called salience matrix. This matrix shall express how important each issue is to an actor, evaluated on a scale ranging from 0 (not important) to 4 (highly important). This matrix is merged with the position matrix, creating the 2MAO matrix which cells are the product of the corresponding cells of the salience and position matrixes (Bendahan, 2003). The final and third input is the influence of the involved actors on each other, filled into the influence matrix (MID) ranging from 0 to 4, respectively meaning from no influence to very high influence.

As being described, the first part of the method is mostly dedicated to the development of the concept of influence both between actors and on actors towards certain objectives or issues. While the input only includes the direct influence between actors, the Mactor model also takes into consideration indirect influence, which is exerted through the use of the influence with other intermediary actors (see Figure 13).

Source: (Bendahan, 2003)

According to this logic, the model automatically computes the matrix of direct and indirect influences (MIDI), which contains, for each pair of actors, the direct influence plus all the indirect influences passing from every possible intermediary actor (Bendahan, 2003).

\[ \text{MIDI}_{a,b} = \text{MID}_{a,b} + \sum_c \left( \min(\text{MID}_{a,c}, \text{MID}_{c,b}) \right) \]

Figure 13 Indirect Influences in the Mactor model
Source: (Bendahan, 2003)
The proposal here is to determine the indirect influence using the minimum of the two direct influences and generate an aggregate value which is the non-weighted sum of the direct and all indirect influences involved. The matrix itself allows determining the influence and dependence coefficients, which are themselves the sums of respectively the rows and the columns of the MIDI matrix, as seen in formulae below.

\[
I_a = \sum_b (MIDI_{ab} - MIDI_{ba}) \quad D_i = \sum_a (MIDI_{ia} - MIDI_{ia})
\]

Having these values and comparing them to the other actors influence and dependence, the relative strength standardized coefficient can be calculated as seen in the equation below, allowing a first sight on the effective power of the observed actors (Bendahan, 2003).

\[
r = \frac{I_a - MIDI_{ia}}{\sum_i (I_a)} \cdot \frac{I_a}{I_a + D_a}
\]

In order to obtain a new matrix called 3MAO which contains an aggregated factor including position, saliency and power the relative strength coefficients mentioned above are then applied to the 2MAO matrix using the formula:

\[
3MAO_{ai} = 2MAO_{ai} \cdot r
\]

Therefore the 3MAO matrix sets the basis of most of the analyses proposed by the MACTOR model and besides that important values can be drawn directly from it, such as the mobilization coefficient (see below), showing how much the different actors are involved in the situation, and the agreement and disagreement coefficients (see below), that indicate how controversial are the different objectives.

\[
Mob_i = \sum [3MAO_{ai}]
\]

\[
Ag_i = \sum (3MAO_{ai} (3MAO_{ai} > 0))
\]

\[
Disag_i = \sum (3MAO_{ai} (3MAO_{ai} < 0))
\]

Moreover, the 3MAO matrix can be used to obtain the matrix of convergences (3CAA see below) and divergences (3DAA see below). For each pair of actors, these two matrixes show how much they agree or disagree on salient and controlled objectives.
\[
3\text{CAA}_{a,b} = \frac{1}{2} \sum \left( [3\text{MAO}_{a_i} + 3\text{MAO}_{b_j}] \cdot (3\text{MAO}_{a_i} \cdot 3\text{MAO}_{b_j} > 0) \right)
\]

\[
3\text{DAA}_{a,b} = \frac{1}{2} \sum \left( [3\text{MAO}_{a_i} + 3\text{MAO}_{b_j}] \cdot (3\text{MAO}_{a_i} \cdot 3\text{MAO}_{b_j} < 0) \right)
\]

Last but not least, the ambivalence coefficient can be calculated for each actor, giving an indication of their expected stability in their potential alliances (see formula below).

\[
3\text{EQ}_i = 1 - \frac{\left( \sum_k [3\text{CAA}_{i,k} - 3\text{DAA}_{i,k}] \right)}{\left( \sum_k [3\text{CAA}_{i,k} + 3\text{DAA}_{i,k}] \right)}
\]

The Mactor method per se provides a great variety of figures and graphics (as to see in chapter 3.4.) and aggregates various coefficients that can be helpful interpreting the data computed with it. One of those figures for instance is the Influence and dependence chart (see Figure 12) which is a bi-dimensional graph in which all actors are organized according to their global influence (ordinate) and dependenc (abscissa) (Godet, Scenarios and Strategies; A toolbox for problem solving, 2004).

This graph can be very useful when analysing the relative importance of the different actors, distinguishing between dominant actors with a relatively high influence and dominated actors with a relatively high dependence. Moreover isolated stakeholders characterized by relatively low influence and dependence and so called relay actors with high influence and dependence at the same time. Furthermore the results of relative strength comparison can also be used to compare the power of the actors in the situation, thus identifying the most influential actors among them and to the system as a whole.

Besides that, the result of the Mobilisation calculations expresses not only the actor's power on objectives, but also their willingness to engage forces to control them a highly interesting perspective when analysing whether a certain objective is realistic or not (Bendahan, 2003). On the other hand the convergence and divergence analysis attempts to spot the potential alliances of actors by identifying how convergent and divergent they are. Figure 14 shows a therefore a proposed graphs which are a synthetic representation of the 3CAA and 3DAA matrixes. Here the actors are represented by nodes connected by arcs which thickness is proportional to the intensity of the convergence or divergence between the two actors. The intensity itself is higher when actors agree/disagree on issues on which they are salient and
powerful at the same time. Furthermore a chart of ambivalences can be traced to determine which actors have the strongest potential alliances and which actors are more likely to break them which also provide interesting insights about the stability of the system.

By using all these tools separately or combined, it is possible to obtain a global and holistic understanding actor positions and power distribution, which can then be exploited to analyze what particular strategies should be adopted by an actor or not.

2.3.2. Description of relevant actors

The following chapter is going to present the relevant actors in this study chosen by the author based on personal experience and the intensive study of related literature. Each actor is going to be presented with a short description of the actor itself, followed by its goals and objectives, strengths and weaknesses.

List of actors

1. Organization of the Petroleum Exporting Countries (OPEC)
2. United Nations (UN)
3. Non-Governmental Organizations (NGO's)
4. Government (Gov)
5. Customers (Customer)
6. Investors (Investors)
7. World Trade Organization (WTO)
8. Society (Society)
9. Private Industry (PrivInd)
10. Third party logistics (3PL)

**Actor description**

*Organization of the Petroleum Exporting Countries (OPEC)*

**Description:**
OPEC is a permanent intergovernmental organization of 12 oil-exporting developing nations that coordinates and unifies the petroleum policies of its Member Countries (OPEC, 2008). Formed in 1960 as a forum for mutual consultation on fixing crude oil prices and production among its member states of Algeria, Gabon, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates (UAE), and Venezuela. Ecuador, one of its original members, dropped out in 1996 due to near exhaustion of its oil reserves.

**Goals and Objectives:**
The Coordination and unification of the petroleum policies of its Member Countries.
The Stabilization of prices in international oil markets.
Securing a steady income to the producing countries; an efficient, economic and regular supply of petroleum to consuming nations; and a fair return on their capital to those investing in the petroleum industry.

**Strengths:**
Strong influence on Oil price
Politically independent

**Weaknesses:**
Dependent on global oil demand
**United Nations (UN)**

**Description:**
The United Nations is an international organization founded in 1945 after the Second World War by 51 countries committed to maintaining international peace and security, developing friendly relations among nations and promoting social progress, better living standards and human rights. Due to its unique international character, and the powers vested in its founding Charter, the Organization can take action on a wide range of issues, and provide a forum for its 192 Member States to express their views, through the General Assembly, the Security Council, the Economic and Social Council and other bodies and committees (United Nations, 2011).

