Integration of Environmental Initiatives in Operations

-Evidence from a sustainability leader

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– Evidence from a sustainability leader

As a response to the increasing pressure from society, governments and consumers, a growing number of companies disclose an environmental engagement in order to improve their reputation and maintain legitimacy. However, critics of such disclosure blame companies for greenwashing and point to the tendency of companies to decouple their environmental initiatives from the work practice. Few studies have thoroughly investigated the operative activities in manufacturing companies in order to explore how environmental performance is integrated. This is surprising, firstly because manufacturing companies have large environmental impact, and secondly because much of their impact origins specifically from the manufacturing processes. Thus, the main purpose of this case study is to describe how a manufacturing company's environmental initiatives are integrated in the work practice of its technical personnel. The findings indicate that the environmental initiatives are decoupled from the operative activities. However, due to a win-win relationship between an enhanced manufacturing process and improved environmental performance, the outcome is generally positive, implying that the company cannot be accused of greenwashing. Therefore, this study suggests that there are differences between decoupling and greenwashing, and that these concepts should not be used for describing the same phenomena.

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1. Introduction

In this chapter we provide the reader with relevant background information for this thesis. We continue by presenting the problem discussion that led us to formulate the research question and purpose of the study. Finally we outline the disposition of the thesis.

1.1 Background

The concept of sustainability and sustainable development has gained increased interest since the publication of the Brundtland report by the World Commission on Environment and Development in 1987 (Lundgren, 2011). A crucial aspect in sustainable development is environmental protection. It is no longer a question whether climate change is taking place or not and there is an increasing awareness of both the intensity of environmental change as well as the important role of humans in causing such change. Environmental degradation has turned into an important question for governments but also for whole societies, and companies are increasingly being pressured to take part in these issues (Sandhu, 2010).

As a result of the debate on the role of companies in achieving sustainable development the concept of corporate social responsibility (CSR) has arisen (Lundgren, 2011). Knippenberg and de Jong (2010) argue that there is no consensus of the precise meaning of CSR among the major authors in the field. However, they state that the general definition is *"a form of self-regulation by business, based on social or moral responsibilities towards society, an effort that goes beyond the existing government regulations."* According to the European Commission, CSR can be defined as a *''concept whereby companies integrate social and environmental concerns in their business operations and in their interactions with their stakeholders on a voluntary basis''* (in Jamali & Neville, 2011 p. 3). This latter definition highlights an important aspect of CSR, namely its voluntary nature. Companies are not obliged by legal means to engage in CSR, however the increased pressure in society as a whole and more specifically by the stakeholders has made it a mainstream business issue (LeFrance & Lehman, 2005).

CSR is increasingly viewed as a result of emergent institutional forces (Angus-Leppan, 2009). New institutional theory argues that companies encounter institutional pressures and that conforming to these pressures increases the companies' legitimacy (DiMaggio & Powell, 1983). Different types of social pressures have over the years become stronger and companies more often deal with the uncertainty these pressures bring. DiMaggio and Powell (1983) argue that as a result of this pressure highly structured organizational fields have come to provide a context in which individual efforts to deal rationally with uncertainty and constraints often lead, on an overall basis, to homogeneity in structure, culture and output. As companies exist in different environments a homogenous decision can more or less easily be implemented in a company structure. Although the initial pressure from society is eased by the availability of an accepted way of acting, the company is likely to have difficulties in adopting the pressure to the rest of the organizational structure, hence lowering the company's likelihood of being able to use the advantages given by this social pressure.

Bureaucratization and other forms of organizational change increasingly occur as the result of processes that make organizations more homogenous without necessarily making them more efficient (DiMaggio & Powell, 1983). As rationalized states and organizations expand their dominance over more arenas of social life, Meyer and Rowan (1977) argued that organizational structures increasingly come to reflect rules institutionalized and legitimated by and within the state. These structural changes are implemented to gain legitimacy rather than to improve efficiency. In today's climate, the *"organizations compete not just for resources and customers, but also for political power and institutional legitimacy, for social as well as economic fitness"* (DiMaggio & Powell, 1983, p. 5).

1.2 Problem discussion

As a response to the increasing societal pressure a growing number of companies communicate their engagement in CSR activities, and more specifically their commitment to environmental sustainability. However, when the desire to reach such societal expectations is large, companies run the risk of saying much while doing little and their actual improvements in regard to environmental performance are being questioned (Bazillier & Vauday, 2010). Scholars argue that corporate level environmental strategies without supporting operational practices do not have large impact on the companies' overall environmental performance (Jimenez & Lorente, 2001). Accordingly, critics of CSR accuse companies for greenwashing and point to the tendency of such companies to decouple their environmental initiatives from the work practices (Gillespie, 2008; Aravind & Christman, 2011). Advocates of legitimacy theory argue that environmental disclosures have little or no relation to the supposed responsibilities and obligations, instead such information is disclosed for strategic reasons. Environmental disclosures are in the view of these scholars, issued to meet public perceptions, to respond to public pressure, or to respond to perceived public opinion and therefore only aim to serve as public relations (Laufer, 2003).

Despite the critique towards CSR and the growing amount of research in the area, few studies have explored a direct connection between strategy, operations, and environmental performance within the same organization (Simpson & Samson, 2010). Based on a review of the last ten years in five different journals in the fields of sustainability and operations management, we have not identified any studies that investigate the environmental performance of operative activities in a manufacturing company[1]. A more general literature review revealed that research on environmental performance in manufacturing companies overall tends to be rather superficial in its description about the practical work. Some authors describe the possibility of adapting operations management to the environmental strategies (e.g Gupta, 1995: Sarkis, 2001) while others commonly use large samples either conducting quantitative research or studying several cases but not in depth (e.g. Hanna et al, 2000; Russo, 2007; Zhu & Sarkis, 2004, Banerjee, 2001). Neither the literature of coupling between policy and practice seems to focus on the operative core in manufacturing companies (e.g. Aravind & Christman, 2011; Behnam & MacLean, 2011; Hess, 2008). The present study intends to

[1] Journal of Cleaner Production, Business Strategy and the Environment, Journal of Operations Management, International Journal of Operations and Production Management, and Journal of Business Ethics.

contribute to the literature by studying the work practice of technical personnel in a manufacturing company through the perspective of environmental performance. This is important for two reasons: firstly, manufacturing companies have large environmental impact; and secondly, much of their impact origins specifically from the manufacturing processes. The selected company, TSAb, is considered to be a front runner with regard to sustainability and has been recognized as sector leader in terms of these issues. Additionally it has been placed high in different international sustainability rankings. Thus, we argue that TSAb is a representative case to study. If environmental initiatives are not integrated in a company that is acknowledged as leader in sustainability, it is likely that the same occurs at other companies in the sector.

1.3 Research question and purpose

Given the manifested need for environmental strategies to be supported by operational practices in order to positively affect environmental performance, and the discussion about companies' tendencies to engage in greenwash and to decouple their environmental initiatives from work practice, this thesis aims to answer the following research question:

> *How are a corporation's environmental initiatives integrated in the work practice of technical personnel in one of its factories?*

With environmental initiatives we refer to TSAb's expressed goals to reduce its environmental impact. In order to answer the research question, data about the company, its environmental initiatives, and the work practice of technical personnel (production line technicians and manufacturing process developers) in one specific factory is collected. With the objective to ensure a complete picture of the work practice, the study includes an investigation of the general work activities as well as the presence of activities that aim to reduce energy use and material losses. According to previous internal research at TSAb, energy use and material losses together with direct emissions constitute the environmental impact related to a company's manufacturing system. Direct emissions from manufacturing processes, not related to energy use, are disregarded in this case since they are assumed to be negligible.

Given the depth of this study, the purpose is not only to describe how the environmental initiatives are integrated in work practice but also to provide deeper knowledge regarding environmental performance in manufacturing companies. The contribution of the paper is multiple. Firstly, it provides TSAb with useful information about their organization and how they can improve an integration of their environmental initiatives in the factory. Secondly, as TSAb is recognized as sector leader both in terms of market share and sustainability we argue that the findings can be translated in to more general conclusions that can be applied on other manufacturing companies. Lastly, this paper contributes to a better understanding of how to study manufacturing companies' integration of environmental concern, and serves as a foundation for further research in this topic.

1.4 Disposition

The rest of this thesis is outlined as follows. In chapter 2 we present the relevant theoretical concepts and explain how these concepts are related to each other. In chapter 3 we describe the selection of method, strategy of inquiry, and data collection, and end by discussing the paper's validity. The collected data from interviews, observations and documentation is presented in chapter 4 and analyzed in relation to the selected theoretical concepts in chapter 5. Finally, in chapter 6 we conclude the paper by answering the thesis question and discuss the broader purpose of the study. Moreover, suggestions for further research as well as recommendations to the studied company are presented.

2. Theoretical framework

This chapter involves the theoretical concepts related to the thesis purpose. These are outlined starting with greenwashing and decoupling which represent some of the most commonly expressed critiques against companies' environmental commitment. The following section concerns legitimacy which serves as the key reason for why companies aim to meet the social demands. The last part of this chapter focuses on integration of environmentally beneficial activities and the positive outcome of such action.

2.1 Greenwashing

Responding to the increasing societal pressure, a growing number of companies announce their engagement in CSR activities. Announcement of such engagement generates benefits in form of improved reputation and legitimacy, however, truly adopting environmentally friendly principles involves costs. According to Tsoutsoura (2004) these costs may for example include high investment costs for new environmentally friendly equipment, changes in the management structure, or an implementation of more stringent quality controls. Therefore, companies tend to use CSR as a way to improve the image and reputation and to sustain their legitimacy while making too small changes in order to actually decrease their environmental impact (for an elaborate discussion of the concept "legitimacy" and the advantages of good reputation see sub-chapter 2.3). In the critical perspective of CSR, the term 'greenwashing' is increasingly being used for denoting such behavior (see e.g. Gillespie, 2008; Hess & Dunfee, 2007; Laufer, 2003). Egels-Zandén and Kallifatides (2010) claim that greenwashing is one of the main critiques against CSR activities.

Greenwashing is frequently used in the literature on CSR. Some authors only mention the term (see e.g. Bond, 2008; Neilson & Pritchard, 2007; Schendler, 2003; Whitmore, 2006) other however discuss it more in depth (see e.g. Gillespie, 2008; Hess & Dunfee,2007; Laufer, 2003; Lyon & Maxweel, 2011; Scherer et al., 2009; Sharfman, 2004). The usage of greenwash is broad and vague (Lyon & Maxwell, 2011) and there almost seem to be as many definitions of the term as there are critics of CSR. Gillespie (2008) defines greenwashing as *"advertising or marketing that misleads the public by stressing the supposed environmental credentials of a person, company or product when these are unsubstantiated or irrelevant"* (p.79). A similar definition is found in The Concise Oxford English Dictionary (10th Edition) stating that greenwash means *"Disinformation disseminated by an organization so as to present an environmentally responsible public image; a public image of environmental responsibility promulgated by or for an organization etc. but perceived as being unfounded or intentionally misleading"* (in Lyon & Maxwell, 2011 p.8).

However, greenwashing refers not only to an exaggeration of the environmentally beneficial behavior but also to covering unethical and harmful activities (Hess & Dunfee, 2007). After discussing the broad and vague usage of the term greenwashing, Lyon and Maxwell (2011) conclude that *"greenwash can be characterized as the selective disclosure of positive information about a company's environmental or social performance, while withholding negative information on these dimensions."* (p.5). Consistently, Fig (2005) explains greenwash as *"use of pro-environmental language to mask bad practice"* (p.605) and

Webster's new millennium dictionary of English defines it as *"The practice of promoting environmentally friendly programs to deflect attention from an organization's environmentally unfriendly or less savory activities."* (in Lyon & Maxwell, 2011 p.8).

Common to these definitions is that when companies are engaging in greenwashing they are misleading the public. Their ability to do so is discussed by Sharman (2004) who brings out the problem of asymmetric information between the company and its observers. The observers have the information that the company decides to publicly disclose but only the company knows precisely what it is doing. Sharman (2004) presents two sides of the problem of greenwashing. On one hand, as a result of Internet, companies are subject to increased scrutiny; hence, the probability of detecting greenwashing has increased. Governments, activists, NGOs and societies have enough monitoring capabilities to detect greenwashing as well as enough penalties to undertake if such practices are detected. On the other hand, since companies are increasingly put under pressure to undertake measures for an improved environment, they may have an incentive to give the impression of being green through greenwashing (Ibid).

The uncertainty if companies use greenwash or not has led to a lowered societal trust in companies which have an environmentally friendly approach (Gillespie, 2008). However, Gillespie (2008) state that there are signals which can improve the understanding if a company uses greenwashing or not. Greenwashing can be signaled through: a vague language – the usage of words without any clear meaning; implementation of environmentally friendly products in a company that has an overall environmentally damaging effect; suggestive pictures giving the interpretation of an unharmed environment; declarations of being more green than the competitors – giving no information about how bad the others are; making an environmentally harming product slightly more green; and providence of data without any evidence or without any correctness at all (Ibid).

2.2 Decoupling

As mentioned in the previous sub-chapter, greenwashing has become a popular concept in the literature. However, the use of the term is broad and vague and there does not seem to be a unified meaning of it. Given that authors tend to present decoupling and greenwah as the same phenomenon (e.g. Egels-Zandén, 2007), we argue that one way of delving deeper into the idea about what greenwashing can be is to relate it to the notion of decoupling. Thus, decoupling may be used as a theoretical tool to move further in the discussion of what greenwashing actually means.

