Proactive integration of environmental concerns in business operations and organizational structure: ECD&M and EMS

Case studies: Volvo Buses, Trelleborg AB, Kinnarps AB

Master’s thesis within Business Administration

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Master’s Thesis in Business Administration

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Abstract

Over the last decades, industrial development has brought prosperity and wealth together with triggering unintended ecological degradation. Therefore, a modern society has increasingly demanded companies to take responsibilities for the effects of those business activities that have a negative impact on the environment. Among businesses this has increased the interest towards adopting proactive approaches and practices which aim to reduce these negative impacts. Therefore, the topic of proactive integration of environmental concerns into organizational structure and day-to-day operations is highly relevant and deserves to be investigated.

The purpose of this thesis is to analyze why and how companies integrate environmental concerns in their business operations and organizational structure as well as to investigate the critical factors that enable such integration. In this thesis, the integrated deductive and inductive research approaches are applied and the qualitative study is selected in order to better understand the motivations, challenges and perceived benefits for companies when proactively integrating environmental concerns into their business operations and organizational framework. Moreover, the multiple cases study of three Swedish manufacturing companies, namely: Volvo Buses, Trelleborg and Kinnarps is selected as the research strategy. By conducting semi-structured in-depth interviews with the environmental managers, there has not been found a generic pattern as for the ways of incorporating environmental concerns into the operational activities and organizational structure. Nevertheless, the evidence of performing environmentally-conscious design and manufacturing (ECD&M) as well as implementing environmental management systems (EMSs) for achieving improvements in material utilization, hazardous waste and emissions reduction, efficient energy consumption and the use of different systems to prevent possible accidents and environmental emergencies have been identified in the studied manufacturing companies.

The thesis concludes with the essence of main reasons and benefits from adopting the environmental practices and eco-efficient strategies. Furthermore, the empirical results focus on the tools and methodologies supporting this proactive adoption. Thus, while Design for Environment (DFE) has gained much attention in theory, still only some elements of this methodology are being experienced by studied companies. In line with this, material selection process is recognized in all three organizations as a vital component in product design. As for Life Cycle Assessment (LCA), although is the most reliable method for outlining the environmental performance of products still its use and implementation is disadvantaged by its complexity, comprehensive scope and time-intensive application. The empirical results also show that the focus on products, unlike manufacturing processes and manufacturing facilities, is still neglected to a certain degree. Furthermore, products are still not within the main focus of ISO 14001. Consequently, from an environmental point of view, EMS covering a wider scope would be preferable and a more useful tool when striving for a sustainable development. Finally, some critical factors for a successful integration of the environmental concerns in business practices are also identified.
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List of Abbreviations

ECD&M - Environmentally Conscious Design and Manufacturing
ECD - Environmentally Conscious Design
ECM - Environmentally Conscious Manufacturing
EMS - Environmental Management System
ISO - International Organization for Standardization
DFE - Design for Environment
DFR - Design for Recycling
LCA - Life Cycle Assessment
LCC - Life Cycle Costing
FSC - Forest Stewardship Council
FU - Functional unit
GADSL - Global Automotive Declarable Substance list
REACH regulation - Registration, Evaluation, Authorization and Restriction of Chemicals
SCR - Selective Catalytic Reduction
SME - Small and Medium Enterprises
VEC - Volvo Emission Control
VPS - Volvo Production Systems
EPS - Environmental Priority Strategies
EPD - Environmental Product Declarations
EEV - Environmentally Enhanced Vehicle
1 Introduction

This chapter aims at presenting the background and problem formulation. Further, the purpose and the research questions are defined and followed by the perspective and outline of the thesis.

Over the last decades, industrial development has brought prosperity and wealth together with triggering unintended ecological degradation. Therefore, a modern society has increasingly demanded companies to take responsibilities for the effects of those business activities that have a negative impact on the environment.

The expectation of socially and environmentally responsible behavior from companies has been justified on the basis of the following two arguments. The first argument relates to the concept of a social contract and based on the notion that companies do not exist in a vacuum, but are part of a society which creates and supports them. Furthermore, firms owe their existence to laws which have been developed by the society. Thus, society’s continued support for the existence of businesses may be contingent upon their performance, which is considered socially desirable. If businesses engage in socially undesirable behavior, society may be forced to take steps to penalize such businesses, which might include boycotts of their products and services, modifications of the existing laws, and the development of new laws to restrict their activities (Seuring & Muller, 2008). The punitive actions become especially evident when businesses violate environmental laws and regulations. The second argument relates to the ‘quality of life’. Dierks (1979) argues that ‘quality of life’ is an important force in molding society’s expectations from businesses. The above mentioned arguments has heightened society’s awareness, and consequently forced businesses to become more responsible for a cleaner environment (cited in Lohmann, 2009).

The open sources of mass media, and some academic publications blamed famous companies, such as Benetton, Disney, Levi Strauss, Nike and others for inhumane working conditions and contaminations of the environment (Seuring & Muller, 2008). This has increased awareness and interest among customers, governmental, non-governmental organizations and other stakeholders towards environmental issues, and consequently, has placed a great pressure on company’s operations.

Some companies have already started to adopt environmental practices by incorporating the external cost of carbon dioxide emissions, reducing waste and contaminations, implementing pollution prevention techniques, introducing end-of-pipe devices and etc. The attention of the business decision makers has been focused on the social and environmental issues not only for their own firm, but also related to their supply chain partners. Thus, leading companies like General Electric are designing products to enable their clients to compete in a carbon-constrained world. The demand for quality food is being addressed by Whole Foods through sourcing local and organic producers. And Novo Nordisk is taking a holistic view of combating diabetes through its both treatment and prevention policies (Gore & Blood, 2006).

The growing concerns about environmental impacts of production and consumption have led to a renewed interest on issues related to reverse logistics, environmental management, green supply chain, and sustainable supply chains (Andersen & Skjott-Larsen, 2009). Although the corresponding literature involving these issues has been characte-
rized as “small but expanding” it can be also used as a key component to gain a competitive advantage (Murphy & Poist, 2000, p. 5). Besides the fact, that companies take a big part in causing and controlling ecological problems, ‘they could also benefit from cost reductions through ecological efficiencies, the development of green markets and first-mover advantage, better community relations, and improved image’ (Schaltegger & Burritt, 2000, p.63).

The research on the relationship between organizational responsibilities for the impact on the natural environment is positively correlated to the company’s financial performance (Lohmann, 2009). The financial performance of the firm is strongly affected by environmental performance through both market (revenue) and cost pathways. From the market perspective, customers are showing preferences for environmentally oriented companies (ibid.). Manufacturers who demonstrate efforts to minimize the negative environmental impacts of their products and processes, recycle post-consumer waste, and establish environmental management systems are likely to expand their markets or displace competitors that fail to promote strong environmental performance. On the other hand, firms that invest heavily in environmental management systems and safeguards can potentially avoid future environmental spills, crises, and liabilities. Costs resulting from materials waste and inefficient processes can also be minimized. The impacts of companies’ products or operations on the environment are better positioned to meet tighter standards in the future. Because environmental requirements are often based on best available technology, an industry leader could gain competitive advantage by establishing the industry standard and creating a potential barrier to entry (Lohmann, 2009).

1.1 Background

In contrast to the past trend, when companies were mostly adopting reactive approaches and investing in ‘end of pipe technologies’ in order to reduce their air emission and wastes as required by government regulations (Rondinelli, 2001), today corporations are trying to stay abreast of any complex, costly and rapidly changing environmental regulation. As companies started to realize that identifying, tracing and assessing the impact of regulations relevant for a process or facility can be a difficult and costly task (Lin, Jones & Hsieh, 2001), they began to adopt proactive “pollution prevention” practices and approaches which aim to reduce or eliminate waste from the very source of pollutants in the manufacturing processes (Morrow & Rondinelli, 2002).

Nowadays, companies are more than ever trying to direct their efforts and a true interest in the adoption of environmental systems and environmental protection practices (Sroufe, 2003). In line with these practices, an Environmental Management System (EMS) can be seen as an organization’s own internal regulatory structure (Darnall & Edwards, 2006). Enterprises that adopt an EMS are constantly analyzing their environmental performance by means of an environmental policy and internal evaluations of those processes that have an impact upon the environment. The process of setting up, monitoring, and reviewing environmental objectives and targets can, in turn, demonstrate how the performance of these operations has progressed over time (ibid.).

Remarkable competition among consumers, industrial and service companies is taking place all over the world. Since society becomes more anxious about the natural environment, businesses have started to adjust their behavior with the purpose to address environmental concerns. Nowadays, environmentally friendly practices as a field of
study must lead to action and change in the corporate attitude towards environmental issues. Hence, environmental efforts towards performing Environmentally Conscious Design and Manufacturing (ECD&M) and introducing EMSs have gained a mass of attention among academics and practitioners. Therefore, the topic of integration of environmental issues into corporate activities and day-to-day operations within manufacturing companies is highly relevant and deserves to be investigated.

1.2 Problem Statement

However, the problem many companies face, nowadays, is the unawareness of the possible benefits that could be resulted from more eco-oriented strategies. As the outcome, most executives and managers do not focus on environmental concerns, and therefore, may neglect this green variable. Moreover, a lack of environmental practices to identify and track the sources of waste can cause a significant problem and mislead the decision making process.

In fact, the problem is likely to be found in underestimating the importance and potential benefits of integrating the environmental factors into product and process design. Likewise, a difficulty lies in changing people’s mindset, as any commitment towards environmental activities implies a change within the company. Therefore, successful orientation towards environmental consideration requires more guidelines and directions within organizational structure of the company.

1.3 Purpose and Research questions

The purpose of the thesis is to analyze why and how companies integrate environmental concerns in their business operations and organizational structure as well as to investigate the critical factors that enable such integration. Hence, the elements of environmentally conscious design and manufacturing (ECD&M) as well as environmental management systems (EMS) are being discussed.

The thesis aims at illustrating the ways of integration of environmental concerns in the product and process design in achieving eco-efficient goals.

For the purpose to be accomplished, it is vital to answer the following questions:

1. What are the driving forces for considering environmental aspects in business activities? This question aims to illustrate the real situation, including the pressures from stakeholders as well as companies’ incentives and attitudes towards environmental issues, so that it will be easier for the reader to understand the nature and purpose of this behavior.

2. By which means can companies integrate environmental concerns in their operational activities and organizational structure? The holistic approach is taken to analyze conscious business practices related to environmentally friendly manufacturing and design as well as corporate activities regarding the introduction of environmental management systems.

3. What are the benefits from implementing the EMS into business practices? Based on the investigation of the case studies, the purpose is to draw on the benefits derived from the EMS application and its impact on the whole business performance.
4. What are the critical factors that enable the integration of environmental concerns within the company? The process of integration of environmental aspects is a task that imposes a change within the company. When conducting a change, the most important to consider is what to change and how to change. The ability of the company to impact the change process will determine and bring about the improvements concerning the environmental aspects. Therefore, the question aims to explain which factors should be taken into consideration when integrating environmental concerns within the company.

To answer these questions the academic literature review as well as empirical study of the practices within the given area will be conducted.

1.4 Perspective

The research on the integration of environmental concerns into business operations and organizational structure is conducted among three Swedish manufacturing firms, namely Volvo Buses, Trelleborg, and Kinnarps. The problem is mainly studied from environmental managers’ perspective. The issues concerning health and safety topics will not be discussed in the thesis, since the research focuses on the business operations and organizational structure of the company.

1.5 Outline

The thesis consists of seven chapters, namely: introduction, literature review, methodology, empirical findings, analysis, conclusion, and recommendations for future research. The short summary of each chapter is represented in the table 1.1.

<table>
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<tr>
<th>The chapter name</th>
<th>Description</th>
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<tbody>
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<td>This chapter aims at presenting the background and problem formulation. Further, the purpose and the research questions are defined and followed by the perspective and outline of the thesis.</td>
</tr>
<tr>
<td>Literature review</td>
<td>This chapter aims at focusing on the theoretical foundation of the concepts related to the stakeholder theory and industrial ecology. The chapter will go through different theories on Environmentally Conscious Manufacturing and Design, as well as Environmental Management System. The tools, namely Life Cycle Assessment and Design For Environment will be also discussed. Critical factors when introducing environmental practices will be touched upon.</td>
</tr>
<tr>
<td>Methodology</td>
<td>This chapter touches upon the research philosophy and research approach, as well as research strategy and method that have been employed for data collection and analysis. Time horizons are described and followed by the validity and reliability of the chosen method.</td>
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<td>Section</td>
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<td>Empirical findings</td>
<td>This chapter aims at presenting the empirical material gathered from interviews at three manufacturing Swedish companies. The general company information, its proactive environmental activities during manufacturing and design of a product, as well as benefits and driving forces towards environmental practices will be presented for each of the companies. The information has been collected through the interviews with environmental managers and responsible personnel, as well as from companies’ websites, annual and environmental reports, and other valuable documentation.</td>
</tr>
<tr>
<td>Analysis</td>
<td>This section intends to analyze the obtained theoretical knowledge and empirical results of the given thesis by using the research methods mentioned in the methodology chapter. The research questions will be answered in order to provide the understanding of the topic as well as completeness of the initially settled goals and purposes.</td>
</tr>
<tr>
<td>Conclusion</td>
<td>This section intends to finalize the theoretical knowledge and obtained empirical results by summarizing the answers of introduced research questions in order to either verify or find differences between the theoretical framework and empirical findings.</td>
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<tr>
<td>Recommendations for future research</td>
<td>This section aims at providing ideas for further investigation in the area of environmental business practices.</td>
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2 Literature review

This chapter aims at focusing on the theoretical foundation of the concepts related to the stakeholder theory and industrial ecology. The chapter will go through different theories on Environmentally Conscious Manufacturing and Design, as well as Environmental Management System. The tools, namely life cycle analysis and design for environment will be also discussed. Critical factors when introducing environmental practices will be touched upon.

This chapter provides a theoretical framework for the empirical part of the thesis. The literature review is divided into seven main parts. The first part provides the explanation of why companies should consider environmental aspects as the first step that should be integrated in a company (Section 2.1). The second and the third parts of literature review discuss different environment approaches as well as the potential benefits that can be derived from the integration of environmental aspects into business operations (Section 2.2 and Section 2.3). The integration of environmental factors in manufacturing industries is discussed in the Section 2.4, and followed by the introduction of Environmentally Conscious Manufacturing and Design (Section 2.5), where both Environmentally Conscious Manufacturing and Environmentally Conscious Design are covered. Such tools as Design for Environment (DFE), Life Cycle Assessment (LCA), and material selection are being discussed in order to provide an understanding of how environmental aspects can be integrated into product development process.

Next part is focused on Environmental Management Systems as a means to assist companies with maintaining regulatory compliance and achieving environmental goals. It summarizes environmental policy, objectives and targets, the process of implementation and continuous improvement in order to give a framework that includes the decisions and actions taken to determine the environmental profile of the company (Section 2.6). The literature review concludes with the essence of cultural and organizational change when introducing activities towards environmental improvements. It explains some critical elements that can enable the implementation of environmental practices (Section 2.7).

2.1 Driving forces for environmental behavior

The green revolution in business started at the end of the last century with the attempt to encourage environmental management to become a universal organizational philosophy where all individuals are involved in greening a company (Sarkis, Gonzalez-Torre, & Adenso-Diaz, 2010). Why do companies ‘go green’? Do they ‘go green’ just because it feels a right thing to do or just because someone or something is putting a pressure on their performance? Are there any potential benefits for the companies when applying green practices? These questions will be thoroughly discussed in the following sections.

Over the last decades, industrial development has brought prosperity and wealth together with triggering unintended ecological degradation. Therefore, a modern society has increasingly demanded companies to take responsibilities for the negative impacts on the environment caused by their business activities. The open sources of mass media, and some publications blamed famous companies, such as Benetton, Disney, Levi Strauss, Nike for inhumane working conditions and contaminations of the environment (Seuring & Muller, 2008). In fact, companies produce externalities that affect both internal and external parties to the firm. These externalities, in turn, often encourage
stakeholders to increase pressures on companies to decrease their negative effects on the environment. In addition, scientific findings about climate change and environmental degradation depict that human impact on the natural environment poses a threat not only on a local or regional level, but also on the global ecosphere. This has increased awareness and concern among stakeholders, customers, governmental and non-governmental organizations concerning environmental issues, and consequently, has placed the pressure on company’s operations.

Stakeholder theory brings to our notice valuable knowledge about ethical aspects, corporate codes and behavior of a company. Moreover, it provides avenues for social corporate responsibility as a scope of activities or policies towards society-related issues, environment, equal employment opportunity, community involvement, product safety, energy usage (Roberts, 1992). Therefore, stakeholder theory is especially suitable in approaching environmental issues. The stakeholder approach focuses on the characteristics and behavior of organizations and provides insights into the integration of environmental issues in business strategy. Ansoff (1965) was among the first who approached ‘the term "stakeholder theory" in defining the objectives of the firm as an ability to balance the conflicting demands of various stakeholders in the firm’ (cited in Roberts, 1992, p.597). The behavior of different stakeholder groups puts a constraint on the corporate strategy and decision-making process. The dynamics of stakeholder pressure on corporate decisions are thoroughly discussed by Freeman (1983). The importance of meeting of stakeholders’ needs when achieving the strategic goals has become a main concern of corporate management. Freeman (1983) concludes that the level of stakeholder power is increasing with the growing importance of meeting stakeholder demands (cited in Roberts, 1992).

Freeman (1984, p.41) describes a stakeholder as ‘‘any group or individuals who can affect or are affected by the company’s activities’’. Freeman’s definition is very broad and inclusive, and therefore, it can be divided into internal and external groups of stakeholders. In fact, managers and employees within the company are referred to the internal stakeholders, whereas, governmental regulatory agencies, environmental pressure groups, local communities, shareholders, suppliers, customers, and general public compose a group of external stakeholders (Schaltegger & Burritt, 2000, p.31). As stated by stakeholder theory, stakeholder pressures induce environmental behavior and performance among various companies. Stakeholder pressure serves as a powerful motivation for the companies to adopt environmental practices (Roberts, 1992).

**Internal stakeholders**

As internal stakeholders, employees with the support from management can often initiate or address proactive environmental activities (ibid.). Both strong leadership and support from top level managers is certainly necessary for comprehension and commitment to environmental issues in the company. In fact, such aspects as: managerial interpretations, managerial attitudes and views, and environmental values of the leaders can put an impact on management decisions concerning environmental activities. Hence, employees as internal stakeholders play an important role in embracing of environmental operational practices (Sarkis et al., 2010).
External stakeholders

As it has been noticed, environmental issues remain a high priority for consumers and/or customers. It is up to them to accept and decide upon the products or services provided by the company. Companies might fear that customers would boycott their products if environmental problems have been reported, this in turn, might lead to the loss in reputation (Seuring & Muller, 2008). Therefore, it is of a great relevance for the companies to address consumers’ and/or customers’ demands and concerns about environment. This is an effective example of how public, consumers and/or customers direct their pressure towards companies. Businesses should address the interests of another group of external (and sometimes internal) stakeholders, those who have financial investments in the companies. These shareholders represent a central group of stakeholders.

‘Environmental awareness and recycling regulations have been putting pressure on many manufacturers and consumers, forcing them to produce and dispose of products in environmentally responsible way’ (Ilgin & Gupta, 2010, p.564). Frosch (1995) discusses the development of the US environmental regulations, which has been introduced in three phases since the Earth Day 1970 (cited in Gungor & Gupta, 1999). The first phase includes the fulfillment of ‘end-of-pipe regulation’ which states restrictions on the types of materials that can be discarded, together with how and where they can be discarded. The Clean Air Act, the Clean Water Act and the Resource Conservation Act have been introduced during this phase. The second phase began with the Pollution Prevention Act of 1990 with a focus on the pollution reduction within the industrial processes. The goal of the final third phase is to insure commitment to ‘clean production’ with coordination of industry and the Environmental Protection Agency (EPA) (ibid. p.817).

As external stakeholders, environmental protection agencies and government take a leading role in the transformation process and incorporating environmental issues into business activities. By establishing the wide range of environmental laws as well as supporting regulations they encourage environmental behavior among companies (for the Swedish environmental laws see Appendix 1). Moreover, there exist an expanding variety of economic instruments, market-based approaches, like price mechanism, that serve as an effective means of addressing environmental issues (Schaltegger & Burritt, 2000). The instruments and different ways through which governmental organizations and other stakeholders influence companies’ performance have been deeply discussed in the literature (Freeman, 1984; Li, 2001; Cespedes-Lorente et al., 2003; Sarkis et al., 2010; Gunningham, et al., 2004; Seuring & Muller, 2008; Roberts, 1992).

Incentive-based instruments for environmental behavior

Although, external stakeholders do not have control over organizational resources, still they are able to mobilize or regulate public opinion in favor of, or in opposition to, the environmental practices within the company (Freeman, 1984). In her paper Li (2001, p.60) states that possible incentive-based instruments for environmental behavior include financial incentives as well as social recognition. The group of financial instruments includes taxes, penalties, fines, subsidies, government procurement and contract policies. These measures taken by the government are perceived to affect a company’s bottom line, and thus, may serve as a trigger for a change. Hence, companies should comply with environmental regulations. In case of not compliance with regulatory
stakeholders, companies are under the risk of individual or class action lawsuits. Such threats and pressures can hurt a reputation and image of the company as well as its relationships with customers (Cespedes-Lorente et al., 2003; Sarkis et al., 2010).

Recognition is another possible incentive for the companies to improve their environmental performance. Through available sources of information - mass media and publicity – the activities, concerns and enactment of the company towards environment and society can be known nation-wide. Therefore, informational tools have strong and influential power concerning company’s environmental performance, which in turn, can increase public concern as well as raise the overall environmental awareness (Li, 2001). Non-governmental organizations and community have a capacity to publish information which could influence consumers to favor the products of competitors that show a stronger concern to the environment. These stakeholders are of a great importance for the company, since they provide a “social license” for companies to operate and may represent a critical factor influencing an organizational decision to adopt various practices (Gunningham, et al., 2004).

Very responsive and receptive approach towards environmental issues has been taken by governments, industries and public. These stakeholders share the same goal of integration of ‘environmentally friendly thinking’ into day-to-day operations (Gungor & Gupta, 1999, p.816). Fig. 2.1 illustrates the interactions among the correspondent parties on the environmental issues.

![Figure 2.1 Interactions between government, users, producers and distributors. (Source: Gungor & Gupta, 1999)](image)

However, it has been recognized in the literature, that companies with proactive environmental practices are more likely to improve both business and financial performance (Klassen & McLaughlin, 1996; Eiadat et al., 2008; Lopez-Gamero et al., 2009). At the same time, the decrease in the liability and risks from proactive environmental practices and campaigns adds shareholder value. Therefore, being influenced by the shareholders, companies may also protect their investments against environmental liabilities and even gain in financial performance (Sarkis et al., 2010).
2.2 Approaches towards Environment

It has been a long discussion among scientists and researchers whether or not environmental practices have a positive effect on financial performance. This debate has been reflected into the notion of different approaches a company undertakes towards environment. The traditional approach proposes that companies withhold barely a compliance attitude towards governmental regulations and consequently it reflects in a negative relationship between environmental and financial performance. According to Porter’s hypothesis (1995) the social wellbeing and organizational competitiveness are strengthened by environmental regulations. However it seems that Porter’s hypothesis can be verified so far under certain conditions such as the existence of more effective and efficient technology (not being yet in use), optimal government regulations and adapted market structure (green market demand) (Porter & van der Linde, 1995). On the contrary, more recent literature affirms that the economic and environmental performance is positively correlated (Porter & van der Linde, 1995; Azzone & Bertele, 1994; Klassen & McLaughlin, 1996; Eiadat et al., 2008; Lopez-Gamero el at., 2009). Therefore, according to prevalent hypothesis, the economic performance improves as the environmental performance is improved.

