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Impact of the Integrated Product Policy on Trelleborg Wheel Systems

Master's thesis

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Abstract

The sustainable industrial development philosophy is becoming a cornerstone of modern technological progress. There is a growing demand for green products, which causes the shift towards more environmentally friendly production patterns. Obviously such a shift creates a need for development of appropriate environmental legislation and policy.

The Integrated Product Policy (IPP) is the tool for improvement of organization's environmental performance. The purpose of IPP is to prevent and reduce the impact of products on human health or the environment throughout their lifecycle. The implementation of the IPP concept in practice takes place via the implementation of IPP instruments in the organization. Furthermore, a Conceptual Causal Loop Diagram (CLD) is developed and presented in this thesis work for better understanding of the Company – Customer – Government system to define the major driving forces for the implementation of the IPP.

Trelleborg Wheel Systems business organisation is taken as the case study for discussion of the IPP instruments and their implementation with emphasize on the Environmental Management Systems at the Trelleborg Group. The analysis of one of the major IPP driving forces – the company's customer's environmental requirements was carried out as well.

Having addressed and analysed the major IPP driving forces and their state of implementation at Trelleborg Wheel Systems the short- and long-term recommendations were made. An overall opinion from the study was that the Trelleborg Wheel Systems and the Trelleborg Group have the right approach in understanding and implementation of the IPP concept.

Keywords: *Integrated Product Policy, Trelleborg Wheel Systems, Customer requirements, Integrated Product Policy Instruments, Environmental Management Systems*

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List of Abbreviations

BLIC – European Association of the Rubber Industry
 CLD – Causal Loop Diagram
 EMAS – Eco Management and Audit Scheme
 EU – European Union
 IPP – Integrated Product Policy
 ISO – International Organization for Standardization
 LCA – Lifecycle Accounting and Assessment
 SWOT – Strength, Weaknesses, Opportunities and Threats
 TWS – Trelleborg Wheel Systems
 US – United States of America

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1. Introduction

1.1 Background

Rubber plays a significant role in the modern civilization. “It is indispensable in transportation, in communication, in furnishing us with light and power, in cushioning our bodies and protecting our senses from the jars and jolts, the noise and tumult of modern life” noted Ralph Wolf in the October 1964 (1). Almost four decades past since then, but rubber is still playing an essential role in today’s society – envisaging further development of the rubber industry.

The rubber industry has one hundred and ten years old history. Since the day of the establishment the rubber industry was “well-known” for emissions and damage caused to the environment. Such practices continued and even worsened in the beginning and mid-20th century. However, the changes occurred with the worldwide adoption of legislation on water quality, toxic substances use, air quality, resources and solid waste management and etc. since the 1960’s to present time. The rubber industry responded implementing aggressive green management practices. Hence, “air, water and waste emissions by the rubber industry have been reduced by 50% in the last 25 years” (2). At present, the rubber industry companies show considerable concerns about improving their environmental performance.

One of the tools to improve environmental performance of the company is the Integrated Product Policy (IPP). The purpose of IPP is to prevent and reduce the impact of products on human health or the environment throughout their lifecycle. Generally speaking, products should be materials- and energy-efficient, at the same time as they should not contain or require the use of the substances that may involve adverse effects on human health or environment (3). The IPP concept is mainly aimed on the businesses that are the ones to take responsibilities for their products, but at the same time it requires government’s involvement in creating appropriate conditions for implementation of IPP by businesses and finally, IPP concept involves customer demand for environmentally sound products as well as environmental concerns by all other stakeholder groups.

The implementation of IPP concept in the rubber industry is an ongoing process involving key rubber producers. The Trelleborg Group as well as its business area the Trelleborg Wheel Systems (TWS) being a part of the rubber industry is implementing the IPP practices too. The present study is focusing on implementation and development of IPP concept at TWS.

Reasons for the implementation of the IPP at TWS are environmental problems and concerns present at the company. One of the major problems at the company is substitution of hazardous chemicals used by TWS. Some of the substitutes significantly deteriorate the product attributes and therefore could not be used by TWS. The Trelleborg Group reports show an increase of energy consumption, atmospheric emissions and waste quantities. Besides that, the TWS is a growing company with a number of acquisitions there is a need for the similar environmental practices within the company as well as a need for an improvement of its environmental management and performance. The development of the European environmental legislation is also a theme of consideration for the TWS, which has a number of plants in Europe. Taking into account all mentioned above environmental concerns at TWS, it is believed that the IPP concept could be a supportive element in addressing environmental needs of the TWS.

1.2 Objectives

The main objective of this thesis work is to study the impact of Integrated Product Policy on TWS and how the use of IPP tools can contribute to the improvement of TWS environmental performance. A particular attention should be given to implementation, operation and development of Environmental Management Systems (EMS) for TWS as supportive instrument for IPP. Potential recommendations for environmental performance improvement within the IPP framework to be taken by TWS will be proposed and analysed.

1.3 Methodology

A literature study was carried out to establish a better understanding of the Rubber industry and the IPP theoretical framework. Review of the latest articles and appropriate legislative acts was a tool used for the literature study. The study of the Trelleborg Group activities was carried out basing on Environmental documentation provided by Trelleborg. Meetings, phone calls or email interviews were conducted when personal communication for additional information was necessary. Since TWS is a part of the Trelleborg Group, which is in charge of the overall environmental performance and objectives of the Trelleborg Group and its business areas, the author carried out interviews at both TWS and the Trelleborg Group. The list of interviewed persons at Trelleborg consists of Torbjörn Brorson (vice president on environmental affairs at the Trelleborg Group), Jose-Luis Losa (Environment and Safety Manager at the Trelleborg Engineering Systems of the Trelleborg Group) and Per Nillson (Environment and Safety Manager at Trelleborg 1 plant of the TWS). Interviews were conducted via questionnaires and additional questions arising from answers on questionnaires.

A multidisciplinary approach (combined environmental, social and economic approach) to address objectives of the present study was used. A Causal Loop Diagram approach was utilised to achieve better understanding of the studied system and relations among system elements as well as to define system's performance in a proper way.

1.4 Scope and Limitations

The scope of the present study is to focus on IPP impact on Trelleborg Wheel Systems branch of the Trelleborg Group. A study was carried out analysing environmental performance of TWS within the IPP framework; no particular analysis for TWS plants as separate units was done. An IPP framework was set by European Union (EU) Commission of the European Communities in its Green Paper on IPP, which was taken as a benchmark point for the present study.

Recommendations for TWS are based on analysis conducted by the present study. Systems analysis approach is used to propose feasible recommendations. Neither Total Cost Accounting nor any other methods for counting financial feasibility analysis of the recommendations proposed is done.

1.5 Paper Outline

The paper is presented in six chapters. The first chapter presents a brief introduction to an issue of the study and defines objectives, methodology and scope & limitations of the study as well as the paper outline information.

The second chapter “Industry and the Environment” is addressing the IPP issue giving general information about IPP and IPP tools for Governments and Businesses followed by an analysis of EMS as supportive instruments for IPP. The second chapter concludes with presentation of Causal Loop Diagram (CLD) of Company-Customer-Government relations emphasizing on Company’s environmental performance within the IPP framework.

The third chapter “Trelleborg Group” provides general information about the Trelleborg Group and its structure, and an overview of the Trelleborg Group’s environmental work including its environmental policy, reporting, etc.

Chapter four being a logical continuation of chapter three focuses only on Trelleborg Wheel Systems bringing in general information about TWS followed by a description of the major production processes carried out on TWS wheel and tire production plants. An analysis of TWS consumer’s environmental requirements is carried out in a separate sub-chapter as well as a discussion of the implementation of new and use of already existing IPP tools at TWS. Chapter four concludes by the description and analysis of TWS environmental requirements to its suppliers.

Analysis and recommendations of the current study are given in chapter five – Discussion of possible recommendations and constraints. A comparison between the IPP theoretical framework given in chapter two and Trelleborg and TWS environmental performance, IPP policy, implementation of new and use of already existing IPP instruments is made. Possibilities and constraints of this matter are discussed from different perspectives. Recommendations particularly to TWS and also to Trelleborg are given.

The last sixth chapter draws a general conclusion of the study.

2. Integrated Product Policy

2.1 General information on Integrated Product Policy

The sustainable industrial development philosophy is becoming a cornerstone of modern technological progress. There is a growing demand for green products, which causes the shift towards more environmentally friendly production patterns. Obviously such a shift creates a need for development of appropriate environmental legislation and policy. Council of the European Union finds that “Industrial development is sustainable when all three criteria of sustainable development are met:

- Production is economically sound, growth oriented and safeguards opportunities of the future generations,
- Employment is improved and other social aspects such as social security, equity, occupational health and labour market relations are taken into account
- Pollution, waste, environmental health risks and other pressures are minimised to the carrying capacity of ecological systems while using natural resources effectively and safeguarding natural capital and its productivity.

Industrial policy is sustainable if its aims and action meet all of the three criteria mentioned above” (4). Achieving sustainable industrial development means that industry will have to adjust production structures and its product mix. Industrial policy should contribute to supporting such an adjustment process.

From historical perspective: “The environmental policy of the past can be described as a source-, substance-, and media- oriented”, states European Consultative Forum on the Environment and Sustainable Development (5). Changes already occurred and one of the relatively new instruments is the Integrated Product Policy approach. The European Union defines IPP as an approach, which seeks to reduce the life cycle environmental impacts of products from the mining of raw materials to production, distribution, use, and waste management. The driving idea is that integration of environmental impacts at each stage of the life cycle of the product is essential and should be reflected in decisions of stakeholders (6). The word “integrated” refers to the whole life cycle of the product (Figure 1). The Life Cycle concept can be used as well for the rubber industry. At the same time “product” refers to the product or the range of products, produced by the company. There is an ongoing debate on inclusion of “services” in the IPP framework. However, this debate lies beyond the scope of this thesis work. Regarding the word “policy” in the definition of IPP, the Commission of the European Communities states that “the general idea is that policy should focus on the setting the main objectives and providing the different stakeholders with the means and incentives to achieve these objectives” (7). Generalising, “IPP is a public policy, which explicitly aims to modify and improve the environmental performance of product systems” (8). Taking into consideration the above stated, it could be said that the major principles of IPP are market based approaches and life cycle thinking.

The definition of IPP sets its major goal and different measures can be taken to achieve this goal. In 1998 Ernst & Young, basing on their research and analysis, proposed groups of specific measures, called “Building Blocks” of IPP. Actually they identified five IPP blocks, which are:

- Measures aimed at reducing and managing wastes generated by the consumption of products,
- Measures targeted at the innovations of more environmentally-sound products,
- Measures to create markets for more environmentally-sound products,
- Measures for transmitting information up and down the product chain,
- Measures, which allocate responsibility for managing the environmental burdens of product systems (9).

A variety of measures, for reaching the main goal of IPP could be taken in order to modify and improve the environmental performance of product systems, bring in classification of pre-requisites, like creation of markets for more environmentally sound products. At the same time prerequisites can be accepted as IPP sub-goals.