The concept of decoupling origins from institutional theory which argues that formal organizational structures occasionally are decoupled from practice and activities in the organization. Jamali (2010) presents the following explanation of decoupling: *''organizations under pressure to adopt particular structures or procedures may opt to respond in a ceremonial manner, making changes in their formal structures to signal conformity but then buffering internal units, allowing them to operate independent of these pressures''*(Scott, 2008 in Jamali, 2010 p.625). In modern societies formal organizational structures have gone

from being systems of coordinated and controlled activities that take place when work is embedded in complex networks of technical relations and boundary-spanning exchanges, to arise in highly institutionalized contexts. As a result, formal organizational structures reflect institutional rules (Meyer & Rowan, 1977).

Meyer and Rowan (1977) describe institutionalized rules as being built into society as a translation of what the society intentionally or unintentionally strives for. Such rules might simply be taken for granted, they may be supported by the public opinion or they might be under the force of law. Institutionalization is involved in the social processes, obligations and actualities and has come to take on a rule-like status in social thought and action. Thus, fulfilling these rules by adopting certain formal structures is crucial for maximizing the company's legitimacy and to increase its resources and survival capabilities (Meyer & Rowan, 1977).

Structures, programs and policies that are in accordance with institutional rules are sometimes different from efficient ones. The motivation to decouple formal structures from practice and activities in the organization arises because of a conflict between structures that reflect institutionalized rules and structures that are optimal in terms of efficiency (Meyer & Rowan, 1977). Similarly, Behnam and MacLean (2011) state that the struggle to balance concerns of efficiency with expectations from external stakeholders is particularly difficult in case of a conflict between the external expectations and the company's strategic and profit-maximizing activities. To balance these opposing interests companies decouple their formal organizational structures from the actual work practice. Hence, the formally adopted structure or program only serves a 'symbolic' or 'cosmetic' role (Hess, 2008).

According to Meyer and Rowan (1977) decoupling enables corporations to maintain standardized with legitimate formal structures, while their activities vary in response to practical considerations. Behnam and MacLean (2011) further this explanation by arguing that activities disconnected from the day-to-day operations of the company are enhancing legitimacy for outside stakeholders, without having genuine impact on the activities in the organization. Similarly, Weaver et al (1999) claims that by decoupling a policy or structure the company signals conformity of external expectations while protecting much of the organizations from these expectations. Even though the company formally adopts a structure or policy, the structure or policy does not interact with other policies and functions, nor are the employees held accountable to it (ibid). Additionally, decoupling has the effect of not only creating false appearances for external actors, but also for the internal actors (Hess, 2008). Consequently, the internal view of the company is imprinted by this.

Meyer and Rowan (1977) argue that another frequent characteristic when companies decouple policy from practice in order to deal with the problem of maintaining a legitimate reputation lies in the logic of confidence, the belief that internal and external participants are acting in good faith. This helps to absorb the uncertainty while preserving the formal structure of the organization.

Decoupling is more or less likely to occur depending on internal as well as external factors of a company. Jamali (2010) states that uncertainty, goal ambiguity, or when the means to reach a certain goal are unspecified serve as commonly mentioned antecedents of decoupling. Behnam and MacLean (2011) refer to studies which have shown that power dynamics, misaligned economic incentives, asymmetric information, and network ties to other 'decouplers' makes decoupling more likely. These mentioned situations origin from the company, but challenging situations can also occur in the society leaving the company unguided of how to handle legitimacy-enhancing activities. Companies are left unguided when the knowledge base for practice is not clear cut and practices have not evolved to the status of social fact or when institutional values themselves are unspecified (Jamali, 2010).

In addition, the likelihood of decoupling depends on the organizational field. Jamali (2010) states that decoupling is more common in organizational fields characterized by ambiguity, conflicting expectations, high transaction costs, limited regulatory commitment and the lack of equipment to monitor compliance. Companies which are built around efficiency attempt to uphold a close alignment between structures and activities. Analyses of results, e.g. monitoring of output quality and evaluation of efficiency, are managed to make sure that the results reach the company's expectations. Hence, a structure or activity that challenges the efficiency is seen and treated as a record of inefficiency and inconsistency (Meyer & Rowan, 1977).

Crucial both in greenwashing and decoupling is companies' strive for legitimacy. Next follows a more elaborate discussion on the concept of legitimacy and its importance for organizations' survival.

2.3 Legitimacy

According to Suchman (1995), organizations become legitimate when their actions are *"desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions"* (in Driscoll, 2006 p.324). LaFrance and Lehman (2005) state that legitimacy theory involves a social contract between organizations and society which implies that the survival of organizations depends on the degree to which they operate within the limits of what is acceptable in society. The authors differ between societal perceptions of corporate behavior, which usually is referred to as corporate image, and societal expectations of corporate activity. When these expectations are different from the perceptions a legitimacy problem takes place. The authors argue that organizations have to manage both the societal expectations as well as the societal perception of corporate image in order to maintain legitimacy. A change in any of these leads to a legitimacy gap which in the long run is harmful for the organization's continued existence (LaFrance & Lehman, 2005; Dowling & Pfeffer, 1975).

Commitment to environmental protection may give organizations several advantages through improved reputation and enhanced legitimacy. Sims (2009) argues that reputation has become a central feature for CEOs and their companies since it creates confidence in the organization and satisfies investors, employees and the general public. A good reputation may provide

companies with a competitive advantage, for example by higher sales through satisfied customers and their referrals, enhanced relationships with the right strategic and business partners, attraction of the best applicants, a positive word of mouth, the potential to increase capital and share price, and sometimes the possibility of charging premium prices. Reputation has proven to generate wealth and is increasingly seen as an essential intangible asset (Ibid).

The desire to enhance the company's reputation and legitimacy however creates an incentive to engage in greenwashing or to decouple formal structures from activities. Brown and Fraser (2006) argue that legitimacy theory is one of the most extensively used theories for explaining why companies voluntarily employ social and environmental accounting. In the same line, Hess and Dunfee (2007) argue that legitimacy theory is used by some authors to explain why an increasing number of companies disclose social and environmental information to stakeholders.

In institutional theory, an organization can obtain legitimacy through different sources such as regulatory and legal aspects or by social approval and public opinion (Driscoll, 2006). Dowling and Pfeffer (1975) evolved three hands-on activities with the aim to help organizations to become legitimate. Firstly, an organization can conform its output, goals, and methods of operation with the prevailing definitions of legitimacy. Secondly, it can communicate an attempt to alter the definition of social legitimacy so that it conforms to the organization's present practices, output, and values. Finally, it can attempt, again through communication, to become identified with symbols, values, or institutions which have a strong base of social legitimacy.

As argued in the previous sub-chapters, the willingness to meet the societal pressure to take part in the combat for reaching sustainable development creates a risk of saying much and doing little. Next, we describe the contrast to such behavior, more specifically integration of environmental initiatives into the company's central processes.

2.4 Integration of environmental initiatives and the concept of win-win

The opposite of greenwashing and decoupling is coupling, i.e. integration of environmental concerns into the core activities of an organization. An integrated structure, policy or program is incorporated in the companies' central processes and influence everyday decisions and actions. Such integration requires making sure that the structure, policy or program has the proper resources to be effective and that the employees are trained and held responsible for following its principles. If integrated, the people that occupy the specialized structures have both confidence of and regular interaction with other departments and their managers. Additionally, both managers and employees see the structure, policy or program as having a valued role in the company's operations and it is commonly supported by other policies and programs in the same organization (Behnam & MacLean, 2011; Weaver et al, 1999).

When discussing the external pressure that companies face to implement International Accountability Standards (IAS), Behman and McLean (2011) state that some of them do not decouple the policies in these standards from practice and instead fully implement a variety of IAS. The authors also argue that companies are more likely to integrate IAS activities into

their operations when they perceive that IAS is a strategic or competitive advantage or a moral imperative. There are also different degrees of integration. Banerjee (2001) argues that different companies integrate environmental concerns at different organizational levels and that the level of integration is reflected in the environmental strategy focus. Some of the companies in Banerjee's study integrated environmental issues at higher levels of strategy while others kept a more functional approach. The variety in environmental actions was larger in the companies that integrated environmental concern at a corporate strategy level. These companies commonly reported larger R&D investments in environmental areas, environmental audits and product evaluations, environmental benchmarking, total quality environmental management and development of green products. Those companies with a more functional approach rather concentrated their activities around waste reduction, recycling, packaging modifications, and pollution control. Hart (1995) argues that at an initial phase companies can reduce their environmental impact through fairly small changes. However, when these 'low hanging fruits' are harvested further improvements require greater efforts.

The importance of integrating environmental concern at operational level in order to reach a positive outcome on environmental performance is highlighted by several authors (Simpson & Samson, 2010; Gupta, 1995; Boiral, 2005; Hanna et al, 2000; Sarkis, 2001; Track et al, 2001). The reason is that the operations function is the source of most of the firm's environmental impact (Jimenez & Lorente, 2001). Similarly, Simpson and Samson (2010) state that the operation management function consumes most natural resources, is responsible for the maintenance of equipment from which pollution is most likely to occur and generates important innovations and technologies. Consequently, they argue that a corporate level environmental strategy without supporting operational practices do not have big effect on the firm's environmental performance.

As mentioned in the discussion of greenwashing, there are immediate costs involved in the implementation of CSR principles. However, environmentally friendly solutions have also been claimed to have other benefits than those related to reputation and legitimacy. It has been argued that if environmental performance is integrated at the operational level there is a win-win relationship between environment and business. Hart (1994) states that this win-win relationship is based on the presumption that decreasing pollution results in higher efficiency and cost savings. Accordingly, Porter and van der Linde I (1995) argue that pollution of scrap, harmful substances, or different forms of energy is a sign of incomplete, inefficient, or ineffective use of resources. Pollution, in other words, can be seen as a form of economic waste. Therefore, when environmental improvement takes the form of resource productivity e.g. higher process yields, less downtime through more careful monitoring and maintenance, material savings, improved use of by-products, lower energy use during the production process, reduced material storage, or conversion of waste into valuable forms, companies simultaneously enhance their production process (Porter & van der Linde II, 1995). However, according to Banerjee (2001) such positive relationship leads to a tendency to implement environmental initiatives that are beneficial for the companies themselves, such as waste reduction, cost savings and improvement in product and process quality. Environmental

strategies are common to be internally focused and evaluated based on the financial benefits they generate to the firm instead of an external strategic focus on sustainable development (ibid).

In the same line, Sarkis (2001) argues that *"the role of manufacturing and operations is at the forefront of those organizations that seek to address the issue of environmental sustainability"* (p.666). With regard to the manufacturing process, the author argues that developments from an environmental perspective refer to issues of reduction, reuse, recycling, and remanufacturing. Sarkis (2001) concludes that besides tools and technology for the integration of environmental programs, measures, and practices in everyday manufacturing operations, acceptance by management and workers is required. Gupta (1995) argues that an important question relevant to the manufacturing process when implementing environmental management concerns how the company can engage in pollution prevention programs, and how it can reduce waste at the source. Gupta (1995) further states that yet another important question concerns how much open disclosure of pollution and health information companies should support, how good their data gathering systems are, and how these systems can be used to solve operations problems.

2.5 Greenwash, decoupling and win-win

In this chapter, we have outlined the main theoretical concepts used in this thesis and the relations between them. We have argued that the frequently used concept 'greenwashing' is vaguely defined in previous research and suggested that 'decoupling' provides a more solid theoretical foundation for discussing how companies separate talk and action. Finally, we have argued that the opposite of decoupling is 'coupling' and that coupling via deliberate actions leads to enhanced environmental performance as well as improved financial performance through an enhanced production process and cost savings.

3. Methodology

In this chapter we start by describing the selection of method and strategy of inquiry. We continue by explaining why TSAb was chosen for conducting this study and the implications this selection brings for a generalization of the result. We also clarify why the focus was placed on certain variables of environmental performance as well as certain work functions in the factory. Moreover, the data collection procedure is explained and the external as well as internal validity of the study is discussed.

3.1 Selection of method

We conducted a qualitative study in order to describe how environmental performance is integrated in the work practice of two functions in a specific TSAb factory. Qualitative research is a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem (Creswell, 2009). More specifically the study was a case study which according to Stake (1995; in Creswell, 2009), means that the researcher explores in depth a program, event, activity, process, or one or more individuals. We explored activities as well as processes carried out by production line technicians and manufacturing process developers in the factory. Moreover, cases are bounded by time and activity, and researchers collect detailed information using a variety of data collection procedures over a sustained period of time (Ibid). Accordingly, we used three different data collection types (for a more detailed elaboration of these see below). The data collection primarily took place in February and March, however when clarifications were needed some additional material was collected also after this period.

Due to the small amount of previous studies in the selected research field, we used an inductive method called grounded theory to have an open approach to the collected data. Grounded theory research is an example of a bottom-up perspective; from phenomenon and practice to theory and explanation (Flick, 2007). Creswell (2009) adds that two primary characteristics of this design are the constant comparison of data with emerging categories and theoretical sampling of different groups to maximize the similarities and the differences of information. The data was collected through interviews, observations and written material and in accordance with GT (2011) the selection of respondents, data collection and analysis of data happened simultaneously until a saturation stage was reached. We reached saturation after five respectively six interviews, but had a number of follow-up interviews to confirm that we understood the information correctly and asked for more detailed explanations if it was needed.