In the past, businesses perceived environment as a limitation or constraint to their operational activities. Environmental problems progressively emerged in the companies’ agenda as more demanding laws and legislations were passed (Azzone & Bertele, 1994). Consequently, the companies were forced to adjust their processes and products to environmental regulations in order to continue to operate. At that time environmental issues were related to operational strategy and were reflected through reactive approaches. Nowadays, in order to be competitive and take a leading position on the market, which most companies strive for, it is not enough to merely accept a reactive approach to environmental problems. By merely reacting to the changes in standards and complying with regulations, a company may lose a strategic opportunity of differentiating its products (Porter & van der Linde, 1995). The economic impact of the lost opportunity will increase in the future. Therefore, Azzone and Bertele (1994, p.69) state that firms need to shift from a traditional reactive approach towards an anticipatory, proactive attitude in order to take advantage of environmentally-based business opportunities. Within proactive strategy Azzone and Bertele (1994) identify the anticipatory and creative approaches through which companies can implement strategic actions and reduce the risk factor in the decision-making process.

Proactive approach

In order to comply with governmental regulations and at the same time to improve their performance, companies are looking for win–win solutions. According to Porter and van der Linde (1995) this implies a proactive search for innovative solutions. The proactive context is aimed at focusing not only on achieving more demanding legislation, but also supplying the customers with the green products they want. This approach is characterized by the existence of the pressure from green consumerism demanding for environmental change in industrial companies (ibid.). Moreover, the importance of market-driven product innovation demanding to solve environmental problems is crucial. Sometimes, when adopting this approach companies are often motivated towards a creation of an environmental department, where the resources should be devoted to the external functions, like marketing and sales. Azzone and Bertele (1994) state, that this approach is most applicable in detergent industry.
According to the corporate environmental management literature (Annandale et al., 2004; Melnyk et al., 2003; Zhu & Sarkis, 2004), 'the adoption of proactive environmental practices by organizations has the capacity to favor good environmental performance' (cited in Lopez-Gamero et al., 2009, p.3111). Furthermore, a good environmental performance can provide a competitive advantage through low cost and differentiation that in turn improve financial performance (Klassen & McLaughlin, 1996).

**Anticipatory approach**

In the anticipatory approach, public opinion is critical, and the attention to environmental problems can bring opportunity to gain a strategic advantage. A company needs to be able to anticipate the evolution of industry norms and standards in order to be able to create and implement brand new technologies. It should be noticed here that environmental issues are becoming an incentive for technology innovation, especially for process technology, as technology change is meant to respond to demanding industry norms and standards. This implies that companies should not fight or ignore environmental standards and regulations, but rather, businesses should be able to anticipate the changes in the environmental moods of government regulatory authority and stakeholders, and ‘to bring environmental issues to the table much like any other business issue, presented without cynicism or suspicion’ (Eiadat et al., 2008, p.142). When taking anticipative approach, companies should put significant resources into the internal research and analysis of environmental problems. For the better execution, finance and production departments should work with these problems together or, if possible, to create an ‘environmental department’, where environment-based decisions will be taken (Azzone & Bertele, 1994, p.74).

**Creative approach**

The creative context is oriented on the long term survival of the company. It is extremely important here to monitor all technologies that have been brought by the discontinuous change in the industry. This approach entails major financial resources, entire recognition of the whole organization and strong commitment of top management towards the relevance of environmental issues. Azzone and Bertele (1994) conclude that technology is the major source of change in the creative approach, and it is highly required to develop exploratory research projects in promising new technologies. Studies provided by Gilbert and Birnbaum-More (1996) and Song et al., (1999) have shown that early adopters in technological innovations due to the early adoption advantage usually have better market and business performances (cited in Lopez-Gamero et al., 2009, p.3111). They demonstrate that these firms gain advantage by introducing more advanced environmental strategies that built on low emissions, reduced input and waste disposal costs. Decisions about purchasing of a new green technology, the consideration of greener distribution and transportation systems can help firms to gain competitive advantages resulting from cost reductions. Lopez-Gamero et al. (2009, p.3112) provide evidence showing that the higher the firm’s level of innovation in pollution prevention technologies, the larger the cost advantage it will gain from environmental strategies.

Both anticipation of changes in public opinion and industry norms and forecasting of their speed and direction are very uncertain and risky. Therefore, authors argue that policies like: influencing governmental policy, taking advantage of the globalization activities, and developing the exploratory investments in green technology will help compa-
nies to gain a sustainable comparative advantage and facilitate the decision-making process. These policies are seemed to complement each other, rather than be alternatives. Thus, in this context, lobbying government means that a company has innovative green products or processes whose application can be reinforced by more stringent standards. Likewise, globalization can serve as a source of competitive advantage if a company is able first to develop new products or process, and then to supply them to the environment-oriented markets (Azzone & Bertele, 1994).

Although management can take a decision not to choose the environmental approach as a source of competitive advantage, still they cannot avoid and ignore environmental problems or take them purely as operative decisions (Eiadat et al., 2008). In this case, companies can have a risk to be threatened by the incompetence to promptly react to environmental changes. Therefore, even less interested management should constantly monitor environmental trends and changes in order to be ready to proper adjust their strategic orientation. Using benchmarking as a tool to compare the position of the competitors, managers can monitor and identify the most critical environmental issues (ibid.).

### 2.3 Potential benefits from environmental behavior

The increasing interest regarding the linkage between environmental performance and the positively related economic performance, has led to the emergence of socio-economic theory known as eco-efficiency (Birkin & Woodward, 1997). Eco-efficiency is the first step towards sustainable development where social, environmental as well as economic issues are addressed. According to eco-efficiency theory, companies are able to increase productivity and thus reduce costs while simultaneously improving environmental performance (Lehman, 2002). As it has been mentioned, before companies considered environment as a constraint of their operational activities, however, nowadays, it can be perceived as a source of competitive advantage and better performance.

In fact, proactive corporate environmental strategies that go beyond regulatory compliance have a positive effect on firm performance. By being environmentally proactive, companies can both gain and improve their competitive advantage through lowering costs and improving differentiation.

Eiadat et al. (2008) go further in investigating the connection between being green and competitive. By conducting an empirical study the authors argue that environmental innovation strategy fully mediates the relationship between stakeholder pressures, government environmental regulation, and managerial environmental concerns - with firms' business performance. It implies that companies with an environmental innovation strategy, or 'who are under pressure to adopt one, are more likely to exhibit a positive business performance' (2008, p.133). In their paper Lopez-Gamero et al. (2009, p.3113) conclude that when companies strive to improve their environmental performance, they are more likely to enhance competitive edge in terms of reducing costs, gaining a strong reputation among customers and other markets through brand new technology or innovative products. These benefits may, in turn, have positive impacts on the firm’s overall financial performance. Eiadat et al. (2008) also identify that two necessary factors, such as input from the regulatory authority and a manager’s own personal concerns about the natural environment can induce a decision - making process on the adoption of environmental innovation strategies (p.142).
Summary

A prudently chosen and thoroughly implemented environmental strategy has a capacity to create a competitive advantage and facilitate decision-making process. A design and implementation of the green strategy requires a strong commitment of the whole organizational structure, and particularly top management (Eiadat et al., 2008). There is not a single environmental strategy, which should be followed by all companies. Rather, there are some different policies and attitudes which can help companies to address environmental concerns. Moreover, for the chosen strategy to be successful it should be consistent with the characteristics and the context the company operates with.

This section has discussed the external and internal pressure and its impacts on company performance. Besides, potential benefits, innovation strategy, competitive advantage, and business performance have been given much attention. It has been noticed that environmental cooperation with stakeholders has put a radical impact on long-term corporate performance. Such pressures are more likely to serve as an incentive leading the companies to take an action towards environmental protection. Some environmental practices are found to gain a certain social legitimacy, and convey the idea that they have a positive effect on financial performance. Therefore, the ongoing environmental degradation as well as economic and social problems associated with it can be challenged in a better way. By utilizing proactive environmental practices, companies may better address pressure from different stakeholder groups.

2.4 Manufacturing and Environment

In developed countries, manufacturing industry accounts for a great share of the industrial sector. Manufacturing industry denotes those industries which are involved in the manufacturing and processing of items, which in turn leads to either creation of new commodities or added value (Young, Byrne, & Cotterell, 1997). The final products can either be referred to as intermediate goods used in the production process or finished goods for sale to customers. Manufacturing companies tend to satisfy their customer’s needs by providing a physical product and/or a service performed by the physical product. These processes cannot but affect society and the environment. Traditionally, manufacturing has paid significant attention to the transformation of resources into goods with respect to its effect on organizational profit, however the harmful effects on the environment was left behind the scope of consideration (ibid.).

In the 18th-19th century the Industrial Revolution transformed society and its interaction with the environment, namely the exploitation of natural resources was significantly increased as well as the pace of development of new processes and products. This in turn, has brought enduring ‘changes in the structure of society and also on the earth through depletion of resources, alteration of natural habitats and pollution from unwanted byproducts of the production process and discarded products at the end of their useful life’ (Young et al., 1997, p.487).

In spite of the key role of manufacturer in achieving enhanced environmental goals and objectives, very little attention has been paid to the impact of manufacturer’s practices and activities (Lin et al., 2001). The basis for the latter argument is that the decisions made by the different actors, in particular manufacturers in the production chain deter-
mine to a great extent the environmental impacts of a product (Berkel, van Kampen, & Kortman, 1999).

Waste is generated at all stages of production, product use, and disposal (DeMendonça & Baxter, 2001). Manufactures’ choices with regards to the raw materials, production methods, and the like, will be responsible for the products’ environmental impact and waste generation through all its life cycle at the different production stages (Berkel et al., 1999). Clearly, the actions and practices executed at the stage of product design create at later stages in the transformation systems waste streams (Sroufe, 2003). Therefore, developing and implementing environmental manufacturing processes seems to be critical for minimizing or ideally completely eliminating waste, reducing energy consumption, improving operations’ safety as well as materials utilization (Lin et al., 2001).

The evaluation of the interaction between industry and environment is often called Industrial Ecology, which provides a framework in order to understand the impacts of industrial systems on the environment. Within this framework, the attempt has been made to define and then implement strategies so that to decrease the environmental impacts of products and processes related to industrial systems (Graedel, 1994). Graedel (1994) defines Industrial Ecology as follows:

‘Industrial Ecology is the means by which humanity can deliberately and rationally approach and maintain a desirable carrying capacity, given continued economic, cultural, and technological evolution. The concept requires that an industrial system be viewed not in isolation from its surrounding systems, but in concert with them’.

Moreover, industrial ecology intends to optimize the total industrial cycle from virgin material to finished material, to component, to product, and to ultimate disposal (ibid.). The industrial ecology and, consequently, environmental concerns have led the manufacturing industry to take a proactive role in the development of cleaner manufacturing processes and the design of recyclable products. As a result, organizations have been starting to adopt proactive approaches of environmentally-conscious design and manufacturing (ECD&M) as well as environmental management systems (EMS) which lead to better environmental and business performances. An increasing number of companies recognize that adopting the ECD&M and EMS is an essential part of the business strategy (Hui, Chan, & Pun, 2000), where ECD&M aims at ‘minimizing the product’s environmental impacts during its design and manufacturing’ (Zhang, Kuo, & Lu, 1997, p.353), and EMS can provide ‘an effective guidance for companies to concurrently establish, develop and review their business practices towards corporate and environmental goals’ (Hui et al., 2000, p.269). The concepts of ECD&M as well as EMS are being discussed in the next sections.

### 2.5 Environmentally Conscious Design and Manufacturing (ECD&M)

At any point of their lifecycles, products can negatively affect the environment in forms of potential toxic or hazardous materials, waste streams and emissions. Therefore, to effectively protect the environment, pollution prevention controls should be incorporated into each and every aspect of manufacturing process (Zhang et al., 1997). Contrary to
the traditional ‘end-of-pipe’ treatment for pollution control, ECD&M is a proactive approach to reduce the product’s environmental impact during its design and manufacturing, and consequently to increase the product competitiveness in the environmentally conscious markets (ibid.).

According to Coulter, Bras and Foley (1995), ECD&M employs two basic approaches (ibid.). The first, zero-wasted life cycle approach assumes that the environmental impact of a product during its life cycle can be decreased to zero, meaning the product can be designed, manufactured, used and disposed with a minimum impact on the environment and with a minimal use of resources, materials and energy. The second approach, incremental waste control life cycle, is based on the notion that there is a certain amount of the negative impact from process cycle. This impact can be reduced by using a ‘cleaner technology’, a source reduction or recycling methods applied to eliminate or reduce hazardous waste generation (Coulter, Bras & Foley, 1995, cited in Zhang et al., 1997, p.353).

According to Zhang et al. (1997), the research in ECD&M can be divided into two areas, namely: environmentally-conscious product design (ECD) and environmentally-conscious process design (also called environmentally conscious manufacturing, ECM). Both ECM and ECD are being discussed further.

2.5.1 Environmentally conscious manufacturing (ECM)

Environmentally conscious manufacturing (ECM) is a process of manufacturing the products where, the overall negative environmental impacts from this production process are minimized (Gungor & Gupta, 1999). The main principle of the ECM is to implement such processes that reduce any harmful environmental impacts of manufacturing, namely: improvements of material utilization, reduction of hazardous waste and emissions, efficient energy consumption (Zhang et al., 1997).

The activities of ECM to a large extent underline the importance of extracting the useful product from raw materials, avoiding waste generation at the source, or using waste to create new products. Moreover, ECM includes replacing existing processes and developing new, waste-free processes, refining operating procedures, redesigning products in innovative ways and increasing recycling activities (ibid.).

In addition to ECM, the issues related to the waste management and pollution prevention have gained significant attention in the literature. According to Wise and Trantolo (1994), waste management aims at reducing the waste generated at the source by applying proper materials, methods and equipment; reusing and recycling the waste; finding innovative solutions for waste treatment (cited in Gungor & Gupta, 1999, p.836).

The term ‘pollution prevention’ was coined in 1976 by the 3M Co, and also referred to as ‘source reduction’ activity (Zhang et al., 1997). The highest preference for the pollution prevention is to reduce waste at the source of generation by using less toxic raw materials, innovative equipment, better bookkeeping and material management. The second preference is to reuse and recycle the waste which cannot be reduced at the source. The next preference is about waste treatment, and final the least preferred alternative is disposal (ibid.).

Two basic techniques have been identified for pollution prevention, such as waste minimization and clean technology (ibid.). Waste minimization embraces source reduction
and environmentally conscious recycling, where source reduction includes any practices or activities for decreasing the amount of any hazardous substance, pollutant or contaminant. According to Shen (1995) there exist two methods of source reduction, such as product changes and process changes shown in the Figure 2.2 (cited in Zhang et al., 1997, p.360).

![Figure 2.2 Source Reduction Methods. (Source: Shen, 1995; cited in Zhang et al. 1997)](image)

As it has been mentioned before, clean technology is a technique for pollution prevention, as it tends to use less raw materials, water, and energy; generate less or no waste; and recycle waste as useful materials in a closed system (ibid.).

### 2.5.2 Environmentally conscious product design (ECD)

The pressure on the industrial companies to take a broader environmental responsibility for their business activities is perceived as a great range of opportunity to achieve competitive advantage. In the world, where environmental performance has been acknowledged as something most companies strive for, there is an underlying demand for environmentally conscious manufacturing and products which are more resource efficient and less polluting. According to Ottman and Terry (1998), companies are capable to gain product differentiation and first mover advantage, define standards, and improve their corporate image and reputation by developing products with superior environmental performance.

In order to effectively develop a product, much attention should be given to the decisions in early phases of product development process. Early product development phases are characterized by semi-defined product concepts and ideas. Moreover, vital features are not always known and various alternatives therefore need to be evaluated. Hence, lack of information, creative thinking and high level ambiguity are factors that can describe early design phases. Thus, it is of a great importance for designers to get to
know as much about the evolving product as possible at the early stage in the design process (Ritzen, 2000).

In order to achieve improvements in the design, traditional product development is focused on the cost, functionality and manufacturability of the product. On the other side, with respect to the increasing awareness and importance of the environmental issues, certain environmental criterion is forced to be addressed when designing a product. Therefore, a number of methodologies have been developed in order to help product designers make environmentally friendly design choices (Ilgin & Gupta, 2010). The overview of the existing methodologies, such as Design for Environment (DFE), Life Cycle Assessment (LCA) and material selection are being discussed further.

2.5.2.1 Design for Environment (DFE)

Environmental impacts caused by the product can be reduced or prevented by addressing environmental issues in product development and consequently guiding design and engineering efforts towards environmental protection. In order to characterize these efforts, such novel concepts as eco-design, life-cycle design and design for environment have been suggested in the literature. Although there are some differences in definitions, these concepts are normally treated as synonyms as they have similar goals (see Appendix 2 for definitions).

As it is seen from the various definitions (Appendix 2), DFE may represent itself as a strategy, a process, an activity, a way of thinking, and/or a basis for decisions. As a research area, eco-design highlights the problem of integrating environmental concerns in product development activities. The reason is that environmental impacts caused by products have to be decreased, for the purpose of creating a sustainable development and society as a whole. Therefore, according to Porter and van der Linde (1995), the increasing demand for resource efficient and less polluting products and environmental considerations in product development has a capacity to increase the attractiveness of products and provide business opportunities for companies. This notion in turn, makes the DFE concept very practical, technical and normative in its orientation (Magnusson, 2000).

According to Fiskel (2009), DFE can be broken down into several stages, namely: manufacturing, consumer use and end-of-life of the product, where different forms of design strategies can be applied. For instance, at the manufacturing stage, in order to minimize the effect on the environment, design objectives may consider the design for energy conservation to decrease the energy use in production. Likewise, the design for minimizing the discharge of the hazardous byproduct can be applied during production. As for the end-of-life stage of the product, design for product recovery (remanufacturing) and material recovery (recycling) may be applied. Product recovery encompasses disassembly, cleaning, sorting, reconditioning, testing, replacing and repairing bad parts. The recovered parts or products can be consequently used in remanufacturing, repair of other products and components and can be further sold to an outsider. The main goal in material recovery is to reduce the amount of disposal and to increase the amount of material returned back to the production cycle. The main reasons for carrying out the recovery process are based on the hidden economic value of solid waste; market requirements; and governmental regulations (Gungor & Gupta, 1999).
In industries the various practices of the DFE embraces: material substitution, substance use reduction, waste resource reduction, life extension, energy use reduction, design for energy recovery, design for remanufacturing and etc. The overview of the DFE practices is presented in the Appendix 3.

The difficulty accompanied DFE is defining the right aspect to consider, meaning that each company with its specific characteristics and products has different aspects to consider in the development process. Therefore, the main goal of DFE is to develop sustainable products which allocate as few resources as possible without compromising other criteria such as: quality, functionality, cost and appearance. According to Luttropp and Lagerstedt (1999), the needs and benefits of the customer as well as technological possibilities and constraints should be also taken into consideration when designing products. In general, the more aspects considered when designing products, the stronger and more attractive the product will be. The factors to be accounted for are represented in the pie chart (see Appendix 4), where every piece represents an important design task (Luttropp & Lagerstedt, 1999).

The problem associated with DFE research is that it often addresses the environmental impacts exclusively, whereas other aspects of product development are either omitted or briefly discussed. The problem of defining environmental performance takes a central position in DFE research.

As it has been discussed by Magnusson (2000), the development of the concept of eco-design has been followed by the introduction of a large number of tools to assist and guide practitioners. According to the purpose, the tools can be divided into two groups, analysis tools and improvement tools. By means of analysis tools, it is possible to recognize main characteristics of environmental impacts of products, and furthermore to compare and assess various design options. Though improvement tools are used to facilitate the generation of improvements options, for instance generic design strategies, guidelines, checklists, design principals and design environmental criteria can be described as improvement tools. Examples of analysis tools are methods to analyze recyclability of the product (Design for Recycling, DFR), as well as methods to evaluate the environmental impacts of products (Life Cycle Assessment, LCA). A particular attention has been devoted to the practice of LCA in DFE research, which is discussed below.

2.5.2.2 Life Cycle Assessment (LCA)

For the creation of an environmentally friendly product, it is required to assess its potential environmental impacts during the development process. In the early stages of product development, the potential for an environmental optimization is high. However, it is important to ascertain that the environmental assessment of the product has to face several problems:

a) in the early design stages the information regarding the product is rarely available;

b) expert knowledge is needed to assess the environmental friendliness of a product;

c) the chosen tools and techniques have to be feasible and efficient (Abele, Anderl & Birkhofer, 2005, p.149).
A common technique for assessing the environmental aspects of a product is life cycle assessment (LCA), which is also known as cradle-to-grave assessment and eco-balancing (ibid.). What makes LCA unique is that all life cycle phases of the analyzed object are taken into account, from raw material extraction, production, product use, waste management, transportation, to the product’s end-of-life. During the life-cycle of a product there is an environmental impact from each activity requiring material or energy consumption as well as an emission to air, water or land. Olesen et al. (1996) define the effects of such emissions or consumption as transformations, which in turn have a complex connection to impacts on the nature; see Figure 2.3 (cited in Ritzen, 2000).

Figure 2.3 An illustration of the complex relationship between a product life-course and consequences for the eco-system (Olesen et al., 1996, Source: Ritzen, 2000).

LCA is used to create a holistic view of the total environmental performance throughout the life cycle of the product. During the life-cycle, each process or material is being considered from an environmental point of view so that the product can be improved. When companies strive for sustainable development, environmental impacts of transformations play a great role (ibid.). It has been found in the literature that LCA is a useful tool. First, it facilitates the selection of materials and processes by comparing the environmental impacts, and second, it offers a comprehensive view and a better understanding of the linkage between product features and environmental impacts (Ritzén, Hakelius & Norell, 1996).

The purpose of this evaluation process is to create an environmental baseline for current products and gather the information necessary to influence future product designs (Donnelly, Beckett-Furnell, Traeger, Osrasinski, & Holman, 2006). In addition, LCA as a tool is used to recognize environmental aspects:

a) at the product assembly level, by identifying target areas for environmental improvements for new products, such as recyclability or material reduction;

b) at the component level, by assisting in selection of materials;
c) as a benchmarking tool, by demonstrating the ‘green’ evolution of products (ibid.).

By means of LCA, it becomes possible to examine and estimate the energy and material flow of a product throughout its life cycle. In order to conduct LCA, the following steps should be followed:

a) goal setting (purpose and scope of the LCA is defined, functional units are ascertained and data quality assessments are performed);

b) inventory analysis (system boundaries are set, process flow charts are drawn, data is collected, calculation and sensitivity analysis is completed);

c) impact assessment (classification, characterization and valuation is achieved);

d) improvement analysis (Nissen, 1995).

The whole assessment process is based on the outcomes determined during the goal setting, where a qualitative description of the issue and the purpose is defined. During the scoping, the allocation procedures, environmental categories, critical assumptions and limitations, data quality requirements are taken into consideration. A significant attention is given to the system boundaries and a functional unit (FU) which is defined in this stage. The FU aims at making comparisons between different products that perform similar or the same functions. For some products it is relatively easy to ascertain a correspondent FU (e.g. liter refrigerated volume for refrigerators), whereas, for other products it can be very difficult (a personal computer). A FU is supposed to be derived from the main function of the product (Zackrisson, 2009).