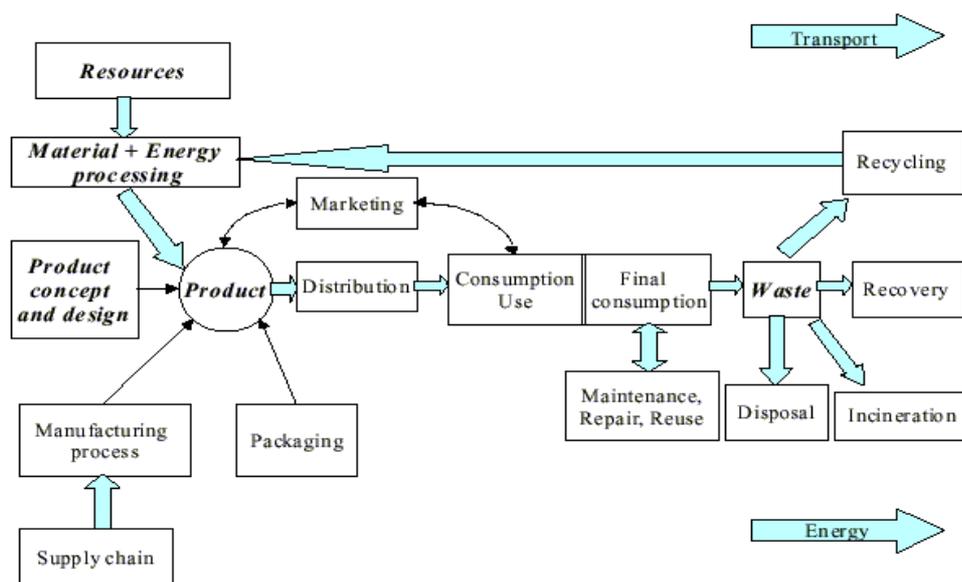


Figure 1: Schematic life cycle of a product (Source: Green Paper on Integrated Product Policy (10))

IPP goals could be reached through the use of appropriate instruments for businesses and governments. In the case of businesses IPP presumes the use of voluntary instruments. Voluntary instruments are advantageous by giving entrepreneurs a possibility of using the input-oriented approach and the precautionary principle, when enforced legislative measures often lead to the use of end-of-pipe approach. The European Consultative Forum on the Environment and Sustainable Development mentions the following instruments (11):

- Creation of demand for sustainable products via education, information and transparency. This will improve cooperation between all stakeholders, especially between government, business and consumers. Businesses have to educate their customers regarding their product's environmental performance, provide sufficient information about environmental impacts of their activities and transparency of their actions.
- Establishment of New Management Mentality taking into consideration sustainable development principle. The New Management Mentality presumes multidisciplinary approach to the company's activities taking into consideration not only environmental, but

also social and economical issues. However responsible entrepreneurship means integration of environmental aspects into all areas and stages of the production policy.

- Certification under Environmental Management Systems using Eco-Management and Audit Scheme (EMAS) and ISO14001. EMS is a powerful tool to encompass environmental aspects in company's management system helping to establish the New Management Mentality. The major idea behind EMS is in establishment of the model providing continual improvement of the company's environmental performance via better management rather than giving precise solutions regarding company's environmental activities.
- Benchmarking enables companies to analyse and monitor their own progress in comparison to others with regards to sustainable development. The company's environmental performance could be compared to a benchmark of its industrial sector, and to the company's environmental performance in a historical perspective. Therefore, benchmarking is classified on internal and external one. Internal benchmarking considers benchmarking within the company, while external is the benchmarking in comparison with other stakeholders such as competitors or international institutions.
- Environmental accounting and innovation networks of responsible companies to provide information and data about sustainability and accelerate the innovation process. Indispensable and "must have" instrument of IPP
- Lifecycle Accounting and Assessment (LCA) for evaluation of environmental aspects of product through all stages of its lifecycle. "LCA is both a concept and methodology for auditing and evaluating the environmental performance of the product, process, or activity from initial stage of resource extraction and processing, following into manufacturing, distributing, use, reuse, recycling and final disposal. In general LCA can be defined as a common approach for assessing the complete environmental impact of the product or a service" mentions Roland Clift (12). The strongest point of LCA thinking is that it can help to avoid making the mistake of doing something while believing that it helps the environment, when it actually causes environmental damage.
- Eco-design can be a strategy to extend the company's market potential in the case of sufficient strong demand for environmentally sound products. Eco-design means that "the environment" becomes a significant part of the product development. In this process the environment is given the same status as more traditional industrial values such as profit, functionality, aesthetics, ergonomics, image and overall quality. In some cases the environment can even enhance traditional business values. Life Cycle Assessment often plays a significant role in product development, including eco-design, and thus, is one valuable tool available to policymakers. Life Cycle thinking is the very basis for sustainable products and services.
- Eco-labelling for informing consumers about environmental performances of the produced goods. "Eco-labelling makes a positive statement that identifies products and services as less harmful to the environment than similar products or services used for a specific function" (13). Eco-labels have to be fair and transparent and need to be assigned by a competent and independent body.

- Product declarations which fulfil the same function as eco-labels, designed basically for institutional and business procurement.

Only leading European businesses are increasingly using the above-mentioned instruments. However, changes towards greener production patterns usually take place under market pressure conditions caused by stakeholder groups, which pursue their own interests. Therefore there is always a room for improvement and further implementation of IPP instruments by businesses, which is essential to provide continual improvement of environmental performance.

At the same time, the governments are supposed to create the appropriate conditions for implementation of IPP and guarantee the shift to greener production. Governments use Market-Based tools together with Command and Control type of tools. However, command and control measures are still predominant in Government policies. Although it is impossible to stop imposing such measures, a balance between command and control and market-based instruments should be achieved. Some Governmental instruments for achieving IPP goals are:

- Market-based instruments
- Green taxes
- Subsidies to promote sustainable activities and products
- Tradable permits aim at limiting the use of a specific natural resource or emission
- National accounting – environmental impacts should be included
- Public procurement
- Information and education to influence consumer decisions
- Research and development support for achieving sustainability

Also, Consumers do play a significant role in the IPP supporting and therefore promoting environmentally friendly products and influencing on governmental decisions in favour of greening production. The consumer's influence runs throughout the entire product life cycle; affecting patterns of purchasing, use and product discard influencing the environmental performance of the manufacturers (14). Manufacturers cannot really pressure consumer groups, though there are certain instruments, which could be used for this purpose (for instance price policy). Consumers and manufacturers could lobby Governmental decisions in their favour, while Governments may respond by imposing new regulations.

2.2 Environmental Management Systems – supportive instruments for IPP

Environmental management attracted interest only in the 1970's. The first European Community Directive pertaining to the disposal of waste oil was issued in 1975 (15). However, only after the Earth Summit in Rio de Janeiro in 1992, environmental standards were prepared in order to guide businesses in their efforts to set up EMS and also to provide an objective measure to determine the appropriateness of the different EMS set up by business enterprises (16).

EMS was mentioned earlier in this chapter as being voluntary IPP instruments for businesses. An EMS is: “a continual cycle of planning, reviewing and improving the processes and actions that an organization undertakes to meet its environmental obligations” (17). Figure 2 shows major elements of EMS model aiming on continual improvement of organization's environmental performance.

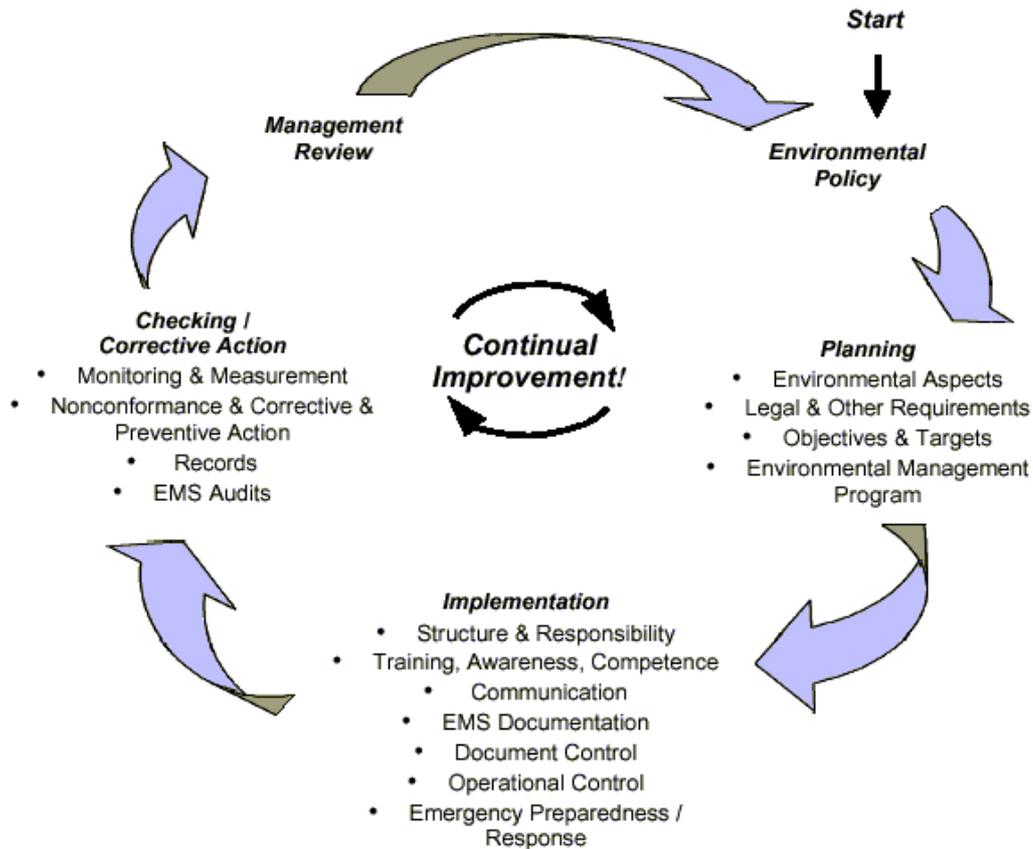


Figure 2: EMS model (Source: Philip J. Stapleton, Margaret A. Glover, *Environmental Management Systems: an implementation guide for small and medium-sized organizations* (18))

As it's shown in the model, the EMS stages are differentiated in establishment of organization's environmental policy, planning, implementation of the planned program, checking/corrective actions and management review. The EMS model could be characterised as a closed reinforcing loop.

There are several systems for the implementation of EMS. ISO14001 and EMAS are the most widespread systems for the moment. ISO14001 is a voluntary certification standard to which organizations may get certification or registration. As of June 2001 the total number of certifications worldwide has reached the 30,260 mark, only 4,404 EMAS certifications, despite the fact that it is largely voluntary standard (19). An increasing number of organizations are modelling their EMS on the ISO14001 standard, as it is a sign of the credibility. The ISO14001 is a standard developed by the International Organization for Standardization (ISO) in September 1996. "ISO is a non-governmental organization established in 1947 with the mission to promote the development of standardization and related activities in the world", states ISO homepage description (20).

The ISO14001 standard requirements are coherent with the basic EMS requirements and are shown on Figure 2. The list of ISO14001 requirements is shown in Appendix 1. Analysis of ISO 140001 certification requirements shows that: ISO14001 standard is a "process instead of a "performance" standard. It does not prescribe a minimum environmental performance that companies must achieve

(21). Therefore there are no limits or maximum point in implementation of ISO14001 standard for corporate environmental management.

ISO14001 standard requires third party recognition, what means certification by an external, autonomous and independent accredited certification organization to audit EMS and then declare that the company's EMS meets requirements of the ISO14001 standard. "Companies should aim at building and maintaining trusting relationships with their customers and other stakeholders. Thus, increased reliance on third-party assistance and the use of comprehensive and reliable claims to establish credibility are essential whereas unsupported environmental claims are risky" mention M-J. Roy and R. Vezina (22).