Another reason for the suitability of using grounded theory is that the collected data aims to understand the integration of systems, actors, strategies, tactics etc. (Creswell, 2009; GT, 2011), which goes in line with our aim to understand the integration of environmental initiatives in the technical personnel's work practice.

As we were given indications on what to investigate in our interviews (energy use and material losses, explained in further detail below) we stepped away from the method of

grounded theory to some extent. However, other new areas of interest came up throughout the interviews and these areas were taken into account when structuring the layout.

3.2 Selection of company

To the authors' knowledge no manufacturing company called TSAb exists in reality. The name is a fictitious one that is used due to secrecy reasons. Because of TSAb's global presence, TSAb Local is used to denote the establishment where the studied factory is located.

TSAb was chosen because of its respectable reputation in terms of sustainability initiatives. The company is acknowledged as one of the top global corporations with regard to sustainability issues and has been appointed as industry leader by well-known international sustainability rankings. We argue that TSAb, being sector leader in sustainability, is a good example to study. If the environmental initiatives are not even integrated in the work practice at a front runner in these issues there is reason to believe that the same occurs at other manufacturing companies; high level of integration on the other hand might encourage peers to follow the same path.

3.3 Selection of environmental performance variables

The thesis focuses on two variables of environmental performance; energy use and material losses. The importance of these variables is described in previous internal research at TSAb where energy use and material losses are argued to be a purposeful representation of the environmental impact of a manufacturing system. These two variables are defined as follows:

Energy use

- Direct electricity consumption of machines refers to energy consumption of the machines in different operation modes. Running mode is the machines' energy consumption when it operates during normal, undisturbed production. Waiting mode is when a machine waits for new components to arrive, which may occur for different reasons such as unbalanced production line, machine breakdowns, and resetting. Unmanned hours mode refers to the energy consumption of the machines when production is closed, e.g. during weekends and holidays.
- Energy consumption of machines other than electricity.
- Indirect electricity consumption in production machines i.e. the machines' usage of compressed air and process fluids.
- Energy consumption of buildings i.e. electricity and district heating.

Material losses

- Components: used or wasted product material but not component material in the final product.
- Indirect material that is not part of the product e g. tooling and process fluids.
- Capital goods e.g. machines and buildings.

As the interviews went on it was revealed that there was a high focus on efficiency in the factory, both in terms of productivity (units/hour) and low costs. Previous internal research at TSAb indicates that productivity, particularly cycle time, has high impact on the environmental performance of a manufacturing system. Therefore, we included productivity as a variable for environmental performance, more specifically as a variable that influence energy use in relation to production level, hereafter referred to as energy efficiency.

3.4 Data collection

We collected data through three different methods: observations, interviews, and internal documents. The observations were mainly conducted in production and helped us to gain a better understanding of the technicians' work practice and daily activities. According to Creswell (2009), a possible limitation of observations is that the observer may be seen as intrusive, however, we took an "observer as participant" role and discretely took notes that we further elaborated as soon as the observation was over.

Eleven face-to-face interviews of between 40 and 75 minutes were conducted. Five of these interviews were conducted with different production line technicians and six with different manufacturing process developers. All interviews were semi-structured which means that the interview guide includes some topics to be covered with suggested questions (Kvale & Brinkmann, 2009). We had two interview guides – one for technicians and another one for manufacturing process developers (see Appendix 1 'Interview Guides'). However both guides where rather similar and mainly differed with respect to some question directed towards certain work tasks. The questions and their order can either be strictly predetermined and binding or the interviewer decides how closely to adhere to the guide and how much to follow up the respondents' answers and the new directions that possibly appears (Ibid). Our interviews can be seen as a mix between these two alternatives. The interview guides included four and six open questions respectively and were more or less closely followed depending on each situation. In addition we had a guide with some suggested follow-up questions which were asked depending on the revealed information. The first part of the interviews was concentrated around the respondents work practice in general and later on we asked more specific questions regarding environmental performance. This enabled us to get a clear view of their work role and to ask for more details about certain directions in cases we thought it was needed. Opening the interviews by asking more general questions about the respondents' job e.g. what a typical day looks like, something they all know very well, also made them feel more comfortable. A further advantage of putting such large focus on the work role and daily activities was that we could see examples of situations where the respondents worked with environmental performance without being aware of it.

Additionally we did some follow up interviews, some were face-to-face interviews but in other cases we asked the questions by email. All face-to-face interviews were recorded and transcribed by the authors. It should also be mentioned that the interviews were conducted in Swedish and that all quotations are translated by the authors. However, we have been very careful not to change the signification when translating statements. Also, we trust that there is a large advantage of having interviews in the respondents' mother tongue as it increases the

feeling of comfort. Creswell (2009) presents the following limitations of interviews: provision of indirect information filtered through the views of interviewees, information in a designated place rather than the natural field setting, the researchers' presence may bias responses, and not all people are equally articulate and perceptive. The possibility of biased responses due to the presence of the researchers is a general drawback of interviews and there was little we could do about it. However, all interviews were conducted at the factory in order to increase the feeling of being in the natural field setting. Also, since the interviews were complemented by observations and reviews of documents we believe that a more objective picture was gained.

We have reviewed internal documents in form of environmental goal descriptions and action plans, manuals and templates for projects (e.g. technical specification, IRE and concept evaluation), as well as purchasing documents that were sent to the supplier in one of the ongoing investment projects. Possible limitations of doing observations are that information may be protected and unavailable to public or private access or that it requires the researcher to search out the information in hard-to-find places. (Creswell, 2009). However, we got access to all necessary documents and databases and the employees at TSAb were very helpful in cases where we had troubles finding information.

The collected data is presented in the section 'Empirical findings'. The information in the first sub-chapter (4.1) is gathered from documents that present the environmental goals and action plans for TSAb Local. The remaining data is mainly gathered from interviews but observations and documents were helpful to gain a deeper understanding and to develop a more detailed picture.

3.4.1 Selection of respondents

According to Flick (2007) the selection of respondents is of major importance in a qualitative study as the answers gathered from the interviews will serve as the base for the thesis' arguments. The present study focused on two functions, namely production line technicians and manufacturing process developers, this selection was based on information gathered from interviews conducted earlier by TSAb. These functions have been argued to have a direct contact with the factory production as technicians are a support function for the production line and the manufacturing process developers handle the different improvement and investment projects in the production lines. Since we are interested in how environmental initiatives are reflected at operational level we argue that both kinds of actors are of relevance.

3.4.2 Sampling methods

As we had decided upon which actors we wanted to interview to gather the best information about our research topic, the aim was to find the employees within these occupations with most information about their work roles and also the ones with most practical experience. With this objective in mind we were encouraged to use snowball sampling by asking interviewees for other workers that might be relevant for our study (Flick, 2007). Since we were especially interested in the interviewees daily work practices most of the recommended respondents had worked in the company for many years. According to Flick (2007) an

advantage of interviewing workers with a lot of experience, knowledge and practice in the relevant topic is that the outcome is more likely to present the relevance in the studied phenomenon.

3.4.3 Analyzing the data

Consistent with Creswell's (2009) thoughts of qualitative data analysis, we reflected, discussed and made interpretations of the data while the collection was going on. In case studies the researcher first makes a detailed description of the setting or individuals and after that analyzes the data for themes or issues (Ibid). Similarly, we started the analysis of the empirical findings by describing technicians' and manufacturing process developers' work role. We continued by grouping the material into three categories: material losses, energy use, and productivity. Material losses and energy use were predetermined and productivity was added based on the information revealed in the data collection. No software program was used for analyzing the material.

3.5 Internal and external validity

According to Creswell (2009) *"qualitative validity means that the researcher checks for the accuracy of the findings by employing certain procedures"* (p. 190). The author further states that validity is based on determining whether the findings are accurate from the standpoint of the researchers, the participants, or the readers and is therefore one of the strengths of qualitative research. Creswell (2009) presents eight internal validity strategies but recommends the use of a combination of these strategies. In this study we incorporated the triangulate strategy by using three different sources: interviews, documents, and observations. Triangulation is used to confirm the validity of the processes and further explains that triangulation in case studies can be done through using multiple sources of data (Creswell, 2009; Tellis, 1997).

Consistent with Creswell's (2009) validity strategies, we were also provided with a working desk in the factory where the study was conducted and therefore spent much time there. In addition we made sure to include different angles and discuss contrary information of the problem to ensure that a fair picture of the situation was given and that the research question was answered correctly. Our interpretations of the finding may be biased since we origin from the same geographical area, have the same gender, are at the same age, and have the same academic background. However, this study was part of a bigger research project and several discussion meetings were held with the other researchers holding other backgrounds and more experience in this field. With no technical background and lack of experience within manufacturing companies we were unfamiliar with many factory terms, processes, programs etc. which in some cases complicated our understanding. Thus, in order to avoid confusions we made sure to ask the respondents to clarify certain things, or in case of programs or documents let us see them with our own eyes. The meetings with the research group were also good opportunities for elucidating such confusions.

A commonly occurring criticism of case study research is that the results are not widely applicable. Advocates of this kind of studies have however disproved such critique (Tellis,

1997). Creswell (2009) for example claims that the aim of qualitative study is not to generalize findings to other individuals, sites, and places. The value rather lies in the specific description and themes developed in context of a particular site. Moreover, Yin (1993) differentiated between statistical and analytic generalization and stated that analytic generalization implies that the empirical results of the case study are compared to previous developed theory (Tellis, 1997). Despite the general critique to case studies with regards to the generalization of its findings we believe that TSAb is of particular interest as it is recognized as sector leader when it comes to sustainability.

4. Empirical findings

This chapter includes information gathered throughout the interviews, observations and information from TSAb's internal documents. The first sub-chapter involves information about TSAb and its environmental goals and action plans. Further we describe the technicians' work role and how they work with material losses, energy use and productivity. An identical structure is followed with information about the manufacturing process developers. We end this chapter by presenting the technical personnel's perceptions about the environmental goals.

4.1 TSAb

Environmental concern at corporate level

TSAb is an industrial company with global presence and employer to above 40 000 people.

There is a high focus on sustainability from top management and TSAb group has expressed ambitious initiatives to reduce its environmental impact. TSAb is recognized as sector leader in sustainability and is placed high in several international sustainability rankings. Additionally, TSAb is member of several international industrial collaborations working specifically with sustainability.

The TSAb production requires a considerable amount of energy use. Since 2002 the company has reported all carbon dioxide emissions either related to electricity use or by on-site combustion of fuel. Additionally, a carbon emissions reduction target has been implemented and TSAb has managed to reduce their emissions substantially.

The environmental concern at corporate level is translated into local goals and activities at different TSAb establishments. This thesis focuses on one specific factory. Next we describe improvement activities, goals and action plans that aim to reduce the environmental impact in TSAb Local where the selected factory is located.

Environmental concern at local level

The local action plan for reducing environmental impact includes improvement work such as: technical changes (e.g. installation of frequency controlled pumps, automatic system to turn off the light, and improved control over ventilation); optimizations in the sourcing of cleaner energy (e.g. green electricity); and increased employer knowledge and awareness (e.g. in which processes are a substantial amount of energy used, what can be done to decrease today's level of energy use?). Larger improvements are to switch from using natural gas to bio-gas and to install new ventilation systems in a majority of the factories to lower the overall energy use. Other improvements that TSAb aims to implement over the years are to reduce the used amount of compressed air, to recycle all ventilation and to change all lighting into low energy lighting. Energy use for TSAb Local, and its environmental effect in terms of CO_2 emissions, is followed up on a monthly basis.

TSAb Local has yearly environmental goals. For 2011 these goals address three types of environmental impact: emissions to air in terms of energy use; waste; and emissions to soil,

water or air. Each type has both a long-term goal as well as goals for the current year. In addition, action plans have been developed to meet these goals. The long-term goal related to the first type is to minimize energy use and is translated into four short-term goals: more efficient use of energy; a five percent reduction in electricity use compared to historically expected amount in relation to value added; a five percent reduction in compressed air compared to historically expected amount in relation to value added; and a two percent reduction in district heating, measured as temperature index of the facility's total use. The action plan for meeting these goals includes local activities at each unit e.g. an energy training, mapping of energy, routines for turning off machines and implementation of machine devices that turn off the machine automatically when they are not in production, routines for leakage seeking, inspection of pressure and flow installations, move production from certain buildings, and improved isolation and ventilation in buildings.

There are two long-term goals with regard to waste and residues. These are minimization of hazardous waste and minimization of packaging waste. The short-term goals are recycling of 90 percent of the grinding swarf and a five percent reduction in waste of corrugated cardboard compared to last year. The action plan for meeting the first goal includes minimizing leakage of hydraulic oil through local action plans and activities. To achieve the second goal local activities to reduce the waste of corrugated cardboard should be implemented. Quality risks and alternative environmental load should be taken into consideration when changes of the packaging shaping are made. The long-term goal addressing the third environmental problem (emissions to soil, water and air) is to prevent unintended emissions. The short-term goal is zero incidents that require information to the Environmental Agency. Local activities should be undertaken e.g. risk evaluation, installation of protective measures, working instructions for elements of risk etc.