During the life cycle inventory process, the quantities of energy and material flows within the system boundaries are identified and the overview of the impact on the environment is consequently created. LCA is also referred to as impact analysis, where the systematic estimation of the inventory is undertaken and transferred into figures, diagrams or indices, reflecting the effects of the environmental impacts identified in the inventory (Nissen, 1995).

Life cycle environmental impact assessment provides an opportunity to identify environmental improvements by combining the list of inputs and outputs. This stage includes the selection of the environmental impact categories with allocation of abundant resources and emissions to the chosen categories. This enables the calculation of the category indicators results. This stage of classification and characterization is typically performed by means of dedicated computer software (SimaPro or Gabi). Thus, the LCA software facilitates the process of drawing diagrams and charts, together with documenting all data concerning the estimations and sensitivity analysis. During the life cycle interpretation, the estimation of the suitability of the system boundaries, FU as well as data requirements with respect to calculated results is drawn. As a result, this stage allows to make conclusions, suggestions, and detects some constraints. Life cycle interpretation results, consecutively, should be evaluated for instance by means of uncertainty analysis, sensitivity analysis, variation analysis and data quality assessment (Zackrisson, 2009).
Problems associated with LCA

Although there are numerous examples of carrying out the LCA, still the steps in its application such as: impact and improvement assessments are causing problems. Since the diversity of environmental impacts is very high, it becomes difficult to assess and especially to compare the environmental impacts of products. Moreover, other problems have arisen. In order to develop an LCA, very extensive examination, data collection and calculations are required, which in turn, results in a high cost. Besides the fact that the results are very voluminous and hard to understand, some of the data required are either insufficient or unavailable (Nissen, 1995). According to Ritzén et al. (1996), the criticism is not focused on the LCA method itself, but on a strong belief that the execution of LCA might be a quick and easy way of solving the complex problems when integrating environmental aspects into product development.

In order to perform LCA, a significant amount of information with respect to the product is of a high need. Therefore, it is possible to conclude, that performing LCA at the beginning of the design process makes little sense, as very little information is available. At the end of the process, when the relevant data is available, it still makes little sense, since everything is already completed and hardly can be changed. Hence, LCA is not applicable at the early stages of design, since it requires a lot of data about the product before it is designed, furthermore, when the details are completed, it is already too late to do any significant changes (Ritzén, et al. 1996). However, LCA is a suitable tool when re-designing products.

According to Brezet and Hemel (1997), further development of given method strives for more reflective usage as well as a more balanced picture, since it does for the area as a whole. Although LCA is the most reliable method for outlining the environmental performance of products, still the implementation and the use of the method in product development is disadvantaged by its complexity, comprehensive scope and time-intensive application (ibid.).

2.5.2.3 Material selection

Generally, by developing the work procedures in manufacturing and product development, the companies aim at improving efficiency, meaning to decrease lead-time and cost as well as increase the quality and competitiveness of the product. In the literature ‘efficiency’ has been defined as ‘doing things right’, (Hill, 1995), whereas ‘effectiveness’ is referred to as ‘doing the right things’. Yet, developing of work procedures for manufacturing and product development embraces ‘doing the right things’ in terms of investigating the business area, market, legislation and so on. Therefore, Norell (1992) indicates that the success of manufacturing and product development is followed by the notion of ‘doing things right from the beginning’ and ‘finding ways to improve efficiency in each stage of the product development process’ (cited in Ritzen, 2000). Hence, the importance of the integration of environmental aspects at the early phases, such as material selection has been emphasized.

Material selection is traditionally based on the cost and mechanical factors, including weight, processability and etc. However, in recent years, environmental factors have been also considered in the material selection (Ilgin & Gupta, 2010). When designing an environmentally friendly product, according to Gungor & Gupta (1999), material selec-
tion also should be considered. Conscious material selection can assist in reducing the negative impact from manufacturing by eliminating or reducing the use of hazardous substances. Moreover, material selection in design process for chemical separation can facilitate the recycling process. According to Zhang et al. (1999), good material and manufacturing process selection can lead not only to the reduction of the environmental impact, but also to the improvement of technical efficiency and productivity.

Numerous techniques and methods for effective and environmentally conscious material selection have been cited by Ilgin and Gupta (2010), among those are: material selection charts (Holloway, 1998); green material cost analysis to acclaim materials with less polluting effect (Tseng et al., 2008); mathematical models for recycling-based evaluation of material content of the product (Knight & Soghi et al., 1999) and others (p.566).

Summary
The integration of environmental factors in manufacturing industry has been discussed, by introducing the Industrial Revolution and Industrial Ecology. Furthermore, the proactive approach to reduce the product’s environmental impact during its design and manufacturing, such as ECD&M (Environmentally Conscious Design and Manufacturing) has been identified. ECD&M employs two basis approaches: zero-wasted life cycle approach and incremental waste control life cycle, which is based on the notion that there is a certain amount of the negative impact from process cycle. This impact can be reduced by using a ‘cleaner technology’, a source reduction or recycling method applied to eliminate or reduce hazardous waste generation. The separate description of involved ECM (Environmentally Conscious Manufacturing) and ECD (Environmentally Conscious Design) has been provided.

The process of ECM includes efficient material utilization, hazardous waste reduction, emission reduction, and efficient energy consumption. Within the framework of ECM, the notions of cleaner technologies, pollution prevention and waste management have been acknowledged. ECD aims at designing products with certain environmental considerations. The overview of the existing methodologies within the ECD, such as Design for Environment (DFE), Life Cycle Assessment (LCA) and material selection have been emphasized. DFE aims at designing a product so that the potential environmental impact throughout its life cycle is minimized. Various practices of the DFE embraces: material substitution, substance use reduction, waste resource reduction, life extension, energy use reduction, design for energy recovery, design for remanufacturing and etc. (Fiksel, 2009). A common technique for assessing the environmental aspects of a product is LCA. What makes LCA unique is that all life cycle phases of the analyzed object are taken into account, from raw material extraction, production, product use, waste management, transportation, to the product’s end-of-life. During the life-cycle of a product there is an environmental impact from each activity requiring material or energy consumption as well as an emission to air, water or land (Ritzen, 2000).

When designing an environmentally friendly product, material selection also should be considered. Conscious material selection can assist in reducing the negative impact from manufacturing by eliminating or reducing the use of hazardous substances (Gungor & Gupta, 1999).
2.6 Environmental Management System (EMS)

During recent years, novel concepts as environmental management systems, design for environment, environmental performance, pollution prevention and life cycle assessment have gained a lot of attention in both academic literature and business world. For the purpose to meet the environmental demands and legislation requirements that were introduced during the late 1970s and 1980s, the systems for directing environmental management were needed. Managers and companies try to address the concerns about ecological compliance by implementing environmental management system (EMS) as a value-added activity (Magnusson, 2000). Therefore, EMS can be considered as a management tool used by a company in order to direct and control its environmental efforts. Although the implementation of EMSs is voluntary procedure, still in some cases pressure from various stakeholders (customers’ demand) can to some extent force companies to adopt an EMS (Ammenberg, 2003).

An EMS consists of a formalized system and database containing the company’s environmental information related to the procedures and processes. This data can then be found in the form of reports for the needs of both internal and external stakeholders of the company (Melnyk, Sroufe, & Calantone, 2003). In spite of the little empirical research on how EMSs are linked to environmental practices and performance, according to Sroufe (2003) several value adding capabilities can be derived from implementing and running an EMS.

The author explains that pollution prevention programs can reduce (1) regulations fines and penalties and (2) the energy and material costs (ibid.). At the most fundamental level an EMS facilitates the compliance between management practices and governmental regulations. Moreover, EMS is used not only to assist companies in maintaining regulatory compliance but also in achieving waste reduction goals beyond regulatory requirements (Darnall & Edwards, 2006).

Compliance basically implies achieving and maintaining the minimal legal and regulatory requirements for tolerable pollution levels in order to avoid governmental sanctions. For example failure to comply could result in increased costs due to fines and penalties as well as costs for the additional resources allocated in day-to-day operations, and in the worst scenario, loosing customers’ orders. On the other hand, waste reduction initiatives go beyond regulatory compliance and focus on the reduction of environmental impacts of company’s activities (Melnyk et al., 2003). The underlying assumption in both cases is that better environmental management can lead to improved regulatory compliance as well as operational and environmental performance which ultimately can improve the company’s bottom line.

By assisting companies in the tracking and tracing of their internal operations, EMS facilitates cross-functional integration of resources and information (Sroufe, 2003). Indeed, the information in the EMS can be used to enhance decision making and help avoiding the risk of a sub-optimized allocation of resources. However, these elements do not only assist in increasing the internal operations performance, but also in enhancing employees’ knowledge, collaboration and commitment towards environmental issues. The strategic literature considers employees’ competence and knowledge as critical factors for success. According to the ‘resource-based view’, sustainable competitive advantage can be achieved and maintained if the company possesses unique resources i.e.
resources that are rare and valuable and that cannot be easily duplicated by competitors (Barney, Wright, & Ketchen, 2001).

In addition to the two main purposes of EMS, namely regulatory compliance and waste reduction, Sroufe (2003) posits that the increasing use and availability of EMSs standards such as: BS 7750 in the UK, the NSF International’s 110 EMS standard, the American National Standards Institute and American Society for Quality Control (ANSI/ASQC) E4 standard in the USA, EMAS in Europe, the international ISO standards etc. can motivate companies towards the certification of their EMS. It is widely acknowledged that the international standards increase investor confidence and can provide international competitive advantage. ISO certification has a global reputation for encouraging environmentally conscious trade (Rondinelli, 2002; Sroufe, 2003) which satisfies the expectations of those internal and external corporate stakeholders that put a premium on environmental and social issues. Therefore the EMS certification has a capacity to cope with different pressure groups, satisfy constantly changing customer demands on a national and international basis as well as make sure that suppliers are operating in a responsible manner and supporting the company’s environmental and social efforts. In short, the EMS has being certified and can secure the entry into markets that have environmental restrictions (ibid).

2.6.1 EMS model

An EMS follows a Plan-Do-Check-Act cycle based on Deming’s continuous improvement model (1986). The PDCA cycle consists of the following steps (Kitazawa & Sarkis, 2000):

- plan a change aimed at improvement (plan);
- implement the change (do);
- evaluate the results (check);
- institutionalize the change (act).

Thus, EMS implementation process includes planning and developing an environmental policy as well as environmental targets and objectives, checking the system, acting on it, systematically auditing and reviewing the EMS’s processes by top management in order to secure continuous improvement in the company (Darnall & Edwards, 2006).

The implementation of an EMS system is customized for the organization that adopts it, however when developing the EMS system some basic generic steps can be observed in the strategic literature. The first step consists of the establishment of a well-defined and open environmental philosophy which makes reference to matters such as the company’s commitments for continuous environmental improvement and pollution prevention efforts. After this step, the company establishes its environmental objectives and targets including its environmental management priorities and structure, and actions necessary to achieve its environmental goals. Since an important component of EMS is continuous improvement, in the third step the company monitors and records the day-to-day operations and related inconsistencies within the system. Finally, the company’s management assesses internal audits, reports, documented actions as well as any new environmental concerns and recommendations in order to adjust the system and secure its continuous improvement (Kitazawa & Sarkis 2000).
In spite of the relatively clear implementation pattern, it has been shown that in practice the EMSs implementation outcomes in terms of environmental impact, still greatly vary from one company to another. In order to reduce this difference and to offer better guidance during the EMS adoption process, ISO created its international EMS standard, ISO 14001 (Darnall & Edwards, 2006).

### 2.6.2 The international standard ISO 14001

As firms started to integrate their environmental management practices into more comprehensive systems, the business community, governments and international organizations saw the advantages of setting standards that corporations could use as guidelines (Morrow & Rondinelli, 2002).

In 1996, the International Organization for Standardization (ISO) designed its Environmental Management Systems (EMS) standard; ISO 14001 (Darnall & Edwards, 2006). The purpose of ISO 14001 is to offer companies’ management a “blueprint” for effectively developing and implementing their EMS. ISO 14001 examines the environmental related elements of a facility, a single plant or a whole organization; such as the allocation of resources, the alignment of roles and responsibilities, and the systemic evaluation of practices, procedures and processes; in order to give consistency, coherence and proactivity to the environmental activities and practices of a company (Lin et al., 2001). Thus, ISO 14001 establishes and also strengthens a company’s EMS (Morrow & Rondinelli, 2002).

In order to evaluate the companies’ compliance with ISO 14001, the standard requires external third party or registrar verification (Darnall & Edwards, 2006). Hence, when a company desires to establish and maintain an EMS under ISO 14001, it must address every requirement covered in Section 4 within the standard. It can be pointed out that these requirements are also based on the PDCA cycle (Kitazawa & Sarkis 2000). The five principle components clearly stated in section 4 of the ISO 14001 document are as follows:

Section 4.1 and 4.2 Environmental policy: defining an environmental policy and ensuring commitment to it.

Section 4.3 Planning: includes five steps: identifying environmental aspects, determining environmental impacts, gathering legal and other requirements, establishing objectives and targets, and establishing an EMS.

Section 4.4 Implementation and operation: accumulating the necessary resources to achieve the goals and targets of the organization.

Section 4.5 Checking and corrective action: checking and monitoring to discover problems in the EMS and correct them.

Section 4.6 Management review: ensuring that EMS is reviewed by top management (ibid.).

The focus of ISO 14001 is on the processes involved in the creation, management, and elimination of pollution rather than on the outcomes of processes (Melnyk et al., 2003; Lin et al., 2001). In other words, this standard is designed to improve the environmental management structure of a company instead of bringing up changes in the environmental performance by settling a particular output level for the company. Therefore, ISO
helps the company to focus on each of its process, by doing so it enables to develop better environmental management practices which ultimately result in an improvement of its environmental performance.

ISO 14001 encompasses the following general areas (Melnyk et al., 2003):

1. ISO 14001 for the organization: standards for EMS, environmental performance evaluation and environmental auditing;

2. ISO 14001 for product and process: LCA, environmental labeling, and environmental factors in product standards.

This section has discussed the issues related to the ISO 14001 standard as well as potential benefits it can bring to the company. The next section intends to analyze operational framework of EMS together the relationship between corporate strategy, environmental management, and firm performance.

2.6.3 EMS operational framework

Environmental management embraces all actions aimed at minimizing the environmental impact of a company’s processes and products. On the other hand, environmental performance measures the progress in terms of reducing and minimizing its environmental impact (Klassen & McLaughlin, 1996). Thus, EMS is crucial for supporting the environmental efforts of a company and helping to improve both operational and environmental performances. Companies can use their EMS to compare their environmental performance relative to the established environmental objectives and further seek improvements where and when it is appropriate (Melnyk et al., 2003).

There exist, however, major barriers to the adoption of the environmental practices by manufacturing companies, among them are: the lack of a verified positive correlation between pollution reduction efforts and profitability. Until recent years, it was considered that environmental efforts were contrary to the theory of the firm and that environmental performance would increase lead times, reduce quality or increase costs thus reducing the company’s profit and decreasing shareholder’s return (Klassen & McLaughling, 1996). Indeed, environmental management was deemed as a requirement for regulatory compliance involving trade-offs between environmental and economic performance. However, Michael Porter and van der Linde challenged those ideas by stating that waste was the sign of inefficient operations related to the products and production processes of the firm (1995). Other authors also link superior performance to environmental practices, by stating that waste elimination leads to lower manufacturing cost and thus, increased revenues (Melnyk et al., 2003; Darnall & Edwards, 2006; Morrow & Rondinelli, 2002).

The implementation of a formal EMS can be time consuming task and potentially expensive to undertake (Melnyk et al., 2003), nevertheless there are potential financial, operational, internal as well as external benefits that can result from its implementation (Klassen & McLaughing, 1996). By forcing people to get involved and knowledgeable about the various processes of ISO 14001 helps the company gain real and long term improvements not only in the decreased amount of pollution that it generates but also in an increased level of its operational performance (Melnyk et al., 2003).
cable benefits perceived by companies studied by Morrow and Rondinelli (2002) are better organization and documentation of their environmental activities, increased legal certainty, improved image and greater employee motivation.

The strategy literature indicates that business should consider the environmental impact of manufacturing processes and products, governmental regulations, and the different pressure groups and various options for its environmental management strategy (Klassen & McLaughling, 1996). The strategy of the company sets forward its environmental orientation (Figure 2.4).

![Diagram of the linkage between corporate strategy, environmental management, and firm performance.](image)

The linkage between environmental and economic performance is found on operations strategy literature. Operations strategy is defined as the pattern of structural (plant and equipment) and infrastructural choices (production planning, performance measurement, and product design) that supports the company’s targets and objectives (Klassen & McLaughling, 1996). In this context the systematic and long term goals of environmental management affect both the structural and infrastructural patterns of a company as it creates a link between the different management systems throughout the whole value chain (product design, the entire manufacturing process, marketing, product delivery and use, customer service, and post-consumer product disposition) with its environmental requirements for the company’s products and process technology. Since the decisions and actions of environmental management will have an impact on the company’s operations, it is essential to consider environmental management as a key functional element of a company’s strategy (ibid.).

According to Klassen and McLaughling (1996), the environmental performance has an impact upon the economic performance through:

(1) market revenue: environmental responsible businesses satisfy the expectations of customers that show preferences for environmentally oriented companies; in addition to this, environmental certifications offer competitive advantage by differentiating the company from the rest of its competitors, which may be necessary to preserve some markets in the longer term;

(2) cost pathways: environmental management systems can help to avoid the risks of environmental spills, accidents and the related liabilities; wastes minimization is performed through enhanced processes which reduces costs.
For Kitazawa and Sarkis (2000), operational activities for waste minimization encompass all the efforts aimed at identifying waste streams. Waste minimization refers (1) to the maintaining a waste minimization level for the activities that have been successfully achieved (2) making improvement by further reducing waste for an operation where source reduction activities have being implemented and (3) identifying operations where waste minimization has not yet been applied. The authors categorize operational activities for waste minimization into five groups (ibid):

1. input change;
2. operational improvement;
3. process change;
4. product reformulation;
5. and inventory control.

This section of the study has analyzed conscious business practices related to environmental impacts generated by the flows of materials and energy into products and product development. The related strategic and critical decision issues including the integration of topics as LCA, DFE, and ISO 14001 will be discussed further. Moreover, the focus will be on how EMS and ISO 14001 assist manufactures in achieving responsible decision making and supporting continuous improvement efforts.

### 2.6.4 Integration of DFE, LCA and ISO 14001

There is evidence that EMS can further contribute to the adoption of more sophisticated environmental strategies that are based on pollution prevention principles. For example, some companies might implement LCA and assess the environmental impacts of their business activities at each step of their value chain - from raw material extraction to disposal and eventually take back phase of products. These advanced environmental strategies assist in the redesign of more efficient processes and contribute to the development of new products with lower life cycle impacts and costs by eliminating hazardous production processes, materials and substances. In order to achieve this advanced strategy goals, the integration of internal and external stakeholders into product development processes, is critical (Melnyk et al., 2003).

Companies having implemented EMS are paying much attention to product development as they realize the importance of integrating environmental aspects in the early stages of the manufacturing process (Berkel et al., 1999; Ammenberg & Sundin, 2003). The possibilities to make changes in product design at the early design phase decrease with time i.e. cost for changes in product increases as they are carried out in later phases of the transformation system (Ammenberg & Sundin, 2003).

The first ISO 14001 philosophies are related to companies’ environmental policy. It is acknowledged that to a certain degree, an environmental policy translates the environmental goals and objectives and by doing so it encourages internal process efficiency through established procedures for waste minimization. The standard for certification has an impact on three major areas of a company (Lin et al., 2001):

1. management systems and systems development as well as the integration of environmental responsibilities into business planning;
2. operations and consumption of natural resources and energy;
3. environmental systems and measures, assessing and managing emissions, effluents, and other waste streams.

However, it should be noticed, that products and product development issues are still not within the main focus of ISO 14001 (Ammenberg & Sundin 2003).

DFE focuses on the minimization of manufacturing environmental impacts by introducing modifications early in the product design process (DeMendonça & Baxter, 2001). DFE initiatives involve life cycle thinking and continuous improvement objectives for corporate strategies and practices (Ammenberg & Sundin, 2003). The realization of environmental improvement for a product within the DFE framework is dependent upon two main factors:

1. the nature and availability of environmental information and how effectively this information is used; therefore LCA is a key tool for enabling the identification and evaluation of the different alternatives for environmental improvement available to the company; and

2. the power position of the company in its product chain which determines whether a company can achieve environmental improvements by itself or needs to influence other actors in the production chain to do so (Berkel et al., 1999).

In addition to this, it should be noted that the information gathering process takes time and effort, especially when other parts of the production chain are also included in the assessment (Berkel et al., 1999). In such case a product’s life cycle assessment becomes a complementary aspect to ISO 14001 EMS and vice versa. The information structure of ISO 14001 EMS can make managers and employees more informed about and involved in waste management decisions and waste minimization operations (Sroufe, 2003). While LCA thinking contributes to a better understanding of which of the materials and energy flows are the most important issues for a company to consider as well as the environmental impacts of its product throughout the supply chain (Ammenberg & Sundin, 2003).

DFE activities have a rather limited performance improvement impact if they are not considered in the strategic management as well as in the day-to-day operations of companies. Standardized EMS organizational structure has the potential to remove this barrier since procedures for the inclusion of environmental criteria are facilitated and made permanent within the EMS (ibid.). DFE activities also necessitate the interaction and collaboration among all actors in the supply chain (from raw material extraction to product’s end of life). The willingness of the overall supply chain to act in this direction (Berkel et al., 1999) would help cast the net of the initially site-oriented EMS, into the overall stages of the product life cycle (Ammenberg & Sundin 2003).

The table 2.1 represents how DFE can essentially provide the ability to be fully compatible with series of ISO 14000 (DeMendonça & Baxter, 2001).

Table 2.1 Overall ISO 14000 series and DFE objectives (Source: DeMendonça & Baxter, 2001)
The introduction of the Environmental Management Systems (EMS) has been followed by the discussion of its model, which is based on Deming's cycle (Plan-Do-Check-Act). Although it has been acknowledged in the literature that the implementation of EMS is customized and varies from company to company, still there are some generic steps which have been touched upon in this thesis. Moreover, in order to reduce this difference and offer better guidance during the EMS adoption process, ISO created its international EMS standard, ISO 14001. Therefore, ISO helps the company to focus on each of its processes, by doing so it enables to develop better environmental management practices which ultimately result in an improved environmental performance. The implementation of a formal EMS can be a time consuming task and potentially expensive to undertake, nevertheless there are potential financial, operational, internal as well as external benefits that can result from its implementation. The most applicable benefits perceived in the companies studied by Morrow and Rondinelli (2002) are better organization and documentation of their environmental activities, increased legal certainty, improved image and greater employee motivation. A strong correlation between corpo-

<table>
<thead>
<tr>
<th>Objectives</th>
<th>DFE</th>
<th>ISO 14000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous improvement in environmental performance</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Maintaining good public/community relations</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Obtaining insurance at reasonable cost</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Enhancing image and market share</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Meeting vendor certification criteria</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Improving cost control</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Reducing incidents that result in liability</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Demonstrating reasonable care</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Conserving input materials and energy</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Facilitating the receipt of permits and authorizations</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Fostering development and sharing environmental solutions</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Improving industry-government relations</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Commitment to compliance with applicable regulations</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Reduced consumption of material extraction</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Reduced consumption of materials processing</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Reduction of toxins containment</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Reduction of wastes during manufacturing</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Increase in energy efficiency</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Recycling of fluids</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Increase in product durability</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Increase in product maintainability</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Increased recycling of materials</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Standardized material identification</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Reduction of assembly and disassembly times</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Reduction of waste treatment</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Improvement in work conditions and safety</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Reduced need for occupational health and safety measures</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Summary

The introduction of the Environmental Management Systems (EMS) has been followed by the discussion of its model, which is based on Deming’s cycle (Plan-Do-Check-Act). Although it has been acknowledged in the literature that the implementation of EMS is customized and varies from company to company, still there are some generic steps which have been touched upon in this thesis. Moreover, in order to reduce this difference and offer better guidance during the EMS adoption process, ISO created its international EMS standard, ISO 14001. Therefore, ISO helps the company to focus on each of its processes, by doing so it enables to develop better environmental management practices which ultimately result in an improved environmental performance. The implementation of a formal EMS can be a time consuming task and potentially expensive to undertake, nevertheless there are potential financial, operational, internal as well as external benefits that can result from its implementation. The most applicable benefits perceived in the companies studied by Morrow and Rondinelli (2002) are better organization and documentation of their environmental activities, increased legal certainty, improved image and greater employee motivation. A strong correlation between corpo-
rate strategy, environmental management, and firm performance has been found (Klassen & McLaughling, 1996).