Another EMS model – the EMAS system, which was originally developed by the EU and modified in 2001, is an alternative to ISO14001. There are some similarities and discrepancies between those two models. Basically both EMS models have the same predecessor British Standard 7750 (BS7750) for implementing EMS, which is not in use anymore. Therefore, "since ISO 14000 and EMAS are based on BS 7750, all three standards have similar components" mentions the Business and Sustainable Development website created by International Institute for Sustainable Development (23). The major differences between ISO14001 and EMAS stated by Carl Dalhammar in "Implementation and certification of environmental management systems in small enterprises: approaches and limitations" (24) are:

- EMAS requires compliance with laws and regulations, while ISO14001 does not specifically require it
- EMAS requires continual improvements of environmental performance, while ISO14001 specifically requires continuous improvement only of the EMS itself
- EMAS requires an environmental statement that must be available to the public
- EMAS specifically requires that indirect aspects should be considered.

The EMAS regulation has been revised and the revision was adopted in March 2001 by the European Union and the European Parliament. The main elements of the revised EMAS regulation are:

- The extension of the scope of EMAS to all sectors of economic activity including local authorities,
- The integration of ISO 14001 as the environmental management system required by EMAS
- The adoption of a visible and recognisable EMAS logo to allow registered organisations to publicise their participation in EMAS more effectively
- The involvement of employees in the implementation of EMAS
- The strengthening of the role of the environmental statement to improve the transparency of communication of environmental performance between registered organisations and their stakeholders and the public
- A more thorough consideration of indirect effects including capital investments, administrative and planning decisions, procurement procedures, choice and composition of services (e.g. catering) (25).

An EMAS revision is a step taken to facilitate the process of establishing and improving environmental management in EU. Basically, an idea beyond EMAS revision can be also characterised, as a step to popularise EMAS certifications, since the number of EMAS certified

organizations is lower than of ISO14001 certified ones within the EU. Only in Germany and Austria there are more EMAS certified organisations than ISO14001 (26). In addition, the integration with ISO14001 scheme shows that the European Union would consider EMAS prior to ISO14001 scheme as for the moment for organisations already certified for ISO14001 EMAS certification can be acknowledged as the next step in the improvement of their environmental management.

“EMAS can be considered as a more credible standard since it requires more external communication than ISO14001. This might make EMAS more attractive for a certain companies, while others might not wish to make a public report”(27) note L. Windahl and J. Thorell. At the same time EMAS certification is limited only to the EU countries while ISO14001 certification is global. Therefore, multinational companies acting worldwide may prefer ISO14001 certification as a part of their internal environmental policy practice.

Overall, EMAS and ISO14001 standards are increasingly gaining businesses’ confidence each year. The number of certified organizations for the Rubber and plastic products industry sector is shown on Table 1.

Years	EMS implementation system	
	Number of ISO14001 certified organizations	Number of EMAS certified organizations
1998	193	No data available
1999	380	No data available
2000	666	No data available
Total	1239	No data available

Table 1: Number of Rubber and Plastics companies with implemented and certified EMS (sources ISO standards survey 10th cycle and EMAS helpdesk (28))

The data on EMAS certification for rubber and plastics companies is not available. The main reason is that “the statistics on NACE codes started to be collected in 2000 and unfortunately EMAS helpdesk has data only from that year to present”, stated Irene Molina (29). According to European Union there are 230 sites with EMAS certification among the Rubber and plastic products industry on October 31st, 2001 date (30).

Concluding, it can be said the IPP is one of the major driving forces for improvement of company’s environmental performance. EMS as itself and EMS schemes being an essential part of EMS are significant tools for implementation of IPP in businesses.

2.3 Causal Loop Diagram

A Causal Loop Diagram is a tool that assists to structure and conceptualise the system and its interactions through the definition of the major aspects of the system and their connections to each other. CLD is the “mental model” - understanding of the system made by the author. In addition, the CLD approach clarifies the problem definition and the system boundaries bringing a new systems thinking perspective on an issue. “The system, to which CLD refers, is defined as a set of

components with relations between the components and between their properties” mentioned Bo Adamson (31).

The CLD of the Environment – Company – Stakeholders system discussed in the current study is presented on Figure 4. The major reason for development of this CLD is to find out the role of the IPP in the Environment – Company – Stakeholders system and the major driving forces for implementation of IPP. An overall goal for implementation of the IPP is to improve the Environmental Performance of the Company, what basically means acting in an environmental conscious way with respect to principles of sustainable development.

The presented CLD assumes that government authorities, customers, company’s top management and competitors are the major driving forces for the company’s environmental management. This assumption is based on the results of the Environmental Management in Swedish Manufacturing Industries study accomplished by Pia Heidenmark (32). She performed a survey among the Swedish companies asking them the question “What are your company’s motives/driving forces for environmental management?” The results of her survey are shown on the Figure 3.

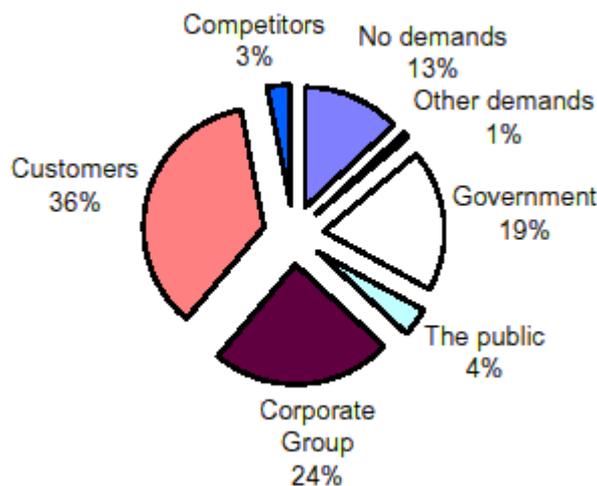


Figure 3: Driving forces for environmental management (Source Pia Heidenmark, *Environmental Management in Swedish Manufacturing Industries*, IIEE Reports 2000:14 (33))

It can be seen from the Figure 3 that the companies consider their Customers requirements as the major driving force for the improvement of their environmental performance, while government's influence is only third in the list after Corporate Group requirements, for some cases it can be referred as Company's top management decision. However company's top management admits that their decision to improve environmental management is in most cases initiated by external factors, mainly by prospective customer requirements or market competition. At the present situation, market demands are becoming the major drivers for environmental management, while the most common driver of the past – government regulations have reduced their significance.

Another interesting notice is the relatively low interest of the public on the improvement of environmental management by companies. On the other hand the government authorities are representing interests and demands of society as well. About 13% of the companies do not believe that there are any demands for improvement of their environmental management and therefore are quite passive in environmental management. Hence, it can be concluded, "there is a strong correlation between the power of external driving forces and the level of environmental management" (34).

There is a market demand for green products. That is why in the modern economy the *Company's Environmental Performance* becomes one of the predetermining factors for its *Customers*. Also product's price and quality aspects are the major factors determining the customer decisions, but they lie beyond the scope of the present study. *Company's Environmental Performance* has an added market value to its products, which may result in attracting more *Customers*. The *Customers* are creating demand for the company's products on the market, supporting therefore company's existence. At the same time *Company's Environmental Performance* is a comparative advantage on the market contributing to high competitiveness of the company, therefore it has a negative effect on the company's *Competitors*. The decrease of *Competitors* on the market increases the number of company's *Customers*. Customers environmental concerns reflect in environmental *Customer requirements* to the company. The *Customer requirements* are influenced by the *Legislative measures* imposed on them. Furthermore, the *Customer requirements* establish the *Need for improvement of the company's environmental performance*. The *Need for improvement of the company's environmental performance* has a positive impact on the *Company's management decision to implement IPP tools*, what basically means that the Company's management should implement IPP instruments as a market demand. The implementation of the mentioned above IPP instruments, *IPP Tools implementation*, is the solution for the improvement of the *Company's environmental performance* satisfying the company's customers as well as increasing the company's competitiveness on the market which may result in with increase of the customers number. The described above loop according to the Environmental Management in Swedish Manufacturing Companies is currently the major driving force for the implementation of Integrated Product Policy concept in the company, therefore improving its environmental management and performance.

The company itself may take actions to implement IPP concept. The *Company's management decision to implement IPP tools* or for the companies, which are parts of the Corporate Group by "Corporate Groups management" (has the same value as *Company's management decision to implement IPP tools* in the presented CLD), may lead to *IPP tools implementation*. The *Company's management decision to implement IPP tools* is influenced by *Economic Success of the Company* on the market, which is in turn created by the *Customers*. The cost of implementing IPP concept has always been a barrier for the companies; therefore the Company management's willingness to

implement IPP is dependent on Company's profitability in a sense. On the other hand the *Company's R&D department* is one of the foundations of the *Economic Success of the Company* and vice versa. The Company's R&D department increases of environmental "*Knowledge available*" factor.

Another key aspect of the system is the Government (*Local authorities*). One of the Government responsibilities is adopting and imposing of *Legislative measures*. As it has been shown on the CLD the *Local Authorities* may and may not take *Legislative measures* depending on several factors. There is also a factor called "*Knowledge available*", which means present available information on the environmental impacts of the products produced and major trends and studies in environment related issues. The "*knowledge available*" factor representing the up-to-date environmental research information and opinion of the environmental institutions will have a significant impact on *Local Authorities*' decisions. On the other hand the *Local Authorities* are also under pressure of the outcomes of *Economic Success of the Company* (economic benefits), which are taxes paid by the Company to the local budget for social programmes; sustaining a good environment for the economic investments due to company's successful business activities; establishment of new job places and etc. Another factor influencing the *Local Authorities* decision-making is the *public opinion*. The *public opinion* may encourage *Local Authorities* to take *legislative measures*, and vice versa the *Local Authorities* may form the *public opinion* to favour their decisions. On the other hand the *public opinion* is formed under the influence of company's positive economical performance (*Economic Success of the Company*). The company's *competitors*, *customers* and the "*knowledge available*" factors are also aspects forming the *public opinion*.

Besides the *Local Authorities* there are also several other factors influencing taking of the *legislative measures*, which are international responsibilities (*International agreements*) of the government, it could be also the company's *competitors*, which may initiate establishment of the appropriate environmental legislation. The company's management inspired by the good Environmental Performance of the Company (*Company's Environmental Performance*) may also support (*Company's management support for implementation of legislative measures*) and even initiate the establishment and implementation of environmental *legislative measures*. Support of the legislative measures by the company and its competitors is explained by the fact that the environment has a market value, which makes it a part of the market competition and by far a tool used in the market competition. At the same time both the company's management and *competitors* may act against the *Legislative measures* as well if it conflicts with their interests.

Environmental *legislative measures* are influencing both the *Company* and its *Customers* increasing their legal responsibilities. Therefore *Customers* being the next stage of the product chain require (*Customer requirements*) improvement of the Company's environmental performance. The increase of the *Company's legal responsibilities* causes the *need for improvement of environmental performance*. The *need for improvement of environmental performance* positively influences the *Company management decision to implement IPP tools* leading the company to *IPP tools implementation* resulting in improvement of the *Company's Environmental Performance*. But increasing the legislative responsibility of the company (for instance, adoption of new taxes) is a subject for decrease of Company's economic welfare (*Economic success of the company*). The decrease of profits would certainly negatively influence decreasing the willingness of the Company's management to implement IPP tools (*Company's management decision to implement IPP tools*).