Energy use is only followed up on a building level, where energy use is aggregated for all activities in that building. These numbers are shown in the following diagrams, both in absolute numbers as well as in relation to production level.

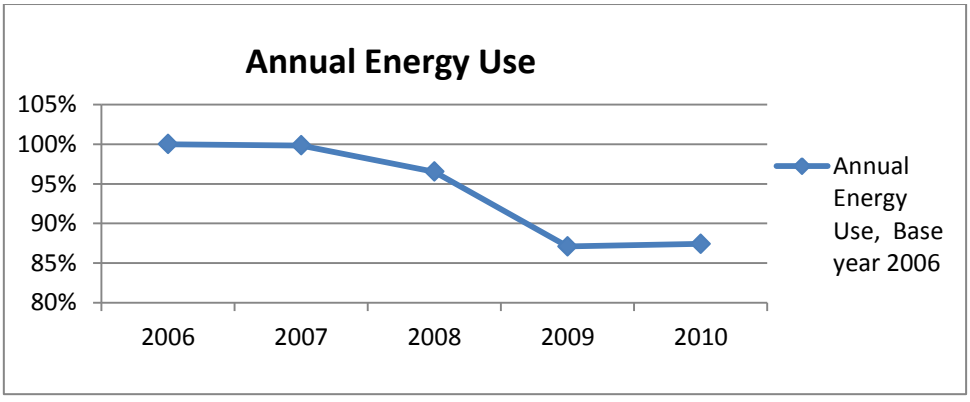

Figure1. Annual energy use 2006 – 2010: Electricity represents approximately 99,92%, natural gas 0,06% and compressed air 0,02% of the total energy use over the last five years.

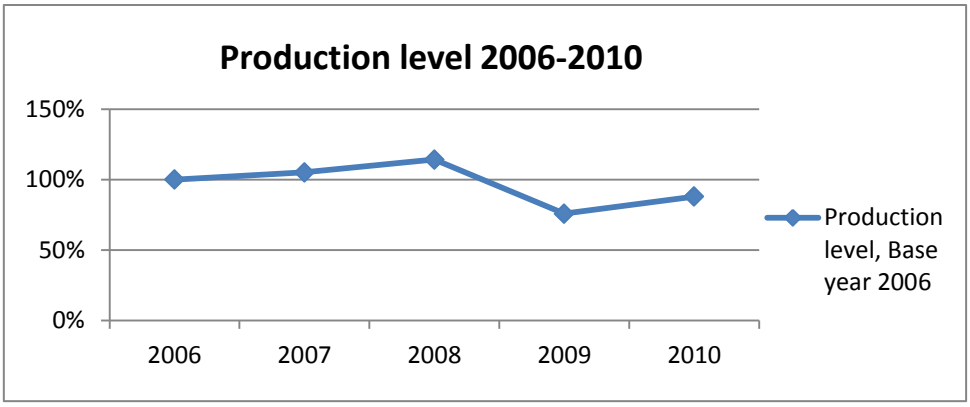

Figure 2. Added value 2006-2010.

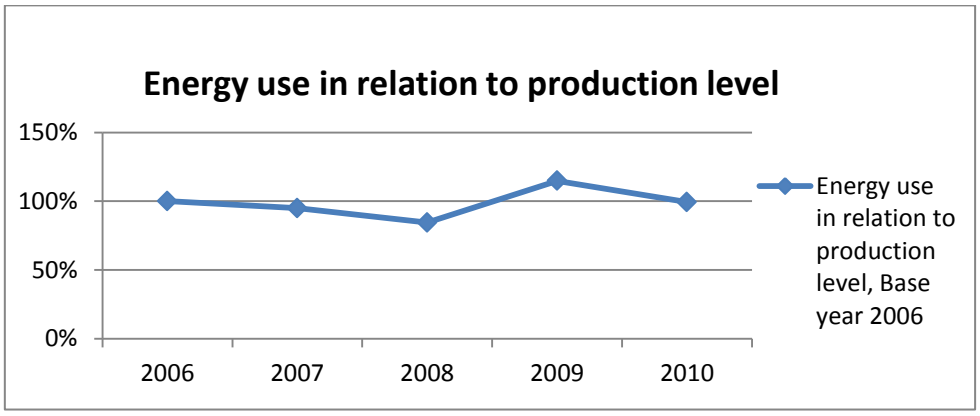

Figure 3.Energy use in relation to production level 2006-2010.

When we asked for the factory's annual energy use for the last five years it was however discovered that these numbers are not compiled. We got separate numbers for electricity, electricity to produce compressed air and natural gas which we added together to understand the total amount of energy used (MWh) each year. The numbers for production level are the annual costs (SEK) spent on incoming deliveries. All numbers are normalized with 2006 as base year.

In this thesis we focus on two functions, namely production line technicians and manufacturing process developers. Next we describe their respective working role in general and how they work with environmental performance more specifically.

4.2 Production line technicians

In the studied factory there are two manufacturing areas with four production lines in each of them. All lines have one, or in some cases, two responsible technicians and there are ten technicians in total. The technicians' working role is very diverse and each working day is different from the other. The reason for this is that the technicians are employed to make sure that the machines in the specific production line are running (80% of the expected work amount) and also to work with improvements in the lines to find more efficient production and cost solutions (20% of the expected work amount). The availability of the machines is prioritized in case of many pending improvement requests; if a machine fails, reparation work

is what the technicians will prioritize and they will work with this until the problem is solved. By not knowing when coming machine failures or problems will occur the technicians need to have a flexible schedule. At times when the production is running smoothly the technicians work to generally facilitate the work for the machine operators, working more directly with production machines, by e.g. writing instructions, ordering working clothes or making sure that components are ordered or in stock.

There are some set meetings for the technicians. The daily morning meetings include the production line's operators, production manager and supply chain manager (if the line has fixed resources in electricians and mechanics they will also attend). During these meetings they discuss what the production has been like during the past night and what is planned for the coming day. These meetings are also an opportunity for the technicians to get information from the operators about necessary improvements and reparations. Besides the morning meeting, another daily meeting is held by the manufacturing manager and includes technicians and production managers in their specific manufacturing area. These meetings are an opportunity for the manufacturing manager to know how the production in the different lines is doing as well as an opportunity for the technicians to ask for help or opinions in tough projects.

The technicians find information about the production in a MS Access database. This information is discussed with the machine operators during the morning meetings which are held to make sure that all workers in the line are up-dated. The technicians also receive information about production problems in the logbooks. These problems are often mentioned at the morning meetings, but written more in detail in the logbooks. Some of the respondents also state that they use the logbook for writing down what measures have been undertaken once an improvement has been carried out in order to have a better structure. When ordering a job from the maintenance department they use a specific system in which they write down job type, who orders the job, who is responsible for it, priority, a description of the problem and when they wish for it to be fixed. They are also supposed to use this system for reporting problems that they repair themselves, however one of the technicians states that they do not use it to the extent they should. The technicians work actively with maintenance work on the machines. Each line has a maintenance stop of two hours every week in which all machines are turned off and the technician, the operators, the electrician and the mechanic from the maintenance department are devoted to maintenance work such as to clean, fix and look after the machines with the aim to increase the machines' lifetime and to prevent unnecessary production stops. In case of problems occurring at other times they might wait to fix it until the maintenance stop in order to avoid unnecessary production stops. The two hours are little time to work on the machines and the actors need to focus on the most relevant parts to start with.

The technicians' work is not followed up daily or on a monthly basis. They used to be evaluated on a yearly basis through a scorecard with the parameters product cassation rate and resetting time but these scorecards are not used this year. The technicians perceive that their

managers are not aware of everything they do but as long as they solve the problems that are important for the line their managers are satisfied.

> *"He [the manager] does not have anything [key performance indicators] that he evaluates me on […] but we have a development discussion one time every year and in between, between these we speak about what I am working on right now and what is most important for the production line and he gives his opinions 'maybe you should have a look at this' and if one solves those problems he believes that one has done a good job."*

Even though the technicians' scorecard is not being used anymore there are yearly scorecards for each production line and these are followed up on a monthly basis. The parameters in these scorecards differ slightly depending on the production line but reoccurring examples are resetting time, cassations, productivity (units/hour), downtime, and reclamations. One of the technicians states that it makes more sense to have a scorecard for the whole line since all employees in one line work to reach the same goals. The technicians' job is dependent on the machine operators' requests. Since the operators are the ones working with the machines they are the ones who usually request machine improvements. Therefore, operators are also important for evaluating the technicians' work. Even though each improvement project is not formally evaluated, the operators' satisfaction is an indication of a well-managed job.

> *"They [improvement projects] are not really followed up. When something is installed it is completed, I guess it is rather that it is brought up again if it was not well managed. If there is a problem, one will hear about it."*

The technicians encourage the operators to handle smaller improvements on their own, since the technicians do not want to become the bottleneck and primarily focus on larger improvements where his/her qualities are needed. The technicians are allowed to handle all types of improvements, but when investment costs exceed a certain amount they need approval from the production manager, the manufacturing manager, the factory manager or the central purchasing department depending on the amount. The production lines are allowed to run improvement projects below 100 000 SEK by themselves.

As already mentioned in chapter 3 'Methodology' it has been argued that material losses, energy use and productivity are central aspects of a manufacturing system's environmental performance. Next we explain how the technicians in the specific factory work with these issues.

4.2.1 Material losses

4.2.1.1 Direct material losses

Direct material losses, consist of material that is supposed to be part of the final product but goes wasted during production (i.e. components in the definition of material losses in sub-chapter 3.3 'Selection of environmental performance variables). This kind of material loss is measured by cassation rates or decrement rates in the factory. The cassation rate includes all

direct material that goes wasted due to quality problems, i.e. when deviations are larger than given tolerance levels. Decrement rate is the difference between the supposed amount and the actual amount of pieces in a produced order. Roughly speaking, if the production line gets 100 pieces of something but in the end only produces 80 units there are 20 pieces missing. If 15 of these pieces were reported as cassation there is still a difference of five and these five pieces are then reported as decrement. Decrement can, for instance, occur if they do not receive the correct amount of pieces from the preceding batch production processes or if the machine operators do not report all cassations.

As already mentioned, cassation rate used to be one of the parameters in the technicians' scorecards. Even though these are not used anymore the respondents perceive that they are encouraged to minimize cassation rates in their respective line. Cassation rate is still one of the parameters in the scorecards for the production lines and the technicians do what is best for their line. When asked if technicians have incentives to reduce the cassation rate one respondent states:

> *"Yes, I can see how much cassation we have when we evaluate it so one tries to reduce it [cassation rate]. Many units end up on the floor so then one has to look at where it occurs and what we can do to solve it."*

When asked the same question another respondent states:

> *"Yes I guess, it is part of the job to have capable machines and everybody is happier, both the operators [and the technicians] because they do not like to waste material, that 'wow, now I have wasted this much', it is not a nice feeling for them and not for us either if we have high cassation numbers".*

Cassation rates are measured for each line and are followed up on a monthly basis through a cassation report from the quality department. Additionally, each line has a yearly cassation rate which they should not exceed, this percentage is usually based on the previous year's rate and strives to lower the percentage for the coming year. Cassation rates are brought up at the daily morning meetings in some of the production lines. In case of unusually high numbers the operators have to explain the reason for this. They also discuss cassation rates during the department meetings.

Many improvement projects are focused on decreasing the cassation rate. The machine operators report cassation and the technicians have facilitated the reporting by conducting instructions for how the operators should report and handle cassations. Until recently cassation rates were reported in an old system that did not make it possible for the technicians to collect the data until about three months after the material was wasted. A new system has been introduced and the data can now be collected directly after it has been added. This new system also enables the technicians to see cassation trends and to understand why material goes wasted. In addition, cassation parameters that indicate the reason for wasting something have been introduced. Today, when a cassation occurs the operators have to report which product quality parameter that was out of tolerance. These parameters have facilitated the

technicians' work to reduce the cassation rates by enabling them to see the reason for cassations and thereby prevent future discards of the same problem. Before the implementation of the cassation parameters many operators did not bother to document all cassations. The undocumented cassations were mistakenly included in the decrement rate rather than cassation rate, thus both rates were misleading. The parameters have deepened the understanding for why cassations must be documented and the two rates are presumed to be more correct now.

Even though the introduced parameters reveal why material goes wasted, the technicians spend a lot of time to solve problems that are related to high numbers of cassations. The solutions are not always obvious at first sight and they have to investigate all possible sources. There are several situations when the lines have experienced unusually high cassation rates but the technicians have been able to solve the problems. In one example a certain product dimension varied greatly and the final solution was to change to another type of monitoring device since the old one caused the variation. An additional problem concerned another product dimension and eventually the technician noticed that the robot clashed with the rail that held the monitoring equipment. This was done automatically which was the reason for why it was not noticed until they had a closer look into the machine. In a third example the technician lacked the knowledge about the reason for the high cassation numbers. Reclamations were sent to the supplier who tried to solve the problem, but TSAb appeared to be responsible for the problem as they used old drafts because a project two years before had not been implemented properly. These drafts were formulas for how to calculate material additions that are required on each unit depending on how much material that is removed in machining processes due to grinding allowance. The drafts were exchanged and the problem was solved. Another improvement to lower the cassation rate consisted of a switch from one grinding cup to another less sensitive and more forgiving one. The problem was that many units were incorrectly polished which caused cassations and by changing to another grinding cup the polishing was improved. The technician tried many different tactics before it was understood that the grinding cups were the problem.