The integration of DFE, LCA and ISO 14001 has been touched upon. DFE focuses on the minimization of manufacturing environmental impacts by introducing modifications early in the product design process (DeMendonça & Baxter, 2001). Yet, it is acknowledged that DFE activities have a rather limited performance improvement impact if they are not considered within strategic management and in the day-to-day operations of companies. Standardized EMS organizational structure has therefore, a potential to remove this barrier since procedures for the inclusion of environmental criteria are facilitated and made permanent within the EMS.

A product’s life cycle assessment becomes a complementary aspect to ISO 14001 EMS and vice versa. The information structure of ISO 14001 EMS can make managers and employees more informed about and involved in waste management decisions and waste minimization operations (Sroufe, 2003). While LCA thinking contributes to a better understanding of which of the materials and energy flows are the most important issues for a company to consider as well as the environmental impacts of its product throughout the supply chain (Ammenberg & Sundin, 2003).

**2.7 Critical factors for the Integration of Environmental Issues**

The main challenge for optimizing environmental product development projects which ultimately affect all other functional areas of the company, lies in the fact that (1) the related operational activities are highly complex, (2) a considerable number of operations where waste is generated, besides manufacturing, is often ignored, such as storage, materials handling, etc. (Kitazawa & Sarkis, 2000) and (3) companies lack an integrated interface between the environmental management functions and departments for research and development (Ammenberg & Sundin 2003; Sroufe, 2003). In the latter case, environmental data may reside in parallel information systems aside from corporate data (Sroufe, 2003).

In addition to this, source reduction activities require a certain amount of awareness, motivation and knowledge about processes, products and materials. This ultimately implies a need for cultural change in mindsets and organizational mechanisms for which top management support is essential (Kitazawa & Sarkis, 2000). Not surprisingly, the company’s employees, especially design engineers require the necessary information and skills to identify potential sources of waste early in the product design stage (De-Mendonça & Baxter, 2001). Thus, it seems crucial for the organization to direct its cultural change efforts towards the realization of:

- cross-functional integration, which is necessary in order to improve communication throughout the company and the whole production chain;
- idea generation capabilities, which are possessed by employees and can be enhanced through learning programs and training;
- overall employee participation and empowerment, which are key for diagnosing waste stream problems and providing remedies; indeed, production employees
work on the field and are the most likely to know the causes of waste and possible solutions (ibid.).

A critical element allowing the implementation of ISO 14001 is cultural change. According to Morrow and Rondinelli (2002), for satisfying ISO 14001 requirements the company needs to have an established system enabling the implementation and operation of ISO 14001 principles. The critical elements for the system are as follows:

- a clearly defined structure of responsibility for environmental management;
- employee programs for training and for acquiring awareness and competence;
- a system of environmental documentation, a documentation control system;
- procedures for operational controls of environmental impacts;
- monitoring, measuring and reporting non-conformance for corrective and preventive actions (Kitazawa & Sarkis, 2000).

In this system, after a company defines the environmental goals it is necessary to assign responsibilities to employees which in turn must be provided with the necessary training in order to acquire problem-solving capabilities through training practice. The execution and progress of the environmental efforts is highly dependent upon the human resources of the company. By assessing its environmental efforts the company determines whether or not a corrective action is needed (ibid.). Clearly, ISO 14001 guidelines for fundamental production requirements, such as commitment to pollution prevention practices (DeMendonça & Baxter, 2001), can be used as a self-evaluation tool for realizing the environmental objectives.

Top management support and commitment is a crucial issue, as the integration of environmental concerns into business processes can represent a major challenge to the existing culture. In order to successfully implement the change, a strong leadership and active support from the top management of the company is required. Furthermore, the dissemination of the corporate goals with respect to the environment to the employees through the communication channels plays a significant role. This process facilitates employees’ involvement and awareness about the environmental concerns. A successful integration of environmental concerns in business activities is also dependent on the significant investment in appropriate technologies and capabilities. Therefore, resource commitment is of a great importance (Pujari, Wright, & Peattie, 2003).

Another critical issue when incorporating environmental concerns in business activities is supplier involvement. Managing vendor relationships is becoming a key managerial and technical challenge, rather than just negotiations and cost reduction policies. Long-term relationships with suppliers can bring benefits to both sides. A manufacturer’s overall eco-performance is to a large extent dependent on its ‘upstream’ environmental impacts. Therefore, it is important for a company to work in partnership with its suppliers in order to include as many environmental factors as possible in its operations (ibid.).

It can be concluded that for a successful integration of environmental issues in business practices, cross-functional integration and communication, clearly defined responsibilities and roles, employee empowerment and involvement, top management support, resource commitment, and supplier involvement are required.
Summary

In order to make it easier for readers to understand and keep track on the theoretical foundation, the graphical illustration of the concepts covered as well as the connection between them is therefore demonstrated in the following model (Fig. 2.5).

Figure 2.5 Model based on the theoretical foundation of the thesis.
3 Methodology

This chapter touches upon the research philosophy and research approach, as well as research strategy and method that have been employed for data collection and analysis. Time horizons are described and followed by the validity and reliability of the chosen method.

The methodology provides a detailed analysis of the research methods, as well as the explanation of the selected method, the results the methods facilitate, and conclusions that have been drawn from this process. This chapter aims at illustrating the types of methods and approaches that have been employed for data collection and analysis.

To find a ‘better’ research methodology is a very complex and mostly impossible process, since concentrating and thinking that one research method is better than another is missing the track. Therefore, it has been suggested that it is ‘better’ to do different things (Saunders, Lewis, & Thornhill, 2007, p.108). In order to develop research methodology which aims to address the research questions the model named ‘research onion’ by Saunders et al. (2007) has been applied (see Figure 3.1).

![Figure 3.1 Research ‘onion’ (Source: Saunders et al., 2007).](image)

This model provides guidelines towards logical and sequential analysis of the phenomenon studied. The choice of a particular element within the different layers of the research ‘onion’ by Saunders et al. (2007) and its assistance in addressing the research questions is further discussed.
3.1 Research philosophy

The first layer of the ‘onion’ model is related to the research philosophy that formulates the different ways of knowledge creation. Among three major ways of thinking about the research philosophy - epistemology, ontology and axiology - it is epistemology that better corresponds to our research process since it ‘constitutes acceptable knowledge in the field of study’ (Saunders et al., 2007, p.129). Contrary to epistemology, axiology is a branch of philosophy that examines judgments about value and ontology takes into consideration the nature of social phenomena as entities (ibid.).

According to Saunders et al. (2007) three different positions can be adopted within epistemology, such as positivism, interpretivism, and realism. The given research has adopted interpretivism as its epistemological position, since it is appropriate for a research among people, such as environmental managers and other employees in order to interpret the company’s external and internal (operational and managerial) contexts. This in turn gives rise to the implementation of ECD&M, EMSs as well as other environmental tools and practices. The position of the interpretivism does not reject positivism and it is characterized by the belief that the complexity of the world cannot be merely reduced to the theory of generalization. Therefore, interpretivism implies a certain degree of subjectivity by making sense out of the world in order to find logic between meanings and actions. This in turn can be particularly relevant for business situations, which are unique and represent the outcome of a particular set of circumstances.

Due to the fact that environmental factors are considered differently by various stakeholders and have a different impact on the company’s performance, and vice versa, there is a need to understand the drivers that push a company towards these environmental motivations as well as actions and activities that support the company’s environmental efforts. The above mentioned approach of interpretivism is verified in a given research.

3.2 Research approach

There are two main research approaches, namely deduction and induction. The purpose of reading the literature will depend, to a great extent, on the approach that the authors intend to use in their research (Gill & Johnson, 1997). On the other hand the selection of each approach depends on the way of reasoning the phenomena. Deductive reasoning is applied when moving from general to more specific. Within this approach, the arguments are based on accepted rules, laws and principles, thus the literature assists in the generation of a theoretical framework which can be tested by using empirical data. However it’s worth noting that it would be very unlikely to review every topic-related literature before the data collection phase (Saunders et al, 2007). Hence, inductive research approach is implemented when moving from specific observations to broader theories. The arguments for the inductive reasoning are developed from observations what allows more flexibility when implementing research changes that might emerge during the research process.

This research study has used the academic literature related to environmentally conscious business practices to help identifying theories and ideas that have been later tested against the empirical data. Since this research aims at the exploitation of the existing theory as well as putting a particular emphasize on the importance of the respon-
dents’ perspective, a rigid division between the collection of the inductive and deductive approaches would be misleading and both the deductive and inductive reasoning had to been applied in this research, which ultimately corresponds to the abductive approach. According to Ali and Birley (1999, p.106) this integrated approach creates a theoretical framework where a part of variables is identified for germane premises (see Tab.3.1).

<table>
<thead>
<tr>
<th>Stage</th>
<th>Purist deductive</th>
<th>Purist inductive</th>
<th>Integrated approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Develop theoretical framework</td>
<td>Area of enquiry identified –</td>
<td>Develop theoretical framework based on constructs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>but no theoretical framework</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Variables identified for relevant</td>
<td>Respondents identify constructs</td>
<td>Some variables identified for relevant constructs – others</td>
</tr>
<tr>
<td></td>
<td>constructs</td>
<td>and explain the relationship</td>
<td>can be identified by respondents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>between them</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Instrument development</td>
<td>Broad themes for discussion</td>
<td>Researcher converts the a priori theoretical framework into</td>
</tr>
<tr>
<td></td>
<td></td>
<td>identified</td>
<td>atheoretical questions</td>
</tr>
<tr>
<td>4.</td>
<td>Respondents give answers to</td>
<td>Respondents discuss general</td>
<td>Respondents discuss the seemingly general questions and</td>
</tr>
<tr>
<td></td>
<td>specific questions</td>
<td>themes of interest</td>
<td>identify constructs which are meaningful to them and</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>explain the relationships between the constructs</td>
</tr>
<tr>
<td>5.</td>
<td>Answers analysed in terms of</td>
<td>Researcher develops theory</td>
<td>Respondent data analysed according to existing theory. OR</td>
</tr>
<tr>
<td></td>
<td>prior theoretical framework</td>
<td>on a purely inductive basis</td>
<td>theory is developed on an inductive basis – without</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>regard to the existing theory.</td>
</tr>
<tr>
<td>6.</td>
<td><strong>Outcome</strong></td>
<td><strong>Outcome</strong></td>
<td><strong>Outcome</strong></td>
</tr>
<tr>
<td></td>
<td>Theory tested according to</td>
<td>Theory developed</td>
<td>Either</td>
</tr>
<tr>
<td></td>
<td>whether hypotheses are accepted or</td>
<td></td>
<td>Existing theory is adapted</td>
</tr>
<tr>
<td></td>
<td>rejected</td>
<td></td>
<td>Or</td>
</tr>
<tr>
<td></td>
<td><strong>Outcome</strong></td>
<td><strong>Outcome</strong></td>
<td><strong>Alternative theoretical framework is presented</strong></td>
</tr>
</tbody>
</table>

Table 3.1 The integrated approach compared to purist versions of the deductive and inductive approaches (Source: Ali & Birley, 1999, p.106)

The abductive reasoning process goes from rule to result to case, thus stressing a continuous interplay between theory and empirical observation (Kovacs & Spens, 2005). The process involves an iterative and systematic movement between the empirical world; data collection process; and a theoretical framework; theory development; that evolve simultaneously. During this “back and forth” movement, the theoretical framework might be subject to modifications when confronted with the empirical world (Dubois & Gadde, 2002), which amplifies the learning loop i.e. it allows the researchers to gain additional insights and to broaden their understanding on both the theory and the practice of the phenomena under study. Additionally, rather than barely focusing on generalizations, the abductive approach is concerned with the particularities of a specific situations since the primary aim of abduction is to develop the understanding of a phenomenon from “new” perspectives (Kovacs & Spens, 2005).
Table 3.2 The abductive research process (Source: Kovacs & Spens, 2005, p.7).

The deductive approach assists authors in the development of a theoretical framework, contrary to inductive approaches, where the gathering and exploring of data precedes the development of theories and relates to the literature (Gill & Johnson, 1997). As mentioned above, the main critics to the inductive approach are related to the condition of possessing competent knowledge of the subject area, without which it would be necessary to start with predetermined theories (Saunders et al, 2007).

Most of the theoretical framework has been built up prior to the empirical analysis, based on the existing premises such as shareholder theory, ECD&M, and EMSs. Thus, it validates a deductive approach. However it would be very unlikely for a research study to review every single piece of the subject-related literature before collecting the data. According to Dubois & Gadde (2002), theory cannot be understood without empirical observation and vice versa. Since the empirical fieldwork; the participant companies’ responses; lead the authors to unanticipated yet related findings, the redirection of the research problem called, in turn, for the re-adaptation of the theoretical framework by adding theory and new concepts.

Furthermore, the complex structures of our case companies; which suggested a deeper study of interdependent variables; encouraged the authors to pursue their research efforts when the possibility of analyzing an embedded subcase, namely kinnarps’ suppliers, emerged at a latter stage of the research process. Due to the fact that this subcase was not independent, it increased its individual contribution to the total case.

Thus the remaining part of theoretical framework, corresponds to and applies an inductive approach. Having this in mind, the abductive approach has been introduced in order to obtain the flexibility needed for adjusting our analysis and interpretations when facing constant emergent new findings through the research study.

3.3 Research strategy

In this section we will focus on the research strategy that ought to enable researchers to answer their research questions and meet their objectives. According to Yin (2009), the
choice between different research strategies depends on the existing knowledge and time availability.

“As a research strategy, the distinguishing characteristic of a case is that it attempts to examine a contemporary phenomenon within its real-life context especially when the boundaries between the phenomenon and context are not clearly evident” (Yin, 1984, p.13).

Among different research strategies the case study has been selected, in order to align the relationship between research objectives, data and theory. Yin (1994) states that case studies give a special attention to the process of the observation, reconstruction of a particular situation or case. In addition, this strategy incorporates the views of the ‘actors’ in the studied cases. According to Yin, (2009), the case study is particular useful for answering the questions “why” and “how” thus fitting with the purposes of the exploratory and explanatory researches (Table 3.2).

Table 3.3 Research Strategy (Source: Yin, 2003)

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Form of research question</th>
<th>Requires control of behavioral</th>
<th>Focus on contemporary events?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment</td>
<td>How, why?</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Survey</td>
<td>Who, where, how many, how</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Archival Analysis</td>
<td>Who, where, how many, how</td>
<td>No</td>
<td>Yes/No</td>
</tr>
<tr>
<td>History</td>
<td>How, Why?</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Case Study</td>
<td>How, why?</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

At the same time, case study strategy aims at satisfying the three tenets of the multi-method qualitative study, namely describing, understanding and explaining (Kumar, 2005). In practice most studies can integrate a combination of them. Furthermore, this strategy is particularly suitable for incorporating the views of the ‘actors’ in the case(s) being under study (Yin, 2009). As far as the given thesis is concerned, the descriptive, and to a certain extent explanatory research perspectives are prevalent. Therefore the inquiry strategy - used for analyzing the environmental issues and their impacts on organizations, individuals and processes and vice versa in order to align the relationship between research objectives, data and theory while giving special attention to the process of reconstruction of a particular situation - pertains to the case study research strategy.

Yin (2009) describes four case study strategies; single case, multiple-case, holistic case and embedded case. This research uses the multiple case studies which covers more than a single case study. According to the author, this case study strategy is particularly advantageous for allowing comparisons and for providing more compelling results. Dubé and Paré (2003) states that the use of multiple case study strategies enables cross-case comparisons and analysis which enhances the understanding of the variability impact on the context of the cases.

Within the case study strategy for this research with the descriptive perspective aims at describing and understanding the context, attitudes and actions of three selected manufacturing Swedish companies; namely Volvo Buses, Trelleborg AB and Kinnarps AB; with regards to the purpose of the research, i.e. to analyze why and how companies integrate environmental concerns in their business operations and organizational structure as well as to investigate the critical factors that enable such integration. Finally, the ex-
planatory perspective is used to clarify how the company can achieve their environmental objectives by means of EMSs and ECD&M tools and practices. Moreover, the critical factors enabling this integration process are explained.

The companies studied in the given thesis are large Swedish manufacturing companies which put a lot of efforts into proactive activities regarding environmental issues. Moreover, the three companies have been chosen according to the following criteria: the level of development and use of LCA and DFE; the level of manufacturing environmentally – friendly products; and implementation of the certified EMS ISO 14001.

3.4 Research method

Different research traditions and therefore different research perspectives have different opinions about to what extent the empirical research can reveal something, and what knowledge we can gain from the qualitative research (Grix, 2004). In some cases, these methods are not mutually exclusive and can be used within same research (Yin, 2009). According to Punch (2002, p.139) both qualitative and quantitative research methods should be understood as umbrella terms, under which a wide and diverse range of ‘paradigms, approaches for data collection and analysis’ are categorized (cited in Grix, 2004, p.116). Indeed, mixed model research methods combines both quantitative and qualitative data collection techniques and analysis procedures as well as combining qualitative and quantitative approaches. Multiple methods are useful if they enable authors to answer the research questions and assess the extent to which the research findings are reliable (Saunders et al, 2007). A summary of qualitative, quantitative and mixed methods is discussed by Creswell (2003) in Appendix 5.

Since the purpose of the thesis is not to make a generalization about the facts or phenomena; which would result from numerical values and statistical analysis obtained through quantitative methods; but rather to describe a particular situation through the generation of the verbal information, a qualitative method has been selected.

A qualitative method usually includes the in-depth analysis of knowledge through, for instance, observations, adapting interviewing techniques, archival or some other documentary analysis. They are of a particular interest for researchers since they offer broader and well-grounded explanations and descriptions that can illustrate a more realistic picture of the research. Another advantage of using qualitative methods is their flexibility and adaptability, (for instance, exclusion or wording of particular interview questions). However, this also might imply a certain degree of subjectivity. The criticism of qualitative research has therefore not only raised the question about its objectivity but also the validity of results, and representativeness which limits the general applicability of its findings.

According to Kelliher (2005) it is important to interpret and acknowledge the views, incentives and values that humans have about their actions. Since these social situations in the research should not be generalized, our research design favors a qualitative method with semi-structured interviews. “Interviews should be used for eliciting personal attitudes and opinions” (Stokes, 2003, p.118). In this research, non-standardized interviews have been used in order to obtain the information that was likely to reveal “how” and especially “why” issues which meet the needs of our descriptive- identifying a general pattern- and explanatory- understanding the relationships between variables- research study.
In addition, to semi-structured interviews with environmental managers, the questionnaire has been sent out to the studied case studies as well as other companies with a purpose to better understand the theoretical foundations and enrich the research findings (Appendix 6). Although, according to Saunders et al. (2007), questionnaires generally contribute to the survey strategy, still both experimental and case study research strategies can make use of these techniques. Since the number of respondents is rather low (7 companies, including the investigated case studies), the analysis of the questionnaire is not given much attention in the thesis.

3.5 Time horizons

As for the time dimension, studies are divided into cross-sectional and longitudinal. Longitudinal research design involves the collection of data for a variable(s) in one or more time periods (Sekaran, 1983) with the main purposes of describing the patterns of change as well as establishing the direction and magnitude of causal relationships (Saunders et al. 2007). On the other hand, cross sectional research design involves the collection of data on more than one case, at a single point in time (Bryman, 2004). This may arise an issue with regards to the difficulty to attribute causation due to the lack of a time dimension, as data is collected at just one point in time, an also the lack of a randomized control group (De Vaus, 2001).

Cross sectional research designs can be used with qualitative research methods, evidenced by the use of semi-structure interviews with a number of participants (Bryman, 2004). Therefore cross sectional studies are deemed to be useful for assessing the prevalence of an outcome since they can provide a single “snapshot” in time (Saunders et al. 2007). This corresponds to the design strategy of this research study which seeks to analyze and understand the motivations to and the actions that are needed for the integration of environmental concerns into product and process design.

3.6 Data collection

Data collection is the phase of the overall configuration of a piece of research (Eastby-Smith, Thorpe & Lowe 2008), therefore the gathering and interpreting evidence is essential for providing good answers to the research questions. According to Glaser and Strauss (1967 p. 65), by collecting of various types of data the researchers can enhance the validity and reliability of the findings for a particular category. In this line of thought, Eisenhardt (1989, p. 538) states that “the combination of data types such as qualitative and quantitative data, can be highly synergistic”. However the main issue according to Salomon (1991) is not about whether different types of data should be linked but rather how and for what purpose it should be done. Thus it would be adequate to consider not only the different strategies for data collection but to organize them with regards to the nature of collected data. It has been mentioned, that the choice of the research method depends not only on the problem and purpose of the study, but also on the nature of the data gathered (Saunders et al., 2007, Kumar, 2005). The body of this research consists of two types of data, primary and secondary.

3.6.1 Primary and data secondary

The primary data has been obtained during the semi-structured interviews with the environmental managers within the studied companies. The sources (units of analysis) of our primary data are manufacturing companies: Volvo Buses, Trelleborg AB and Kin-
narps AB, which have been selected for their recognized environmental efforts. These companies constitute the main categories and serve for the purpose of analyzing the subject-related literature. In order to enlarge the empirical findings and provide more value to the thesis, face-to-face interviews have been conducted with a supply chain manager in Väveriet i Uddebo AB, a Kinnaprs supplier of textile.

On the other hand, the secondary data has been derived from published documents germane to the topic and companies’ web sites. The literature on ECD&M and EMSs has been applied as the source of secondary data, which includes academic publications, dissertations, scientific and other documents such as internal annual corporate and environmental reports. This literature review has resulted in a theoretical framework for the integration process of environmental factors into company’s operational and organizational framework. Following this step empirical cases, which constitute the primary data, have been progressively selected in order to give consistency to the study.

**Face-to-face and telephone interviews**

It’s worth noting that the nature of an interview can be structured, unstructured or semi structured (Yin, 2009; Saunders et al. 2007). The typology should be also adapted to both the research strategy and research purpose (Saunders et al. 2007). Table 3.4 displays the typology of interviews that are more suitable to the different research strategies.