The presented CLD shows that the decrease of the company's profits (*Economic Success of the Company*) caused by imposition of *Legislative measures* on the company by the *Local Authorities* is causing a decline of the taxes paid by the Company to the local budget for social programmes; worsening a local economic environment for investments; increases unemployment rate or at least does not contribute to the establishment of new job places and etc. Therefore there is a balance between government's legislative actions and the company well being. The feedback of governmental actions on government itself discussed in this paragraph stresses an importance of cooperation between businesses and governments by introducing "step by step" decision – making policy.

Summarizing, the "mental model" (CLD) distinguishes Customers and the organizations influencing on taking legislative measures (International responsibilities and Local authorities) as driving forces for the implementation of IPP in the Company. The Company itself most probably will not take immediate measures on improvement of its environmental performance unless there is a strong demand from identified driving forces of the system for that, but at the same time the company's and its personnel awareness of environmental issues may lead the company's management to implement IPP concept at the company. Companies are recommended to collaborate with scientific institutions for improvement of environmental performance and expansion of knowledge on manufacturing processes within the company. It's important to note that the CLD focuses mostly on environmental issues, therefore the discussion of economic and social issues was brought on relatively simplified level.

3. The Trelleborg Group

3.1 General Information about the Trelleborg Group

The Trelleborg Group was established in 1905 as a manufacturer of industrial rubber and tires. Since then the group has become a leader of the Swedish rubber industry. Expansion of its industrial operations outside Sweden since 1954 resulted in entering the World rubber and tire market. Currently the Trelleborg Group is a significant player in the World's rubber products market. The Trelleborg current strategy is aimed on "concentration and expansion". According to the Trelleborg Group: "concentration" meant that Trelleborg would now focus on the industrial competence at its disposal, while "expansion" meant that the Group would utilize substantial amounts of its financial resources for external growth" (35).

The Group has annual sales of SEK 19 billion, operates in 40 countries with about 16500 employees. The Trelleborg Group is currently on 19th position in the 2001 Global Tire Company Ranking, while holding 13th position on the World Top 50: Non – Tire Rubber Products ranking (36). The Group's position in the rankings improves annually, for instance the Trelleborg North America is currently ranked 15th in the North American Rubber Industry Top 100 (37) comparing to its 23rd position in 1999. The Trelleborg Group is on fifth position in the World market for industrial rubber according to T-Time (Table 2) (38). Presented rankings prove the Trelleborg Group as a successful and prospective company on the rubber market.

Company	MUSD
1. Bridgestone	2.2
2. Hutchinson	2.1
3. Freudenberg	2.0
3. Tomkins	2.0
5. Mark IV	1.5
5. Trelleborg	1.5
7. Continental	1.4
8. Goodyear	1.2
9. Dana	1.1
9. Federal Mogul	1.1
9. Parker	1.1

Table 2: Company ranking of the sales on the World Market for Industrial Rubber (source: T-Time, "LAC acquisition strengthens Trelleborg's position as a world leader in anti-vibration systems for the auto-industry", 2001 (39))

The Trelleborg Group operations are carried on in four major business areas, which are:

- **Trelleborg Wheel Systems** develops; manufactures and markets complete wheel systems for forest and farm machines, trucks and other materials-handling equipment. TWS is focused on two market segments: solid/pneumatic industrial tires and Forest and farm machine tires.
- **Trelleborg Automotive** the leading global supplier of anti-vibration systems for automotive and industrial applications and of laminate products for noise suppression.

- **Trelleborg Engineered Systems** develops, manufactures, markets and distributes flow-control systems and engineered solution polymer materials that increase the value of its customer products.
- **Trelleborg Building Systems** is a leading supplier of polymer and bitumen-based building products for sealing and waterproofing applications within industry and the Do-It-Yourself market (40).

Business area	January–September 2001, SEK M	January–September 2001, %
Trelleborg Automotive	7,446	52.3%
Trelleborg Wheel Systems	2,400	16.8%
Trelleborg Engineered Systems	2,518	17.7%
Trelleborg Building Systems	1,323	9.3%
Elimination	-236	-1.5%
Other Companies	775	5.4%
Group	14,226	100%

Table 3: Trelleborg Group’s net sales for the January–September 2001 (calculations based on Trelleborg Interim Report January-September 2001 (41)).

The Trelleborg Automotive has the largest amount of the net sales accounting for 52.3 % of the total amount of the Trelleborg Group’s net sales, while the subject of the present research the Trelleborg Wheel Systems (TWS) accounts for 16.8% of the net sales for the period January-September 2001 (Table 3). However, “during the past four years TWS earnings have grown by 100%” according to Maurizio Vischi (Maurizio Vischi, Focus on Profitable Expansion, 2001 (42)). In spite on the relatively low share of the net sales mount in the Trelleborg Group “the TWS is ranked the third within the European market with the forest and farm tires”(Maurizio Vischi, Comments by the President, 2001 (43)).

A leading position in the world rubber industry urges the Trelleborg Group to take a leading position among businesses operating in the rubber industry for promotion of the sustainable development philosophy. The following part of this chapter is an overview of the Trelleborg Group’s environmental performance.

3.2 The Environment and the Trelleborg Group

Environmental Policy

As a matter of fact the Trelleborg Group, one of the key players in the rubber industry, conducts a broad scale environmental work aimed on continual improvement of its environmental performance. The Trelleborg Group’s environmental policy sets the framework for approaching environmental issues. The Group’s objective is that “the activities of the Trelleborg Group shall not harm the environment or have a negative effect on human health, the environmental aspects shall be integrated in day to day operations of the group” (44).

The Trelleborg's present environmental policy prioritises total ISO14001 certification of its plants, which could be completed by the end of the 2002. After complete ISO14001 certification of the Trelleborg Group a new environmental policy priorities will focus on "chemicals substitution issue as the new major environmental goal of the Group followed by the development of an LCA analysis of the Trelleborg Group products and raising environmental awareness of Trelleborg's personnel" mentioned Torbjoern Brorson, the Vice President on Environmental Affairs (45).

Environmental Organisation

The environmental organisation of the Trelleborg Group is decentralized making local on site environmental managers the key figures responsible for the environmental work under the coordination of the Trelleborg Group's Vice President on Environmental Affairs. Nevertheless the Trelleborg Environmental Affairs is in charge of establishing the Group's environmental policy and strategy, the overall EMS of the Group and Group's manuals, standards and position papers. While at the site level the Group requires establishment of the site environmental policy and strategy, the site environmental management, as well as register of the major environmental aspects at the sites, site audit, and other environmental work. It could be concluded that the Trelleborg Group's environmental organisation encourages autonomous environmental decision making at the Trelleborg sites level since it's compatible with company's general environmental policy.

Basically, "the individually formulated policy document is generally more specific and addresses more concrete goals than a group policy... Companies with their own detailed environmental policy are generally more engaged in environmental management than those with a group policy" (46). Consequently, decentralised environmental system approach allows the Trelleborg sites to act according to particular process- and site-specific environmental requirements, and at the same time gives a proper allocation of responsibilities within the company.

Environmental Management Systems

One of the actual reasons for a decentralised environmental organization at Trelleborg rises from Trelleborg's environmental policy on EMS certification. As it was already mentioned: "each plant at Trelleborg shall develop its own environmental policy as part of the ISO14001 system. Furthermore, by the beginning of the 21st century, Trelleborg shall comply with the requirements of ISO14001 and/or EMAS at Trelleborg's existing production plants" (47).

The Trelleborg Environmental Affairs developed an Environmental Management System Manual, guidance for the establishment and operation of EMS by Trelleborg sites, which specifies the requirements for the EMS implementation at sites. In other words, "the aim of the manual is to demonstrate the global Trelleborg AB EMS" (48), or paraphrasing to show a template example for the company sites.

Currently the Trelleborg's general strategy for EMS focuses on the production plants rather than on all business units of the company. The Trelleborg EMS Manual explains on the matter: "for practical and economic reasons it is not realistic to externally certify all organizations within the group. Each Business Area management is therefore responsible to take the strategic decision for which organization to be certified" (49). So, the short-term objective of the Group's strategy on EMS is in the implementation of EMS at production plants, while an EMS certification of all Trelleborg organizations can be referred as the long-term objective, depending on the strategic

decision-making by the Trelleborg business areas, their intentions in environmental terms and the economic feasibility study of the particular certification.

In 1997, just the following year to the publication of ISO14001 standards only one of more than 60 Trelleborg plants received an ISO14001 certificate; another plant was certified in 1998. However, “after the year 2000 the number of certified plants was 23, and it was estimated that at least 40 plants would obtain certification by the end of 2001” – mentions Trelleborg’s Environmental Report 2000 (50).

“Currently, there are 30 out of 78 Trelleborg plants certified by ISO worldwide and 2 plants are expected to obtain certification at the end of November 2001, while several others would probably receive certification in December 2001” mentioned Jose Luis Losa (51). In spite on the fact that the Trelleborg Group might not reach the previously estimated 40 certified plants level in 2001, dynamics of ISO14001 certification of Trelleborg’s plants from 1996 till 2001 presented on Figure 5 shows that the company’s goal for EMS implementation, stated in its environmental policy, is being accomplished and that certification of all Trelleborg plants is simply a matter of time.

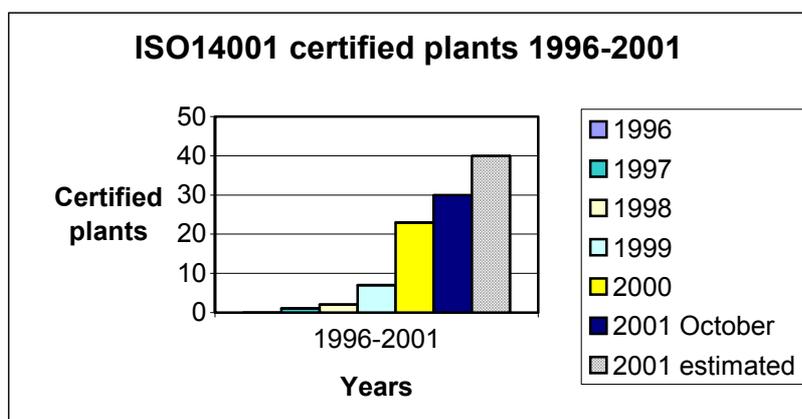


Figure 5: ISO14001 certification dynamics of Trelleborg sites (source: Trelleborg Environmental Report 2000 and personal communication with Jose Luis Losa (52))

In 1998 the Trelleborg Group launched a personnel-training program with introduction of ISO14001. According to T-Time: “More than 150 key employees have completed training activities relating to the EMS and the environmental auditing technique.” (53) Personnel education improves the environmental management and increases reliability of environmental practices at the company.

Even though the EMAS registration is seen as an alternative option for ISO14001 certification in the Trelleborg’s environmental policy statement, actually there is not any single Trelleborg plant registered by EMAS. Torbjörn Brorson mentioned that: “firstly, EMAS requirements are harder comparing to ISO 14001 requirements and secondly, EMAS – registered organization has legal responsibilities to registration agency” (54). In addition EMAS registration is applicable only to EU member countries, what makes it less attractive to Trelleborg, which operates in non-EU member countries as well. That is why most of the Trelleborg’s sites receive ISO14001 certification or applying for it.

Environmental Communication

Both internal and external environmental communication tools are in use at the Trelleborg Group. An internal network (intranet) Trellnet, being an environmental information source and database, provides dynamic dimension of the internal environmental communication at the Trelleborg Group along with personnel trainings, workshops and other environmental activities within the company. The Trellnet role in environmental work at the company seems indispensable for the moment. However, according to Jose-Luis Losa “there is also a need to arrange internal workshops on IPP, basically on getting better understanding and improving environmental performance of the company” (55).