**Goals and Objectives:**
1. Eradicate extreme poverty and hunger
2. Achieve universal primary education
3. Promote gender equality and empower women
4. Reduce child mortality
5. Improve maternal health
6. Combat HIV/AIDS, malaria, and other diseases
7. Ensure environmental sustainability
8. Develop a global partnership for development
9. Peacekeeping

**Strengths:**
- Strong global acceptance
- Global network and representatives
- Strong influence on public opinions

**Weaknesses:**
- Complex decision process
- No real political power
Non-Governmental Organizations (NGO's)

Description:
A non-governmental organization (NGO) is a legally constituted organization created by natural or legal persons that operates independently from any government and a term usually used by governments to refer to entities that have no government status. In the cases in which NGOs are funded totally or partially by governments, the NGO maintains its non-governmental status by excluding government representatives from membership in the organization (Lindblom, 2005).

Goals and Objectives:
1. Social equality
2. Environmental protection
3. Political equality

Strengths:
- Flexibility and direct contact
- Support by public opinion
- Politically independent

Weaknesses:
- Dependent on Public Support
- Dependent on private financial aid

Government (Gov)

Description:
A government is the organization, or agency through which a political unit exercises its authority, controls and administers public policy, and directs and controls the actions of its members or subjects

Goals and Objectives:
- Political stability
Economic growth and development

**Strengths:**
- National Support
- International Influence
- Power to change legal circumstances

**Weaknesses:**
- Short-term influence
- Dependent on public opinion
- Dependent on international influences
- Combination of various regional interests

**Customers (Customer)**

**Description:**
A customer (also known as a client, buyer, or purchaser) is usually used to refer to a current or potential buyer or user of the products of an individual or organization, called the supplier, seller, or vendor. This is typically through purchasing or renting goods or services. However, in certain contexts, the term customer also includes by extension any entity that uses or experiences the services of another. A customer may also be a viewer of the product or service that is being sold despite deciding not to buy them. The general distinction between a customer and a client is that a customer purchases products whereas a client purchases services.

**Goals and Objectives:**
1. Good purchase prices for goods and services
2. Good product attributes
3. Environmental sustainable products
4. Good availability of products and services

**Strengths:**
- Independent definition of needs
- Very diversified
Customer needs are very influential on product
Purchase Power, Power of Demand

**Weaknesses:**
Lack of uniformity

*Investors (Investors)*

**Description:**
An individual who commits money to investment products with the expectation of financial return. Generally, the primary concern of an investor is to minimize risk while maximizing return, as opposed to a speculator, who is willing to accept a higher level of risk in the hopes of collecting higher-than-average profits (Sornajah, 2010).

**Goals and Objectives:**
1. Return on Investment
2. Long Term Profits of investment
3. Short Term Profit of investment

**Strengths:**
Influence on Production
Influence on company decision making

**Weaknesses:**
Lack of knowledge about company insides
Lack of knowledge about company’s internal and external circumstances

*World Trade Organization (WTO)*

**Description:**
Is the international entity that makes and applies the rules of trade between nations across the world. It now has 153 members and its decisions are applied as part of international commerce law and regulation. This player also works as a court where international conflicts considering commercial issues are solved and
the decision, penalties and other solutions implicate on legal obligations for the parts involved (World Trade Organization, 2011).

**Goals and Objectives:**
1. Improve the welfare of the peoples of the member countries
2. Establish trade regulations and rules among the member countries
3. Growth of global trade

**Strengths:**
- Very globally influential among member countries
- Power to punish misconducts
- Not bounded to governments

**Weaknesses:**
- Lack of transparency
- Not regulated by the people

**Society (Society)**

**Description:**
Society refers to the arena of uncoerced collective action around shared interests, purposes and values. In theory, its institutional forms are distinct from those of the state, family, and market though in practice the boundaries between state, civil society, family and market are often complex, blurred and negotiated. Society generally embraces a diversity of spaces, actors and institutional forms (Taylor, 2010).

**Goals and Objectives:**
1. Political stability
2. Social equality
3. Fair pricing for products
4. Environmental consciousness
5. Ecological, economic and social sustainability

Strengths:
- Opinion leaders
- Influence on supply side
- Influence on demand side

Weaknesses:
- No real organization of interest

_Private Industry (PrivInd)_

Description:
Private industry is a basic category of business activity. The term industry is sometimes used to describe a very precise business activity (e.g. semiconductors) or a more generic business activity (e.g. consumer durables). If a company participates in multiple business activities, it is usually considered to be in the industry in which most of its revenues are derived.

Goals and Objectives:
1. Efficient production processes
2. High qualified and motivated employees
3. High demand for own products or services

Strengths:
- Influence on politics
- Employer and therefore influential on social issues

Weaknesses:
- Controlled by governments and society
- Dependent on customers’ needs and governmental regulations
Third party logistics (3PL)

Description:
A 3PL is an outsourced provider that manages all or a significant part of an organization's logistics requirements and performs transportation, locating and sometimes product consolidation activities. Third party logistics describes businesses that provide one or many of a variety of logistics-related services. Types of services would include public warehousing, contract warehousing, transportation management, distribution management, freight consolidation (Gattorna, 2003).

Goals and Objectives:
1. efficient flow of materials through the supply chain
2. high speed of logistics
3. cost efficient transport
4. Management of logistical distances

Strengths:
Specialized entities
Organizational independence from producers and consumers side
Availability of know-how and means

Weaknesses:
Influenced by legal regulations
Dependency on infrastructure
3. Methodology

3.1. Research Type and Research Strategy

For the classification of this research we have used the taxonomy proposed by Vergara (2007), which characterizes studies according to two axes: ends and means. According to the ends, the research is both exploratory and descriptive. Exploratory because there is little or no information about the perception of how Green Logistics influences the emissions of Greenhouse Gases (GHG), in particular the subject has not been studied according to the perspective of prospective planning as delimited by Michel Godet.

The research can be considered descriptive as well, since it describes the characteristics of a phenomenon but also establishes the relations between the main variables influencing it by using a different and highly holistic approach.

According to the means, the research is bibliographic and documental, since it was realized through the investigation of books, reports, articles and thesis as well as through the conduction of a questionnaire.

This questionnaire was sent out to about 3000 contacts from the Logistics industry in Germany and Brazil. The idea of the questionnaire was it to analyze the hypotheses, which will be listed in chapter 3.4, arising out of the results of the Structural analysis and the Mactor analysis.

The study can be characterized as transversal, because the data was collected at one point in time.

3.2. Presentation of Driver Variables

According to the calculation of the URCA/CHIVAS model which, has been elaborated by the author based on personal knowledge and experience, discussions with classmates and the extensive study of related literature. Out of 44 variables selected for the model, 15 key or driver variables were computed and extracted by the model.

In figure 15 those 15 driver variables are listed in a hierarchical order based on the motricity computed for each of the variable.
The URCA/CHIVAS model extracted the variable “Environmental Consciousness” as the most influential one, with a motricity of 513.173.2 when looking at the entire system of Green Logistics. For practical reasons I decided to continue working only with the 10 most influential variables which will be explained below. Interestingly among those 10 selected driver variables are 4 cultural, 3 legal, 1 political and only 2 economic variables.