<table>
<thead>
<tr>
<th>Exploratory</th>
<th>Descriptive</th>
<th>Explanatory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structured</td>
<td>✓ ✓</td>
<td>✓</td>
</tr>
<tr>
<td>Semi structured</td>
<td>✓</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>Unstructured</td>
<td>✓ ✓</td>
<td></td>
</tr>
</tbody>
</table>

✓ ✓ = more frequent, ✓ = less frequent

In this research semi – structured interviews have been chosen since they facilitate obtaining the answers to a large number of open-ended questions for the development of the research topic. The data was recorded by hand note taking and the non-standardized list of themes and questions to cover are displayed in Appendix 7. A number of performed interviews varies from company to company due to the time limitations and companies’ location.

In order to gain a better understanding, and a clear view of the integration of the environmental concerns into business activities, some additional face-to-face interviews have been conducted with the following companies: Itab, Agility and Sharp Jönköping. This initiative has been justified by the personal benefits and interest in the topic. However, the interpretation of the obtained results is not discussed in this study.
Moreover, the study employs a telephone interview method as the other qualitative interview method in order to make contact with those participants that could not be interviewed personally with respect to the distance (Trelleborg AB) and the lack of time due to their busy schedule (Volvo Buses).

3.6.2 Procedures for data collection

The data for this research has been obtained while keeping in mind the principles for data collection recommended by Yin (2002): the use multiple sources of evidence, known as triangulation, has been used with the purpose of giving a more convincing and accurate image of the company’s situation. The triangulation of data sources occurs when facts or phenomena in a case study are supported by more than one source of evidence (ibid.). The authors have gathered multiple sources of evidence in this research by the means of interviews with environmental managers within the different participant organization as well as through reviews of external sources; particularly the participant organization’s internally published reports.

In this research project three case studies have been carried out in order to cover the empirical part on the topic of environmental issues; EMS and ECDM tools and practices oriented towards waste reduction programs and objectives. Each case study is based on open-ended questions requiring narrative responses for fulfilling the research questions of why companies are motivated towards the implementation of EMSs and environmental tools, how they are integrated within the company’s organizational and operational framework and support their environmental efforts. Once the data collection phase has been completed the answers are used for the development of the individual case reports and cross-case analysis. The cross case analysis, including comparisons with the other sources of data, intends to converge upon and interpret those facts that have relevant evidence in order to compose an adequate answer for each of the case study research questions.

3.7 Data analysis

Data analysis is essential for developing concepts through the process of coding which consists of asking questions such as what, where, how, when, etc. and making comparisons with similar events (Saunders et al, 2007). According to Yin (2002) the analysis of case study evidence is one of the most challenging issues when developing a case study which, in addition, is highly dependent on the author’s rigorous thinking style and the interpretation of the obtained data and evidence.

Referring to Saunders et al. (2007) there is not a single generic approach for analyzing qualitative data, but rather various research approaches and strategies. However an aspect shared by all analytical procedures is the organization of the collected data in a systematic fashion and as rigorously as possible (Yin, 2009; Saunders et al., 2007). For Saunders et al. (2007) this involves the categorization and unification of empirical data, followed by the need to recognize their relationships and develop them into categories and finally transform the derived data into conclusions. As for the strategy, used in the analysis of the qualitative data, it contains both, deductively and inductively based analytical procedures.

In the first step is was necessary to address our research questions which involved the development of a good theoretical background based on theories and academic articles.
related the phenomenon under study. The ideas and insights obtained from the literature preceded the process of knowledge categorization and unitization which allows us to establish (1) categories and units in order to allocate gathered empirical data to the respective categories and (2) a structural guide for analysis. In the thesis, the embedded units of analysis (companies) and an overall pattern (matching) of complexity, in adequacy with the theoretical framework, have been used to analyze “why” it is needed and “how” it is possible to integrate environmental concerns into business operations and organizational structure. The categories of data collection are: stakeholder pressure, EMSs and ECD&M. For recognizing the relationships and casuals links i.e. systems and practices supporting the company’s environmental efforts, the empirical data collected has been sorted and assigned to the categories previously set up in the theoretical framework. The theoretical framework assists us in identifying the data from inside the case companies that needed to be collected, such as annual reports, and the primary data through qualitative inquiry methods (interviews) in order to provide an in-depth and more detailed picture of the phenomena. The data collection phase revealed that our theoretical framework had to be redirected as new facts were discovered and their inclusion was deemed necessary for enhancing the reader’s understanding of the subject. During this step in our abductive research, our theoretical framework was supplemented with more specialized theories, as those pertaining to ECD&M. The final step comprised further interviewing the respondents in order to support and analyse the important aspects of the data previously collected and the development of our theoretical framework.

Indeed, the theoretical framework has been used not only for formulating the research questions and objectives but also as a data analysis guide (Yin, 2009), with each section covering a topic relevant to environmentally responsible business and the abductive approach was appropriate for matching and combining both existing theories and the empirical data in order to problematize on the research questions and to develop the conclusions of this study. A summary of the procedures for data collection and analysis with respect to the participating companies is presented in the Appendix 8.

### 3.8 Validity and Reliability

The credibility and persuasiveness of the research findings is measured in terms of the attained level of validity and reliability (Saunders, et al., 2007). Reliability tests whether the operations of a study, if undertaken by other researchers, can be repeated and yield the same results (Easterby-Smith et al., 2008; Saunders et al., 2007). According to Robson (2002) participant’s error and bias and observer’s error and bias threat the reliability of a research (cited by Saunders et al., 2007). In order to secure and achieve the reliability for a case study four testing procedures, common to every social science method, have been developed (Kidder & Judd, 1986, cited in Yin, 2009):

- **Construct validity**, identifying correct operational measures for the concepts being studied.

- **Internal validity**, seeking to establish a causal relationship, whereby certain conditions are believed to lead to other conditions, as distinguished from spurious relationships.

- **External validity**, defining the domain to which a study’s findings can be generalized.
- **And reliability** demonstrating that the operations of a study—such as the data collection procedures—can be repeated with the same results.

Different tactics for case studies that can be used within each of these testing procedures are shown in Appendix 9.

According to Dubois & Gadde (2002), authors aiming at testing the relationships and patterns in complex structures and processes are prisoners in the positivistic trap. Traditionally, the research focus in positivism is on testing or refining the existing laws or theories supported by established assumptions on what constitutes knowledge. It is also reductionist since it tests and measures selected variables that constitute hypothesis and research questions while neglecting the need to examine the causes that might have influenced the outcomes. (Creswell, 2003). Even though our research philosophy, namely interpretivism, do not reject positivism, the authors followed Pfeffer’s (1982 cited in Dubois & Gadde, 2002) recommendations for achieving the credibility of their work and which should be characterized by “logical coherence” i.e. the adequacy of the research process and good theory (Dubois & Gadde, 2002).

This study used qualitative research methods which usually include in-depth analysis of knowledge, for instance, interviewing techniques or some other documentary analysis (Saunders et al., 2007). These methods are of a particular interest for researchers since they offer broader and well-grounded explanations and descriptions that can illustrate a more realistic picture of the research. Another advantage of using qualitative methods is their flexibility and adaptability, (e.g. the addition, exclusion or wording of particular interview questions) which might also imply a certain degree of subjectivity (ibid). Therefore the main threat to the reliability of the qualitative research is related to question about its objectivity but also to the validity of results which limits the general applicability of its findings (Saunders et al., 2007).

Validity is concerned with the accuracy of the research findings; if “findings are really what they appear to be about” (Saunders et al., 2007 p. 150); and whether the research findings can be generalized (Yin, 2002; Saunders et al., 2007). However as we have stated in before, our motivation behind the choice of a qualitative and abductive research case study is to reflect on the research subject and to gain the richness and particularity of the cases under study. Since the empirical evidence revealed the complexity and the important circumstances where the cases under study take place, the authors could not provide single and “correct” causes, thus no hypothesis, originating from a sending context to a receiving context, were developed. (Lincoln & Guba, 1985 cited in Sanders, 1995).

The focus of validity in the given study is placed upon the inter-subjectivity of the results where the aim is to understand how individuals make a sense out of their reality. Therefore our efforts have been directed towards an accurate explanation of a phenomenon occurring within a particular set of conditions through the generation of verbal information by means of qualitative methods. For Marshal and Rossman (1999) the evidence collected with non-standardized methods such as in-depth interviews is not necessarily repeatable since it reflects the reality at the time they have been collected (cited in Saunders et al., 2007). Although semi-structured interviews offer a holistic, multifaceted picture of the reality, due to the opportunity to hold an open discussions on the matter, still the generalization of results is limited. Thus, in order to ensure the inter-
subjectivity of the primary and secondary data different measures have been undertaken by the authors.

During the interviews a neutral position has been adopted and semi-structured in-depth interviews; containing open-questions were carried out. The open-ended questions helped us capture a maximum range of responses with the participants’ different views in their own words thus avoiding the risk of influencing their answers and obtaining an enhanced understanding of which categories the participants belong to. Besides the face-to-face interviews that allowed the researchers to read the body language of the participants and follow up questions, a systematic approach has been applied to the collection and interpretation processes for the data and evidence used to fulfill the purpose and research questions in order to ensure consistency. A systematic research is based on logical relationships and not just beliefs (Ghauri & Gronhaug, 2005; cited in Saunders et al., 2007). The authors have referred back to the handwritten notes from the interviews for dealing with disputes on the alternative interpretations that might have aroused out of the evidence.

The use of multiple sources of evidence has allowed the researchers to run cross-sectional analysis by cross checking the data against the theoretical framework. Indeed, triangulation has been helpful during the verification process, as it allows the comparison between the theoretical concepts and the evidence gathered from the case study. The documentary information has been used, in addition to the personal and telephone interviews, in order to corroborate and provide more evidence to the previously mentioned sources of data and to avoid over relying on the answers given by the participants. Furthermore a review process has been carried out in order to make sure that the participant’s responses within the “line of inquiry” (Yin, 2009). During the data analysis, confronting the theory with the gathered evidence has helped in reducing error and bias risks and establishing the relationships between the factors leading to the integration and maintenance of ECD&M tools and practices and EMSs.

Finally, a manual approach has been used for transcribing the note takings of the qualitative data which includes labeling the categories in the margin of the transcripts in order to recognize their source of origin and facilitate the information retrieval before sending a case study draft to the participants for final checking and approval. This was done with the purpose of ensuring factual accuracy.
4 Empirical findings

This chapter aims at presenting the empirical material gathered from interviews at three manufacturing Swedish companies. The general company information, its proactive environmental activities during manufacturing and design of a product, as well as benefits and driving forces towards environmental practices will be presented for each of the companies. The information has been collected through the interviews with environmental managers and responsible personnel, as well as from companies’ websites, both annual and environmental reports, and other valuable documentation.

4.1 Introduction: Volvo Buses Corporation

By forming an independent division of the Volvo Group’s subsidiaries, Volvo Buses is seen as one of the world’s largest manufacturer of buses and bus chassis. The product range within Volvo Buses comprises: city buses, intercity buses and tourist coaches, and services in the areas of servicing, financing, vehicle diagnostics and traffic information systems. There are approximately 7 900 employees working within Volvo Buses worldwide, with production facilities in Europe, North and South America, Africa and Asia. The head office is located in Sweden, Gothenburg, where mainly product planning and product development are concentrated (www.volvobuses.com).

Volvo Buses has developed a wide distributor network for after-sales services by offering a distribution of servicing and spare parts at 1 200 workshops located in more than 80 countries. As far as natural gas engines for buses are concerned, Volvo takes a pioneering position as one of the world’s technological leaders. According to the related specification, these engines are designed for a lean mixture of fuel and air, which provides high fuel efficiency, low emissions and low combustion temperature. In order to reduce the emissions even more, Volvo’s natural gas buses are equipped with an oxidizing catalytic converter as a standard. Volvo’s natural gas systems are delivered complete with tank package, chassis, pipes and fixtures, or as a complete bus (company presentation slides).

4.1.1 Volvo Buses & Environment

Volvo Buses is recognized as a global leader in the bus manufacturing industry. Moreover, the company concentrates not only on satisfying customers’ requirements, but also paying significant attention to the environmental issues. Based on the corporate values, proactive environmental programs are essential for achieving long-term progress and sustainability.

Volvo’s Buses corporate values are characterized by quality and environmental programs for continuous improvement, technical development and resource efficiency. Environmental management has therefore, been recognized as a critical element for achieving and promoting the long-term sustainability goals such as: reducing the environmental impacts resulting from production processes and activities; reducing of the environmental impact of products; reducing the environmental impacts of its own transports (Volvo Group’s Sustainability Report, 2009).

Volvo Buses in Sweden has chosen to challenge the increasingly tougher EU regulations for heavy duty vehicles by catalyzing its environmental efforts in the conception of cleaner products and technologies, such as fuel efficient SCR (Selective Catalytic Reduction) route and more fuel efficient engines for bus coaches. These efforts have re-
sulted in diesel engines that have successfully obtained the approval of European regulatory instances and Environmentally Enhanced Vehicle (EEV) emission requirements as well as the interest of the market. With Volvo Emission Control (VEC), Volvo Buses is setting new standards for environmentally optimized buses (ibid.). During the interview with E.Jobson, the factors as compliance with governmental legislation and customers’ requirements have been identified as driving forces for the integrating environmental aspects in business processes.

Volvo’s Buses internal policy for continuous improvement is aimed at reducing the environmental impact of its products, operations and services. This policy highlights three main factors:

- taking in account the complete life cycle;
- making pollution prevention as a prerequisite for all operations;
- encouraging suppliers, dealers and other business partners within the sphere of influence to adopt the principles in this policy.

The environmental and quality concerns are reflected in the environmental policy which is the foundation for EMS. In order to ensure the consistency and stability of the environmental work, Volvo Buses' plants and units have been certified according to ISO 14001. E. Jobson, an environmental director explains that the rationale for adopting ISO 14001 has been an internal policy decision. As a result of this certification, operations at Volvo Buses' production facilities are regularly inspected by an audit team under the leadership of the Group Environmental Auditor (Volvo Group’s Sustainability Report, 2009).

The environmental ambitions at Volvo Buses include increasing the focus on cost control and reduced product costs. When assessing the benefits derived from being certified with ISO 14001, E. Jobson considers that ISO 14001 has been particularly important for achieving improved control of costs thanks to the harmonized and consistent documentation of existing processes. Other intangible benefits include improved base for public relations and communication as well as enhanced support from customers in dialogue with authorities. According to E. Jobson EMS: ISO 14001 has helped Volvo Buses to achieve the improvements in all manufacturing areas, particularly, in design and product developments by reducing the environmental workload of product life cycle practices, thereby contributing to the overall reduction of operations impacts (personal communication, 01.04.2010).

Audits at Volvo Buses are carried out under its certified EMS which covers its whole value chain i.e. from product development and purchasing to after-sale service and product take back or disposal. Environmental activities for auditing include monitoring the wastes and emissions as well as the resources, particularly energy consumption of the operations and activities of business units. E. Jobson explains that this systemic control takes place once a year and it has been performed in all Volvo’s factories since 1994. Once environmental data is gathered it’s submitted to decision makers for analyzing all key contributors. Audits results are addressed by internal directives and remediation programs in order to give consistency to the corporate environmental work (Volvo Group’s Sustainability Report, 2009).
4.1.2 Environmentally conscious design and manufacturing

As mentioned previously, all facilities are required to be consistent with the overall environmental continuous improvement policies regarding the use of chemicals, energy consumption, air and water emissions and waste management practices. Environmentally conscious manufacturing within the company includes recycling, remanufacturing and reusing. When a product of the company has finally reached the end of its service life it must be possible to recycle it effectively. Volvo Buses has therefore drawn up detailed instructions for how oils and chemicals are to be dealt with and how the bus should be dismantled more efficiently, together with descriptions of what different parts it is contained of. Many of the parts in a bus can be renovated and re-used. In terms of resources, this is the more efficient than recycling. E. Jobson highlights that Volvo Buses follows Volvo Production Systems (VPS) - a well - developed system which facilitates product returns from clients. Renovated parts and about 80% of the parts in a used engine can be renovated and re-used. About 70% of a bus consists of various metals for which established recycling systems already exist. The rest consists of wood, glass, rubbers and plastics, etc. Today, most of these is sent to landfills, but some can be used as fuel in order to recycle the energy.

Volvo Buses is continuously working on reduction of energy and water consumption, and production emissions. At most production facilities, all waste as production waste and packaging materials is sorted at source for energy generation and material recycling. Already since 2004, all facilities within the company have been striving to become carbon dioxide free. In addition, based on requirements for a minimum impact on the environment and operational considerations, the transportation of materials has been streamlined.

When developing a product, the company focuses on both air emissions and fuel consumption reduction. Since the mid-1970s, Volvo Buses has managed to decrease its emissions of hazardous compounds in the exhaust fumes by between 60% and 85%. At the same time, the consumption of fuel and carbon dioxide emissions has been reduced by about 30% for heavy buses (company presentation slides).

As it has been mentioned before, during product design Volvo Buses aims at increasing fuel consumption efficiency, reducing carbon dioxide emissions so that to ensure lower environmental impacts of its products. The company performs different assessing methods to determine the environmental impacts and optimize the decision making process at the design stage of its products. These include Life Cycle Assessment (LCA), Life Cycle Costing (LCC) as well as Volvo’s EPS system (Environmental Priority Strategies in Product Development) and Global Automotive Declarable Substance list (GADSL) which is applied for material guidance (company presentation slides).

One important aspect when developing new products is that they should have lesser environmental impact than the products they replace, therefore in - house experts and cross - functional teams are needed to carry out and obtain specific product related information with the help of LCA. This method serves to analyze the environmental impact of the products from design to scrapping and recycling. It also determines whether or not improvement efforts for the product performance are necessary to be deployed.

The results of life cycle method have revealed that more than 90% of the total environmental impact of a bus arises when it is in use; therefore the company’s focus is on reducing fuel consumption, carbon dioxide emissions and other air pollutants that might
be harmful to human beings and the environment. In addition to this, the obtained results are written down in Environmental Product Declarations (EPD) for customers and contain the product’s information relative to the production, use and end of life (company presentation slides).

Volvo Buses uses LCA to consider the alternative solutions available after studying and evaluating the potential impact of products and materials. GADSL Lists are also used for analyzing the chemicals and substances that are forbidden or have to be declared before their integration in any new product. Achievements in these areas include the decreased use of environmentally hazardous chemicals in accordance with Volvo’s chemical and product blacklists.

EPS is based on the potential costs for repairing damages made to society, in areas as health, eco-systems, production, natural resources, and etc. The environmental impact caused by an activity or process forming part of products life cycle is expressed in Environmental Load Units (ELU). By aggregating ELUs from the overall products life cycle, Volvo Buses is able to calculate products’ overall environmental impact (Miljövarudeklaration-Volvo 8500 Längentré led buss, 2002).

The highest risk of waste at Volvo Buses includes the amount of energy consumed and emissions generated during the manufacturing processes. “In line with filters and controls emissions and discharges, Volvo Buses has also applied internal and branch specific routines in all factories with more than 50 % of ownership for limiting these operational risks” (E.Jobson, personal communication, 01.04.2010). These procedures are used for preventing pollution and facilitate environmentally-conscious manufacturing.

4.1.3 Critical success factors

For the environmental goals to be accomplished, Volvo Buses requires its business partners to support the companies’ environmental efforts. All Volvo Buses transport suppliers are certified in accordance with the environmental standard ISO 14001. As for the company suppliers of production materials and services, they must be third party certified to ISO 14001 or EMAS while also comply with Volvo’s Black and Grey list when delivering chemicals or materials that will be included in Volvo’s products or services. Volvo Buses demands to all its suppliers to take responsibility for minimizing the environmental impacts of the products by considering packaging, recycling and design solutions. In this way Volvo Buses secures a minimized total environmental impact and reduces the potential risks related to the reliance on suppliers (Miljövarudeklaration-Volvo 8500 Längentré led buss, 2002).

The organization has allocated responsibilities in a decentralized manner, “the entire organization has to be responsible for environmental issues, not just me as environmental manager,” emphasizes E.Jobson, environmental director of Volvo Buses (personal communication, 01.04.2010). Employees’ involvement, knowledge and competence are critical elements allowing the integration of environmental factors in all operations. Volvo fosters employee skills development through continuous training at both individual and managerial levels. At individual level, competence development is supported by continuous training programs and activities that range from e-based training to individual coaching and mentoring. The learning process is based on personal “business plans” elaborated for each individual in order to ensure that employees clearly understand their role in the team and what is expected from them. On the other hand, at managerial level,
Trainings aim to improve manager’s leadership and communication skills. These training programs focus on increasing awareness of environmental regulations and legislation including the labor laws. Volvo Buses has increased its employee’s competence at service workshops through extensive training. According to E. Jobson the implementation of ISO 14001 has given rise to employee morale, commitment, and sense of pride (personal communication, 01.04.2010).

All business areas and business units are in charge of the implementation of environmental programs based on their particular needs and conditions. Incentives are part of the company’s motivation policy and they are distributed based on employees’ cooperation, commitment and internal mobility. Managers are also rewarded in relation to their contribution in achieving key organizational objectives.

4.2 Introduction: Trelleborg AB

Trelleborg AB is a global leading company in the engineering of polymer solutions and unique know-how applications for sealing, damping and protecting in the demanding industrial environment. The company was founded in 1905 with the headquarters location in Trelleborg, Sweden. Nowadays, approximately 210000 employees form its workforce in more than 30 countries. The company is composed of four business areas: Trelleborg Engineered Systems, Trelleborg Automotive, Trelleborg Sealing Solutions, and Trelleborg Wheel Systems.

Most operations are carried out within different sectors of the industrial area of rubber. The products are meant to seal, dump and protect, meaning that they help to reduce the environmental impact during their life (reduce noise and vibrations, energy savings, for instance, profile for windows, doors and walls to insulate and prevent energy loses); prevent hazardous chemicals from entering the environment (during transfer of oil and chemicals through the Trelleborg production hoses); prevent food and drinking water from being contaminated, prevent soil contamination in landfills (use of rubber membranes to prevent leachate to reach the ground, etc.). Operations include the production of antivibration, hoses and seals for a wide range of market areas, construction and infrastructure, vehicles, oil and gas offshore, agriculture and aerospace as well as transportation equipment (www.trelleborg.com).

4.2.1 Trelleborg & Environment

According to Victoria Hellström, Trelleborg’s new Vice President, Environment, “the corporate environmental philosophy within the Trelleborg Group is supposed to be a center of expertise in environmental issues, supporting all business areas” (company presentation files). Although the decision making process within the company is highly decentralized with environmental coordinators at each plant site, still environmental issues are highly prioritized on the central corporate agenda. It has been also admitted, that the integration of the environmental issues in the daily activities facilitates more efficient solutions for systematic treatment.

Each unit within the company has a direct responsibility for issues relating to the environment. Every production plant has an environmental coordinator and a person responsible for occupational health and safety issues. The central Group function, which is a part of the Group Legal Department, is responsible for controlling and coordinating environmental issues. There also exists the Group’s Environment Forum, a group that
meets four times a year and consists of environmental managers from the four business areas which have been mentioned in the company introduction (Trelleborg, Corporate Responsibility report, 2009).

Trelleborg has extensive production operations in about 30 countries, which means that environmental issues create an inevitable part of the company’s responsibility. The two main environmental goals for the group have been identified as to:

- reduce environmental impacts and risks;
- increase resource efficiency.

These goals are carried out at both local and central levels. As stated in Trelleborg’s Sustainability Report 2009, one of the company’s environmental goals - avoidance or ideally elimination of hazardous chemicals and materials used in products and process - is tightly related to customers’ demand who specify products’ characteristics and inputs. For achieving these goals, environmental efforts are needed in following critical areas: environmental management, operational activities in source reduction, cultural and organisational changes.