The internal environmental communication at Trelleborg is mainly based on position paper, environmental standard and environmental manual tools. The Trelleborg environmental position papers are clarifying the purpose of addressing an environmental issue by the company, providing guidelines and defining responsibility for implementation of position paper. Site-related environmental issues such as eco-labelling, waste management, area classification and others, which the Group’s sites are facing throughout their activities, are covered by the position papers. Environmental standards, such as Environmental Reporting and Environmental due diligence audit, along with Environmental Manuals like EMS Manual provide a broader analysis and bring in company’s strategic understanding of the general environmental issues.

Environmental Communication between all stakeholder groups from policy formulation to implementation is crucial characteristics of the IPP. Therefore it represents a particular interest from the present thesis work point of view. Trelleborg’s stakeholder groups could be classified in the following groups:

- Suppliers
- Customers
- Shareholders
- Competitors
- Media, NGO’s, scientific institutions and local communities
- Legal authorities
- Employees

There is a wide range of methods, which can be used for environmental communication with stakeholders. Some of them are used for a particular stakeholder group (for example environmental requirements to customers), while others are aiming on several stakeholder groups (for example environmental report). Therefore a stakeholder dialogue could be held in various dimensions pursuing common and specific interests of the stakeholders. The key for the company’s success in environmental stakeholder communication is in establishment of the equilibrium between common and specific environmental communication methods.

As it was mentioned above customers may have an influence on the company’s environmental performance (for instance via customer requirements). Therefore, there is a demand for environmental communication between customer and client stakeholder groups. Trelleborg environmental communication with its customers is carried out mainly in the framework of discussion of their environmental requirements to the company. In turn, Trelleborg demands a set of environmental requirements to its suppliers as a part of the environmental communication.

Trelleborg is a member the European Association of the Rubber Industry (BLIC), which is basically aimed to deal with the European authorities. Participation in BLIC's activities provides discussion of rubber industry related issues with competitors and authorities on local and international levels. BLIC's vision is

- Representation of European Rubber Industry to all interested stakeholder groups in Europe and the world
- Co-ordination between members, what actually means communication with competitors
- Communication of information among BLIC members and with the authorities
- Promotion of the Rubber industry via better communication with authorities and improving awareness of all interested stakeholder groups (56).

At the same time Trelleborg is collaborating with scientific research institutions such as universities and research centers for research on environmental issues, for example: several Master's thesis works has been done at Trelleborg. In addition, Trelleborg participates at the local and international dialogue initiatives such as workshops and conferences on environmental and rubber industry issues. For instance, the Trelleborg Group was one of the sponsors of the Global Environmental Youth Convention 2000 held by the International Institute for Industrial Environmental Economics at Lund University (57).

The Trelleborg Group issues quarterly the T-Time magazine, which covers Trelleborg news and information about the Group's environmental work with up-to-date information for all interested stakeholder groups, which is available at the Trelleborg's website.

There was a growing interest in corporative environmental reporting in 1990's. The Agenda 21 adopted in Rio De Janeiro in 1992 mentioned: "business and industry should be encouraged to report annually on their environmental records, as well as on their use of energy and natural resources" (58). Currently, "environmental reports can be considered a sort of small World where many crucial points in the relationship between a company and its stakeholders meet together", mention Bartolomeo and Ranghieri (59). The Trelleborg Group issues annual "Trelleborg Environmental Report" for various interested stakeholder groups since 1998.

In the year 2001 Deloitte & Touche rated the Trelleborg Group's Annual Environmental Report 2000 as the 5th most developed environmental report in Sweden (Figure 6) (60). The Trelleborg Environmental Report 2000 score of 42% can be assessed as successful result, in comparison to other Swedish Corporate Environmental Reports with average score of 32%, with reservation for further improvement of the report.

The evaluation was conducted basing on the following criteria checklists, which cover not only purely environmental, but ethical and social aspects as well:

- Criteria for preparation of the report (*This checklist is designed to ensure that all criteria for preparation of the report have been met*) – 5 %
- Environmental, ethical and social aspects (*Description of environmental, ethical and social aspects that are significant for the organization's business value/operational benefits*) – 15 %

- Management and internal control (*Description of management and control activities related to environmental, ethical and social aspects, as well as conditions relating to permits, legal requirements, accidents and incidents*) – 25 %
- Environmental, ethical and social data (*Description of an organization's significant material flows and emissions*) – 15 %
- Environmental, ethical and financial accounts (*Description of the interaction between environmental, ethical and social aspects and development of business value/operational benefit*)– 25 %
- External considerations (*Description of significant external requirements pertaining to environmental, ethical and social aspects*) – 10 %
- Overall impression (*Checking the overall impression of the report*) – 5 %

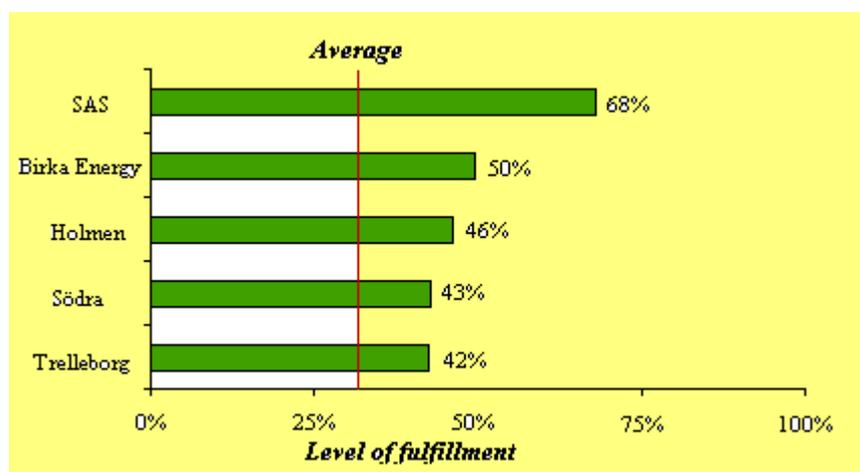


Figure 6: Five most developed “Environmental Reports 2000” in Sweden by Deloitte & Touche

The Trelleborg Environmental Reports as well as recent company news and T-Time editions can be accessed on the Group’s internet website www.Trelleborg.com, which is an international fast growing communication sector. In addition, the Trelleborg website has an interactive feature “Questions and answers” to the Group’s environmental manager, which facilitates various stakeholder groups dialogue. Therefore the Trelleborg website can be taken into consideration as one of the environmental communication methods with all stakeholder groups.

Concluding, the environmental communication review, it could be said that the Trelleborg Group uses various environmental communication tools and methods with an overall goal to address different stakeholder groups and establish a stakeholder dialogue.

4. The Trelleborg Wheel Systems

4.1 General information about the Trelleborg Wheel Systems

The world tire industry is a US \$ 70 billion market (Figure 7) with steady growth over the last years. The passenger car and light truck sector is the largest sector in tire industry accounting for 60.2% of the market. The largest areas of sales are in replacement tires; currently about 75% of the tires sold are for replacement, while the rest is for the new vehicles. Almost 80% of the tires produced are being sold in Europe, North America and Japan. Japan uses approximately the same amount of tires as the rest of Asia.

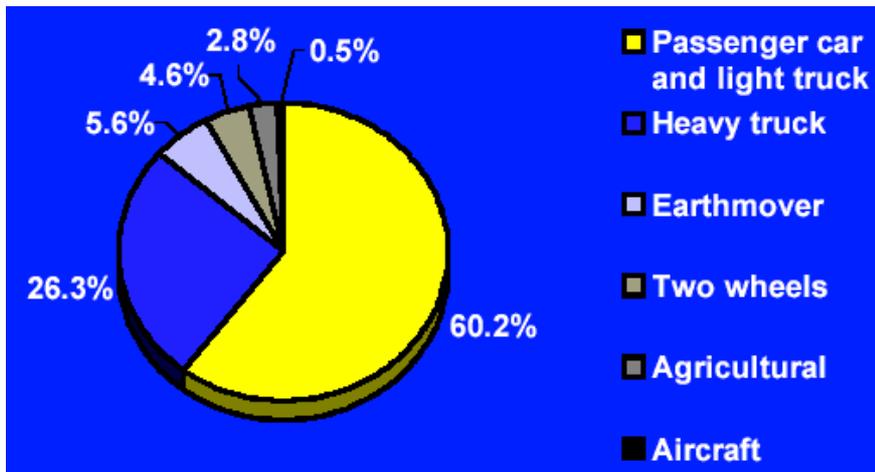


Figure 7: The world tire market sectors (Source: *The World Tire Market, Michelin Fact-book 2001, Michelin, 2001 (61)*)

According to Michelin fact-book the three largest companies (Michelin, Bridgestone and Goodyear) form 55.4% of the market, while six mid-size players make up another 23% of the market (Figure 8). TWS belongs to the rest of the market players, which altogether constitute only 21.2% of the market. The tire market is highly competitive; that's why the relatively small companies like TWS are looking for their own specific niche in the market.

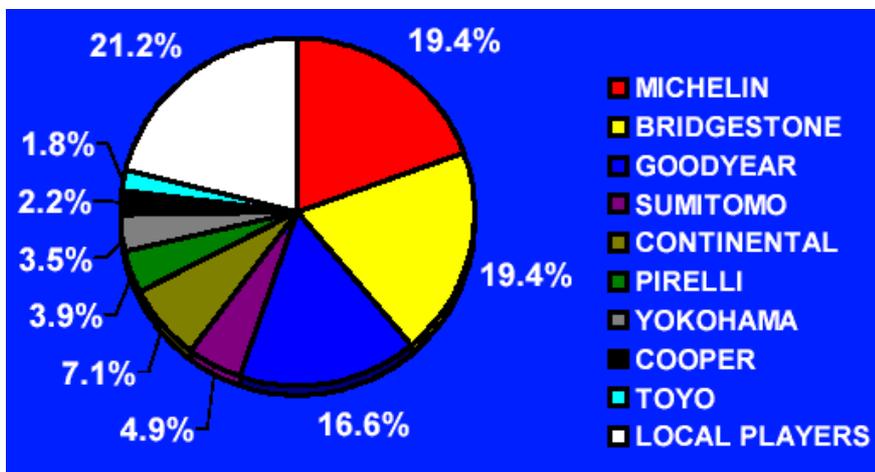


Figure 8: Tire industry breakdown (Source: *The World Tire Market, Michelin Fact-book 2001, Michelin, 2001 (62)*)

The TWS develops, manufactures and markets complete wheel systems for forest and farm machines, trucks materials – handling equipment. The major market segments for TWS are solid industrial tires and forest and farm machine tires, which are the so-called niche for TWS. Currently TWS is 3rd largest farm machine tires supplier in Europe. The company aims to expand on North and South American and South-east Asian markets as well as to Australia and South Africa. However, on the global scale the TWS is relatively a small, but growing producer comparing to its major competitors Michelin, Bridgestone, Goodyear and Continental.

4.2 Tire production process at Trelleborg Wheel Systems

The tire production process goes through several basic steps (Appendix 2), which are:

1. *Compounding and mixing* elastomers, carbon blacks, pigments and other chemicals like plasticizers, vulcanizing agents; accelerators, and initiators,
2. *Extruding* the rubber mixture between pairs of large rollers to prepare it for the feed mill, where it is slit into strips to take the shape to the *tread and sidewall materials*,
3. *Calendering* operation – processing fabrics and coating them with rubber
4. Processing *bead wires* and coating them with rubber in an *extruding process*,
5. *Cutting and cooling* the various extruded and calendered outputs
6. *Building* – assembling all of the components (bead wires, coated fabrics, treads and etc) on a tire-building machine
7. *Lubricating the green tire* (green tire spraying)
8. *Vulcanizing and molding the tire* with heat and pressure
9. *Finishing the product (63)*.