1. **Environmental Consciousness**

Environmental consciousness takes in consideration the movement to protect the quality and continuity of life through conservation of natural resources, prevention of pollution, and control of land use (Jeucken, 2005).
2. *Oil Price*

The oil price is one of the most important measures for various economic issues, the standard measure is US$ per barrel which are roughly 164 liters. The price of crude oil from which petroleum products such as gasoline are derived, is influenced by a number of factors, beyond the movements of supply and demand, notably geopolitics. There is not one price for crude oil, but many. World crude oil prices are established in relation to three market traded benchmarks, West Texas Intermediate (WTI), Brent and Dubai and are quoted at premiums or discounts to these prices (OECD, 2007).

3. *Responding to customer requirements*

Stretches how the industry in general and especially the logistics industry is responding to changing customer requirements and desires regarding sustainable ideas.

4. *Resistance to fossil fuels*

Takes in consideration a growing tendency towards the resistance of the use of fossil fuels such as coal, petroleum and natural gas by a rising part of the global community.


The next variable shall give a link to the investment by the energy industries into alternative sources of energy and the efficient usage of non-renewable sources.

6. *Carbon Trade*

Carbon trading is a practice that allows one country to offset its effective carbon dioxide emissions by investing in reforestation and "clean energy" in another less-developed country (Epstein, 1990).
7. **Sustainable Transport Policies**

Sustainable transport policies introduce to the system rules and restriction for the transportation in order to give incentives to the use of "sustainable transportation.

8. **Tax Incentives for Sustainable Technologies**

Taxes are being used for the government to generate financial means. Products or services can be taxed according to various different approaches. Tax incentives for sustainability can be one characteristic of this variables and its influence on the system.

9. **Preference to local products**

Expresses the preference of local products customers might have. Local products have the attributes of a short logistical distance from the point of production until the point of consumption. Moreover it has a strengthening effect on the local industry and society.

10. **Environmental fees**

Environmental fees can enhance the cost effectiveness of pollution control efforts, as well as finance infrastructure investments. They are usually being charged from companies by the local government.
3.3. List of objectives

Drawn from the list of driver variables extracted from the URCA/CHIVAS model we can now utilize those 10 selected most influential variables to formulate objectives for the actors. Each driver variable represents one objective; the description of each objective is already given in the description of the driver variables. Due to the influence of the driver variables the author assumes that for the well-functioning system “Green Logistics” it is crucial that the actors seek to accomplish the objectives.

The list of objectives that will be analyzed together with the actors’ profiles is as follows:

1. Cope with Environmental Consciousness (EnvConsc)
2. Reduce dependency on oil price (OilPrice)
3. Meet Customer Requirements (CustReq)
4. Cope with the tendency of a general resistance to fossil fuels
6. Adapt to Carbon Trade restrictions
7. Adapt to sustainable transport policies
8. Benefit from tax incentives for sustainable technologies
9. Cope with a tendency to a customer's preference towards local products
10. Installation of Environmental Fees (EnvFees)
3.4. Presentation of Results of the MACTOR Analysis

After running the MACTOR model with all his 7 stages and inputs given by the author as described in chapter 2.3, the system computed the following results for the interrelations between the actors and objectives listed and explained in section 2.3.1 and 2.3.2 of this paper. The input of perceived relationships among actors and objectives was performed by the author based on personal judgment obtained by extensive readings and individual experiences and knowledge. All of the following results and graphs are directly computed by the MACTOR software. The input in form of certain values given by the author into the matrices of the MACTOR model are shown in detail in the appendix of this thesis, this chapter mainly shows the computed results of this input.

3.4.1. Direct and indirect influences

Matrix of Direct and Indirect Influences (MDII)
The MDII matrix determines the direct or indirect influences of order 2 between actors. The utility of this matrix is its more complete vision of the games of competitiveness (an actor can reduce the number of choices of another by influencing it through an intermediary actor). The "sum" operation used to calculate the MDII does not produce (in this new matrix) the same scale of intensities adopted to evaluate direct influences in MDI. Despite this, values in MDII are a good indicator of the importance of direct and indirect influences actors have on each other. Two indicators are calculated from the MDII:

- The degree of direct and indirect influence of each actor (li, by summing rows).
- The degree of direct and indirect dependence of each actor (Di, by summing columns).
Values represent direct and indirect influences between actors:
The higher the value, the more influence the actor has on the other.

Map of influences and dependences between actors

Map of influence and dependence between actors is a graphic representation of actors’ positions with respect to influences and dependences (direct or indirect: Di and Ii) between each other. Positions are calculated automatically by the Mactor software.
Net scale of influences (NS)

The net scale of direct and indirect influences measures, for every couple of actors, the distance between the direct and indirect influence. Each actor exerts (receives) direct and indirect influences of order 2 (from) each actor. The net influence scale will indicate for each couple of actors the surplus influence either exerted or received. If the scale is positive (+ sign), actor i (rows of NS matrix) has more direct and indirect influence on actor j (columns of NS matrix) than it receives from this actor. This is the opposite when the scale has a negative (−) sign. The next step is to calculate for each actor the total difference of direct and indirect influences by adding up the net influence scales on the rest of the actors.
Values are relative whole numbers:
The (+) sign indicates the actor exerts more influence than it receives.
The (-) sign indicates the actor exerts less influence than it receives.

MDII competitiveness

MDII competitiveness vector

The Matrix of Direct an Indirect Influences (MDII) provides two types of useful information:

- The direct and indirect influences actor i has on actor j (MDII)ij where i!-j and are equivalent, by definition, to the direct and indirect dependence actor j has with respect to actor i.

- The indirect influences actor i has on itself coming through an intermediary actor. This is called retroaction (MDII)ii. When an actor is more competitive so will be its influence, but its dependence and retroaction will be quite weak. It is foolish to think that only the actor's influence measures its competitiveness. An actor can be very influential, be also very dependent and at the same time be very retroactive: this would result in a weak competitiveness. However, an actor being moderately influential, and having no dependence or retroaction will be very competitive.
Figure 19 Ranking of actors according to their competitiveness
Source: MACTOR Software

Ri* is the competitiveness of actor i considering its max: influences; direct and indirect dependence; and feedback.

Histogram of MDII's competitiveness
The MDII competitiveness histogram is created from the MDII competitiveness vector.

Figure 20 MDII Competitiveness histogram
Source: MACTOR Software
3.4.2. Actors Objectives Relationship

Simple position matrix (1MAO)

The simple position 1MAO matrix shows the valency of each actor with respect to every objective (likely, unlikely, neutral, or indifferent). This matrix, result of Mactor's phase 3, is not made up of the initial data entries. Mactor recalculates it from 2MAO.

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<th>Actor</th>
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<th>NGO’s</th>
<th>Gov</th>
<th>Customer</th>
<th>Investors</th>
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Figure 21 Simple position matrix (1MAO)

Source: MACTOR Software

-1: actor unlikely to achieve objective
0: Neutral position
1: actor likely to achieve objective

Valued position matrix (2MAO)

The 2MAO matrix specifies the actor’s position on each objective (pro, against, neutral or indifferent). This matrix is the initial information given by the user and also presents marginalities.
Figure 22 Valued position matrix (2MAO)
Source: MACTOR Software

The sign indicates whether the actor is likely to reach objective or not.

0: Objective has a bleak outcome
1: Objective jeopardises the actor’s operating procedures (management, etc...) / is vital for its operating procedures
2: Objective jeopardises the success of the actor's projects / is vital for the success of its projects
3: Objective jeopardises the accomplishment of the actor's mission / is indispensable for its missions
4: Objective jeopardises the actor’s existence / is indispensable for its existence

Histogram of actor’s implication towards its objectives 2MAO

This histogram is produced from the valued relationship matrix (order 2) between actors and objectives, 2MAO. It represents the actor's objectives mobilisation. The histogram is used to identify for each actor, the extent of its position with respect to the defined objectives, e.g. pro or against.
3.4.3. Convergence between actors

Convergence matrix (1CAA)

The Matrix of objectives convergences between actors or simple Convergences Actor X Actor (1CAA) identifies for a couple of actors the number of common positions they have on objectives (pro or against). This would identify the number of possible alliances. "Neutral" and "indifferent" positions (coded as "0") are not taken into consideration. This is a symmetrical matrix.