With regard to the motivation for reducing cassation rates, some technicians state that added cost and invested time in the production phase increase the willingness to reduce cassations in the lines. They are less motivated to decrease the waste of unmanufactured material since it has not passed through the production line. According to the respondents the motivation to decrease such material is affected by the amount – even though there is no added cost they feel obligated to avoid wasting large quantities. One technician states:

> *"The things I have done [improvements that has been carried out in order to decrease the cassation rate] have been due to the added cost, that is the incentive rather than the actual cost of the unit. But sure, I was upset when I saw that they had wasted so many units that have not yet passed through the production line. In that case there were no added costs, or we had paid for the preparation phase, but not in our line. But there were so many of them. In other cases it is about the time we spend on grinding, particularly the bottleneck."*

4.2.1.2 Losses of indirect material and capital goods

Another kind of material losses is waste of indirect material such as machine parts and other material that is not part of the final product. As opposed to cassations indirect material losses are not followed up and discussed in each production line. If a line exceeds its budget they have a look at the use of grinding wheels or other machine parts but not in other case. Even though there is not as high focus on reducing this kind of waste as on reducing cassations, there are examples of improvements that have been done. In one production line the technician has helped the operators to do reconstructions of the machine covers in order to decrease waste of grinding wheels. To change the grinding wheels is an undesired and time consuming task which served as the motivator for this project.

The implementation of monitoring devices in one of the production lines is another improvement that has resulted in reduced losses of indirect material, but also of capital goods (i.e. machines). In 2002-2003 TSAb invented a decision support system which was able to measure vibrations on equipment such as spindles and engines and enabled the technician to foresee breakdowns. Since TSAb was about to launch this new system externally they wanted two of their own lines to do some manual measurements. When they started doing these measurements the line decided to introduce operator maintenance where they measured the use of cooling- and grinding water. These measurements revealed that they got far too little water which explained why the engines broke down faster than expected. By using the new monitoring device the technician could clearly show the lack of water supply to the responsible division who could fix the problem. The production line has continued to use this monitoring device ever since. Another measure that reduces waste of indirect material and capital goods is the already mentioned maintenance stops that take place once a week in all production lines. The aim of these is to prevent unnecessary production stops and to increase the lifetime of the machines.

A possible improvement with regard to indirect material losses that has not been done due to cost restrictions concerns the lack of storage of carton leftovers. Packages of cartons that are not opened are sent back to the supplier for them to keep the packages in stock, but the cartons in opened packages are thrown away. These packages can contain up to 100 cartons and the current behavior disturbs the responsible technician who wants to find a way to store the cartons. However, he has not been able to find a sufficient solution so far.

> *"Someone must have calculated on the storage costs so if we bothered to find a storage area it would probably be more expensive with warehouse charges [than the cost of wasting unused cartons]."*

4.2.2 Energy use

There seems to be no direct economic incentives for a production line manager to invest in reducing the production line's energy use since energy use is only followed up on a building level, where energy use is aggregated for all activities in that building. The general opinion between the technicians is that they are not encouraged to reduce energy use in their production line. However, one technician mentions:

"… Not that I feel encouraged [to lower the energy use] but I know that it would be seen as something positive if I did it. But there is just no time for it."

As indicated in the quote it is also a matter of priority. According to another technician, they are somewhat aware of and willing to work with energy use but since they are followed up with measurable parameters the technician does not perceive that energy use is prioritized from above in the organization. Another technician states that unfortunately they do not think much about the energy use, it is more important to reach the planned production level.

"… of course all of us would like it to be a bit more focus on energy use, but it is frankly not prioritized here… it is lost somewhere on the way down [from the top management]. Focus is to make sure that we produce what we should and if we did that, there might be room to focus on something else as well."

Another reflection is that energy use never is mentioned during the meetings they have:

"… energy use is never mentioned in there [the meetings], but cassations can be mentioned since we check these [the amount of cassations] once a month. It is more about money, but the production lines look more into the amount of material."

However, during the recession the workers were encouraged to lower the energy use through different measures.

"… it [encouragement to lower energy use] was during the recession in 2009. It was much we could shut down since we did not produce all days per week. We switched off computer screens, lighting and these things. It was a lot more focus on that part. Today we produce more or less all week around, it is just between Saturday and Sunday morning we do not have any production. During these hours the machines are switched off, but overall there is not an encouragement to switch off everything."

An issue preventing them to reduce energy use by turning off machines, when not actively producing, is that the technicians believe such actions would cause unpredictable problems in the machines when started again. Some of the respondents believe that this issue is something one could work a lot with but it has not been done so far. One technician describes some possible improvements related to energy use in the production line:

"I do not work much with it [improvements related to energy use], but I know that one could lower it [energy use] in a few different ways. For example, we try to avoid turning some machines off since they are unreliable and one does not know if they will switch on again once they are turned off. So, this is one thing we could work with. I also know that some lines have made their machines able to switch in to some type of waiting mode. That is another thing one could work with. However, I believe that everything has to do with how old the control system one has and our control system [in the line] is fairly old on most of our machines.

Everything is a question about priority and it might be other things that are preferred more than this."

Another technician states that there are many opportunities to decrease the use of compressed air, hydraulic oil, and other process media that is over used:

"… I think that one could do some improvement work on pneumatics and hydraulics and everything else that we over use today. We do not work hard with this today, but I still think that we could do that. But in that case I think we need feed-back to know how much one has used. It would be good if one could follow this [the use of pneumatics and hydraulics] over a few months; why has it increased or why has it decreased?"

Even though the technicians are aware of the high costs related to energy use, the lack of airflow meters in the lines makes them feel incapable of reducing it. One technician states that even if energy use occasionally is mentioned among technicians, it is extremely difficult to work with it since they lack both input and the ability to see if the usage has decreased. In order to have a larger improvement project accepted (by the manufacturing manager, factory manager or central purchasing department depending on the projects costs) the technicians perceive that they need to estimate the expected results and this is today impossible in the case of energy use. One of the respondent states:

"…it feels very far-away to do an improvement that might cost money if one cannot show that you get a result… "

Despite the perceived difficulty for the technicians to work with energy use one example of such project is an energy reducing measure in one of the production lines. The measure is addressed to the packaging machine which has a vacuum pump that consists of an ejector that is continuously running even if no units need to be packaged. In order to reduce the energy use, the technician has ordered a ventilator and asked an electrician for possible solutions for the pump to automatically switch off when it is not needed. However, this project is still ongoing, both because this type of improvements takes time as the technical part is complicated and also because the technician is obligated to focus on production related issues rather than this type of improvement projects.

In 2010, a decision was made at a central unit that all machine operators should go through energy training where many of the production line technicians also participated. The goal with the training is to increase the awareness about how much energy the factories use, understand the costs of leakages in the production line and to increase the knowledge of how to find leakages. One part of the course was placed in the lines where the workers had the opportunity to seek for leakages in their own machines, both leakages of compressed air and of lubricate oil. Thus, the training provided knowledge of how to decrease energy use and to lower the risk of machine problems causing cassation or other types of lowered output which has an effect on the efficiency of energy use. The technicians and machine operators now know what the machines should sound like and the look of a unit that has not been e.g.

polished appropriately due to lubricate oil in the grinding water. Lubricate oil in the grinding water obstructs the polishing and reduces the quality of the material. Material that has endured such conditions must be reworked and this forces the machines to work more for the same amount of material output.

The impression of the course was mainly positive. One technician praises it and says:

> *"I thought it [the energy training] was really good because it was practical. It was not just something 'over there' like in a beautiful world where we live in peace and so on. We shall think about the environment and that is nice, but it was good that it was practical and that one could apply it. That we could talk and then go to the production line and test if one could find its own leakages. All of us turned in to detectives and thought it was great."*

However, some technicians experienced a problem with the fact that all workers in the different lines were educated at fairly the same time.

> *"…I think we found hundreds of leakages and it is impossible to repair them all at once. The risk is then that you lose motivation. If I would implement it I would start with one production line and then set up enough resources to repair them. It is just silly to find all these leakages and then just mark them with a note. Now there are notes hanging everywhere in the production line."*

The technician continues by describing that they still have many leakages with notifications in the line that have not been repaired. The same respondent feels that the workers are encouraged to understand the importance of leak seeking, but when the leakages are found they are not prioritized. Another technician mentions the same problem and states that when their production line had done the training the mechanics (which are responsible for repairing the leakages) were already overloaded with work and had difficulties to prioritize the leakages.

According to the technicians an overall understanding of energy costs has been spread in the factory in the past few years. One technician told us an anecdote that some years ago, in summer time, a couple of operators cello taped the compressed air pistols to have a steady stream of air blowing out of them, using them as fans to cool down. Apparently the factory has been able to spread some knowledge about energy costs since then. As already mentioned, the recession forced the factory to economize and operators were told to turn off machines whenever possible to cut costs. Now that the recession is over the production runs both days and nights. This reduces the ability to lower energy costs through shutting down machines and the energy education therefore focuses on reparations during production.

4.2.3 Productivity

The interviews reveal that there is a high focus on productivity in the factory. Each production line has an expected output per hour and everybody is responsible to make sure that this amount is achieved. One example of how important productivity is for the factory can be

noticed in one of the newer production lines which does not reach its expected output. To solve this problem the factory has put much effort and resources to improve this. For example five different groups have been conducted – resetting time, quality, components, competences, and maintenance, with the aim to increase the productivity.

The technicians are encouraged to work with productivity related issues in order to ensure that the line reaches its expected output. One of the key performance indicators of production lines is output per hour and the technicians perceive that this is a priority for management. The production lines have to meet the planned output and deliver the orders in time, accordingly the technicians' main task is to keep the machines and the production running and much of their work is concentrated around keeping or increasing the productivity.

There is a high focus on downtime in most production lines. Downtime is equivalent to machine breakdowns causing disruptions in production. During such stops the other machines are usually not turned off because they historically have had quality problems when turning them on again, causing high cassation rates. An additional problem has been that they were unable to turn the machines on again. All technicians work with improvements that aim to reduce production disruptions in parts of or the entire production line. One example is an improved buffer system in one of the production lines which prevents them from having a production stop each time a machine breaks down. When speaking about the reason for initiating the project, the responsible technician states:

> *"… at the same time as a machine broke down, the whole line's production was interrupted. No more material was produced. This is a thing that we were criticized for, since our efficiency was not where it should have been if we had a buffer area."*

The machines are placed very close to each other so it is hard to have buffers between the machines but the technician has worked to improve their ability to have a larger buffer between the last machine and assembling. After improvement, the buffer size for smaller types has increased more than ten times. To have a buffer after the last machine implies that they can run both sides of the production line independently of each other which enables them to have maintenance or a breakdown for several hours without affecting the production level.

Another initiative to improve productivity was to order a label-printer to one line. The origin of the problem was that the line did not have its own printer and had to use the one in another line. Every time a new label was going to be printed the packaging machine in the other production line had to be turned off, resulting in a production stop.

A third technician changed engines in the grinding machines so that they have the same type of engines in all machines. When a problem occurred in one of the grinding machines, after the introduction of the same engines, they could run the other one for a while, save the units, and move the engine to the other machine and run that one which made it possible to reduce the number of the production stops by half. Having the same kind of engines also enables them to lower the stock of spare parts since it is enough to have only one spare engine. The

main benefit of always having a spare engine in stock is that the production can be up and running as soon as the engine is installed, there is no need to wait for delivery.

The production lines are to different degrees affected by the resetting time of the machines. The frequency of such resets depends on the amount of product types that are produced in each line as the operators have to reset the machines every time a change of product type occurs. The length of the resetting times differs among the lines which makes it a larger concern for some technicians than for others. Besides technical aspects of the machines, the length of the resetting time also depends on the operators why part of the problem for the technicians is to make the different production shifts carry out the resets as efficiently as possible. The length of the resetting time may also differ among the machines in the same line but a machine is usually turned on as soon as the reset is done. In addition, old machines and robots usually require longer resetting time than new ones. A technician in a line with older machines states that investments in new machines and robots with shorter resetting time are not done due to budget restrictions.

One of the technicians has worked a lot to shorten the machines' resetting times. In the past it was not much focus on the machines' resetting time since the delivery per type of units was larger. Today the deliveries include fewer numbers which has led to high production losses as more resets are needed. The technician has cut the planned resetting time by almost two thirds. The technician is currently working to reduce the mechanical resetting even further. Decreased mechanical resetting, or less variation, affects the time required for quality resetting (i.e. the needed test rings to reach the exact settings after a mechanical reset) which is a benefit that they were not aware of when starting the project. Less time for quality resetting in turn leads to less cassation of direct material since less test units are needed.

The technicians all believe that improvements are things that facilitate the machine operators' work. Changes in the production line that have no clear benefits and increase the work amount for the operators are usually not long-lived. Facilitations for the operators should go in line with an improved flow in the production. Examples of this type of improvement work have been: ergonomic facilitations that have lowered the amount of heavy lifts for the operators and increased the assembling speed of the units; different kinds of instructions for how to handle resets, cassations, machine stops etc.