The first stage of tire manufacturing “Compounding and mixing” consists of rubber mix production from polymers (raw and synthetic rubber), carbon black, oils and miscellaneous chemicals which include processing aids, vulcanizing agents, activators, accelerators, age resistors, fillers, softeners and specialty materials (odorants, colorants and etc). The process of weighing and mixing rubber components is called compounding and carried out in compounding area. Then compounds are put in a mixer and stirred until a homogeneous mass of rubber is created. The mechanical mixing heats the rubber, so the rubber has to be cooled after mixing. At the next stage the cooled rubber sheets are warmed up and passed to extruders for “extruding process”. Extruders transform the rubber into various shapes. At the “calendering stage” of tire production “a fabric of textile or steel cord is coated with a film of rubber on both sides” (64). Then extruded and calendered rubber components are combined (layered and built up) with bead wires, polyester, aramid, and other reinforcing materials. The rubber coming from extruders and calendering is cooled and cut afterwards. The “building process” starts with placing the carcass plies on a drum, after which the rubber-coated wires are added and the plies are turned up around them. At this stage the belts, tread, and sidewall rubber are wrapped, around the drum, over the fabric. The drum is then collapsed and the uncured (green) tire is coated with a lubricant (green tire spray) and loaded into an automatic tire press to be molded and cured. The “curing process” (vulcanization process) converts the rubber, fabric and wires into a tough, highly elastic product, bonding the various parts of the tire into one single unit. The vulcanization is a chemical reaction between butadiene (rubber) and sulfur. Basically sulfur is cross-bonding polymer molecules of the rubber

matrix, “sewing” the rubber matrix, giving it its elasticity. The last “finishing the tire” stage involves trimming, buffing, balancing and quality control inspection (65).

4.3 Trelleborg Wheel Systems Customer Requirements

The Gothenburg Research Institute in their “Svenska miljöbarometern 1997 – 98” report has drawn a conclusion that “customers have the greatest influence on company’s environmental management” (66). As it was mentioned in previous chapters as well the role of the customers in greening the company is becoming or already became a dominant factor for the company. The study of the “Environmental Management in Swedish Manufacturing Industries” shows that “there are several larger Swedish companies committed to the environmental management that have begun to place demands on their subsidiaries, contract manufacturers and suppliers. Environmental management among larger companies has a great significance for smaller companies” (67). The Trelleborg Group and particularly TWS are relatively small companies comparing to its major customers such as Volvo, Electrolux, General Motors, Ford, Massey Ferguson, Nacco and etc. what stresses the importance of carrying out the customer requirements analysis. For the time being customer requirements is one of the major driving forces for the Trelleborg Group to implement IPP tools.

The analysis of the Trelleborg customer requirements was carried out basing on “Environmental Requirements for suppliers” checklists and environmental policy statements of its customers. The studied customer checklists and environmental policy statements are mentioned in Appendix 3.

The major concerns of the Trelleborg customers are in the field of Internal Environmental Management, Environmental Reporting, New Environmental Management Mentality and Environmental Policy, and the use of toxic chemicals. The analysis of customer requirements showed high demand for establishment of Company’s Environmental Policy and Goals (mentioned in all requirements checklists). A particular attention was given to the employees’ awareness about the company’s environmental policy and goals, most of the Trelleborg customers are interested in raising employees awareness on environmental issues, which ensures a high level of company’s environmental performance. Volvo and Ulinco Gummi and Plast AB were interested in setting of environmental goals asking: “Do environmental goals go beyond applicable legislation?” In my opinion this question is a sort of “New Environmental Management Mentality” measuring. Sustainable development principles, being a cornerstone of the “New Environmental Management Mentality”, require the company to comply with the existing legislation engaging at the same time in a process of continual improvement of the company’s environmental performance, which goes beyond the existing legislation keeping the company on the “safe side”.

All of the studied Trelleborg customers showed considerable interest in Internal Environmental Management particularly in EMS. Most of the companies had no particular preferences of the EMS certified schemes implemented at Trelleborg except Tetra Pak and Scania which were interested in ISO14001 and did not mention EMAS in the questionnaire. The reason for Scania to focus only on ISO14001 certificates comes from Scania’s own preferences; all of the Scania’s operations in Sweden are ISO14001 certified since April 1999 (68) while Tetra Pak requires its manufacturing sites to achieve either EMAS or ISO14001 certifications (69). So that basically for the moment it does not matter much for Trelleborg customers which EMS certification Trelleborg sites will have, the only thing which matters is an EMS certification itself. Therefore, obviously Trelleborg customers do not require and probably will not require in a short-term perspective EMAS

certification from Trelleborg, so that there are no obstacles from Customer's side to implement ISO14001 scheme at Trelleborg as a choice of Company's EMS preference.

Another important issue raised by all customers was about the use of chemical substances and compliance of this issue with legislation. Volvo and Scania are presented the classification of chemical substances. The major concern was about elimination of the "black listed" chemicals used in Trelleborg production processes. Dealing with the issue of substitution or elimination of hazardous chemicals is one of the major environmental requirements to the Trelleborg. However the Trelleborg has all required licenses on all of its production sites using hazardous chemicals answering therefore on the compliance with legislation requirements by majority of its customers.

Volvo and Ulinco Gummi and Plast AB raised the question of making comparisons of performance in environmental area with similar processes used in other companies. This would allow Trelleborg to be updated with the latest trends in the rubber industry and to evaluate the Company's environmental performance in comparison to its competitors.

In addition to above mentioned all of the Company's customers required the Environmental Report from Trelleborg. This fact undermines the significance of the Environmental Reports, which Trelleborg voluntarily publishes on the annual basis distributing among stakeholders of the company. Volvo and Shenker showed interest in an LCA analysis of the Trelleborg products. An LCA analysis will probably become more common requirement by the Company's customers since it's quite essential for them in carrying out LCA analysis of their own products. The customers may refer to the Trelleborg's LCA analysis in their own LCA analyses.

Summarizing the major environmental customer requirements to the Trelleborg were:

- Establishment of the New Management Mentality
- Existence of Environmental Policy and Environmental goals
- Implementation of EMS and third party EMS model certification
- Substitution and elimination of hazardous chemicals
- Legislation compliance with the use of hazardous chemicals
- Environmental Report
- LCA analysis

4.4 Integrated Product Policy instruments at Trelleborg Wheel Systems

The IPP instruments were presented and discussed in Chapter 2. This subchapter will discuss the implementation and current state of IPP instruments at TWS one by one. According to Pia Heidenmark: "group's environmental management has a great influence on the environmental management of member facilities" (70). As a matter of fact it should be taken into consideration that IPP instruments have to be implemented on both Trelleborg Group and Trelleborg business area levels in order to provide the best environmental performance and allocation of responsibilities within the company; while the Trelleborg Group should be the driving force for the TWS in implementation of IPP instruments.

Creation of demand for sustainable products: the TWS informs its customers regarding the environmental performance of their products via its Trelleborg Group's Annual Environmental

Report, TWS website, T-Time magazine, various prospects and etc., but at the same time there is also a lack of appropriate information like LCA analysis.

Establishment of the New Management Mentality is a complex issue, dependent on all environmental performance factors. Basically the idea of the New Management Mentality, the responsible entrepreneurship, considers implementation of the rest of IPP instruments, since all of them are somehow aimed to support reaching sustainable development goals in industry. Generalising, even the process of implementation the IPP instruments can be seen as an establishment of the New Management Mentality.

The present integration of environmental aspects into all areas of the product policy at Trelleborg Group and particularly TWS shows establishment and development of the New Management Mentality. In addition, the Company's Environmental Policy has an overall objective to reach sustainable development goals; hence proving once more an existence of the New Management Mentality at Trelleborg and TWS.

Environmental Management Systems: according to the Trelleborg Wheel Systems website: "All Trelleborg Wheel Systems are required to have their systems fully implemented according to ISO14000 series" (71). However currently there are only four certified plants at TWS, which are:

- Milk liner production, Agri Trelleborg (Sweden)
- Mixing department, Trelleborg (Sweden)
- Wheel production, Hadsten (Denmark)
- Agricultural and forestry tire production plant, Tivoli (Italy)

TWS largest plant in Tivoli recently received ISO14001 certification in December 2001. At the same time several other plants are expecting certifications in the nearest future. For the moment there are no EMAS registered plants at TWS.

Being a business area of the Trelleborg Group EMS policy of TWS is similar to the Group's EMS policy.

An internal **benchmarking** is widely used at TWS, while TWS does not use any external benchmarking. Potentially use of the external benchmarking is helpful to improve TWS environmental performance and in addition it is one of the customer requirements to the Trelleborg Group. However, for the moment TWS uses only internal benchmarking.

Environmental accounting and innovation networks: the objective of this IPP instrument is in providing information and data about sustainability and accelerating the innovation process. The major aim is to open up ways of making information more accessible. The Trelleborg Group and the TWS as business area of Trelleborg is the member of the European Association of the Rubber Industry, which is an innovation network by itself. The Trelleborg Annual Environmental Report, which also includes TWS, plays a significant role in providing interested parties with environmental information. In addition, collaboration of TWS with research centers and universities, as well as participation on various workshops on sustainability issues can be classified as innovation network. The TWS interactive website is also a network making company's environmental information accessible to all stakeholder groups.

For the moment the TWS does not have the environmental accounting report.

Lifecycle Accounting and Assessment: there are no LCA studies of industrial or agricultural tires carried out by TWS. However, the TWS participated in the European Association of the Rubber Industry's full LCA study of the 195/65 R15 passenger car tire. This LCA study can be used as the reference LCA in Europe for car tire manufacturers.

“It is thus absolutely not relevant to extrapolate any of the information below to the truck tires domain.” notes BLIC report (72). Nevertheless, the experience gained and methodology of carrying out LCA studies were the advantages of the passenger car tire LCA analysis for the TWS. Basically, there is already a well-defined LCA analysis framework for making LCA analysis of various tires.

The schematic flowchart showing the stages in the life cycle of a tractor tire is presented on Figure 9. BLIC in their LCA analysis report notes, “The environmental load in the production phase of a car tire is mainly due to the production of raw materials, and not by the car tire production itself” (73). Most probably the same applies for the agricultural and forestry tires as well, since both tire production processes are basically quite similar. Therefore, the TWS suppliers contribute the most to overall tire production pollution. So that, the Trelleborg customer requirements to its suppliers should be aimed on decreasing the environmental load in the raw materials production phase.