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Figure 24 Convergence matrix (1CAA)
Source: MACTOR Software
The values represent the degree of convergence: the higher the intensity, the more actors have common interests.

**Map of convergences between actors**

The map of convergences between actors maps the actors with respect to their convergences (data in matrices 1CAA, 2CAA, 3CAA). That is, the closer actors are to each other, the more their convergence is intense. This map is used to create a graph of actors’ convergences.

![Map of order 1 convergences between actors](image)

*Figure 25 Map of order 1 convergences between actors*

*Source: MACTOR Software*

**Graph of convergences between actors**

The graph of convergences between actors maps the actors with respect to their convergences (data in matrices 1CAA, 2CAA, 3CAA). That is, the closer actors are to each other, the more their convergence is intense.
3.4.4. Divergence between actors

**Divergence matrix (1DAA)**

The Matrix of divergences of objectives between actor or simple Divergences Actors X Actors (1DAA) identifies for each couple of actors the number of objectives on which these actors do not hold the same position (one actor is pre the objective and the other is against it). In other words it describes the number of potential conflicts. "Neutral" and "indifferent" positions (with code "0") are not taken into consideration. This is a symmetrical matrix.
The values represent the degree of divergence: the higher the intensity, the more actors have diverging interests.

**Map of divergences between actors**

This maps the actors' positions according to their valued divergences (data found in Matrix 2DAA). That is, the further apart actors are to each other, the more their divergence is intense.
Figure 28 Map of order 1 divergences between actors
Source: MACTOR Software

Graph of divergences between actors

The graph of divergences between actors, maps the actors of order 2 with respect to their divergences (data in matrices 1DAA). It helps to identify potential alliances and conflicts.
3.4.5. Actor ambivalence

**Actor’s ambivalence matrix**

Two actors can share both converging and diverging positions on different objectives. Hence, we call this couple of actors ambivalent. If they wish to become allies, they have to work only on those common objectives, and put aside their diverging objectives. Actor ambivalence is calculated with three equilibrium indicators using their simple, valued, then valued and weighted positions.
This indicator varies from 1 (very ambivalent actors) to 0 (not ambivalent actors).

**Histogram of actor’s ambivalence**

This histogram is produced from the actor ambivalence vector.

### 3.4.6. Net distance between objectives

**Map of net distances between objectives**

This map is used to identify objectives on which actors take the same position (either pro or against). It hence enables to isolate groups of objectives where there is a strong convergence (when objectives are close together) or divergence (when objectives are far apart) on the part of actors’ opinion. It also maps objectives with
respect to the net scale (the difference between the valued convergence matrix and the valued divergence matrix, respectively $2COO$ and $2DOO$).

**Figure 32 Map of net distances between objectives**

Source: MACTOR Software

**Graph of net distances between objectives**

This graph is used to identify objectives on which actors take the same position (either pro or against). The stronger the link between objectives, the higher the convergence of actors' opinions on these objectives.
Figure 33 Graph of net distances between objectives
Source: MACTOR Software
3.5. Interpretation of MACTOR Results

In order to draw the right conclusions and create the hypotheses to test with the questionnaire, the various results and graphs of the MACTOR model need to be analyzed and interpreted. The results presented in graphs were calculated automatically by the MACTOR software based on the fillings of the Matrix of Direct and Indirect Influences (MDI) and the Valued Position Matrix (2MAO) by author himself. Those two Matrices can be found in the appendix of this paper.

Beginning with the map of influences and dependences between actors it can be analyzed that 4 actors are identified as highly influential on the other actors. The highest influence was calculated for the actor Third Party Logistics (3PL) followed by the Government (Gov), the World Trade Organization (WTO) and the Customers (Customer). The most dependent actor is the Private Industry (PrivInd) followed by the Investors (Investors), the Society (Society) and the Non-Governmental Organizations (NGO´s). The actors United Nations (UN) and Organization of the Petroleum Exporting Countries (OPEC) are neither influential nor dependent. Interestingly it can be observed that the most influential actor 3PL also is highly dependent which limits his strength to achieve his objectives.

This leads us straight to the actual competitiveness of each actor to achieve his objective calculated by the software. Here both vectors, Influence and Dependency, are taken into consideration because an actor can be very influential and also very dependent and at the same time be very retroactive: which would result in a weak competitiveness.

The Histogram of MDII’s Competitiveness shows that four actors can be seen as highly competitive. The actor with the highest competitiveness is actually the Government followed by the WTO, Third Party Logistics and the OPEC. In other words, even when the 3PL were identified as most influential they are after all not the actors that are most likely to achieve their objectives due its high dependency on other actors of the system. The Government and the WTO on the other hand are less influential but more independent on the interests of other actors which after all gives them more power to compete with the other players involved. This consideration gives interesting implications on the way the objectives of the whole system, calculated by the URCA/CHIVAS model and if it is likely for them to get achieved.
The next interesting result given by the MACTOR software is the Histogram of actor’s implication towards its objectives. This histogram shows graphically which objectives of the system are actually highly probably to be supported by the involved actors. Based on the interest of the actors towards the objectives a simple list of agreements and disagreements summed up by the actors statements toward each of the objectives. With twenty agreements and only five disagreements the biggest consensus among the actors have is on reducing the dependency of fluctuations of the oil price. Moreover other objectives:

- Meet Customer Requirements,
- Benefit from tax incentives for sustainable technologies,
- Sufficient investments in Energy Industry Development, Alternative Energy, Technology, Efficiencies and Cost Savings,
- Cope with sustainable transport policies,
- Cope with Environmental Consciousness,
- Cope with a tendency to a customer’s preference towards local products,

reached a higher number of agreements than disagreements towards their achievement.

Interestingly there is no consensus among the actors on the three remaining objectives:

- Cope with the tendency of a general resistance to fossil fuels,
- Adapt to Carbon Trade restrictions,
- Installation of Environmental Fees.

According to this result the author implies that the last three mentioned objectives are not going to be achieved by the system and can therefore be left aside when making further implications. Due to the lack of agreement among the actors towards those three objectives there can be no tendency seen that would lead to the assumption of their fulfillment, taking in consideration the underlying system.

When looking at the Map of Order 1 convergences between actors four different groupings can be observed, those groupings represent that the actors within each group have a high convergence. This graph can be very useful when analyzing possible alliances among the actors. The more intense the convergence, the higher
the possibility of an alliance between two or more actors. The first group consists of only two actors which are the OPEC and WTO, due to their converging interests they can be seen as a strong alliance. Interestingly the objective of reducing the dependency of fluctuations of the oil price which was ranked as the one with the most agreements among the actors faces a strong alliance of two relatively competitive actors that could cause interferences. The Alliance between OPEC and WTO will be referred to as “Alliance 1”.

Other alliances are the one of the UN, together with the NGO’s, the Government and the Society or “Alliance 2” and the one of the Private Industry together with the Investors and the 3PL, “Alliance 3”. It can be observed that the Customers can not be included in any of the other groups due to their distance to them. The implication followed by it might be a weak position without allies for the Customers which could highly influence the most related objective “Meet customer requirements” that was the second best in terms of agreements among all actors.

Alliance 2 consist of actors that could have been sorted together probably even without any further considerations. All four actors have a kind of a public function and their main goal is the well-being of the community of people, globally and locally. They also stand for social and ecological interests.