Much attention is given to the environmental aspects which include waste, energy and raw materials consumption, emissions to water and air. An important aspect in Trelleborg’s environmental work is the environmental management standard ISO 14001, a compulsory requirement for production plants and development units in the Group. According to Trelleborg Sustainability report, (2009), at the end of the year 2009, the proportion of facilities with ISO 14001- certification represents 71 percent (70) of all plants (Figure 4.1). From the diagram it is possible to notice that the number of certified plants declined compared with 2008, but the total share has risen due to the closure or divestment of units.

Figure 4.1 Number of certified plants (Source: Trelleborg Sustainability report, 2009).

As pointed out from the interview with the environmental director, J. Luis Losa, “many of our customers’ insist on us having certified environmental management systems. In order to stay a successful company in the long term, we have to be able to show our customers and other stakeholders that we are running our business in a responsible way” (personal communication, 22.04.2010). Here, J. Luis Losa puts emphasis on good environmental practices for limiting the amount of resources that goes to waste, which is in line with lean production principles.

### 4.2.2 Environmentally conscious design and manufacturing

Actions for continuous improvement within the company include monitoring and recording the day-to-day operations and related inconsistencies in energy and material consumption; water emissions; and waste generation. Referring to the Sustainability report (2009), Trelleborg has already taken clear steps towards preventing and decreasing
the climate-related effects of its operations, partly through improvements in energy efficiency. In order to decrease the level of energy consumption, and thus the costs of energy and related emissions, the group has applied energy savings plans and programs at all facilities. The Energy Excellence Program consists of the identification of projects for improvement and self-evaluations at every unit or facility. These programs tend to cover saving measures in areas such as: heating, lighting, ventilation systems etc. and are implemented by a team formed under the coordinators’ supervision (ibid.).

Water is used in production primarily for cooling and cleaning. Due to the implementation of recycling systems, major savings have been achieved. Emissions to water are limited and mainly comprise organic material measured in chemical oxygen demand (COD), 413 tons (466), and nutrient substances, 9 tons (10) (Trelleborg Sustainability report, 2009).

Multiple projects are under way to replace solvent-based products in several areas, which can lead to positive effects on both environment and the work health and safety. It has been found that continuous improvements encompass the issue of finding waste disposal alternatives with a higher degree of recycling and lower cost. This activity is implemented in the local operations. The table below demonstrates the target indicators for evaluating, monitoring and checking how the company’s efforts progress over time.

Table 4.1 Target indicators and results in 2009 (Source: Trelleborg Corporate Responsibility Report, 2009)

<table>
<thead>
<tr>
<th>Area</th>
<th>Results 2009</th>
<th>Measures and progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>1,288 GWh (1,521)</td>
<td>Improved energy efficiency has resulted in a 2.2 percent decrease, relative to sales, compared with 2008. The Energy Excellence Program for systematically enhancing the efficiency of energy was introduced at all production units.</td>
</tr>
<tr>
<td>Climate</td>
<td>Decrease in absolute terms, but a 7.7 percent increase, relative to sales, compared with 2008.</td>
<td>Energy Excellence savings also reduce the impact on the climate. New “15 by 15” climate strategy adopted (see page 7).</td>
</tr>
<tr>
<td>Chemicals</td>
<td>Work and planning for this commenced in conjunction with adaptation to EU’s REACH legislation.</td>
<td>Work on the adaptation to REACH continues (see page 8, as well as the box on page 9).</td>
</tr>
<tr>
<td>Waste</td>
<td>59,400 tons (78,600). The decrease was 9 percent, relative to sales, compared with 2008.</td>
<td>The focus will initially be on the largest plants.</td>
</tr>
<tr>
<td>Emissions</td>
<td>1,265 tons (1,375). A decrease in absolute terms, but a 5 percent increase, relative to sales, compared with 2008.</td>
<td>Projects in progress to reduce VOCs in several product areas, for example, the printing blanket area, which is a solvent-intensive production process.</td>
</tr>
<tr>
<td>Environmental management</td>
<td>71 percent.</td>
<td>A number of facilities are awaiting joint certification.</td>
</tr>
<tr>
<td>Water</td>
<td>2.5 million cubic meters (3.9), a 26 percent reduction, relative to sales, compared with 2008.</td>
<td>Comprehensive recycling projects in such facilities as Twid and Ermont have generated significant results. Focus will remain on the largest plants.</td>
</tr>
</tbody>
</table>

Trelleborg sustainability analysis highlights three central aspects that have been assigned high environmental priority both externally and internally. These include: product quality and safety; use of hazardous chemicals in manufacturing; and emissions to
air and water. Therefore, according to the environmental director of the company, J. Luis Losa, when developing a product the most important aspects that are taken into account are as follows:

- customer's requirements: “in the case of customer - tailored products, the customer may have specific requirements on shape, color, dimensions, durability, performance, used raw materials, etc. In order to achieve that, our engineers work in close cooperation with the customer to be able to clearly establish these requirements. It can happen that the customer may specifically require not using certain chemicals with respect to Global Automotive Substance Declarable List” (personal communication, 22.04.2010);

- product properties and performance: product - use conditions (chemical resistance, food contact quality, ageing, wear or mechanical resistance, etc.) and required performance (durability of the product depending on use and weather conditions, low vibrations, energy efficiency, etc.);

- raw materials and chemicals selection: “directly related to required properties and performance, raw materials and chemical selection is where we identify the most relevant environmental issues” (personal communication, 22.04.2010). Depending on the final properties and performance, different chemical substances will be used in the production process (manufacturing of rubber preparation which is a mixture of chemical substances and polymers, other auxiliary chemicals which may be used during the production process, etc.). However, some of them may be classified as hazardous according to the European Union or US legislation. Therefore, chemicals legislation is a key issue, since the use of some chemical substances may be prohibited or restricted.

As a chemical user, Trelleborg is affected by the EU chemical legislation REACH that implies restrictions in the use of polyaromatic hydrocarbons in extender oils and tires (REACH Regulation EC/1907/2006, for more information see http://sweden.intertek-etlsemko.com). The adoption of REACH legislation has continued in 2009 with a focus on communication with suppliers and customers regarding REACH-related issues to ensure compliance (Trelleborg Annual Report, 2009).

These considerations must address legal compliance requirements and customer requirements, product liability, as well as environmental, health and safety aspects in the manufacturing and use phase of the products. It can be concluded that, proactive work is under way in the Group to decrease Trelleborg’s environmental risks and environmental footprint, and consequently to increase resource efficiency. The priority areas, which are underlined in the Group’s environmental policy, are environmental management, material and energy efficiency, and environmentally compliant product and process development.

4.2.3 Critical factors

On the company (management) level the critical factors for integrating environmental issues into business activities are good communication with the customers and suppliers; internal know-how and expertise, access to relevant information and flexibility during production planning. Trelleborg encourages its suppliers and partners to comply with the same governmental demands and principles, and to join the UN initiative, the Global Compact—responsible business practices (Table 4.2). There have been taken
measures towards energy efficiency in form of Energy Excellence Program, and the new climate strategy.

Table 4.2 Suppliers’ commitment (Trelleborg, Sustainability Report, 2009)

<table>
<thead>
<tr>
<th>Suppliers</th>
<th>Self-assessment implemented at 250 highly prioritized suppliers, of which 25 percent was returned for further clarification.</th>
<th>The ongoing pilot project pertaining to self-assessment and auditing of highly prioritized suppliers will be further developed in 2010.</th>
</tr>
</thead>
</table>

The internal continuous work regarding the environmental issues is conducted through the mandatory training for all employees in both e-learning format and conventional classroom workshops. This learning process is intended to inform all employees about environmental, health and safety issues and involve them in a continuous improvement process.

Moreover, for the purpose to motivate employees and facilitate their performance and development, Employee performance reviews have been created within Trelleborg. In 2009, a shared internal tool was introduced to streamline this process and to make it uniform for the Group. At the review, the manager and employee discuss targets for the past year and the future, career development, mobility and development needs. Performance and potential are evaluated. If the employee has managerial potential, a development plan shall be prepared (ibid.).

4.3 Introduction: Kinnarps AB

Kinnarps is a Swedish manufacturing company with a head office in Kinnarp, Sweden. The company offers a wide range of complete solutions based on customers’ needs in the field of workspace interior. It was established in 1942 by Evy and Jarl Andersson. Kinnarps is the number one in Scandinavia and Europe’s second largest supplier of workspace interior solutions, with approximately 200 showrooms all over Europe. It is also represented in 35 countries all over the world. The turnover of the company is about 400 million Euros, and a number of employees is 2200. Kinnarps keeps under control the whole chain from sourcing of raw materials, production, logistics, delivery to installation and after-service (www.kinnarps.com).

Kinnarps has three plants that are situated in Kinnarp, Jönköping and Skillingsaryd. Kinnarp plant produces decks and assembles chairs, while Jönköping plant is dealing with the supply of metal components for those chairs. And finally, upholstered furniture is produced in Skillingsaryd plant. Kinnarps delivers approximately 350 000 cabinets, 330 000 table tops and 250 000 desk chairs per year. The company offers such services as transportation, installation and after service to its final customers (ibid.).

The business philosophy of Kinnarps is represented in a form of ‘snowflake’ and termed ‘better at work’ (Figure 4.2).

Figure 4.2 Snowflake “Kinnarps business philosophy” (Source: Kinnarps webpage, www.kinnarps.com).
This philosophy shows eight ways of creating efficient and inspiring environments where people work to become better. Along with quality, competence, economy, solutions, innovation, design and ergonomics, environment has been chosen as the way of developing a better work.

4.3.1 Kinnarps & Environment

What makes Kinnarps unique is its control over the whole business: from raw materials and production to the delivery and installation of complete furnishing solutions. It should be noted that environmental issues are taken into account all the way from the concept to the recycling and unique logistics. In order to be environmentally-friendly a holistic approach is applied instead of distinguishing single ‘green product’.

Kinnarps persistently keeps track of its materials in production which helps to assure that all timber supplies come from carefully monitored and certified forests. Through years Kinnarps has established a close cooperation with the Forest Stewardship Council (FSC), an independent international organization which guarantees that the world’s forests are used in a responsible way. This collaboration has resulted in the implementation of Chain of Custody certification which is perceived as a huge step towards assuring sustainable forestry. Kinnarps follows and exceeds the most stringent environmental requirements with help of the applied comprehensive environmental management system.

Since 1997 Kinnarps has certified its EMSs in accordance with ISO 14001. According to the questionnaire, factors such as: compliance with governmental regulations, improved operational performance, and mainly customer requirements serve as the motivations for the certifying EMSs. Moreover, it has been recognized, that EMS: ISO 14001 has helped to achieve the goals in such areas as design and development, manufacturing, environmental practices with sub-contractors and suppliers, waste management, and distribution. During the interview the sustainability manager states, ‘ISO 14001 has promoted an increased control over all the operations within the company due to required internal audits’ (H.Wahlgren, personal communication, 19.05.2010). Therefore, it can be concluded that ISO 14001 serves as an internal driver of the environmental work.

In the question about the benefits derived from implementing EMS: ISO 14001, Kinnarps, points out the following aspects: compliance with governmental legislations, resource utilization, waste generation, and improved financial performance. At the same time, it is noticed, ‘that all these benefits are possible to achieve and without an EMS, however, EMS works as the motor in the system to ensure all of the mentioned reasons above’ (H.Wahlgren, personal communication, 19.05.2010). As for the intangible benefits, employee morale, commitment and sense of pride, improved public image and community relations, as well as customer satisfaction can be emphasized.

Within the frames of ISO 14001, the following activities and documents have been established: Environmental policy; Environmental inspection; Risk assessment; Requirements on subcontractors; Continuous improvement of environmental targets; Internal and External audits.
The Environmental policy issued by Kinnarps is characterized by an active commitment to the environment and continuous improvement. The goal of all environmental activities within the company is to achieve long-term sustainable development. In order to reach this goal, Kinnarps has the intention to exploit as fewer resources as possible in order to reduce its negative environment impact. This can be achieved only if both management and all employees consciously follow this policy. Kinnarps environmental policy has a focus on ten main aspects that can influence the company’s performance: responsible forestry, efficient transportation, external and internal communication, employees’ competence, a good working environment, pollution prevention, economical use of resources, care about people and environment, life cycle approach and compliance with legislation (Kinnarps Environmental Policy, 2004).

4.3.2 Environmentally conscious design and manufacturing

In order to operate in an environmentally responsible way, Kinnarps intends to find a balance between daily environmental efforts, long-term planning and corporate vision. Such balance can be found in the company’s effort to reduce carbon dioxide emissions at the source. From an environmental point of view Kinnarps production is presented as a smarter product development, which implies lower material consumption, more efficient utilization and more recycling of raw materials. In order to reduce the material consumption and accordingly the waste generation, Kinnarps creates cyclic systems where by-products and waste can preferably be reused and if not, then, recycled (Kinnarps Environmental Declaration, 2008).

The overall production process is illustrated in the figure below (Fig.4.3), which provides an overview of the materials used and preventive measures taken in order to reduce the impact on the environment. Likewise, the figure shows what is being recycled in terms of materials and energy as well as what is being generated and produced in terms of emissions and products.

![Figure 4.3 Kinnarps’ overall production process (Source: Environmental Report, 2008, p.9).](image-url)
The production process is composed of inputs such as: chemicals, water, energy and different raw materials as wood, steel and fabrics; and outputs in the form of production and transport emissions, noise, furniture, water and other waste. All waste is sorted at source for energy generation and material recycling. From this figure, it should be noticed, that combustible waste such as wood, cardboard packaging and other non-reusable packaging is transformed into fuel briquettes. These briquettes are, in turn, used as fuel in the company’s own district heating plant which heats Kinnarps’ production buildings and offices. Over 70% of Kinnarps’ industrial waste is being reused by briquetting wood. This has been practiced within the company since 1977. As for non-combustible waste or other non-recyclable waste, it is sent for disposal. Disposed waste makes up only 1.5% of the total amount of solid waste, while metal waste including glue and lacquer containers, steel tape is sent for recycling (ibid.).

According to Kinnarps Environmental Declaration (2008), all used furniture can be processed 100% to obtain material or produce energy, as involved metals are recyclable; plastics are adjusted to material recycling or energy generation; all wood and fabrics are exploited for energy generation; and the electronic/electrical parts of desks can be separated and must not be disposed of (p.14).

In order to ensure more energy-efficient and less environmentally polluting recycling, the company emphasizes the importance of the material selection and labeling. Kinnarps’ range of materials consists of no wood from rainforests, but only from responsible managed and environmentally certified forests. All chemical products are supplemented with a safety data list to ensure environmental health and safety criteria. All substances are complied with the priority list published by the Swedish Chemicals Agency. As for chemicals, Kinnarps follows the EU chemicals legislation REACH (Registration, Evaluation, Authorization and Restriction of Chemical substances) which does not allow chemicals that may perform any harmful impact on health and environment (Kinnarps Environmental Declaration, 2008).

Moreover, rigorous demands are put on fabrics and textiles in order to provide environmentally conscious manufacturing process. Kinnarps fabrics follow the specification list for textiles, based on the requirements of the Nordic Swan eco-label, Good Environmental Choice, the EU Flower and Öko-Tex. The plastics which Kinnarps uses in production are labeled so that to enable the recycling process (ibid.). Clear identification of used materials, in turn, can facilitate the process of disassembly (colors, codes, etc.).

It can be summed up that when designing a product, significant attention is given to the material selection process. According to Kinnarps environmental policy, it is stated that, “The entire approach to product development is rooted in environmental thinking. Therefore, we analyze the environmental impact of our products and select all materials to ensure recycling for as much as possible” (company presentation files). The products are being developed at Kinnarps in an efficient and conscious ways for the company for the environment respectively. When designing a product, the company, therefore, intends to integrate form, function, and ergonomics together with environmental aspects.

Environmental activities in Kinnarps are characterized by the effort to offer products and services with a minimum environmental impact during their life cycle. Therefore, by applying life cycle approach in production processes and product development, the company aims at reducing the environmental impact of both its product and facilities. Hence, when reuse is no more an option, Kinnarps tries to go beyond the current legisla-
tion and proactively recycle as much as possible, carefully disposing of the rest (Kinnarps Environmental Report, 2008).

4.3.3 Critical factors

In order to fulfill its environmental goals, Kinnarps applies stringent demands on its suppliers. As it has been acknowledged during the interview with one of the suppliers, ‘by meeting the demands imposed by Kinnarps, our company can internally benefit by sustaining a high quality of the supplied textile’ (personal communication, S.Olsson, Väveriet i Uddebo AB, 21.05.2010). Moreover, by awarding the "Kinnarps Environment Prize" to deserving suppliers, the company can encourage the environmental activities, increase awareness and interest among its suppliers.

The issue concerning environment has become a part of the corporate culture. As a result, under the management of Human Resource department, the company has established a new branch, named Academy, which facilitates training to its suppliers and employees regarding quality and environmental issues. ‘Education and communication is the key to successful integration of environmental aspects in the entire process, points out H.Wahlgren. Moreover, it has been mentioned that to work with the EMS implementation, the support from the management is required. ‘Without this support, you will not succeed at having an effective implementation. Everyone involved need to understand their role and responsibilities in the process’ (H.Wahlgren, personal communication, 19.05.2010).

The process of implementing EMS: ISO 14001 is time consuming and costly for the company. But the real difficulty as H.Wahlgren states, ‘is to explain someone who has been doing their job for 10, 15 or 20 years that “now, we are going to work like this instead”. To get an understanding takes time and patience’. Therefore, constant communication, trainings and top management support have been distinguished as critical issues in implementing ISO 14001.
5 Analysis

This section intends to analyze the obtained theoretical knowledge and empirical results of the given thesis by using the research methods mentioned in the methodology chapter. The research questions will be answered in order to provide the understanding of the topic as well as completeness of the initially settled goals and purposes.

Due to the adopted deductive analytic strategy, the theoretical framework regarding the process of integration of environmental concerns into the company’s processes and products has been used as a predetermined analytical framework with the resulting data categories and related codes. However, the existing theory for formulating the research questions and objectives in the qualitative research has faced a major challenge of “being too premature to define the theoretical constructs before the investigations occurs” (Bruman, 1988 cited in Saunders et al., 2007). Therefore, the introduction of an inductively - based analytic strategy at a later stage has been necessary.

In order to analyze the information provided by the participants during the in-depth semi-structured interviews the narrative analysis is employed in the thesis. This analysis starts with the transcription of verbatim and handwritten notes of these interviews and is followed by the development of new constructs and relationships between the empirical data constructs. The process of coding and categorization is employed as both existing theories and empirical findings are supposed to be matched and combined. By analyzing the data inductively, new variables and components related to the subject have been found, such as “cultural and organizational changes”, which have not been originally stated within the deductive analysis when developing the theoretical framework.

The final and sometimes most difficult task for any research is to complete the paper and analyze the results achieved during the whole process of writing the thesis. In order to do this, it is recommended to look back at the stated purpose, particularly the research questions and estimate if they have been achieved and answered correspondently. The purpose of the thesis is to analyze why and how companies integrate environmental concerns in their business operations and organizational structure as well as to investigate the critical factors that enable such integration. Hence, the elements of environmentally conscious design and manufacturing (ECD&M) as well as environmental management systems (EMS) that can help and support companies in the process of integration environmental concerns into business activities have come under discussion.

5.1 Driving forces for environmental behavior

Over the last decades, both academic literature and business practices show an increasing interest in consideration environmental impacts within the business activities, ever since industrial development has brought prosperity and wealth together with triggering unintended ecological degradation (Seuring & Muller, 2008). In addition, scientific findings about climate change and environmental degradation depict that human’s impacts on natural environment poses a threat not only on a local or regional level, but also on the global ecosphere. This has increased awareness and concerns among stakeholders: customers, governmental and non-governmental organizations concerning environmental issues, and consequently, has placed an increasing pressure on company’s operations. As stated by stakeholder theory, stakeholder pressures induce environmental behavior and performance among various companies. Stakeholder pressure serves as a
powerful motivation or driving force for the companies to adopt environmental practices (Roberts, 1992).

**Legislation**

External stakeholders such as environmental protection agencies and government take a leading role in the transformation process and incorporating environmental issues into business activities. By establishing the wide range of environmental law as well as relevant regulations they encourage environmental behavior among companies. Moreover, there exist an expanding variety of instruments, market-based approaches, which serve as an effective means of addressing environmental issues (Schaltegger & Burritt, 2000). The group of financial instruments includes taxes, penalties, fines, subsidies, government procurement policy and government contract policies (Li, 2001). “Governments are increasing their demands on emission reduction, therefore Volvo Buses is constantly following new legislation, mostly US and European legislation” (Environmental director, Volvo Buses). Therefore, it can be underlined that measures taken by the government are perceived to affect a company’s bottom line, and thus, may serve as a leading trigger for change towards better environmental performance.

In order to follow governmental procurement policies, Kinnarps has established a close cooperation with the Forest Stewardship Council (FSC), an independent international organization which guarantees that the world’s forests are used in a responsible way. All chemical products are supplemented with a safety data list to ensure environmental health and safety criteria. All substances are complied with the priority list published by the Swedish Chemicals Agency. As for chemicals, Kinnarps follows the EU chemicals legislation REACH which does not allow chemicals that may perform any harmful impact on health and environment (Kinnarps Environmental Declaration, 2008).

Mandatory evaluation of all chemicals with regards to the environment, health and safety allows Trelleborg to record all risky chemicals. Moreover, the fulfilment of the requirements in EU REACH regulation facilitates the identification and substitution of hazardous chemicals. The internal company phase-out list of prohibited and restricted chemicals is under development. Once approved and implemented, Trelleborg will have clear internal guidelines on which chemicals cannot be used, and which other chemicals are restricted only for critical uses.

**Customers’ requirements**

In case of none compliance with regulatory stakeholders, companies can undertake the risk of individual or class action lawsuits. Such threats and pressures can hurt a reputation and image of the company as well as its relationships with customers (Cespedes-Lorente et al., 2003; Sarkis et al., 2010). The compliance with customers’ requirements plays a significant role in the customer-oriented companies, especially when it comes to the environmental performance of the provided products or services. “Right now customer's requirements and legal compliance are the main driving forces for integration environmental concerns into business activities”, (Environmental manager, Trelleborg).

As it has been noticed from the empirical findings, environmental issues remain a high priority for customers. It is up to them to accept and decide upon the products or services provided by the company. Companies might fear that customers would boycott their products if environmental problems were reported, which in turn, might lead to the loss in orders and reputation (Seuring & Muller, 2008). “Inadequate procedures of the man-
agement when dealing with environmental aspects can potentially harm the environment and thus the company’s reputation and relationships with the community” (Corporate communication, Trelleborg). Therefore, it is of a great relevance for the companies to address customers’ demands and concerns about environment. This view is also supported in the literature by Seuring and Muller (2008), who demonstrate how public and customers can put pressure on companies for taking responsibility for the environment.

Therefore customers influence to a great extent the environmental performance of producers and products by means of their purchasing behaviour. However two main issues arise from this observation:

(1) Since environmental impacts are closely related to materials and energy flows and these flows are in turn, tightly link to products (Ammenberg & Sundin, 2003), procedures related to product development, recycling, and pollution prevention; such as substitution of materials leading to environmental problems, redesigning to facilitate disassembly, the use of components for recycling, etc; would be heavily affected and determined by customers requirements.

(2) It remains questionable whether the market has the capacity to make accurate decisions that will reduce the environmental impacts of their products demand, i.e. whether customer are able to compare and analyze the environmental effects generated by their choices and make environmentally sound judgements (Berkel et al., 1999).