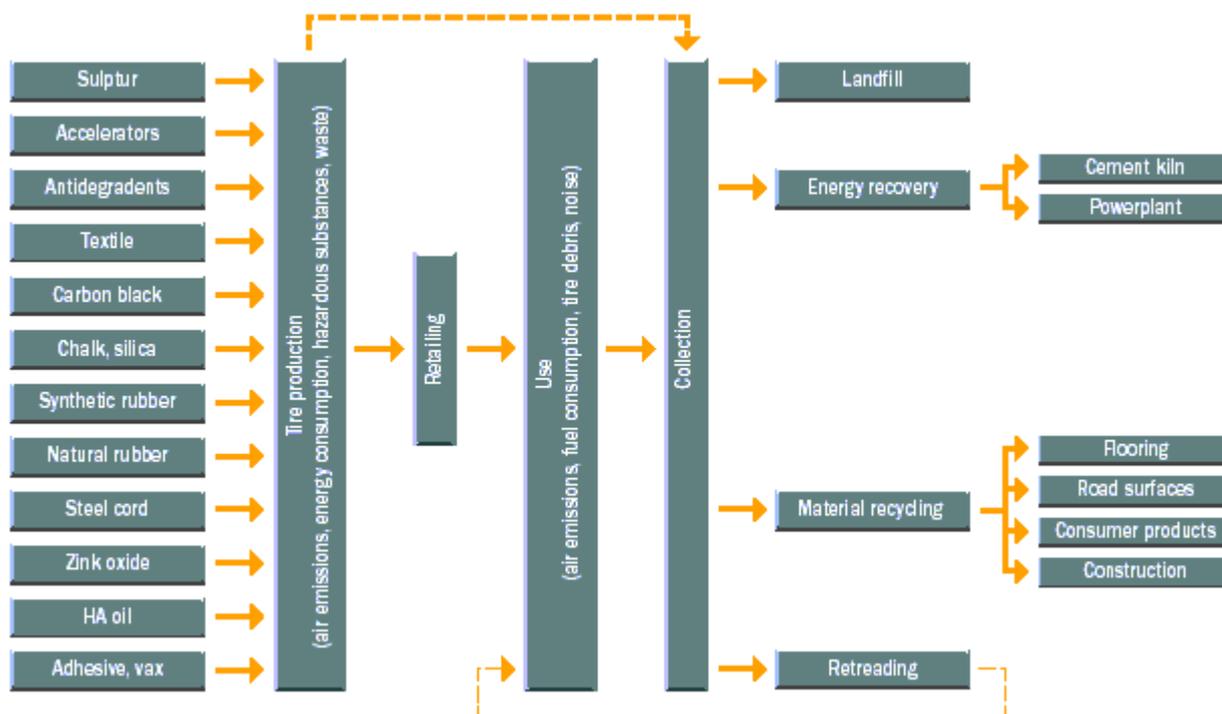


Figure 9: Schematic flow chart showing lifecycle stages of the tractor tire (Source: Trelleborg Environmental Report 2000 (74)).

Eco – design: currently the TWS does not produce any products with eco–design, one of the possible reasons is in lack of LCA analysis. LCA analysis plays a significant role in product development including eco–design. Another reason is in consumer demand for the product. There's currently very low demand for eco–designed rubber products.

Eco-labelling and Product declarations: for the moment there are no eco-labels or product declarations used in TWS. As for the Trelleborg Group only, Trelleborg Rubore in Kalmar, Sweden, producer of noise insulators and anti-vibration goods, has reported that they had conducted an LCA study on one of their products for eco-labelling (75).

4.5 Trelleborg Wheel Systems environmental requirements to its suppliers

Currently the TWS environmental requirements to its suppliers are limited to the compliance with legislation requirements on chemicals use. The Trelleborg Group has elaborated an “Environmental Assessment of Suppliers” procedure, which ensures legislative compliance. At the same time with implementation of EMS at TWS the company would have to ask its suppliers for ISO14001 certification. However suppliers with EMS certification are given priority in contracts, at the same time the TWS will start requiring EMS certification from its suppliers in 2-3 years.

According to Trelleborg Environmental Report “during 2000, a global purchasing organization was formed and work is now in progress to establish Group wide policies and procedures for how environmental issues are to be handled in this context” (76). Undoubtedly the establishment of such organization within Trelleborg will systematize environmental relations with the Company’s suppliers improving environmental management of the Group.

5. Discussion of possible recommendations and constraints

The following chapter discusses the possibilities and constraints for the implementation of IPP concept at the TWS. Some of the IPP instruments representing its concept are already in use at Trelleborg while others are still at the consideration stage. However in spite on the stage of IPP instrument's implementation, taking into consideration the idea of continual improvement, there is always a room for the improvement of the IPP instruments. The major interest of the present discussion is in comparison of the "IPP toolbox" presented in Chapter 2 with information on Trelleborg and particularly TWS presented in Chapters 3, 4 independently of the stage of particular IPP instruments use at the company. By other words it is a comparison of the IPP theoretical framework with the company's environmental performance within the IPP framework.

One of the major concerns of the present thesis study was the implementation of EMS at the Trelleborg Group. The environmental policy statement of both the Trelleborg Group and its business area TWS considers EMS certification as the priority issue of the company's environmental development. Also, the analysis of the company's customer requirements showed a strong demand for EMS certification at Trelleborg and TWS. And finally, "companies that are EMS certified are expected to have an advantage over non-certified companies when selling to industrial and governmental consumers. Studies have shown that ISO9001 certified Japanese companies performed better in European markets than their counterparts without certification. This trend is expected to repeat for ISO14001" (77). The same trend applies to the companies with EMAS certification as well.

So that ISO14001 and EMAS EMS schemes were presented, discussed and compared in the previous chapters. The current situation at Trelleborg shows the company's priorities are set to ISO14001 scheme rather than to EMAS. However, "EMAS can be considered as a more credible standard" (78). Nevertheless both of them have basically the same label EMS certification. Both schemes are voluntary and third party certified. The major difference would be in taking legal responsibilities for EMS performance, requirement of continual improvement of environmental performance, requirement of the public environmental statement and consideration of indirect environmental aspects by the company with EMAS certification. Currently the EMAS regulation has been revised and ISO14001 certification became a part of EMAS II (the revised EMAS). For the moment EMAS II can be described as the next stage of improvement of the company's environmental performance after ISO14001 certification. The major constraint of the EMAS regulation is in its limitation to EU boundaries. For the companies operating at the EU it would be preferable to have an EMAS certification on a long run because there could be requirements for the company's EMAS certification in order to obtain production or operating permits in the EU countries or for instance the governmental institutions would be encouraged to work with EMAS certified companies rather than ISO14001 certified ones. "EMAS should bring in future "regulatory benefits" for participating organizations. Member States are supposed to consider how EMAS registration may be taken into account in the implementation and enforcement of environmental legislation", mentions the Green Paper on IPP supporting the above idea, "this will lead to environmental controls taking into account the EMAS implementation through lightened frequency or bureaucracy; more flexible reporting and permit procedures and in certain cases, subsidies for the implementation of the management system and registration fees" (79). It's recommended to consider implementation of the EMAS at Trelleborg and particularly TWS production sites in the long-term future.

On the other hand there have not been any concrete experiences of the impact of EMAS II due to its relative novelty. Therefore, “it is difficult to assess what this change is likely to bring” (80). At the same time an ISO14001 is worldwide system with expected “behavior”, what makes ISO14001 more favorable for implementation at the moment even in Europe. Undoubtedly, on the long-term perspective the Trelleborg should consider possibility of EMAS II certification of its plants. Hence, it is recommended to carry out ISO14001 versus EMAS comparative study in the future.

The IPP instrument “**creation of the green customer demands**” is partly addressed at TWS taking into consideration the fact that customers must have easy access to understandable, relevant, credible information about TWS products. It is recommended for TWS to continue informing customers about TWS products via methods, which TWS are already using, mentioned in Chapter 4. During the study it was found that there is no any environmental information provided for the TWS products at TWS website (<http://www.trelleborg.com>) with exception of battery containers. Since an Internet is becoming a growing source of information for potential customers, the TWS should consider updating information about its products on the company’s website.

The general recommendation to the TWS regarding the “creation of the green customer demands” issue would be carrying out LCA analysis of its products and their eco-labelling, promoting of TWS products through customer and environmental NGOs, promotional communication with governments. And finally, the TWS must ensure that information for “green customers” should be easily accessible by them.

The **New Management Mentality** IPP instrument implies taking into account the sustainable development principles at the company. In the case of TWS the company is establishing the New Management Mentality and it is an ongoing process within the company. The general recommendation is to carry on internal personnel trainings at Trelleborg leading to the establishment of environmentally creative work atmosphere. At the same time the New Management Mentality expands over the responsible entrepreneurship pattern for the company’s management. It is recommended for the company’s management to keep continuity in their environmental work.

Benchmarking is an IPP tool enabling the company to analyse and monitor its progress. It was mentioned in Chapter 4 that the TWS is using internal benchmarking. Dr. Georg Winter notes, “The sustainable company of the future should have institutionalised benchmarking” (81). Complete institutionalisation of benchmarking is another objective for the TWS in implementation of the IPP concept. In addition, the TWS probably underestimates the role of the external benchmarking. The external benchmarking allows the company to make a comparison with competitor’s performance. Therefore the company using external benchmarking would be able to adjust its environmental performance to the best available practices. So, the recommendation for the TWS and the Trelleborg Group as well is to use external benchmarking and furthermore to institutionalise external benchmarking in company’s operations. The constraint for the implementation of the benchmark practices could be caused by the fact that “A prerequisite for benchmarking environmental performance is availability of continuous and reliable information” (82). Therefore the TWS obstacle in introducing external benchmarking and institutionalizing benchmark practices could be the low availability of continuous information on company’s environmental performance.

Environmental accounting and innovation networks are another IPP instruments for businesses. As it was found by at the CLD presented in Chapter 2: the environmental performance of the

company influences its economic well-being. The environmental accounting report is of growing interest for the company's stakeholders. Therefore it's recommended for the TWS and Trelleborg to present an environmental accounting report on an annual base. Since, "currently there is no standard way of presenting environmental information and no analytical standards for their interpretation" (83), the company would have "freedom of choice" preparing the environmental accounting report. The "freedom of choice" means freedom for the company in choosing the data for presentation in the report, by other words it means the low level of requirements to the accounting report. So that there would not be regulatory obstacles in preparing the first environmental accounting report as well as the relatively low cost of preparing the report.

The Trelleborg Group and TWS participation in innovation networks was brought in the Chapter 4. Basing on that the recommendation for the Trelleborg Group would be further participation in innovation networks activities striving for the continual improvement of the company's environmental performance. In addition it would be recommended for the Trelleborg Group to prepare "Annual Sustainable Development" report instead of "Annual Environmental Report" in a long-term perspective. The World Business Council on Sustainable Development would present the "Sustainable Development Reporting" guidelines in June 2002 (84). The overall purpose of which is to create the business care for sustainable development reporting. The major obstacle is lying in the cost of the report. Therefore it's important to carry out a comparative SWOT (Strength, Weaknesses, Opportunities and Threats) analysis of "Environmental Reporting" vs. "Sustainable Development Reporting" after publication of Sustainable Reporting guidelines by WBCSD. However, the third party verification is the recommendation for the "Annual Environmental Report". "The purpose of the verification is to ascertain whether the data presented in the report is obtained with due care and is not subject to material errors" notes Deloitte & Touche (85). Advantages of the third party verification of "Environmental Reports" are given in Appendix 4. The major constraint in this case is the high cost of the third party verification, considering that many of the environmental reports produced do not have third party verification this recommendation would be attractive for the Trelleborg on a long run.

The **Lifecycle Accounting and Assessment** is an IPP tool designed for evaluation of environmental aspects of product through all stages of its lifecycle. It was already mentioned in Chapter 4 that "passenger car tire LCA analysis" was carried out by BLIC with the participation of Trelleborg. It was found that that LCA study is not applicable to any other types of tires except for passenger ones. Eventhough that study set up the reference example for tire LCA, the Trelleborg still has to conduct an LCA study for its products. It is expected that the BLIC will carry out another LCA study and most probably and LCA study of the agricultural tires. The main constraints for TWS to carry out an LCA study by itself are the high cost of an LCA study and time. In addition, an LCA study is not prioritised for the moment by the Trelleborg Group's environmental management, which currently focuses on EMS certification of its production plants and substitution of hazardous chemicals. Summarizing the best option for the Trelleborg would be initiating and participation in LCA study of the Trelleborg Group products together with interested parties represented in BLIC.