Alliance 3 on the other hand clearly can be seen as the business alliance consisting of members with clear economic interests.

The related Graph of order 1 convergences between actors visualizes in a different way how the relationship between each actor is, if there is a convergence and if it is strong or weak. It is good visual tool that emphasizes the convergences discovered before. Nevertheless it is interesting to comment that the highest convergence among all actors is between the UN and NGO’s which stands for very strong ties of those two actors.

Furthermore the Map of order 1 divergences between actors and the related Graph confirm the implications from the considerations made out of the underlying convergences. However it should not be forgotten to mention that the highest divergence between all actors is between the society and the OPEC. In other words the interests and objectives of the OPEC are highly contrary to the ones of the Society. Since most of the system’s objectives are culturally driven a strong relation
to the society as their interpreter might be assumed. Those objectives face a strong opposition by the OPEC and its ally WTO.

The Histogram of actor's ambivalence shows a ranking based on the ambivalence of each actor which expresses the amount an actor can have converging and diverging positions on an objective. In this ranking the Customer has the highest ambivalence followed by the Private Industry and the Investors. The ambivalence demonstrates that an actor is less determined to on an ally with another actor. Since the Customers do not belong to any of the three existing alliances and they are highly ambivalent it could be possible that they join each of the existing alliances depending on certain objectives.

When analyzing the Map of net distances between objectives and taking into consideration that the author already excluded three objectives, which also show relatively high distances to the other objectives, out of further observation we can basically consider two groupings. The first group consists of the objectives “Reduce dependency on oil price fluctuations” and “Profit from tax incentives for sustainable technologies”. The second one consists of the objectives “Sufficient investments in Energy Industry Development, Alternative Energy, Technology, Efficiencies and Cost Savings”, “Cope with sustainable transport policies”, “Cope with Environmental Consciousness” and “Cope with a tendency to a customer’s preference towards local products”.

Interestingly the objective “Meet Customer Requirements” shows a high net distance to the other objectives which means that its achievement is not necessarily linked to the achievement of the other objectives. On the other hand the objectives in Group 1 and Group 2 have in common that each of its member objectives obtain a similar level of achievement. In other words if one objective of Group 1 and 2 is achieved it is very likely that the other objectives in the same group will be achieved as well.

The relatively high distance of the three excluded objectives to the other objectives can be seen as an indicator that emphasizes the decision to not maintain them among the relevant objectives.

3.6. Hypotheses

As stated before the results of the MACTOR calculation gives an overview of the objectives within the system “Green Logistics” that are likely of getting achieved with
the involved actors. This seven determined objectives will be transformed in this section into hypotheses that will be tested by asking logistics decision makers about their relevance. The idea is that this seven hypotheses will not be rejected and therefore serve as the key elements of a well-functioning sustainable logistics system. The hypotheses are as follows:

1. Oil is the chemical base for fossil fuels such as gasoline; diesel and kerosene which are the most commonly used fuels for transportation and so for the logistics industry. The price of oil on the world market has thereby a high impact on the cost efficiency of logistics. It can be assumed that the higher the price gets the higher gets the tendency of the logistics industry to use alternatives to fossil fuels.

2. To meet customer requirements is one of the essential functions of logistics. Customer satisfaction can be achieved in various ways such as speed of delivery, quality of the delivered good or the possibility of returning goods due to reclamations. A broad demand for environmental friendly and sustainable logistics has the potential to influence decision makers towards those tendencies. It can be assumed that a higher demand from the customer side towards sustainable and green logistics supports the spreading of Green Logistics projects.

3. Tax incentive on sustainable technologies are usually based on public initiatives in order to promote the development and use of technologies that are more efficient in economic terms and less harmful in ecological terms. It can be assumed that the logistics industry is willing to benefit from those incentives by investing in sustainable technologies.

4. In order to benefit from alternative technologies and for them to be implemented by a significant number of logistics companies, those technologies have to have a certain level of sophistication. To reach this state and guarantee a wide distribution of use, sufficient investments in Energy Industry Development, Alternative Energy, Technology, Efficiencies and Cost Savings are needed. It can be assumed that with increasing investments in the
energy industry development a higher level of sophistication of sustainable technologies will be obtained and therefore logistics companies tend to implement more of them.

5. Sustainable transport policies can be established by local, regional or national authority in order to tackle existing problems such as pollution or extensive traffic noise caused by transportation activities (cars, trucks, planes, trains, planes etc.). They can result in forcing an increased use of sustainable technologies or alternative fuels or simply can restrict certain areas or types of vehicles from being utilized. It can be assumed that the implementation of sustainable transport policies forces the logistics industry to use ecologically less harmful modes of transportation and therefore apply Green Logistics tools.

6. An increasing consciousness for environmental issues can result in a challenging task for the logistics industry. Since transportation and the attached industry is one of the worst polluters a rising awareness in such a manner can result in heavy contradiction and disfavor against it. In order to not risk a bad image it is absolutely crucial to adapt to those tendencies. It can be assumed that it is necessary for the logistics industry to adapt to an increasing environmental consciousness in wide parts of the society by implementing Green Logistics strategies.

7. The tendency to a customer’s preference towards local products results to shorter logistical distances from the point of sale to the point of consumption and therefore a less harmful way to transport goods within the supply chain. A rising tendency like that can be a serious threat to the business model of logistics companies. It can be assumed that the tendency towards local products forces the logistics industry to adapt their business model towards shorter transportation distances and the different use of the transportation mode. An example could be the use of the ecological friendly inland waterway transport for shorter distances instead of the highly ecologically harmful use of airplanes for long distances.
4. Data Description and Analysis

4.1. Data Presentation

After developing the seven hypotheses stated in chapter 3.5 an online survey (Attachments) promoted by the Online provider www.surveymonkey.com was sent out to 3019 E-Mail addresses of logistics decision makers in Brazil and Germany. The contact data itself was obtained by the database of the German-Brazilian Chamber of Commerce in Rio de Janeiro which has vast experience in organizing logistics events such as the biannual German-Brazilian Logistics Conference held in Rio de Janeiro. The survey consisted of a total of ten questions ranging from demographic data such as name, country and contact information. It was also asked to name the position in his company and industry sector of the participants company. For each of the seven hypotheses a five point Likert scale with the following response possibilities was established:

1. Strongly agree
2. Agree
3. Neither agree/ nor disagree
4. Disagree
5. Strongly disagree.

The so called Likert scale is a psychometric scale commonly and is the most widely used scale in survey research. It usually facilitates it for a respondent to specify his level of agreement to a statement (Dawes, 2008). The Likert scale also avoids the problem of developing pairs of dichotomous objectives and consist of a series of statements either favorable or unfavorable attitude toward the concept under study (McDaniel, 2009). By using it, the respondent has the possibility to express its level of agreement or disagreement. Moreover it is important that the use of a five point Likert scale also allows the respondent to express his or her indifference towards a certain topic.

From 3019 persons asked a total of 64 people responded online to the survey. The calculated response rate for the online survey is 2,1%. According to the research of Wright and Mardsen, that showed a tendency towards an average response rate of
online surveys of about 3% the presented response rate seems to be within the acceptable range (Wright, 2010).

The mailing itself was performed in two steps. The first one was the initial mailing to all of the 3019, ensued by a follow-up mailing seven days after the initial one. For the follow-up mailing incorrect E-Mail addresses were excluded and participants that already had been responded were not contacted again. The 7+3 approach was therefore chosen based on personal experience.

For analyzing whether the seven developed hypothesis are perceived as a realistic outcome of the structural analysis and the following actor’s strategy observations the following graphs are extracted from the received responses. Each of the hypothesis are presented as followed with the total result, the result for Brazil and for Germany separately giving a value for each mean of the observed group.