These informal rules, related to the operators' wellbeing, sometimes place barriers on what can and cannot be done in the line. One fairly new production line with a large amount of robots has had major problems with keeping the robots running, which has lowered the overall productivity. One solution for this problem, according to the responsible technician, could be to replace the robots with manual work, but this would not be accepted by the operators. Additionally, the already mentioned buffer system has met resistance from the operators. The technician believes that it is due to the fact that a larger buffer system forces the operators to be more attentive. If something occurs that causes defects on the produced units there is a risk that all units in the buffer system have these defects and need to be

wasted. Therefore, a high buffer system could potentially result in higher cassation rates, if the operators do not pay attention to production and notice the defects in time.

Despite the high focus on productivity all measures are not prioritized. One of the production lines has found a new type of tools that would increase the efficiency by 20 percent. Although these tools are more efficient both in terms of produced output and costs they have not been purchased due to the high acquisition cost and the fact that the line meets its planned production level.

4.3 Manufacturing process developers

The process development department is a support organization to production and is responsible for purchasing and installing new equipment. Their projects are divided into improvement projects and strategic projects. Strategic projects, in turn, are divided into internal strategic projects from the factory and external strategic projects from the TSAb management. Process developers mainly work in projects but they also help the production lines to solve acute deviations. Process developers are never responsible for acute deviations but their department have a couple of technical specialists who would drop anything they have at hands to help solving a production stop. However, this seldom happen since the resources within the lines are capable to handle most problems.

All projects follow a standardized project model, group project model 2 (GPM2). In addition, a model for all investment projects in TSAb Local has been developed based on GPM2 rather recently. The new investment project model, hereafter called NPM, includes all necessary steps of a project as well as manuals and documents that support the process developers in their work. All new projects follow the directions that come from NPM, as it serves as a guarantee that the project upholds a certain quality. The main goal with NPM is to have a more standardized and structured working process in investment projects. The need to develop such a model had its origin in historical problems such as exceeded budgets and too long project implementations. Before the use of NPM the process developers had less guide lines and the projects were less structured. Although the NPM demands a lot of administration and paper work it facilitates for the process developer to calculate costs, estimate time and reduce production stops. One example when NPM is especially beneficial is in the preparation part before a machine is installed; the machine operators training sessions should already have been performed and preparations to facilitate the approval of the machines should have been done. To have new production lines working properly used to take one to one and a half years, but this has improved since the introduction of NPM. Another advantage is that the environmental coordinator participates more extensively in the projects as a result of the implementation of NPM.

Projects that are undertaken by the process development department are initiated by a need description from production (i.e. machine operators, technicians or production managers) in the case of improvement projects and internal strategic projects or from the TSAb management in case of external strategic projects. In some cases the competent process developers find possible improvements and initiate projects with the aim to implement this.

Such projects, however, are not encouraged since technicians and machine operators often need to perceive that they have a problem to follow new instructions that eventually come out of projects.

In investment projects, payback time is a crucial aspect. However in some more strategic projects this is less important. The process developer department does not have a payback time on external strategic projects since they have not initiated them. These projects involve changes that affect the whole company e.g. to synchronize systems with new legislations, to make sure that all factories have the same standard, or to secure products from being replicated.

The need descriptions are sent to a project portfolio management (PPM) group, consisting of representatives from the process development department and from the different manufacturing areas, who suggests what projects to proceed with. The final decision about whether the need to start a project is large enough is taken by the PPM-committee which is the same as the factory management group.

The first step of a new investment project is a pre-project in which the main goal is to find the right concept, develop product- and function descriptions that will form the basis for future demand specifications, and to anchor the project in the organization. Furthermore the aim is to get a clear view of possible risks and uncertainties to secure a successful project and to have a clearer focus on costs. In addition, they have to make explicit project delimitations. In this phase process developers evaluate different ideas and concepts and choose one or maximum two of them. In order to increase the likelihood of a successful outcome they investigate shortages and improvement opportunities from earlier projects when starting a new project.

The second step is the initiation phase which aims to get deeper into the chosen solution so that a relevant investment request (IRE) can be made. This step includes to do sharp technical specifications, to contact different suppliers and to receive offers. In addition, they do a media specification with the media use of all machines in each project. After receiving and compiling all the offers the estimated costs for the project are calculated and the process developers send the IRE. Depending on the amount of the costs the IRE has to be approved at a certain level such as the management, the board etc. If the IRE is approved the process developers start preparing for the third step, the delivery phase. The delivery phase aims to buy and implement the investment. The purchasing department is responsible for the negotiation with suppliers but process developers are involved in the negotiation of technical specifications. It is important that the installation process does not require too long production stops. Therefore, process developers have to plan for the installation of new machines so that it goes as smoothly as possible. After the installation process the post project starts and the responsibility is transferred to the sponsor of the project who make sure that the end effect goals are met. All projects are ended by a risk analysis which is carried out by a process developer and handed over to the sponsor of the project.

Each project has a project goal and an end effect goal. The end effect goal is set by the project sponsor, usually a mid-level manager, and should fit with the project goal. The project goal is set by the project team together with the project sponsor.

NPM contains manuals and documents that support the process developers. These include investment manuals, manuals for criteria evaluation, maintenance analysis manuals, etc. When evaluating different concepts during the pre-project process developers use a matrix where they set different criterions and decide how important each of these criterions is. In order to find the best concept each concept is evaluated with regard to these criterions. The different headings in the manual are 'Environment Health and Safety' (EHS), Economy, Capacity, Quality, Down time, Technology, Supplier maintenance, and Project time, each with a number of criterions beneath. The process developers set the criteria for EHS together with the environmental coordinator who has larger knowledge about such issues. If environmental performance is considered to be important in a project it receives high weighted score in the evaluation.

What is most important for a concept is decided by the sponsor and the steering group and is expressed in the needs description. The sponsor of the project also makes the final decision about which alternative to choose. Hence, the power of the process developers to make decisions about the requirements of an investment is limited, however, they are included from the beginning of the process to help the sponsor with recommendations. Also, the project team consists of people from different departments: the production manager and machine operators from production, the environmental coordinator and one representative from the maintenance department which all have a say in different decisions that have to be made. From the process development department a project team usually consists of one project manager, partial project managers, and technicians that are specialized in different areas. These teams have at least one project meeting every week.

When developing a concept together with the supplier, process developers always follow a technical specification. This is a standardized document which is adapted to each case. In the technical specification the machine specific features should be positioned either as requirements or options. If all features of a machine cannot be met, those that are expressed as options are removed.

Like technicians, process developers do not have certain key performance indicators at individual level. They have annual individual development discussions with their manager during which they speak about what they should achieve during the year. When asked if they are evaluated based on specific key performance indicators one respondent states:

> *"No not individually, we do not have anything [key performance indicators]. Or sure we have individual development plans and what one is expected to achieve during the year and what one should think of and so on but there are no measurable things really, it is more the projects as such, that they are successful. And that might be the goal this year; to finish the pre-project. Then if it becomes a*

project or not is not up to me so that cannot be a goal, so it is to achieve the goals one has for the moment."

Answering the same question, another respondent states:

"...particularly important is that it [the project] ends up within the right costs range and that it works as good as we thought, he [the manager] surely looks at that, not only him but others as well."

Next we describe how process developers work with the selected variables for environmental performance: material losses, energy use and productivity.

4.3.1 Material losses

4.3.1.1 Direct material losses

Similarly to technicians, the aim to have low cassation rates is evident in the process developers' work. Cassation rate is one of the priority parameters for improvement projects.

"The improvement projects, as we call them, are prioritized based on cassation, resetting time, efficiency. I guess those are the most important and we evaluate them based on how big savings we do."

In the case of investment projects there are strict requirements on the machines' capability. High machine capability implies that the risk of being outside the tolerance rate is minimized, thus leading to less cassations. Process developers strive to have machines with as high disengagement rate of machine operators as possible, it should not be necessary for them to constantly watch over the machine.

"The machine capability should be so stable, so high that the risk to have a piece outside [the tolerance rate] is minimal. That is the requirement and it is a statistical view around it, if you have high capability you probably have low cassation; under the conditions that you steer it the right way. It is method, human, machine, it is a three dimension picture this. […] it is also important that the person who steers the machine has the right competence. Our responsibility is the last dimension."

Reduced cassation rate is also a way of returning the investment faster. One of the ongoing investment projects involves a change of grinding machines. The main goal is to increase the machine safety but lower costs, higher efficiency, fewer cassations, and higher quality is also demanded.

"The main reason for initiating the project was that the security precautions were not complete - they [the machines] were very dangerous to run. This is one reason in its own, but you also need to be able to get return on the investment."

According to the responsible process developer they probably found a concept that met the quality requirements and simultaneously gave low cassation rate. However, the process developer states that the goal to reduce cassations is met:

> *"Yes there is less cassation in the new machines, though I do not have numbers on it. What is actually changed is that they have a process that is more stable so that they steer the quality better. One does not need to maneuver the installations, instead they are written into the process so fewer defects occur."*

4.3.1.2 Indirect material losses

Indirect material is specified in the technical specification where guidelines of desired type, materials, suppliers etc. with regard to machine parts are given to the machine supplier. For instance if a machine has grinding disks they specify a required label. Other kind of indirect materials such as plastics are also included in the technical specification to the extent it is possible.

4.3.2 Energy use

When discussing the new project model NPM, one of the process developers states that environmental impact is expressed clearly in the manuals they use. Another respondent states that NPM has had a positive impact on environmental standards and that energy is included to a higher degree in the new project model. The model encourages environmentally beneficial options early on in the process, for instance it recommends the process developers to choose electric engines which are more energy efficient than other options.

One respondent states that when evaluating different concepts in the pre-project they have to look at the different aspects if and how energy use could be managed. In the technical specification there are some directions and requirements of environmental performance of the machines, mostly with regard to energy use. One such example is that energy efficient engines should be used. However, a process developer states that energy use never has a higher priority than capability when buying new machines. Yet another respondent says that even though it is stated in the technical specification that an evaluation of the energy use should be made it is an aspect that is easily disregarded since a certain machine requires certain power or flow of process media. The respondent states:

> *"…if one would do a concept evaluation in which the parameters are evaluated it [energy efficiency] would end up low down, if there was not an obvious difference [in energy efficiency]."*

Another example of a direction in the technical specification is energy monitoring the machines. A respondent states that the desire to increase the control of energy use arose when sustainability started to gain focus within top management. The implementation of monitoring devices in one of the factory's production lines was seen as a way to help reaching the companies' overall goal to reduce the energy use. The same respondent states that a problem with regard to such monitoring is the lack of guidelines and directions for how to treat or use

the data. They already have a lot of instruments that measure energy use and gather information about efficiency curves but the information is not saved.

It is expressed as an option in the technical specification that the supplier, if possible, should avoid compressed air. One of the process developers states that the recommendation to remove compressed air is followed to the extent it is possible. However, the list of requirements and options is long and the demands about production, quality and safety are prioritized to a larger extent than avoiding compressed air. Even though they ask for different alternatives to compressed air during the phase of specification it might be difficult to get those other qualities modified simply for the sake of avoiding compressed air. The same process developer says:

> *"Quality will probably never end up at the lower end [in the priority list] because it is quality we sell. But there are other things that run the risk of ending up in the lower end and I personally believe that compressed air ends up a long way down since it is an option."*

However the respondent also emphasizes that there are many options in a project that are not met. Another process developer emphasizes the hierarchy between requirements and options:

> *"One could say [to the suppliers] 'try to minimize' so that one can compare the different offers with each other and chose the one with the least effect on energy use or what it can be that you focus on, media etcetera. We want to and we work to have a system as closed as possible to minimize the media and energy use. But then again, you might need to give up these demands to reach the right quality."*

Similarly to monitoring devices, the problem of having few guidelines is emphasized in the case of compressed air as well. One respondent states that even though they are recommended to avoid for instance compressed air and air cylinders they are not aware of the benefits of it. The respondent asked a washing machine supplier to specify the extra cost for having an alternative to compressed air in an ongoing project.

> *"…I have asked for, I want to know the price difference. But I still do not know how profitable it is. I do not know the benefits of it [avoiding compressed air] so I would like to have guidelines for that, the benefits of it."*

The respondent also explains that compressed air is standard in these machines and the supplier was surprised about the request. The final decision is not made yet. Another process developer discusses that they cannot have too much requirements, but that the supplier needs to be able to handle its job:

> *"… One can argue that this or that seems like the better option, but you do not want to intrude too much, the supplier must be able to work and we cannot take that responsibility from them."*

There is an environmental checklist in the IRE in which the process developers have to answer different questions regarding how they have taken different environmental aspects (energy use, chemicals, emissions, and waste) into account. In the energy use part it is stated that energy use is a significant aspect both in terms of environment and costs and that the overall goal is to reduce energy use in relation to production volume. The questions are: if the supplier specify energy use on its equipment; if they have tried to reduce the machines' energy use; and if the life cycle cost for energy can be estimated. Additionally, it is stated that the use of pneumatics should be avoided to the extent it is possible; direct usage of electricity is first choice. There are two questions regarding pneumatics: if there is pneumatic devices in the equipment; and if pneumatic devices can be replaced by more energy efficient technique.

One respondent states that the process developers are encouraged to actively think about how to minimize energy use. Changing a technique to one that uses less energy may have direct cost advantages. According to another respondent there is an awareness of the desire to find energy efficient machines if available but they are not obliged to choose such options. There are few guidelines and little information which makes it difficult to know if an alternative is better, more environmentally friendly, or cheaper in the long-run. It is also difficult to know if they should choose the energy efficient alternative if it is more expensive than standard.