The **eco-design** instrument of an IPP is not currently used at TWS. Eco-design can be a strategy to extent the company's market potential in the case of sufficient strong demand for environmentally sound goods. The design concepts of the strategy for the integration of the environment into the design process are given in Appendix 5. Some of the requirements for eco-design mentioned in Appendix 5 would require an LCA analysis of the product, which Trelleborg is not able to carry out for the moment. In addition currently, there is no demand for the eco-design products in rubber

industry (86). Therefore there is actually almost no need for the implementation of the eco-design instrument in the nearest future. The best possible scenario for the Trelleborg and TWS is to wait until the rise of market demand for the eco-design products and the Trelleborg products' LCA analysis results. The development of the eco-design products is a long-term perspective for the Trelleborg and TWS as well.

And finally, the **eco-labels** and **product declarations** are discussed as an IPP instruments. There are three types of ISO14020 series eco-labels:

- ISO14024 – Third party environmental labelling programs (Type I environmental labelling)
- ISO14025 – Environmental Declarations (Type III environmental labelling) – presentation of technical report about the product, requires third party environmental labelling
- ISO14021 – Environmental Labels and Declarations – Self – Declared Environmental Claims (Type II environmental labelling)

The idea of eco-labelling the TWS products was studied in 1999-2000 by Nabila Zouhri in her MSc thesis named “Labelling Agricultural Tyres at Trelleborg Company: Possibilities and Constraints”. The author drew some short- and long-term conclusions basing on her study. Recommendations given by Nabila Zouhri basically were:

- “Short-term: in the absence of official third party criteria for agricultural tires, self – declarations seems to be the most effective, cheap and short term solution to add value to their product and mainly satisfy the local stakeholders;
- Long-term: the Trelleborg and other companies should consider ISO Type I eco-labels (with reservation of several factors mentioned in Nabila Zouhri’s thesis study)” (87).

The general impression from Zouhiri’s study is that “the eco-labels and self-declarations are important instruments to increase credibility of the TWS products, but they are not so developed and structured IPP instruments for immediate implementation in the rubber industry”. The Green Paper for IPP mentions that “green-claims and self-declarations, ISO Type II, are perhaps most likely for the foreseeable future to be used on a broad scale” (88). Therefore, the author agrees with and favours Zouhiri’s short-term recommendation for the TWS on self-declarations. While on a long run both the ISO Type I and Type III declarations are feasible for the TWS.

Summarizing, the analysis made by the author in the present study showed that the major constraints for implementation of the IPP in the Company are mostly financial feasibility of the actions proposed, time scale and in some cases the lack of the institutional framework for the actions to be taken (example: eco-labelling for rubber industry case). Therefore some of the recommendations proposed by the study cannot be taken immediately or in a short-term period. In practice most of the proposed long-term recommendations will require additional study by the day when the company’s management would consider them as priority objectives set to be implemented in short-term.

The long and short-term recommendations the author refers to are considered to be taken in more than three years time and in less than three years time respectively. In author’s opinion it is the best possible time scale for the recommendations proposed.

6. General conclusions

This study reviewed the IPP concept defining a set of instruments for the IPP implementation for businesses. Furthermore the conceptual CLD was developed for the better understanding of the Environment – Company – Stakeholders system and its behaviour on the implementation of IPP instruments. Then, the Trelleborg Group's and its business area TWS environmental performances were studied and described through the established IPP framework. Furthermore, a number of the customer requirements to TWS and the Trelleborg Group were studied in order to find out the market demand for implementation of the IPP instruments. The study found that the major driving forces for implementation of IPP at the company are external among which a particular importance is given to the customer requirements follow by the governments legislative measures imposed.

The objective of the present thesis work was the discussion of possibilities and constraints on the implementation of new and impact of the already implemented IPP instruments on TWS. The discussion resulted in a number of short- and long- term recommendations for the IPP instruments were made.

The major short-term recommendations were:

- Prioritisation of the ISO14001 certification of TWS and the Trelleborg Group
- Support and development of the New Management Mentality established at Trelleborg
- Strengthening of the methods used and introduction of the new methods for the support of the “green customer demand”
- Carrying out an LCA study of the TWS major products (tires)
- Establishment and presentation of the Environmental Accounting Report
- Implementation of external benchmarking along with institutionalising of internal benchmarking
- Self-declaration of ISO II eco-labels

At the same time, the major long-term recommendations were:

- Study of the possibility of EMAS certification of the TWS and Trelleborg's production sites located in EU
- Presentation of the “Sustainable Development Report” instead of “Environmental Report”
- Eco-design of Trelleborg and TWS products
- ISO I and ISO III type eco-labelling of TWS products

Furthermore, building capacity of the stakeholder dialogue especially collaboration with scientific centers is the recommendation based on CLD study.

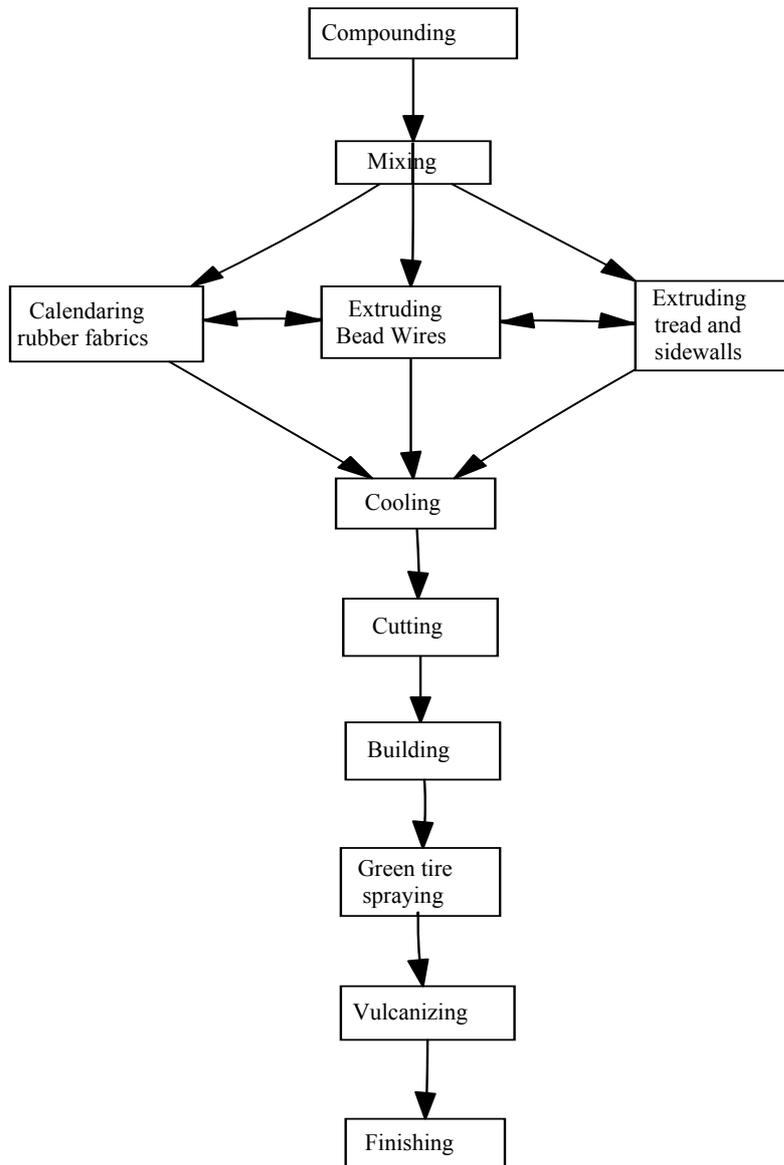
An overall opinion from the present study is that the TWS and the Trelleborg Group have the right attitude and are on the right track in understanding and implementation of the IPP concept. The TWS and the Trelleborg Group's position in use and implementation of IPP instruments can be evaluated as a starting point therefore requiring the right set up of the values and identification of the major driving forces for implementation of the IPP concept.

The IPP concept is aimed on improvement of company's environmental performance with almost no effect on its financial resources. For industry and retailers, the IPP offers the opportunity to bring in their experience to promote a business-oriented approach towards greener markets on the basis of innovation and economic growth; the IPP converts their experience into market opportunities.

Appendices

Appendix 1 – ISO14001 Environmental Management System requirements

1. General requirements (the organization shall establish and maintain an EMS, the requirements of which are given in this list)
2. Environmental Policy (top management shall define an environmental policy)
3. Planning
 - a. Environmental aspects
 - b. Legal and other requirements
 - c. Objectives and targets
 - d. Environmental management programme
4. Implementation and Operation
 - a. Structure and responsibility (roles, responsibility and authorities shall be defined, documented and communicated in order to facilitate effective environmental management)
 - b. Training, awareness and competence
 - c. Communication
 - d. EMS documentation
 - e. Document control
 - f. Operational control
 - g. Emergency preparedness and response
5. Checking and corrective action
 - a. Monitoring and measurement
 - b. Non-conformance and corrective and preventive action
 - c. Records
 - d. EMS audit
6. Management review (89)

Appendix 2 – Tire Manufacturing Process (source: Environmental Protection Agency (90))**Appendix 3 – List of analysed Trelleborg Customer Requirements checklists and Environmental Policy statements**

- Volvo – Environmental Requirements for suppliers self-assessment checklist,
- Schenker (Stinnes Logistics) – Environmental Questionnaire,
- Tetra Pak – Frågeformulär vid leverantörsbedömning ur miljösynpunkt,
- Tetra Pak – Environmental Policy
- Opel Espana de Automoviles, INC. – Environmental Policy statement, Environmental Questionnaire
- Electrolux Wascator – Miljöenkat

- Study on ISO14001 Environmental Management System Implementation for Small and Medium Sized Enterprises for the Hong Kong Government
- Ulinco Gummi & Plast AB – Environmental Self – Evaluation of Environmental Situation
- Scania – Environmental Self Assessment for Suppliers
- Scania – Environmental Policy

Appendix 4 – Advantages of the third party verification of “Environmental Reports” (source: Deloitte and Touche (91))

- Higher credibility to the information in the report and to the stakeholders,
- Increased assurance to company management that information communicated externally is reasonably supported by evidence,
- Increased quality of the processes for data collection and information gathering,
- Additional control of data aggregation and plausibility of collected data,
- Constructive support to the internal learning process and facilitation of the feedback to the reporting units

Appendix 5 – Concepts of the eco-design strategy (Source: Green Paper on Integrated Product Policy by Commission of the European Communities (92))

- Design for cleaner production and use (examples: source reduction, leading to reduced mass, less wastes, minimal energy consumption)
- Design for reduction/substitution (of hazardous, toxic or otherwise environmentally unfriendly materials, in the product or in accompanying consumption)
- Design for use of renewable materials
- Design for durability (examples: reparability, maintainability)
- Design for longevity (examples: upgradability; classic design, accommodation of future needs)
- Design for extended function (examples: multifunctionality, modularity)
- Design for reuse and recycling (examples: simple disassembly, reduced material complexity, use of recyclable and recycled materials; component recovery through closed loop re-manufacturing and secondary applications)
- Design for simplicity (should lead to lower manufacturing costs, lower material mass, greater durability, easier disassembly for maintenance or asset recovery)

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