The distribution of the participants according to their nationality is shown in Figure 34, where can see that of the 64 total participants 36 were Brazilian, 17 German, 6 from the USA, 3 French and 2 Norwegian.

![Country of Participants](image)

**Figure 34 Distribution Chart Nationality of Survey Participants**

Source: Created by author with Microsoft Excel 2010 based on survey results
Hypothesis 1:

**Rising Oil Price --> increased use of alternative fuels (Total)**

- Strongly Agree: 5
- Agree: 25
- Neither Agree nor Disagree: 10
- Disagree: 5
- Strongly Disagree: 0

Mean = 2.29

**Rising Oil Price --> increased use of alternative fuels (Germany)**

- Strongly Agree: 0
- Agree: 12
- Neither Agree nor Disagree: 0
- Disagree: 2
- Strongly Disagree: 0

Mean = 2.47

**Rising Oil Price --> increased use of alternative fuels (Brazil)**

- Strongly Agree: 0
- Agree: 14
- Neither Agree nor Disagree: 2
- Disagree: 0
- Strongly Disagree: 0

Mean = 2.22

Hypothesis 2:

**Customer requires increased use of sustainable logistics --> Industry will adapt to it (Total)**

- Strongly Agree: 0
- Agree: 15
- Neither Agree nor Disagree: 5
- Disagree: 1
- Strongly Disagree: 0

Mean = 1.89

**Customer requires increased use of sustainable logistics --> Industry will adapt to it (Brazil)**

- Strongly Agree: 5
- Agree: 10
- Neither Agree nor Disagree: 5
- Disagree: 0
- Strongly Disagree: 0

Mean = 1.94

**Customer requires increased use of sustainable logistics --> Industry will adapt to it (Germany)**

- Strongly Agree: 5
- Agree: 8
- Neither Agree nor Disagree: 10
- Disagree: 0
- Strongly Disagree: 0

Mean = 1.59
**Hypothesis 3:**

Hypothesis 4:

**Use of alternative energies and technologies depends on its level of sophistication (Total)**

**Use of alternative energies and technologies depends on its level of sophistication (Brazil)***

**Use of alternative energies and technologies depends on its level of sophistication (Germany)**

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85
Hypothesis 5:

Establishment of Sustainable Transport Policies --> Increased use of environmental friendly approaches
(Total)

Mean = 2.57

Establishment of Sustainable Transport Policies --> Increased use of environmental friendly approaches
(Brazil)

Mean = 2.39

Establishment of Sustainable Transport Policies --> Increased use of environmental friendly approaches
(Germany)

Mean = 2.94

Hypothesis 6:

Increased Environmental Consciousness --> higher rate of Green Logistics implementations
(Total)

Mean = 2.01

Increased Environmental Consciousness --> higher rate of Green Logistics implementations
(Brazil)

Mean = 2.22

Increased Environmental Consciousness --> higher rate of Green Logistics implementations
(Germany)

Mean = 2.0
Hypothesis 7:

Growing customer preference towards local products --> more environmental friendly modes of transportation (Total)

- Strongly Agree: 15
- Agree: 20
- Neither Agree nor Disagree: 10
- Disagree: 5
- Strongly Disagree: 0

Mean = 2.48

Growing customer preference towards local products --> more environmental friendly modes of transportation (Brazil)

- Strongly Agree: 5
- Agree: 10
- Neither Agree nor Disagree: 15
- Disagree: 20
- Strongly Disagree: 0

Mean = 2.69

Growing customer preference towards local products --> more environmental friendly modes of transportation (Germany)

- Strongly Agree: 0
- Agree: 5
- Neither Agree nor Disagree: 10
- Disagree: 15
- Strongly Disagree: 20

Mean = 2.29
4.2. Data Analysis

When looking at the total results of the survey and the answers given by logistics decision makers in Brazil and Germany it is interesting to state that all 7 hypotheses, articulated based on the results of the structural analysis followed the analysis of the actor’s strategies, are perceived as realistic. Taking the five-point Likert Scale, as described in chapter 4.1, and its values for the given answers in numbers the average value should be 3 which is similar to the answer possibility of “neither agree nor disagree”. Following this approach, every mean value below 3 would indicate an acceptance towards the hypothesis given in the form that the majority of the participants agree to them. Interestingly all 7 hypothesis have a mean below 3 ranging from 1,59 to 2,94 (among all observed groups) giving a relatively strong acceptance for Hypothesis 2 which deals influence of customer requirements towards the increased use of sustainable modes of transportation. The lowest acceptance can be observed for Hypothesis 5 and the influence of the establishment of sustainable transport policies on the rate of implementation and use of less environmental harmful modes of transportation.

Furthermore it can be observed that each hypothesis show slight difference between the differentiated groups “Brazil” and “Germany”. While Brazilians tend to show a higher acceptance to hypotheses 1, 3, 4 and 5 Germans do so for the hypotheses 2, 6 and 7. Unfortunately out if these results, a clear pattern according to the nationality of the participants cannot be concluded. A further research on that issue might surely show some interesting results and comparisons which shall not be part of this work. Nevertheless I was surprised that Germans tend to agree stronger to the so called “soft” and vaguer factors such as the influence of customer requirements, environmental consciousness and the preference to local products on the increased use of Green Logistics and its modes and methods. Brazilians on the other hand show a stronger acceptance for more graspable factors such as the oil price for instance. Surely interesting conclusions can be drawn when taking these results as a basis for a cross-cultural comparison on sustainable industry approaches.
4.3. Research Limitations

The most significant limitations for the research methods used in the project is simply the fact that perceptions are, by definition personal and subjective. They may provide information or conclusions that might not be applicable for the larger population. This limitation is especially valid when it comes to the use of the models URCA/CHIVAS and Mactor.

For performing those two models it is recommended to form a research or experts group. This is especially true when it comes to the choice of the variables of the URCA/CHIVAS model and their interrelations and also for the interpretation of the involved actors and their strategies and objectives used in the Mactor model. Due to the limited resources of this research an extensive use of an experts group would have been out of the question.

Nevertheless the one-person-approach might lack the benefit of external points of view and the direct input of logistics specialists when creating the list of variables, their interdependencies and the actors analysis followed. However, a collective and participating method greatly limits the risks of incoherence and at the same time offers an invaluable opportunity to build up together a common experience or common knowledge. This can be seen as a strong limitation to the results of the URCA/CHIVAS and Mactor model.

When conducting online research, investigators can encounter problems regarding sampling. For example, relatively little may be known about the characteristics of people responding to online surveys, aside from some basic demographic variables, and even this information may be questionable. Even though this survey was conducted to a list of logistics decision makers, their actual knowledge and personality remains uncertain.

Moreover problems such as multiple email addresses for the same person, multiple responses from participants, and invalid/inactive email addresses make random sampling online a problematic method in many circumstances.

Although some studies of online survey methods have found that response rates in email surveys are equal to or better than those for traditional mailed surveys, these findings may be questionable because non-response rate tracking is difficult to ascertain.
Even when the precise characteristics of a sample are known by the researcher, people can still respond in socially desirable ways or misrepresent their identity or their true feelings about the content of the survey. This is especially true when it comes to environmental issues where a certain positive attitude towards it is socially highly appreciated.

Since this online survey was conducted to people personally unfamiliar to the researcher the email could have been perceived as an unwanted email advertisement which could have been considered an invasion of privacy. The invitation for the survey may simply have been deleted. Even though this was not the case of the underlying research it still might limit the access of participants.