None of the respondents is able to mention a project where a machine was selected based on its energy use. However, one respondent states that energy efficiency was brought up early on in the process of one of the ongoing projects. The machine's total annual energy use was calculated and compared to the machines of the competitors. However, there were no remarkable differences and they did not put pressure on the supplier with regard to the machines' energy use. On the other hand, when the same project is finished, the production line will be able to remove a process where a lot of material is classified as hazardous. Removing this process implies one less machine which leads to less energy use.

4.3.3 Productivity

As already mentioned, process developers carry out both investment projects and improvement projects. Improvement projects do not involve any major investments and are prioritized based on cassation, resetting time and efficiency. Eventually, it is not possible to do more improvements with the existing mechanical equipment and it becomes necessary to do an investment project which involves bigger investments. Production capacity and quality are important aspects of investment projects but lately there has also been an increased focus on reducing the production costs. Production costs are discussed in the following two quotes:

> *"It varies a lot, but today costs are seen as very important; to lower the standard cost […] The projects I have been involved in have all been accepted due to capacity improvements. That is what have been most crucial and is therefore prioritized."*

> *"…but now I think it is shifting so that it [the project] also must be very good in terms of costs, to make sure that the production costs less after [implementing the project]. […] every unit should cost less than they do today."*

Projects are initiated due to different reasons such as new regulations, capacity problems, and safety problems. Productivity is always taken into consideration, but cannot be improved each time. Some of the ongoing projects have been initiated because of safety problems; higher productivity was demanded in one of them and aimed for in the others. Due to the high safety risks one investment project was prioritized even though the payback time was calculated to be five years, two years above the TSAb standard. One respondent describes the main goals for a present project:

> *"The main criterion [for this project] was machine safety, but other criterions are cost reductions, improved efficiency, lowered cassations and improved quality. In that exact order I think."*

Another of the ongoing investment projects was initiated with the aim to increase productivity through improved accessibility in one of the production lines. The outcome of the project could be explained as a very complicated calculator which will facilitate for the operators. Today the workers have to find the material and to count the units to make sure it is the right amount, commonly the material is not found or there are units that are gone missing, leading to lowered production. By facilitating for the operators, this new equipment will result in higher productivity. Productivity was also important in a finished project:

> *"There [the project] it [the priority] is very focused on output. Quick output."*

Flexibility is crucial for TSAb's survival and they try to satisfy all customers' needs. However, changing to a new order with a different product type requires resetting of the machines and if the order is too small the economic gain might be lost. One of the process developers states that resetting times of the machines are considered important since they are the source of a significant part of the production losses. There are also stringent requirements for resetting time in the technical specification. No resets imply that the machines automatically change all adjustments and this has been achieved in one robot in the factory's newest line. However, the requirement of such short resetting times, or in best case zero resets, makes the machines substantially more expensive. Therefore, there has been a large focus on less variation in resetting times more recently. This has enabled them to find solutions for reasonable prices. Additionally there are other requirements in the technical specification that are related to productivity e.g. cycle time and downtime.

4.4 General perceptions of the environmental goals

As already mentioned in sub-chapter 4.1 actions to meet some of the local environmental goals for TSAb Local are directly implemented in the studied factory. However, none of the respondents knows the specific goals, most have heard about them but they do not remember them.

> *"…do not know more [about the environmental goals] then that we shall recycle. We have this recycling station where we throw away mixed waste and timber and so on. Then I think it is that we should decrease leakages, but that is something we work continuously with."*

Some state that they have read the goals on their own initiative:

> *"I have seen the paper [including the environmental goals] but I cannot remember exactly what was written. I remember that I found them too unspecific. I have seen them, but I think it was on my own initiative, not in the group we have not looked at them".*

One respondent also states that they do not know how to work with these goals or what they can do to help the company meet them.

> *"We have not got anything on our table in this department, but that is something that would be interesting if we did – what could we do to meet the environmental goals? I think that could be an interesting task actually."*

One process developer feels that the lack of some measures obstructs the goals from being fulfilled:

> *"… I find the environmental goals so and so… say that you want to reduce the energy use in the production lines, but we do not have any measuring devices on the line level… especially the technicians want to have direct feed-back…"*

According to another process developer, they do not have any collaboration with the environmental manager. The respondent also states that they do not know if and what the environmental coordinator wants them to do in terms of environmental performance.

5. Analysis

The analysis is outlined starting with discussing TSAb's overall ability to be seen as a legitimate company. This is taken more into detail by a continuous analysis if the expected coupled activities are actually integrated in the daily work practice of the technical personnel. We continue by analyzing what the technical personnel strive for and how this affects the environmental performance. Finally we end the chapter with a deeper discussion about TSAb's performance in relation to the applied theory.

Comparing TSAb's general initiatives and successes with the theoretical findings gives a notion that the company has many reasons to be seen as a legitimate company. As written in the empirical findings TSAb's environmental concerns origin from the corporate strategy level which according to Banerjee (2001) is an advantage for a company. Environmental initiatives that origin from such an influential level, increases the external legitimacy. TSAb has repeatedly expressed its interest in these initiatives and has, based on environmental improvements, won prizes on the way.

Another argument that supports a high company legitimacy is that TSAb is using one of Dowling and Pfeffer's (1975) expressed ways to become legitimate. The authors argue that there are several ways for a company to become legitimate and in accordance with one of these possible ways, TSAb clearly communicates the environmental initiatives through symbols, values, and institutions which have a strong base of social legitimacy. However, as argued in the greenwashing and decoupling literature (e.g. Gillespie, 2008; Hess & Dunfee, 2007; Meyer & Rowan, 1977; Behnam & MacLean, 2011; Hess, 2008) gaining legitimacy through disclosed environmental initiatives does not necessarily imply that a company actually implements activities and practices that are in accordance with these initiatives. Scholars (e.g. Jimenez & Lorente, 2001) argue that in order to influence the environmental performance, environmental strategies have to be integrated at the operational level. Thus, what has been studied in this thesis is how TSAb's environmental initiatives have been integrated at the operational level through in-depth evaluations of the daily work of the operational core. These findings place a bit more nuance to the discussion of how well TSAb has been able to integrate its environmental initiatives in the company. However, the findings also reveal that the current work practice reduces the environmental impact in other ways than first expected.

5.1 Environmental initiatives at operational level

TSAb does not only have initiatives describing actions 'over there' but have hands-on goals which are implemented on the different establishment levels; corporate group level, national level and factory level, and which are easily evaluated. If Jamali's (2010) identified antecedents that can distract a company to properly implement environmental initiatives and eventually make these lead to decoupling are reliable, TSAb runs a small risk of being blamed for decoupling since their goals are so structured. Jamali (2010) primarily mentions uncertainty, goal ambiguity, or unspecified means to reach a certain goal as such distractions.

The environmental goals and action plans indicate that the environmental initiatives are integrated in the operational functions. Banerjee (2001) argues that companies with an integrated functional approach are concentrated on activities around waste, reduction, recycling, pollution control etc. Similarly, Gupta (1995) and Sarkis (2001) argue that pollution prevention and waste reduction are important aspects when adapting the manufacturing process to improve environmental performance. All these areas can be identified in the goals and action plans, however, in order for integration to actually appear these areas need to be translated into work practice. According to Meyer and Rowan (1977) decoupling implies that formal organizational structures have no effect on the actual work practice. In other words, the environmental goals, although structured, need to result in some kind of action. Both leakage seeking and energy training are part of the action plan, hence a sign that the environmental goals at least to a certain degree have been translated into work practice in the factory. This suggests that the goals for TSAb Local are not just a way to descend the "policy talk" from concern level to local level.

However, there are also examples of actions that have not yet been implemented. For instance, the action plan includes the implementation of machine devices that turn off the machines automatically when they are not in production. As stated by one respondent some lines have made their machines able to switch in to waiting mode, but so far they do not seem to have implemented any devices to automatically turn off the machines. Additionally, very few of manufacturing process developers or technicians are familiar with the environmental goals. They do not know how to work with these goals or what they can do to help the company meet them. One respondent has more insight and claims that there are some obstacles that hinder technicians to work with the goals. For example the respondent criticizes the action plan related to the energy reduction goal since energy use is not measured at production line level.

An additional difficulty with regard to the factory's energy use is that the usage is divided into electricity, electricity to produce compressed air, and natural gas; information about the total amount of energy use is not available. As argued by Gupta (1995) an important question when adapting operations management to environmental management is how good the data gathering systems of pollution are and how these systems can be used to solve operations problem. Considering TSAb's goal to reduce energy use it is surprising that there is not higher control of the factory's total energy use. Also, according to the documents that contain the environmental goals, energy use for TSAb Local is followed up on a monthly basis. Thus, they could be expected to have numbers of the total energy use for each factory.

5.1.1 Environmental initiatives in the technicians' work practice

Behnam and MacLean (2011) argue that integration of a structure or program in the company's central processes requires that the employees receive the necessary training. In the studied factory many of the machine operators and technicians have taken the energy training which is an attempt to integrate actions to reduce the energy use. The energy training was primarily seen by the technicians as a positive course since the workers were taught to convert the theoretical knowledge into practice. The training was not just a way to earn some extra

legitimacy but meant to change the workers behavior, to give some extra attention to leakages causing a decreased environmental performance. This goes in line with Behnam and MacLean's (2011) argument that complete integration requires environmentally related practices.

An obstacle to integration is according to Meyer and Rowan (1977) a difficulty for some companies to integrate social pressures and simultaneously reach their expected financial outcome. However, the content of the energy training focused on environmental performance, but did to an equal or even larger extent focus on financial costs. For TSAb the more important outcome of this training could therefore have been to decrease the production costs by lowering the use of energy. We argue that such action is taken with the aim to facilitate an integration of social pressures by simultaneously include financial results in them. Such win-win relationship between environmental initiatives and financial incomes is according to Banerjee (2001) as well as Hart (1994) a possible outcome since a reduction in pollution leads to cost savings. The decoupling literature emphasizes a separation between policy and practice, hence the focus is on the work practice in the organization rather than the outcome (Meyer & Rowan, 1977). This implies that for TSAb to act in accordance with coupling, they should seek leakages with the aim to lower the environmental impact. However, in the case of the energy training the incentive is improved financial performance rather than environmental performance, which means that there is a decoupled relationship between environmental initiatives and work practice.

The technicians' job is very diverse and learnt through the empirical findings is that they primarily work to make sure that the production is running smoothly. The possible ways to integrate environmental initiatives in the technicians' work practice would probably be to either recommend them as tasks in improvement projects or to include them in already existing work practices. The energy training was an excellent opportunity to implement an environmentally beneficial act into the work practice in the factory. According to theory concerning decoupling (e.g. Meyer & Rowan, 1977; Behnam & MacLean, 2011; Jamali, 2010), reaching complete integration would require the knowledge from the training to be translated into practice. However, even though the training resulted in practice in form of leakage seeking, all leakages have not been repaired. The mechanics are responsible to repair machine leakages, but their main priority defined in their work instructions is to repair areas that negatively affect the production. Thus they are only to prioritize leakages that exceeded a certain size, since large leakages might cause machine breakdowns. If the environmental initiatives were coupled to work practice in the factory, environment would be considered to be one of the important aspects in the factory, and would therefore obtain more focus. The found leakages would be repaired to a larger extent, no matter the size, to signalize the importance of the issue. Here the outcome from the energy training was somewhat down prioritized in favor of the production. According to Meyer and Rowan (1977) efficiency driven companies have a close alignment between structure and activities in their prioritized areas. TSAb's way to prioritize other activities prior to environmental measures indicates that environmental concern is decoupled from the daily work practice which is more concentrated on productivity than reducing the environmental impact.

The empirical findings indicate that the technicians are not encouraged to prioritize activities related to energy use. The production lines' scorecards are an indication on what is important and should be prioritized. However, energy use is not measured at line level, but only at factory level and is not integrated among the scorecard parameters. Accordingly, the technicians seem to have initiated few efforts in order to reduce the factory's energy use. Some technicians state that although there are some possible improvements with regard to energy use, this area is not prioritized and they do not perceive being encouraged to work with such improvements. Weaver et al (1999) argue that an integrated policy, program or structure influence everyday decisions and actions, hence if the environmental initiatives would be coupled to the actual operations in the factory, energy use would be prioritized to a larger extent and the workers would be encouraged to initiate energy related projects. The low prioritization of energy reducing measures is highlighted by the example of the packaging machine in one of the production lines where the project has not been finished partly because the technician has to focus on production related issues. Additionally, Weaver et al (1999) argue that if integrated, both managers and employees see the structure, policy or program as having a valued role in the company's operations. Such argument further emphasizes that the low prioritization of energy related activities is a sign of decoupling.

The fact that energy use is not measured at production line level is in our opinion a sign that the environmental initiatives are decoupled from practice. As argued by Behnam and MacLean (2011) integrating a policy requires making sure that it has the proper resources to be effective. Without energy monitoring devices in the production lines, the production line managers do not have any incentive to lower the energy use. In other words it also implies that the employees are not encouraged to work with these issues. Again, the production lines prioritize activities with measurable effects that influence the parameters included in their scorecards. In other words, energy use is not expressed as an important issue to work with. This is consistent with how Scott (2008) defines decoupling since internal units are buffered and operate independent of TSAb's environmental initiatives. Similarly, Behnam and MacLean (2011) argue that integration of a program or structure requires that employees are held accountable for adhering to its principles. TSAb has a goal to reduce energy use, however, since there is no measurement at production line level in the studied factory the employees are not held accountable for following this goal.