It has been noted that all three studied companies: Volvo Buses, Trelleborg and Kinnarps are highly customer-oriented, thus customers impose high demands on the products’ quality and specifications. In order to achieve and satisfy customers’ requirements, the engineers, for instance, in Trelleborg work in close cooperation with customers to be able to clearly establish and fulfill these requirements. In this case, close communication is vital, since customers may specifically demand not to use certain chemicals with respect to Global Automotive Substance Declarable List (GASD).

**Cost reduction**

Besides potential benefits from compliance with governmental legislation; innovation strategy, competitive advantage, and economic performance have been given much attention in both literature and empirical results. Some environmental practices are found to gain a certain social legitimacy, and convey the idea that they have a positive effect on financial performance (Porter & van der Linde, 1995; Klassen & McLaughlin, 1996; Eiadat et al. 2008; Lopez-Gamero et al. 2009). The environmental ambitions at Volvo Buses include increasing focus on cost control and decreased product costs. When assessing the benefits derived from certified EMS, it is considered that ISO 14001 has been particularly important for achieving improved control of costs thanks to the harmonized and consistent documentation of existing processes within Volvo Buses.

Supported by the implementation of the Manufacturing Excellence program which includes Energy Excellence, Trelleborg AB permits a more efficient use of resources in process and product development through the reduction of waste, waste recycling and energy conservation. Hence, due to the efficient use of resources, a company can decrease its manufacturing costs (Hui et al., 2000).
Melnyk et al. (2003) assume that better environmental management can lead to enhanced regulatory compliance, better operational and environmental performance which ultimately can improve the company’s bottom line. Achievements in this area within Volvo Buses include the decreased use of environmentally hazardous chemicals in accordance with Volvo’s chemical and product blacklists. The empirical findings of the studied companies show that at most production facilities, production waste and packaging materials are all source separated for recycling. In addition, transportation of materials to and from the facilities is being streamlined for a minimum of environmental impact. These activities in turn, lead to the improved business performance. All this allows companies to use raw materials, energy, or labour in a more effective way, and thereby reduce business or operational costs (Hui et al., 2000).

5.2 Proactive approaches towards better environmental performance

The industrial ecology and, consequently, environmental concerns have led manufacturing industry to take a proactive role in the development of cleaner manufacturing processes and the design of recyclable products. As a result, organizations have started to adopt proactive approaches thereby performing environmentally-conscious design and manufacturing (ECD&M) as well as implementing environmental management systems (EMS) which lead to better environmental and business performances. An increasing number of companies recognizes that adopting the ECD&M and EMS is an essential part of a green business strategy (Hui et al., 2000), where ECD&M aims at ‘minimizing the product’s environmental impacts during its design and manufacturing’ (Zhang et al., 1997, p.353), and EMS can provide ‘an effective guidance for companies to concurrently establish, develop and review their business practices towards corporate and environmental goals’ (Hui et al., 2000, p.269). The concepts of ECD&M as well as EMS are being further analyzed in accordance with the theoretical and empirical findings.

ECD&M

According to Zhang et al. (1997), the process of ECD&M is divided into two areas, such as environmentally-conscious product design (ECD) and environmentally-conscious process design (also called environmentally conscious manufacturing, ECM).

ECM

With a purpose to minimize the overall negative environmental impacts from production, environmentally conscious manufacturing (ECM) has gained much attention from both literature (Gungor & Gupta, 1999; Zhang et al., 1997; Young et al., 1997; Pujari et al., 2003; Ilgin & Gupta, 2010) and studied companies. Most popular activities found within the firms in terms of ECM are waste minimization and pollution prevention. Waste minimization embraces environmentally conscious recycling and source reduction, i.e. decreasing the amount of any hazardous substances, pollutants or contaminants (Zhang et al., 1997).

The compliance to the EU REACH legislation among the studied firms has assisted in elimination of chemicals that may perform any harmful impact on health and environment. Moreover, when manufacturing the products, firms generally try to avoid legal, but from the environmental perspective poorly performing materials.
All three companies actively participate in waste separation at source activities; all waste is sorted at source for energy generation and material recycling. Over 70% of Kinnarps’ industrial waste is being reused by briquetting wood, furthermore, all used furniture can be processed 100% to safe material or produce energy. According to estimations within Volvo Buses, about 70% of a bus consists of various metals for which established recycling systems already exist. The rest consists of wood, glass, rubbers and plastics, etc. which mostly is sent to landfills, or can be used as fuel in order to recycle the energy. Due to the implementation of the recycling systems at Trelleborg, major savings have been achieved in the areas of waste reduction. The emissions to water are limited and mainly comprise organic material.

According to the questionnaire, with respect to the environmentally friendly process design, activities such as: use of systems to prevent possible accidents and environmental emergencies in the company; filters and controls for emissions and discharges; systematic control of the energy used; and use of standardized and re-usable packaging to facilitate its return from clients, have been recognized by all studied companies.

**ECD**

In the world, where environmental performance has been acknowledged as something most companies strive for, there is an underlying demand for environmentally conscious products which are more resource efficient and less polluting. With respect to the increasing awareness and importance of the environmental issues, certain environmental criteria are forced to be addressed when designing a product. Hence, a number of methodologies have been developed in order to help product designers make environmentally friendly design choices (Ilgin & Gupta, 2010). The existing methodologies, such as Life Cycle Assessment (LCA), Design for Environment (DFE), and material selection are being discussed in the literature and partly practiced within the studied companies.

Taking into consideration the entire life cycle of the product and process has been recognized as one of the environmental goals within the studied companies. Volvo Buses uses LCA to consider the alternative solutions available after studying and evaluating the potential impact of products and materials. The results of these life cycle methods have revealed that more than 90% of the total environmental impact of a bus arises when it is in use. Therefore, the company’s focus is on reducing fuel consumption, carbon dioxide emissions and other air pollutants that might be harmful to human beings and the environment.

Although LCA is the most reliable method for outlining the environmental performance of products, still the implementation and the use of the method in product development is disadvantaged by its complexity, comprehensive scope and time-intensive application (Brezet & Hemel, 1997). Therefore, in order to facilitate the process, the integration of internal and external stakeholders into product development processes, is critical. Some practices conclude that LCA is more suitable when re-designing products (Ritzen et al., 1996; Melnyk et al., 2003). “An important aspect when developing new products is that they should have lesser environmental impact than the products they replace, therefore in house experts and cross functional teams need to carry out and obtain specific product related information through LCA” (Environmental director, Volvo Buses).

According to Ilgin and Gupta (2010), DFE is used for the purpose of addressing environmental issues in product development and consequently guiding design and engi-
neering efforts towards environmental protection. The main goal of DFE is to develop sustainable products which allocate as few resources as possible without compromising other criteria as quality, functionality, cost and appearance (Magnusson, 2000). As it has been found during the research, both functional and commercial aspects are still a higher priority when designing a product. “More environmentally friendly chemicals may be used, but the customers have to be ready to pay a related extra cost” (Environmental manager, Trelleborg).

Although DFE has not gained much attention among studied companies, still some elements of this methodology are being practiced. The questionnaire reveals that the most common procedures in terms of design among the companies are the use of component joints that are easy to assemble and disassemble and clear identification of the used materials in order to facilitate disassembly (colors, codes, etc.). In addition to this, material selection process has been recognized in all three organizations as a vital component in a product design. Volvo Buses has applied Black and Grey lists and GADSL for material guidance. Before 2011, Trelleborg is planning to establish a list of substances to be phased out, once approved, it will be easier for the company to use clear internal guidelines on which chemicals cannot be used, and which other chemicals are restricted only for critical uses. All substances at Kinnarps are complied with the priority list published by the Swedish Chemicals Agency. As for the chemicals, the company follows the EU chemicals legislation REACH which does not allow chemicals that may perform any harmful impact on health and environment.

**EMS**

In order to meet environmental demands and legislation requirements that were introduced during the late 1970s and 1980s, the systems for directing environmental management were needed. According to Magnusson (2000), managers and companies try to address the concerns about ecological compliance by implementing environmental management system (EMS) as a value-added activity. Therefore, EMS can be considered as a management tool used by a company so that to direct and control its environmental efforts (Ammenberg, 2003). Volvo Buses has recognized that environmental management is a critical element for achieving and promoting its long-term sustainability goals in reducing the environmental impacts resulting from its production processes and activities, products, and its own transports.

For the purpose to support companies in the process of integrating environmental concerns in organizational structure, the application of EMS has been recognized as one of the most practiced procedures among the investigated companies. The implementation of an EMS is customized for the organization that adopts it, however when developing the EMS some generic steps can be followed according to Kitazawa and Sarkis (2000).

The first step consists of the establishment of a well-defined and open environmental philosophy. Thus, in their business policy, all three studied companies make reference to actual commitments to environmental improvements and pollution prevention efforts. After this step, it is necessary to establish the environmental objectives and targets including environmental management structure and actions in order to achieve these environmental goals (ibid.). Accordingly, environmental goals of Volvo Group are used as a self-assessment tool for monitoring the entire organization. The goal of all environmental activities within Kinnarps is to achieve long-term sustainable development. As stated in Trelleborg’s Sustainability Report (2009) the company’s environmental goals
include avoidance or elimination of hazardous chemicals and materials used in products and processes. These goals are in turn, tightly related to customers who specify products’ characteristics and inputs. These goals are carried out at a local and central levels. The structure for achieving environmental goals is based on cross-functional teams approach and basically depended on environmental managers, coordinators that are assigned for each plant.

Since an important component of EMS is continuous improvement, the third step is designed to monitor and record the day-to-day operations and related inconsistencies within the system. All facilities are required to be consistent with the overall Volvo Group’s environmental continuous improvement policies regarding the use of chemicals, energy consumption, air and water emissions and waste management practices. Thus, Volvo’s Buses internal policy of continuous improvement aims at reducing the environmental impact of its products, operations and services by taking into account the complete life cycle; making pollution prevention as a prerequisite for all operations; and encouraging suppliers, dealers and other business partners to adopt the principles of this policy. In order to monitor and record the day-to-day operations and related inconsistencies within the system, risk assessment programs are observed in the literature (Ammenberg & Sundin, 2003; Kitazawa & Sarkis, 2000; Darnall & Edwards, 2006; Morrow & Rondelli, 2002) and highly practiced within the investigated companies.

Finally, according to Kitazawa and Sarkis (2000), in order to adjust the system and secure its continuous improvement, it is important to undertake internal audits and reports, document actions and incorporate new environmental concerns and recommendations. Follow-up is conducted at Trelleborg annually through self-assessments and audits. Within certain areas, self-evaluation and internal audits are reinforced by external audits, such as ISO 14001 environmental audits. While at board level, it is the Audit Committee that has the task of supporting and following up the work on corporate responsibility issues. Audits at Volvo Buses are carried out under its certified EMS which covers its whole value chain i.e. from product development and purchasing to after service and product take back or disposal. Environmental activities for auditing include monitoring the wastes and emissions as well as the resources, particularly energy consumption of the operations and activities of business units. Within the frames of ISO 14001, Internal and External audits have been established at Kinnarps.

Among the proactive activities towards environment, the most popular one that is observed in the literature and practiced by the investigated companies, is the implementation of the certified EMS. In order to offer better guidance during the EMS adoption process, ISO created its international EMS standard, ISO 14001 (Darnall & Edwards, 2006). ISO 14001 examines the environmentally related elements of a facility, a single plant or a whole organization. This includes the allocation of resources, the alignment of roles and responsibilities, and the systemic evaluation of practices, procedures and processes; in order to give consistency, coherence and proactivity to the environmental activities and practices of a firm (Lin et al., 2001). All three companies have introduced a certified EMS, namely series of ISO 14000 that encourages conscious business practices and making pollution prevention as a prerequisite for all operations. ISO 14001 is a critical element for all environmental efforts which has become mandatory for all production plants within investigated companies.

Benefits from EMS
It has been found in the literature (Melnyk et al., 2003; Lin et al., 2001) that ISO 14001 takes into account the processes involved in the creation, management, and elimination of pollution rather than on the outcomes of processes. The implementation of ISO 14001 certified EMS, programs for operational safety and resource efficiency in manufacturing allows Trelleborg to minimize and prevent operational risks in all production units. In other words, this standard is designed to improve the environmental management structure of a company rather than bringing up changes in the environmental performance by settling a particular output level for the company (ibid.). The implementation of ISO 14001 has facilitated and increased control over all operations within Kinnarps due to the required internal audits. Moreover, the standard has been identified as an internal driver for the environmental work in the company.

According to Melnyk et al. (2003) the implementation of a formal EMS can be a time consuming task and potentially expensive to undertake. Nevertheless, referring to Klassen and McLaughling (1996) there are some potential financial, operational, internal as well as external benefits that can be obtained from its implementation. Melnyk et al. (2003) state that by forcing people to get involved and gain knowledge about the various processes of ISO 14001 the company achieves real and long term improvements not only in the decreased amount of pollution that it generates but also in an increased level of its operational performance. This view is also promoted by Morrow and Rondinelli (2002), who argue that the most applicable benefits are better organization and documentation of the environmental activities, increased legal certainty, improved image and greater employee motivation. Thus, according to the environmental director at Volvo Buses, the implementation of ISO 14001 has given not only a possibility to handle environmental risks in a systematic and preventive manner, but also a rise to employees’ morale, commitment, and sense of pride. Moreover, when assessing the benefits derived from the certified EMS, Volvo Buses considers that ISO 14001 is particularly important for the achieving improved control of the costs thanks to the harmonized and consistent documentation of the existing processes. Other intangible benefits include improved base for public relations and enhanced support from customers in dialogue with authorities.

Sroufe (2003) explains that pollution prevention programs can reduce regulations fines and penalties as well as the energy and material costs. At the most fundamental level an EMS facilitates the compliance between management practices and governmental regulations. Moreover, as stated in the literature, EMS is used not only to assist companies in maintaining regulatory compliance but also in achieving waste reduction goals beyond regulatory requirements (Darnall & Edwards, 2006). Thus, EMS: ISO 14001 has assisted Volvo Buses in achieving improvements in all manufacturing areas, particularly, in design and product developments by reducing the environmental workload of product life cycle practices, thereby contributing to the overall reduction of operations impacts.

5.3  Critical factors enabling the integration of environmental concerns in business activities

Supplier involvement

The close cooperation with suppliers is recognized in the literature as a critical element when considering environmental issues in business activities (Johansson, 2002). Placing demands on some level of environmental work among suppliers is believed to reach a
higher level of security when it comes to the environmental performance of the products (ibid.). Thus, Trelleborg encourages its suppliers and partners to comply with the same regulatory demands and principles, and to join the UN initiative, the Global Compact—responsible business practices, energy efficiency program, and climate strategy.

The environmental program at Volvo Buses also requires business partners to support the subsidiaries’ environmental efforts. Suppliers of production materials and services must be third party certified ISO 14001 or EMAS, while also comply with Volvo’s Black and Grey list when delivering chemicals or materials that will be included in Volvo’s products or services. Volvo demands all its suppliers to take responsibility for minimizing the environmental impacts of the products, including packaging, recycling and design solutions. In this way Volvo Buses secures a minimized total environmental impact and reduces the potential risks related to the reliance on suppliers.

As it has been already mentioned, to be environmentally responsible does not stand alone nor applies to one company. The support and compliance to governmental regulations among suppliers is also vital. According to Kinnarps, having the suppliers on board takes just as long time as the internal processes but is equally crucial for running a good environmental operation. Therefore, the supplier’s participation in or adoption of environmental practices plays a significant role when considering all business atmosphere.

**Top management support & cross-functional integration**

The integration of the environmental aspects is a task that imposes a change within a company. The most important to consider when conducting a change is what to change and how to change. The ability of the company to impact the change process will determine and bring about the improvements concerning the environmental aspects. In the literature cultural change has been admitted as one of the major barriers when considering environmental issues in business activities (Tingström, 2007; Kitazawa & Sarkis, 2000). This change, according to DeMendonça and Baxter (2001), implies cross-functional integration, which is necessary in order to improve communication throughout the company and the whole production chain. As it has been mentioned before, engineers in product development department at Trelleborg work together with chemists from R&D, environmental managers, technical managers and production managers. This cross-functional integration in turn, can facilitate the process of integrating environmental issues into product development projects.

Top management support and commitment has been identified by Pujari et al. (2003) as a crucial issue, since the integration of environmental concerns into business processes can represent a major challenge to the existing culture. In order to successfully implement the change, a strong leadership and active support from the top management of a company is required (ibid.). Therefore, a strong leadership as well as support from top level managers have been recognized as certainly necessary for comprehension and commitment to environmental issues in the studied companies.

According to Pujari et al. (2003), successful integration of the environmental concerns in business activities is also dependent on the significant investment in appropriate technologies and capabilities. Therefore, resource commitment is of a great importance. According to the questionnaire sent out to the companies, it is possible to assume, that the resources to document existing processes, as pointed out by Volvo Busses; labor and money, as mentioned by Trelleborg; and understanding from personnel in Kinnarps are
crucial and of a great importance for the process of integration of environmental concerns in business activities. Mainly time and human resources, but also the lack of acceptance from the managerial personnel as well as other employees have been identified by the environmental manager at Derome AB (one of the companies participated in the questionnaire).

Referring to the empirical findings and literature review it can be derived that employees can pose difficulties in the process of incorporation of the environmental concerns in business activities, thus, top management support and commitment is crucial.

**Employees’ commitment**

Among the reasons for adopting the environmental practices, both theory and empirical study identify the compliance with legislation and satisfaction of customers’ demands concerning the environmental work. Volvo Buses enhances this view with the essence of employees, who according to Roberts (1992) can initiate or address proactive environmental activities with the support from management. Strong leadership and support from top level managers, referring to Sarkis et al., (2010) is certainly necessary for comprehension and commitment to environmental issues in a company. In fact, special programs, service workshops and extensive training allow Volvo Buses to increase workforce motivation, co-operation, commitment and internal mobility.

The analysis of the empirical findings shows the continuous participation in employees’ training programs within the studied companies, which seems to be a proven trend when adopting environmental practices. Thus, Volvo Buses fosters employees’ skills development through continuous training at both individual and manager levels. Based on e-learning format and conventional classroom workshops, employees at Trelleborg participate in the internal mandatory trainings regarding environmental issues. Kinnarps has developed a special branch responsible for learning processes within the company. ‘Education and communication is the key to success’ (Sustainability manager, Kinnarps).

In order to ensure that employees clearly understand their role in the team and what is expected from them, constant communication is proven to be vital by the studied companies and observed literature (Kitazawa & Sarkis, 2000; Johansson, 2002). Furthermore, the dissemination of the corporate environmental goals to the employees through the communication channels plays a significant role. This process, as Pujari et al. (2003) explain, facilitates the employees’ involvement and awareness about environmental concerns. Thus internal communications channels, e.g. TrellNet (intranet), E-Connect (digital newsletter) and Connect (internal magazine) is used in Trelleborg to enhance dialogue with employees.

Employees’ involvement, knowledge and competence are found to be critical within studied companies, as they allow successful integration of environmental activities in business operations. Moreover, according to DeMendonça and Baxter (2001), the overall employee participation and empowerment is essential for diagnosing waste stream problems and providing remedies. Indeed, production employees work on the field and are the most likely to know the causes of waste and possible solutions.
## 5.4 Cross-case analysis

The summary of the cross-case analysis is shown in the table 5.1 which gives an overview of the studied cases together with the reviewed concepts.

Table 5.1 Cross-case analysis

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<th>Volvo Buses</th>
<th>Trelleborg</th>
<th>Kinnarps</th>
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<tbody>
<tr>
<td><strong>Driving forces</strong></td>
<td><em>Legislation:</em> EU regulations on heavy duty vehicles; Global Automotive Declarable Substance list (GADSL)</td>
<td><em>Legislation:</em> EU REACH (Registration, Evaluation, Authorization and Restriction of Chemical substances); GADSL</td>
<td><em>Legislation:</em> Forest Stewardship Council (FSC); Swedish Chemicals Agency; EU REACH</td>
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<td><em>Customers’ requirements</em></td>
<td><em>Customers’ requirements</em></td>
<td><em>Customers’ requirements</em></td>
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<td><strong>External stake-holders</strong> (Schaltegger &amp; Burritt, 2000; Roberts, 1992; Li, 2001)</td>
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<td><strong>Internal Stake-holders</strong> (Roberts, 1992; Sarkis et al., 2010; Li, 2001)</td>
<td>Employees as a source of embracing environmental operational activities</td>
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<td><strong>Eco-efficiency</strong> (Porter &amp; van der Linde, 1995; Klassen &amp; McLaughlin, 1996; Eiadat et al., 2008; Hui et al., 2000)</td>
<td>Cleaner technology: Fuel efficient Selective Catalytic Reduction route; fuel efficient engines; Volvo Emission Control; Environmentally Enhanced Vehicle emission requirements; cost control</td>
<td>Resource and operational efficiency; Energy Excellence Program; Environmental Blue Grading (environmental risk assessment model)</td>
<td>Raw material selection criteria based on efficiency, Increased material utilization efficiency and more recycled material.</td>
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<td><strong>Environmental Practices</strong></td>
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<td><strong>ECM</strong></td>
<td>Pollution prevention; waste management; recycling, remanufacturing, reusing; reduction of energy and water consumption; waste is sorted at source;</td>
<td>Energy efficiency; recycling systems; reduction of carbon dioxide emissions; decreased use of hazardous chemicals in manufacturing; control of emissions to air and water;</td>
<td>Lower material consumption; waste reduction policies: waste is sorted at source; recycling; reusing; fuel briquettes made up from the waste is used for heating facilities</td>
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<td><strong>ECD</strong></td>
<td>DFE; Volvo Production System to facilitate product returns from clients</td>
<td>LCA; Volvo’s EPS system (Environmental Priority Strategies in Product Development)</td>
<td>Life-cycle approach</td>
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<td></td>
<td>Material selection: Black and Grey Lists, Substances and chemical checklists;</td>
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<td>Suppliers (Johansson, 2002)</td>
<td>Vendor selection process: ISO 14001 or EMAS certifications, compliance with Volvo’s Black and Grey Lists</td>
<td>UN initiative, the Global Compact – to ensure responsible business practices among suppliers; Self-assessment and auditing of prioritized suppliers</td>
<td>Certified suppliers: ISO or EMAS; ‘Kin-narps Environmental Prize’ to deserving suppliers</td>
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<tr>
<td>Employee commitment, communciation, (DeMendonca &amp; Baxter, 2001; Pujari et al., 2003; Johansson, 2002; )</td>
<td>‘Business plans’ for employees, environmental managers; training programs and courses plus frequent performance reviews</td>
<td>E-learning and e-training programs, conventional classroom courses</td>
<td>Suppliers and employees’ training regarding quality and environmental issues; own branch responsible for learning process (Academy)</td>
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<tr>
<td>Top management support; cross-functional integration (Sarkis et al., 2010; Kitazawa &amp; Sarkis, 2000)</td>
<td>Top management support</td>
<td>Employee performance review by support of a manager</td>
<td>Top management support</td>
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<td></td>
<td>Cross-functional integration between marketing, R&amp;D and production facilities</td>
<td>Engineers in product development work together with chemists from R&amp;D, environmental and technical managers.</td>
<td>Cross-functional integration between marketing, R&amp;D and production facilities</td>
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6 Conclusion

This section intends to finalize the theoretical knowledge and obtained empirical results by summarizing the answers of introduced research questions in order to either verify or find differences between the theoretical framework and empirical findings.