Another limitation is that although there exists extensive research on logistics, the aspects of green and sustainable logistics are relatively new and therefore very broad in terms of definitions and scope, yet sometimes not really distinguished. Moreover the elaborated combination of tools for scenario planning
5. Conclusions and implications for future studies

As shown in the graphics, it can be indicated that all seven hypothesis were validated by the responses of the 64 participants of the online survey. Even considering a tendency of people answering towards green aspects simply because it might be socially accepted, it can be stated that the elaborated hypothesis were seen as reasonable.

Before getting into detail about each of the seven variables it might be interesting to have a look at the underlying variables that were detected as driver variables. When dividing the wide set of variables I set up eight categories in order to cover all aspects of the system. Those very same eight categories are technology, culture, politics, social, environment, economics, legal and demographics.

Interestingly, when looking at the motricity of variables or which variables actually are driving factors within the system, the URCA/CHIVAS model calculated that 4 cultural, 3 legal, 2 economic and 1 political variable can be called drivers. This can be seen as interesting because exactly half of the variables could be described as soft factors (cultural and political) and the other half as hard factors (economic and legal).

A driver variable is a variable that has a relatively high motricity and at the same a relatively low dependency on other variables.

This shows that the system Green Logistics covers a wide range of aspects that should be considered when thinking about how to implement a sustainable logistics strategy. For the author, it was also quite remarkable that for instances technological variables such as “Product Design”, “Integration of IT into the Supply Chain” or simply the “Speed of Logistics” did not came out as drivers to the system. Moreover basic economic factors of classical logistic frameworks such as “Inventory Management”, “Freight Cost” or “Modal Split” were not detected as drivers.

The results of URCA/CHIVAS as the first of two steps for the development of the hypothesis already could be seen as an indicator of a less technical outcome different to the classical school of logistics management which focuses mostly on such variables as mentioned just now.

In order to verify those driver variables, the author included the actors and their specific strategies into the system. As described in chapter 3.5 only seven variables were stated as valid after taking in consideration the actors. Those seven together
with the objectives of the actors formed the actually hypothesis tested by the online survey.

As the survey showed all elaborated hypothesis can be seen as valid. It can be concluded that first, the oil price is an important factor when talking about logistics in general and Green Logistics in specific. Since oil is the chemical base for fossil fuels such as gasoline; diesel and kerosene which are the most commonly used fuels for transportation it is obvious that a price increase automatically affects the prices for logistics. This almost simultaneously results in higher costs for 3PL’s and also for the internal, external and final customers. Due to the increasing global demand for the natural resource oil and a limited quantity of natural reserves the tendency towards rising oil prices is fairly realistic in the long run. For Green Logistics initiatives, it is important to be aware of that. The relationship of oil price and final customer price will most likely be a key factor for private customers and the industry to broaden their horizon towards other energy sources such as alternative fuels. For a logistics company looking for implementing green strategies, it could be very favorable use that mentioned relationship and the trend towards rising oil prices to invest in the use of alternative sources for energy such as solar or electrical before their competitors. This could not just result in less dependency on the oil price, but also in a good marketing action and a strategic advantage towards competitors that stick to the use of only fossil fuels. Either way, it might be necessary to state that the technical sophistication for the broad industrial use of alternative fuels has not yet reached a sufficient level of efficiency to substitute or replace fossil fuels entirely. Moreover biofuels could be seen as an interesting alternative but even though they show the highest degree of sophistication among all the alternatives they cause problems such as deforestation and can therefore not be seen as a totally sustainable alternative in the opinion of the author.

When talking about customers (internal and external) it is crucial for every type of corporation to offer customer satisfaction. How this can be achieved is without a doubt part of more than one research. The classical logistics measures it mostly with its speed, its cost and the quality of the delivered good. When talking about sustainable approaches the aspect of environmental and socially adequate means has to be added. What was trying to be proved by the survey was the fact that customers asking for that initiatives will make logistics companies adapt to that
demand. The survey showed that for the respondents it is quite clear that this actually would happen. For a logistics company this could have two major implications, the first one is simply that the customer decision towards sustainable logistics approaches will reflect in the industry to adapt them. The second implication is that for logistics companies it can be extremely useful to analyze what exactly their customers understand as sustainable and how that demand can be transformed into certain logistical functions. A higher degree of customer satisfaction taking into consideration green and sustainable approaches can be seen as a crucial factor for the company’s success.

Another interesting variable that was proved to be important to the system is the fact that tax incentives offered by the local, regional or governmental authority would help tremendously in enforcing Green Logistics initiatives. It was shown that such incentives would be appreciated by the industry and therefore results in a broader application of sustainable practices. Since the society, the government and the NGO’s as important actors in the model all favor sustainable industry activities it should be obvious that those parties agree on a common approach towards precise incentives. It is worthwhile to have a look on that legal or political aspect of the system because it is external to the logistics companies but can have a crucial impact on internal functions. Here the conclusion can be drawn that political authorities have to analyze exactly which incentives actually contribute to the implementation of Green Logistics methods. Particularly, in times when the sophistication of alternative energy sources is not sufficient it is crucial to overcome exactly that by forcing the private industry into using and adapting it to their needs. With monetary support by the authorities this process can surely be fostered. After all the use of modes and technologies that are less harmful in terms of energy consumption, emissions, waste and noise can be extremely beneficial especially when taking into consideration the external costs of those factors for the society.

When thinking of Green Logistics initiatives the link to the research and development laboratories of universities and companies is seems natural. For such initiatives being successful, the existing level of sophistication of alternatives to the status quo is a critical issue that raises concerns. As mentioned before alternative sources of energy such as wind, solar, geothermal, biomass i.e. lack the effectiveness of conventional fossil fuels which makes them less likely to get implemented simply
because the cost for the same amount of performance is usually higher. For changing that two major factors can be outlined. The first and obvious one is the price for the source of energy, or if the price goes up for fossil fuels in comparison to alternative sources a change of use patterns can be expected. The other implication is an improvement of the sophistication of alternative sources of energy and technologies. As the survey proved, a general negative attitude towards them cannot be observed. Quite the contrary can be assumed, not only that the investments in such research and development was detected as a driver variable but also the fact that companies would implement them when reaching a sufficient amount of sophistication proves its importance. For their holistic success Green Logistic approaches and all approaches towards sustainability need to stretch all three dimensions according the Triple Bottom Line (TBL) idea, social, environmental and mostly economic issues. It is not very likely that a broad penetration of sustainable logistics frameworks will be possible without being economically reasonable for the implementing company. For that to happen, and the acceptance of the approach can be presumed according to the survey, investments in the development of further and better sources of alternative energy and sophisticated technological alternatives are crucial. This draws an implication especially for the public sector that needs to invest in university and research laboratories but mostly for the private industry because the result of this survey clearly shows that there is an existing demand for sophisticated sustainable technologies.

That sustainable transport policies can be a useful lever to force the industry towards Green Logistics projects was confirmed by the survey. In other words it means that public authorities actually have the means to influence the private industry towards more sustainable activities. Especially when looking at the external costs to the society caused by noise, pollution and waste that arises from transport activities it seems reasonable for a society to direct on of the main causes for that into the direction of sustainable transportation. For political decision makers it might be interesting to analyze which sustainable transport policies exactly show which results when applying them on the public transport or on the transport of goods within the supply chain for example. It was elaborated before that there are numerous reasons that explain the success of a holistic Green Logistics approach, but the use of
transport policies and their results (responses to the online survey) can be a useful tools for those kinds of companies that do not have this sustainable mind set yet. The general environmental consciousness in growing parts of the society and the tendency towards local products can be seen as similar. Both are culturally influenced and are difficult to grasp and measure. Nevertheless it was proved that their existence influences logistics decision makers towards sustainable actions. A growing awareness of wide parts of the society can be observed, it can be assumed that this simultaneously has an influence on consumer behavior in general towards sustainable products, services and also a preference to products of sustainable acting companies. For logistics companies this trend can lead to a different approach of customer satisfaction that needs to be stretched in order to remain a good standing with the customer. When talking about a preference towards local products one can easily slip into philosophical spheres assuming that in our globalized world people tend to look for something tangible and close to relate themselves to. For logistics terms it mainly results in a difference of logistical distances that need to be gapped within the supply chain. According to the TBL this would results in fewer emissions caused by long distances (ecological), less transport time and cost (economical) and a strengthening of a local industry (social). The survey showed that the logistics industry is willing to adapt to those tendency which can be seen as a first step of strengthening those tendencies in order to really change the industry behavior.