Remarkable competition among consumers, industrial and service companies is taking place all over the world. Since society becomes more anxious about the natural environment, businesses have started to adjust their behavior with the purpose to address stakeholders’ environmental concerns. This growing awareness about environmental impacts of production activities has led to a renewed interest on the issues related to the proactive “pollution prevention” waste minimization practices, environmental management systems introduction, and generally, integration of the environmental concerns into corporate activities and day-to-day operations.

Having in mind the purpose of the thesis which is to analyze why and how companies integrate environmental concerns in their business operations and organizational structure as well as to investigate the critical factors that enable such integration, the conclusion derived is based on the theoretical framework as well as the conducted empirical study.

Q.1. What are the driving forces for considering environmental aspects in business activities?

The theoretical framework demonstrates the importance of the external and internal pressure on the performance of the company, namely: governmental regulation, customers’ demands, environmental and social pressure groups. It has been noticed that environmental cooperation with stakeholders has a radical impact on the long-term corporate performance. Therefore, this pressure is more likely to serve as an incentive leading the companies to take an action towards environmental protection.

The investigation of the driving forces towards environmental behavior among the studied companies is reflected in the notion of customer-orientation, and the importance of the governmental legislation. Therefore, the compliance to both governmental regulations and customers’ demands has played a major role in the question of why companies consider environmental factors in their business activities. It can be concluded, that the main reasons for adopting the environmental practices that have been identified in both theory and practice within this work are the compliance with legislation as well as the satisfaction of customers’ demands concerning the environmental work.

Nowadays, the environment is no longer perceived as a barrier in business activities, but rather as a driver towards better performance and eco-efficiency. It indicates in the literature and practice, that the environmental challenges that organizations face every day, can also be translated into opportunities for cost reductions through ecological efficiencies and the development of green markets, first-mover advantage, better community relations and improved image (Porter & Van der Linde, 1995; Yakhou & Dorweiler, 2002). Therefore, in order to stay competitive and successful on the market, companies find it beneficial to follow eco-efficient strategies.
Q.2. By which means can companies integrate environmental concerns in their operational activities and organizational structure?

As for the ways of incorporating environmental concerns into the operational activities and organizational structure, the evidence of performing environmentally-conscious design and manufacturing (ECD&M) as well as implementing environmental management systems (EMSs) has been found.

With respect to ECM, improvements in material utilization, hazardous waste and emissions reduction, efficient energy consumption have been found to a greater extent within the investigated firms. The use of systems to prevent possible accidents and environmental emergencies; filters and controls for emissions and discharges; systematic control of the energy used; and the use of standardized and re-usable packaging to facilitate its return from clients have been recognized as the most practiced activities by studied manufacturing companies.

When weighing the evidence of environmentally friendly design, products are rarely brought up as significant environmental aspects even though they represent a large part of the manufacturers material flows. Yet a great attention is put on manufacturing processes and manufacturing facilities. The most reasonable interpretation to why manufacturers do not prioritize products as major environmental aspects is due to the fact that it is hard for the company to follow what happens to the product after leaving the manufacturing facility. It is therefore much easier to put much efforts and attention on the facility and its emissions. Another argument is that products are still not within the main focus of ISO 14001. Hence, if existing standardized EMSs had a stronger connection to the products, then the environmental problems from products’ life cycles would be reduced. This in turn, would increase the environmental efficiency of EMS.

Although the research has pointed out that DFE is an important way for manufacturing companies to reduce their impact on the environment, still its application within the studied companies has a tendency to be weak. Indeed at Volvo Buses it is applied for all construction projects, whereas at Trelleborg and Kinnarps it appears relatively more likely that DFE efforts tend to be short-term projects, rather than a part of the daily product development process. Therefore, by integrating a DFE into the EMS could make these DFE efforts more cohesive with product development process. This in turn could assist in achieving continuous improvements and advanced environmental targets in product design.

While DFE has not gained much attention in practice, still some elements of this methodology are being experienced by studied companies. The most common practice in terms of design among the studied companies is the use of component joints i.e. that are easy to assemble and disassemble and clear identification of used materials in order to facilitate disassembly (colors, codes, etc.). In addition to this, material selection process has been recognized in all three organizations as a vital component in product design. Although LCA is the most reliable method for outlining the environmental performance of products from raw material extraction to disposal and eventually take back phase of products, still the implementation is found mostly in Volvo Buses. Since the use of this method in product development is disadvantaged by its complexity, comprehensive scope and time-intensive application. Nevertheless, the life cycle approach is applied in Kinnarps with a purpose to decrease the overall environmental impact of its products.
The most common practice experienced by all studied companies is the implementation of the certified EMSs, which in turn assist companies in directing and controlling corporate efforts towards environment.

Q.3. What are the benefits from implementing the EMS into business practices?

The analysis of the empirical and theoretical data, gives reason to assume that at the most fundamental level an EMS facilitates the compliance between management practices and governmental regulations. Moreover, EMS can be used not only to assist companies in maintaining regulatory compliance but also in achieving waste reduction goals beyond regulatory requirements.

As a whole, the investigation of the benefits companies can achieve from the implementation of EMSs includes the compliance to governmental legislations, resource utilization, waste generation, and improved financial performance. In this case if correctly implemented, the EMS works as the motor in the system to ensure the mentioned benefits.

By focusing on each of the processes, ISO enables the studied companies to develop better environmental management practices which ultimately can lead to the improvement of its environmental performance. Thus, EMS: ISO 14001 has assisted Volvo Buses in achieving the improvements in manufacturing areas, by reducing the environmental workload of product life cycle practices, thereby contributing to the overall reduction of operations impacts.

Q.4. What are the critical factors that enable the integration of environmental concerns within the company?

The process of integration of the environmental aspects is a task that imposes a change within the company. The most important to consider when conducting a change is what to change and how to change. The ability of the company to impact the change process will determine and bring about the improvements concerning the environmental aspects. Therefore, cultural change has been admitted as one of the major barriers when considering environmental issues in business activities. To change employees’ mindset remains a big issue for a company, therefore, the communication and learning programs along with top management support are prescribed in the literature and practiced within the studied companies. This in turn will ensure the commitment to environmental activities and the awareness of roles and responsibilities among employees.

A manufacturer’s eco-performance is to a large extent dependent on the ‘upstream’ environmental impacts. Therefore, it is important for a company to work in partnership with suppliers so that to include environmental factors in their supply operations. It can be concluded that for a successful integration of the environmental issues in business practices, such factors as: cross-functional integration and communication, clearly defined responsibilities and roles, employee empowerment and involvement, top management support, resource commitment, and supplier involvement are recognized to be critical in both literature and investigated companies.
7 Recommendations for future research

This section aims at drawing on the ideas for further investigation in the area of environmental business practices.

With respect to the employed research methodology, the thesis implies inability to generalize for all organizations and industries, since a manufacturing perspective of large corporations has been applied in the given paper. Therefore, there is a need to investigate the process of adoption of environmental practices in small and medium enterprises (SME). In order to get a broader picture, service sector should also be taken into consideration. However, there has been a notion of social issues; still there is a need to further investigate the environmental practices towards sustainable development which includes consideration of environmental, economic as well as social issues.

Moreover, a deeper investigation of environmental management accounting that can demonstrate the cost-benefit side when implementing eco-efficient strategies in business activities could contribute to further research. Likewise, the statistical evidence of implemented practices as well as real examples that show the profitability of these eco-efficient strategies could also add more value to the development of the topic.

The investigation of different types of leadership and their influence on the environmental practices implemented as well as the inclusion of the shareholders’ view and values would enlarge and provide the opportunity to consider the problem from the shareholders’ perspective. A wider perspective of employees’ attitudes, suppliers and customers’ views towards environment would expand the picture and in fact provide a deeper view on the process of incorporation of environmental aspects in business activities.

Due to the geographical situation, the research has been conducted with Swedish manufacturing firms, therefore, the analysis or comparison between other countries could be beneficial. As a highly-developed country, Sweden with its orientation on social and environmental protection, and with high level of innovative environmental activities can serve as a good example for developing countries who have just started taking steps towards environment and eco-efficiency. Moreover, this research on the integration of the environmental factors into business activities can provide an overview of the common practices and offer a guidelines for managers to follow.

The findings of a given research gives roots to the development of the topic of eco-innovation, where environmentally friendly design and manufacturing serves as a the theoretical foundation. In addition, this study can contribute to the further development of the Product Oriented Environmental Management Systems (POEMS) which focuses on the products rather than on facilities with a help of LCA and DFE.
List of references


**Secondary material**


Miljövarudeklaration Volvo 8500 Lägentre led buss, 2002
Appendix 1

The governmental legislation regarding the environment in Sweden is represented in environmental acts and codes below (source: http://www.lexadin.nl).

Environmental Law

- Fishery Conservation Areas Act (SFS 1981:533)
- Forest Act
- Forest Act 2004
- Heritage Conservation Ordinance (1988:1188)
- Ordinance (2001:527) on Environmental Quality Standards on Ambient Air
- Public Water Areas (Boundaries) Act (SFS 1950:595)
- Radiation Protection Act (1988:220)
- The Animal Welfare Act
- The Animal Welfare Ordinance
- The Swedish Environmental Code
## Appendix 2

The definitions of Design for Environment as well as ecodesign are represented in the following table.

Table. Examples of different definitions within the DfE subject area (Source: Johansson, 2001).

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design for Environment (DfE)</td>
<td>“systematic consideration, during new product and process development, of design issues associated with environmental and human health and safety over the full product life cycle” (Fiksel, 1993)</td>
</tr>
<tr>
<td>Ecodesign</td>
<td>“Design which address all environmental impacts of a product throughout the complete life cycle without unduly compromising other criteria like function, quality, cost and appearance” (Poyner and Simon, 1995)</td>
</tr>
<tr>
<td></td>
<td>“Ecodesign considers environmental aspects at all stages of the product development process, striving for products that make the lowest possible impact throughout the product life cycle” (Brezet and van Hemel, 1997)</td>
</tr>
<tr>
<td>Eco-effective design</td>
<td>“Eco-effective product design aims to systematically establish and implement goals in product design with the aim of improving environmental performance” (Frei, 1998)</td>
</tr>
<tr>
<td>Environmental Responsible Manufacturing (ERM)</td>
<td>“a system which integrates product and process design issues with issues of manufacturing production planning and control in such a manner as to identify, quantify, assess and manage the flow of environmental waste with the goal of reducing and ultimately minimizing its impact on the environment while also trying to minimize resource efficiency” (Melnyk and Smith, 1996)</td>
</tr>
<tr>
<td>Green design</td>
<td>“a design process in which environmental attributes are treated as design objects or design opportunities, rather than as constraints. A key point is that green design incorporates environmental objectives with minimum loss of product performance, useful life, or functionality” (U.S. OTA, 1992)</td>
</tr>
<tr>
<td>Life cycle design</td>
<td>“takes concurrent engineering one step further, whereby all life cycle phases – need recognition, development, production, usage, and including disposal or recycling – are considered simultaneously from the conceptual design stage through the detail design stage” (Alting, 1993)</td>
</tr>
</tbody>
</table>
# Appendix 3 Overview of DFE practices

Table. Overview of DFE practices (Source: Zhang et al., 1999)

<table>
<thead>
<tr>
<th>Design for Recovery and Reuse</th>
<th>Design for Energy Conservation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design for material recovery</td>
<td>Reduce energy use in production</td>
</tr>
<tr>
<td>Avoid composite material</td>
<td>Reduce device power consumption</td>
</tr>
<tr>
<td>Specify recyclable materials</td>
<td>Reduce energy use in distribution</td>
</tr>
<tr>
<td>Use recyclable packaging</td>
<td>Reduce transportation distance</td>
</tr>
<tr>
<td>Design for component recovery</td>
<td>Reduce transportation urgency</td>
</tr>
<tr>
<td>Design reusable containers</td>
<td>Reduce shipping volume required</td>
</tr>
<tr>
<td>Design for refurbishment</td>
<td>Use renewable forms of energy</td>
</tr>
<tr>
<td>Design for remanufacture</td>
<td>Design for Material Conservation</td>
</tr>
<tr>
<td>Design for Disassembly</td>
<td>Design multifunctional products</td>
</tr>
<tr>
<td>Facilitate access to components</td>
<td>Specify recycled materials</td>
</tr>
<tr>
<td>Optimize disassembly sequence</td>
<td>Specify renewable materials</td>
</tr>
<tr>
<td>Design for easy removal</td>
<td>Use remanufactured components</td>
</tr>
<tr>
<td>Avoid embedded parts</td>
<td>Design for product longevity</td>
</tr>
<tr>
<td>Simplify component interfaces</td>
<td>Extend performance life</td>
</tr>
<tr>
<td>Avoid springs, pulleys, harnesses</td>
<td>Design upgradable components</td>
</tr>
<tr>
<td>Avoid adhesives and welds</td>
<td>Design reusable platform</td>
</tr>
<tr>
<td>Avoid threaded fasteners</td>
<td>Design for serviceability</td>
</tr>
<tr>
<td>Design for simplicity</td>
<td>Design for durability</td>
</tr>
<tr>
<td>Reduce product complexity</td>
<td>Design for closed-loop recycling</td>
</tr>
<tr>
<td>Reduce number of parts</td>
<td>Design for packaging recovery</td>
</tr>
<tr>
<td>Design multifunctional parts</td>
<td>Design reusable containers</td>
</tr>
<tr>
<td>Utilize common parts</td>
<td>Develop leasing programs</td>
</tr>
</tbody>
</table>

Design for Waste Minimization | Design for Chronic Risk Reduction |
Design for source reduction | Reduce production releases |
Reduce product dimensions | Avoid toxic/hazardous substances |
Specify lighter weight materials | Avoid ozone-depleting chemicals |
Design thinner enclosures | Use water-based technologies |
Increase liquid concentration | Assure product biodegradability |
Reduce mass of components | Assure waste disposability |
Reduce packaging weight | Design for Accident Prevention |
Use electronic documentation | Avoid caustic and/or flammable materials |

Design for Separability | Avoid pressure relay |
Facilitate identification of materials | Minimize leakage potential |
Use fewer types of materials | Use childproof closures |
Use similar or compatible materials | Discourage consumer misuse |

Avoid Material Contaminants | Design for Waste Recovery and Reuse |
Design for Waste Recovery and Reuse | Design for Waste Incineration |
Appendix 4

The following figure represents the aspects that should be taken into consideration in the process of product development:

Figure. Representation of all the demands that must be addressed in product development (Source: Luttropp & Lagerstedt, 1999).
Appendix 5

Creswell (2003) focuses on three research method approaches: quantitative, qualitative, and mixed methods approaches and states that in order to understand them it is necessary to bear in mind three research design questions:

1. What constitutes knowledge?
2. Which are the general strategies of inquiry?
3. Which are the data collection and data analysis methods that will be used?

A Summary of Quantitative, Qualitative, and Mixed Methods Approaches (Source: Creswell, 2003)

<table>
<thead>
<tr>
<th>Research approach</th>
<th>Knowledge claims</th>
<th>Strategy of Inquiry</th>
<th>Method</th>
<th>Use these practices of research, as the researcher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantitative</td>
<td>Postpositivist assumptions</td>
<td>Experimental design, Quasi-experimental design</td>
<td>Predetermined, Closed-ended questions, Performance, attitude, observation and census data, Statistical analysis</td>
<td>Tests or verifies theories or explanations, Identifies variables to study, Relates variables in questions or hypotheses, Uses standards of validity and reliability, Observes and measures information numerically, Uses unbiased approaches, Employ statistical procedures</td>
</tr>
<tr>
<td>Qualitative</td>
<td>Constructivist assumptions</td>
<td>Ethnographic design</td>
<td>Emerging methods, Open-ended questions, Field observation, document data, Text and image analysis</td>
<td>Positions himself of herself collects participant meanings, Focuses on a single concept or phenomenon, Brings personal values into the study, Studies the context or setting of participants, Validates the accuracy of findings, Makes interpretations of the data, Creates an agenda for change/reform</td>
</tr>
<tr>
<td>Qualitative</td>
<td>Advocacy/Participatory assumptions</td>
<td>Narrative design</td>
<td>Open-ended interview and audio-visual data, Text and image analysis</td>
<td></td>
</tr>
<tr>
<td>Mixed Methods</td>
<td>Pragmatist assumptions</td>
<td>Mixed methods design</td>
<td>Both predetermined and emerging methods, Both open-and closed-ended questions, Multiple forms of data drawing on all possibilities, Statistical and text analysis</td>
<td>Collects both quantitative and qualitative data, Develops a rationale for mixing, Presents visual picture of the procedure in the study, Employs the practices of both qualitative and quantitative research</td>
</tr>
</tbody>
</table>
Appendix 6 Questionnaire

Company information:
Company……………………
Name……………………
Position…………………..

Please mark or put a cross into the correspondent fields

1. What are the driving forces for the environmental practices and certifying your environmental management system?
   - Compliance with governmental regulations
   - Customer requirements
   - Shareholders pressure
   - Improved operational performance
   - Other

2. Implementation of certified EMS
Has your company implemented a certified environmental management system?
   - No
   - Yes
   - ISO 14001
   - EMAS
   - Both ISO 14001 and EMAS

3. In which areas EMS: ISO 14001 has helped to achieve the goals?
   - Design and development
   - Manufacturing processes
   - Packaging and transportation
   - Environmental practices with sub-contractors and suppliers
   - Waste management
   - Distribution
   - Use and end-of life products
   - Other

4. What are the tangible benefits from implementing environmental practices and EMS: ISO 14001?
   - Compliance to governmental legislations
   - Resource utilization
   - Waste generation
   - Improved financial performance
   - Other

5. As well as intangible benefits?
   - Employee morale, commitment, and sense of pride
   - Improved public image and community relations
   - Customer satisfaction
   - Other
6. What are the critical factors for integrating environmental concerns in business practices?
   - Employees’ commitment
   - Top management support
   - Settled goals, roles and responsibilities
   - Environmental policy
   - Other

7. Which difficulties did you face when implementing EMS: ISO 14001? (With respect to timing, human resources, monetary resources, etc.)

8. “Green practices” in the company
   Type of materials employed
   - Reduction in the variety of materials used for manufacturing your products
   - Reduction in raw materials to manufacture products (i.e. the use of recycled material)
   - Avoidance of legal, but poorly performing (from an environmental perspective) materials to manufacture products
   - Other

9. Design
   - Application of Life Cycle Assessment for product design
   - Practice of Design for Environment
   - Utilization of component joints i.e. that are easy to assemble and disassemble
   - Clear identification of used materials in order to facilitate disassembly (colors, codes, etc.)
   - Other

10. Manufacturing
    - Implementation of systems to prevent possible accidents and environmental emergencies in the company
    - Filters and controls for emissions and discharges
    - Systematic control of the energy used
    - Use of standardized and re-usable packaging to facilitate its return from clients
    - Other

Besides the investigated companies, the responds have been obtained from the following firms:

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Participant</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Derome</td>
<td>Bertil Ivarsson</td>
<td>Environmental manager</td>
</tr>
<tr>
<td>Ahlifax</td>
<td>Jan Hedenborn</td>
<td>N/A</td>
</tr>
<tr>
<td>Itab</td>
<td>Jonas Torstensson</td>
<td>Production manager</td>
</tr>
<tr>
<td>YIT</td>
<td>Kjell-Ake Martin</td>
<td>Environment &amp; Quality manager</td>
</tr>
</tbody>
</table>
Appendix 7 Semi-structured interviews

1. **Company introduction:**
   a) What is the main business activities carried out in your business unit or business facility?
   b) Can you describe the operational procedures for the business activities?

2. **Environmental impacts**
   c) Which are the causes for potential environmental impacts of these activities?
   d) To which activity or activities waste generation is mostly related to?
   e) What green achievement has the facility or business unit achieved in its operations?

3. **EMS**
   f) What factors motivate the company to introduce and certify EMSs, and what are the differences in facility characteristics associated with these decisions?
   g) In which way environmental considerations are integrated into the standardized EMS?
   h) What are the barriers the company faces when implementing an EMS?
   i) What effect does the implementation of an EMS have on a facility’s environmental performance, regulatory compliance, and economic performance?
   j) Who is involved in the developing and implementing an EMS, and what difference does such participation make to EMS outcomes?
   k) Does the company have third party auditing regarding environmental policy?
   l) How does the organizational commitment to EMSs evolve over time?

4. **Environmental concerns in manufacturing and design**
   a) What are the incentives regarding the integration of environmental concerns in process and product design?
   b) Which environmental issues are taken into account in manufacturing and product design?
   c) To which extent the environmental criteria are integrated in manufacturing and product design?
   d) What environmental activities is the company involved in during manufacturing and designing a product?
   e) What specific tools and techniques does the company use for integrating environmental concerns into operational activities?

5. **Critical factors**
   a) On the company (management) level what are the critical factors for the integration environmental concerns into business operations and organizational structure?
   b) What are the most significant resources committed to such integration?
   c) What difficulties the company might face during the process of integration?
   d) Despite the personnel and management within the company, who is involved in this process?
   e) Which internal and external factors can facilitate and influence the process of integration?
Appendix 8

A summary of the procedures for data collection and analysis with respect to the participating companies is presented below.

DATA COLLECTION AND ANALYSIS for Volvo Buses, Trelleborg and Kinnarps

The Data collected from three cross sectional case studies on EMS and environmental tools and practices has been used to analyze the reasons and ways of adopting environmental practices, including the benefits derived from their adoption and the barriers to implementation.

Data has been collected from two sources:

- Corporate documentation, memoranda, publications etc.
- Semi-structured interviews with top managers (environmental managers).

A manual process for transcribing the hand written notes derived from the narratives of the participants has been followed by the categorization and unitization of the data which has been subsequently coded to ensure validity. The coding has been based upon the analysis of literature on widely accepted environmentally responsible business practices and allowed for the identification of drivers, barriers, benefits procedures for implementing such environmental systems, practices and tools. However, a part of the coding structure has been modified in an iterative manner when the empirical evidence was obtained and did not reflected the pre-established theoritical framework, which in turn, had to be redirected to conform the emergent research findings.

The data analysis has been conducted at two stages:

1. within each of the three case studies to provide a good understanding of the case and enable a unique pattern for that particular case to emerge;
2. across the three cases to identify common patterns and unique features.

At the first stage the interviews summaries, document summaries and data coding and categorization have been performed. Units of each transcript with specific characteristics have been identified and examined in order to establish the object of the specific characteristic, afterward the characteristics have been grouped in order to provide a chain of evidence.

At the second stage, categories displaying unique characteristics have been selected and explored across the cases in order to identify similarities and differences between them. Finally the dynamics of the company’s environmental strategy and policy has been identified.
## Appendix 9

Table represents the case study tactics for four design tests (source: Yin, 2009)

<table>
<thead>
<tr>
<th>Tests</th>
<th>Case study tactic</th>
<th>Phase of research in which tactic occurs</th>
</tr>
</thead>
</table>
| **Construct validity** | • use multiple sources of evidence  
                        | • establish a chain of evidence  
                        | • have key informants review draft case study report | • Data collection  
                        | • Data collection  
                        | • Composition |
| **Internal validity** | • do pattern matching  
                          | • do explanation building  
                          | • address rival explanations  
                          | • use logic models | • data analysis  
                          | • data analysis  
                          | • data analysis  
                          | • data analysis |
| **External validity** | • use theory in single case studies  
                          | • use replication logic in multiple case studies | • research design  
                          | • research design |
| **Reliability**     | • use case study protocol  
                        | • develop a case study database | • data collection  
                        | • data collection |