The general conclusion of this research is that there are several variables or leverages that can influence directly or indirectly the successful implication of a Green Logistics strategy. Some of them are quite intangible but still have an impact that should not be underestimated. For logistics decision makers it might be useful to analyze these factors and base a strategy on them in order to establish a system that is well-rounded and holistic. A working Green Logistics initiative should not onlyu look into the key indicators of traditional logistics but also take into consideration other aspects that might not be internal but as external factors crucial to the stability of the system. Another important factor that needs to be underlined by this research is the fact that sustainable approaches towards logistics need to include social, environmental and economic variables. The author is not naïve believing that Green
Logistics can be an alternative to the classical logistics without reaching its effectiveness and giving the desired economic output. Moreover the research showed that there is a general tendency to support such ideas. Those might be seen as hypothetical in some terms due to the lack of sophisticated alternatives in terms of technologies, fuels and mindsets. Either way the outlook me is quite positive because it can be assumed that a general awareness of such issues as poverty, global warming, deforestation, population growth etc. is no longer seen as a problem that some have and others do not.

For the society it is crucial to give that feedback to the industry, because it was shown that they would adapt to it. Customers internal or external have a great power on the shape of the industry simply in the way they behave when deciding for one product and rejecting another. This needs to be stimulated by political initiatives such as specific educational programs that will establish this attitude in the long run.

The logistics industry as a major contributor for emissions, together with the growing demand of a growing global population, it urges for sustainable approaches in order successfully face the described existing social and ecological problems. Green Logistics can be a useful tool, but as this research showed in cannot be seen as a one-way road. The society and the logistics industry react simultaneously on each of the others moves; one cannot succeed without being backed up by the other. In plain words the customer needs to constantly force the industry to act sustainable while the industry needs to implement this demand into their way of acting.

“There are no passengers on Spaceship Earth. We are all crew.”

Marshall McLuhan, 1964
6. List of References


Dawes, J. (2008). Do data characteristics change according to the number of scale points used? An experiment using 5-point, 7-point and 10-point scales. *International Journal of Market Research (Vol. 50, Issue 1)*, 63-75.


Figures

Figure 1
Source: http://www.ipcc.ch/publications_and_data/ar4/wg1/en/spmsspmprojections-of.html (Date of access: 20\textsuperscript{th} of September 2010)

Figure 2
Source: http://www.futuretimeline.net/22ndcentury/images/world_gdp_2100.jpg (Date of access: 18\textsuperscript{th} of August 2010)

Figure 3
Source: http://www2.goldmansachs.com/ideas/brics/drivers-of-global-consumption-doc.pdf (Date of access: 6\textsuperscript{th} of June 2010)

Figure 4
Source: “The state of Food and agriculture”, FAO report 2009. p 116

Figure 5

Figure 6
Source: http://www.kwe.co.jp/en/service/casestudy/logistics/green/index.html, (Date of access: 2\textsuperscript{nd} of August 2010)

Figure 7
Source: (Srivastava, 2007)
Figure 8
Source: http://www.people.hofstra.edu/geotrans/eng/ch5en/conc5en/
forwardreversedistribution.html, (Date of access: 12th of August 2010)

Figure 9
Source: http://www.greenlogistics.org/PageView.aspx?id=97,
(Date of access: 28th of August 2010)

Figure 10
Source: URCA/CHIVAS Software

Figure 11
Source: Created by author based on (Cavalcanti, 2006)

Figure 12
Source: GODET, M.; “Scenarios and Strategies; A Toolbox for Problem
Solving”, 2004. p. 72

Figure 13
Source: (Bendahan, 2003)

Figure 14
Source: (Bendahan, 2003)

Figure 15
Source: URCA/CHIVAS Software

Figure 16 - Figure 33
Source: MACTOR Software

Figure 34
Source: Created by author with Microsoft Excel 2010 based on survey results
7. Appendices

7.1. Questionnaire

Dear Sir or Madam,

My name is Martin Nietz a German graduate student from the FGV/EBAPE Business School in Rio de Janeiro.

In order to finish the research for my master thesis project "Green Logistics - key elements of a well-functioning sustainable logistics system" I would kindly ask for your contribution to the study by filling out the questionnaire which can be accessed by clicking on the following link:  http://www.surveymonkey.com/s/JJY8367

The link opens a window generated by the electronic survey software of Survey Monkey. This link does not contain any viruses or anything related to that.

The target group for this research is “logistics decision makers”. The questionnaire consists of 10 questions and the time needed for completing it should not be longer than 3 minutes. There are no wrong or correct answers; the idea of this survey is to capture the perception of logistics decision makers.

Please do not hesitate contacting me in case of further questions.

Your feedback is highly appreciated!

Thank you very much in advance

Kind Regards from Rio de Janeiro

Martin Nietz
MSc. Candidate
Brazilian School of Public and Business Administration - EBAPE
Getulio Vargas Foundation - FGV
1. Please fill out the fields below to your own appraisal, none of the information are required but will be highly appreciated.

Name:
Company:
City/Town:
ZIP/Postal Code:
Country:
E-Mail Address:

2. In which area/industry does your company act?

☐ Logistics
☐ Consulting
☐ Engineering
☐ Industry. If so, which:______________
☐ Other: ________________________

3. What is your position in your company?

☐ Manager
☐ Owner/President
☐ Coordinator
☐ Administrator
☐ Other: ________________________

4. A rising oil price ultimately results in an increased use of alternative fuels in the logistics industry.

☐ strongly agree
☐ agree
☐ Neither agree nor disagree
☐ disagree
☐ strongly disagree
5. If our internal or external customers require an increased use of sustainable and Green Logistics we will adapt to it.

☐ strongly agree
☐ agree
☐ Neither agree nor disagree
☐ disagree
☐ strongly disagree

6. If tax incentives towards the use of sustainable technologies within our company would be offered we would implement those technologies.

☐ strongly agree
☐ agree
☐ Neither agree nor disagree
☐ disagree
☐ strongly disagree

7. The use of alternative sources for energy and technologies depends for us on the level of its sophistication and cost efficiency. If higher investments in research and development for that kind of technology would end up in making them efficient, we would implement them.

☐ strongly agree
☐ agree
☐ Neither agree nor disagree
☐ disagree
☐ strongly disagree

8. The establishment of sustainable transport policies forces/forced my company to use less environmental harmful approaches, modes and methods.

☐ strongly agree
☐ agree
☐ Neither agree nor disagree
☐ disagree
☐ strongly disagree
9. A rising environmental consciousness in wide parts of the society has an influence on the decision making process of implementing Green Logistics strategies in my company.

- strongly agree
- agree
- Neither agree nor disagree
- disagree
- strongly disagree

10. A tendency of customers towards the preference of local products would result in the use of different and less environmental harmful modes of transportation.

- strongly agree
- agree
- Neither agree nor disagree
- disagree
- strongly disagree
7.2. Additional graphics from survey