The interviews with manufacturing process developers however revealed that an implementation of energy monitoring devices has been initiated. As a result of the emerging focus on sustainability issues within top management, there has been a growing desire to increase the control of energy use and implementation of monitoring devices on machines was a resulting arrangement in the factory. This could be seen as a sign of coupling since the new policy at corporate level actually led to practice in the factory. However, the implementation of monitoring devices has only taken place in one production line and the information is not saved because the technicians and machine operators do not know what to do with it. In this case, TSAb fails to provide the necessary education and the specific environmental initiative falls short. For coupling, Behnam and MacLean (2011) argue that a company needs to make sure that the employees receive the right information. Hence, like the energy training,

implementation of monitoring devices was a good start, however in the end none of these initiatives fully led to a change in work practice.

5.1.2 Environmental initiatives in the process developers' work practice

Compared to technicians, manufacturing process developers have a more regulated work role since all their projects have to follow an investment project model (NPM) that contains certain steps. In addition, the project model includes standardized manuals, templates and other documents that support them in their work. Environmental performance is included to a larger extent than before the implementation of NPM and the new model has had a positive impact on environmental standards. Already in the concept evaluation the different concepts are evaluated based on environmental criterions. In addition, energy use is directly integrated in these formal documents e.g. manuals and templates. In the checklist for the IRE, the process developers have to respond to questions if and how energy use has been taken into consideration. In the technical specification it is stated that the machines' energy use should be evaluated. Including the environmental coordinator in the projects is another attempt to integrate the environmental initiatives among the employees. As stated by Weaver et al (1999), when a structure is integrated into the companies work practice people that occupy the specialized structure have both confidence of and regular contact with other employees. On the other hand the dialog between the coordinator and process developers seems limited as some respondents feel that they do not know what the coordinator wants them to do in terms of environmental performance.

The implementation of energy related issues in manuals and templates forces the manufacturing process developers to reflect on energy solutions in all projects. However, there are no consequences if a less energy efficient solution is prioritized instead of a more energy efficient one. The manuals serve as reminders and encouragements rather than instructions. Regarding the concept evaluation, it depends on the project sponsor's requests if environmental criterions receive high or low weighted scores. Today there is a low pressure on the project sponsor to consider environmental aspects in projects, hence they are rarely prioritized. When considering these tools from a coupling/decoupling perspective one has to evaluate how thoroughly these tools are used. If they are not taken into action, which they rarely appear to be at the factory, they cannot be considered as being integrated in the work practice (Behnam & MacLean, 2011).

One example when energy related guidelines in the formal documents are not completely taken into consideration is in the phase of negotiating machine features with the supplier. Energy use is discussed, but it is commonly a weak parameter compared to other ones. The technical specification for instance states that the machines should have energy efficient engines and that compressed air should be avoided to the extent it is possible. However, these desires are commonly positioned as options, rather than as requirements and the process developers are not obliged to choose energy efficient alternatives. There are many other features such as production capacity, quality, capability, and safety that are prioritized and which would never be compromised on in favor of energy efficiency – indicating that energy does not seem to be a variable that is considered important. Since many of the desired features

with regard to energy use are commonly stated as options in the technical specification they are easily removed. Even if they state that energy use is considered, none of the respondents was able to mention one single example where they actually chose a machine because it was more energy efficient than the alternatives. Hence, energy use does not seem to be taken into consideration to a high extent when selecting new machines, which is a sign of decoupling. As argued by Weaver et al (1999) an integrated initiative should influence decision making.

Meyer and Rowan (1977) argue that the integration of formal structures is crucial for legitimacy and to increase the company's resources and survival capabilities. Formal documents are part of the organizations formal structure, thus, the signs of environmental initiatives addressed for manufacturing process developers are seen exactly where one can expect them to be. At first sight one can believe that the factory takes energy into consideration since this is suggested by the manuals and templates, but through deeper investigation energy use has little power against many other prioritized parameters and there are no consequences if energy use is not prioritized. In line with decoupling our findings suggest that the energy related instructions in the manuals and templates are rarely followed. Including environmental initiatives in the documents implies that the policy talk is descended to lower levels in the organization, yet they are still only incorporated in the formal structure. This is consistent with Meyer and Rowan's (1977) explanation of decoupling, since these policies are talk rather than action and are not really integrated into work practice. Scott (2008) states that *''organizations under pressure to adopt particular structures or procedures may opt to respond in a ceremonial manner, making changes in their formal structures to signal conformity but then buffering internal units, allowing them to operate independent of these"* (in Jamali, 2010, p.625). Similarly, the internal units in the factory, i.e. the process developers, work independent of the disclosed environmental initiatives. The quotation also indicates that the central unit in charge of the NPM model should have made tougher requirements if they were sincere about these documents' effect on improving environmental performance.

Throughout the interviews we have found that the manufacturing process developers believe that they in fact work with the environmental initiatives. This is in accordance with 'in good faith' which, according to Meyer and Rowan (1977), is a common characteristic when policies are decoupled from practice. The process developers' intention is not to disregard environmental initiatives, instead we have picked up many excuses for why energy use has not been considered: all machines have a similar degree of energy efficiency; some machines need a certain amount of energy to function; some solutions (e.g. compressed air) are standard functions in the machine and therefore cheaper and more reliable; they are tied to certain suppliers; or the process developers do not want to intrude too much in the suppliers' job. The general opinion, according to the process developers, is that there have been unlucky coincidences which have prevented energy efficient solutions to be chosen. All of the above listed excuses are fair explanations, but still a sign of decoupling. If a company was sincere in integrating environmental initiatives at operational level, the mentioned excuses would not be accepted. Instead energy use would always be considered an important machine feature and

the process developers would be encouraged to pressure the suppliers to supply energy efficient solutions.

In sum, although there are signs of coupling between TSAb's environmental strategy and operative practices, the general picture is one of decoupling. Environmental initiatives are added to formal instructions and training at the factory level, but only rarely do these initiatives trickle down to technicians and process developers' actual practices. In this way, TSAb's staff and headquarter functions buffer the operative core from stakeholders' increasing environmental demands. Hence, TSAb's environmental profile has changed during the last decade improving the legitimacy of TSAb, but for the operative core it is still business-as-usual. Simpson and Samson (2010) argue that a corporate level strategy without any support in operation practices does not have big effect on the company's environmental performance. However, figure 1 and 3 in the empirical findings (sub-chapter 4.1) indicate that the selected factory has been able to lower its environmental impact. What is then creating the positive outcome? Next, we discuss the prioritized areas and the consequences in terms of environmental performance of activities related to such areas.

5.2 Consequences of operations on environmental performance

The main focus in the factory seems to be concentrated around efficiency, both in terms of productivity as well as costs. This does not come as a surprise, considering that TSAb is a manufacturing company. It is important to keep in mind that the factory's main goal is to reach the expected production level and to make sure that the customers' orders are delivered on time. The focus on productivity might however not be a problematic issue in terms of environmental impact, instead high productivity has been argued by internal research at TSAb to positively affect the environmental performance of a manufacturing system.

The technicians' main task is to make sure that production is running. Productivity is a scorecard parameter and each line has an expected output to reach. Thus, the technicians are encouraged to improve or make sure that the production line maintains a certain level of productivity. There are many factors that negatively affect productivity as they disturb the production flow and such factors are included in the scorecards to ensure that they are prioritized. Some of these also influence environmental performance which is consistent with the win-win relationship between an efficient production process and environmental performance discussed by Hart (1994) as well as Porter and van der Linde II (1995). Examples of such parameters are: 1) downtime; 2) resetting time; and 3) cassation rate, and will be discussed in the following paragraphs.

The first parameter considers downtime. When a production stop occurs due to a machine problem the remaining machines are usually not turned off, thus energy is used even if the production is down. The reason why the machines are not switched off is because they are unreliable and the workers are not always able to switch them on again when the production fault is solved. Therefore, under the current circumstances, downtime has an indirect effect on energy use and a reduction in downtime implies higher energy efficiency i.e. a reduction in energy use in relation to the amount of produced units. An example of a measure that aims to

reduce downtime is the maintenance stops. Less downtime through more careful machine maintenance is mentioned by Porter and Van der Linde II (1995) as an example of activities that enhance both the resource productivity as well as the production process.

The second parameter considers resetting times which have similar effects on productivity as downtime. The machines are turned off during the actual resetting, but are switched on again as soon as they are reset. The resets in some machines take longer time than in others – hence some machines are running while waiting for the other machines to be ready for production. Shorter resets would therefore not only improve productivity but also energy efficiency. Since older machines take longer time to reset, investing in new machines would increase productivity as well as energy efficiency. However, new machines are not bought due to the high investment cost. On the other hand it is also true that one could question the environmental friendliness of wasting functioning machines. According to the manufacturing process developers, there are machines with substantially shorter resetting times but they are simply too expensive. Thus, even if machines with shorter resetting times would be beneficial in terms of productivity they are not bought due to high investment costs. The high costs have resulted in a focus on less variation rather than short resetting times. However, less variation in resetting time between different machines means that the time when some machines are turned on while waiting for the other ones to be reset is shortened. Hence the energy efficiency is increased anyway.

Having long resetting times has become a problem due to changes in the market. Historically, TSAb used to receive orders of large quantity which meant that they did not have to reset the machines very often. Now that they receive orders of less quantity they are forced to reset the machines more frequently which has led them to strive for shorter resets. One possible reason for why customers order smaller quantities is the popular business models just in time (JIT) and lean production, resulting in that the customers make an order at the time they need them rather than buying and keeping in storage which they have done historically (see e.g. Levy, 1997). This would imply that lean production potentially could be problematic for environmental aspects which challenge other research arguing for a positive relationship between lean production and pollution reductions (see e.g. King & Lenox, 2001).

TSAb offers a wide range of product variants to their customers. This implies that they produce units of different types, sizes, special features etc. which increases the need for resetting machines. TSAb's flexibility is on the other hand a business strength and could be one of the reasons for why the company is market leader. To reduce the amount of different types of units would have benefits both in terms of productivity and environmental performance but the solution cannot be on behalf of their customers' dissatisfaction. If the market demands a large range of product variants and smaller quantities, TSAb has no option but to adapt to these demands. Thus, under the current circumstances it would not be feasible to have less resets and the company therefore have to focus on shortening the resetting times in order to gain productivity.

The third parameter concerns cassation rates. Since all lines are evaluated based on cassation rates the workers have a clear incentive to reduce such waste which is reflected also in the work practice. The general aspiration to avoid wasting units forces the workers to constantly improve their cassation rate by finding new solutions in the machines and there are several examples of improvement projects that have been carried out in order to reduce cassations. Cassation rates are also discussed during different meetings in the factory. To have low cassation rates is important also in the work of process developers. Cassation rates are integrated in their manuals through requirements of high capability which simultaneously results in fewer cassations. The capability requirements are considered to be important and are usually not compromised on. The importance of few cassations is also manifested in one of the current projects which have reduced cassations as one of the goals. Additionally, cassations are one of the priority parameters for manufacturing process developers' improvement projects. According to Gupta (1995) as well as Sarkis (2001), reducing waste is one way to adapt the manufacturing process to become more environmentally friendly. However, the motivation for technicians to reduce cassations is related to costs or invested time on each unit that goes wasted as each wasted unit means lowered output. Similarly, in the case of process developers cassations are seen as an easy way to get a positive return of investments. Hence, the high focus on cassations is a result of its impact on efficiency rather than on environmental performance.

Process developers are not part of the production per se, however, they are responsible for ensuring that the factory has the necessary equipment to manage a high production. Therefore the process developers are in many ways encouraged to strive for the same parameters as the technicians. As written above, examples of prioritized machine features are production capacity, quality, capability, and safety. The NPM project model has led to increased efficiency and improved environmental performance since it encourages a preparation part before a production line is installed, which for example includes a machine operator training session. Such preparation decreases the implementation phase and enables the line to function without major defaults. The importance of an early implemented training session is highlighted in the quote where a process developer talks about the three dimensions to reach low cassation. Even though process developers strive to find machines with high capability, the human dimension is equally important since the machines must be managed in the right way.

In sum, consistent with the win-win relationship between an efficient production process and environmental performance (Porter & van der Linde I, 1995), the activities that are concentrated around productivity and low costs also influence the environmental impact of the factory. Porter and Van der Linde II (1995) argue that when environmental improvements take the form of resource productivity such as less downtime or material savings, companies simultaneously enhance their production process. However in the studied factory it is the other way around; the intention behind these activities is not to improve the environmental performance – such effect is just a consequence. On one hand, as a result of the win-win relationship, the outcome of the current behavior at operational level is relatively good. On the other hand, the outcome would have been better if the environmental initiatives were

integrated in the daily activities so that improvements that aimed to reduce the environmental impact were carried out.

5.3 Decoupling not greenwashing

Environmental performance appears to be seen as a side-effect and is not an integrated part in operations. There are few aspects in the work practice of the two studied functions that signals on coupling between TSAb's disclosed environmental initiatives and the activities that are undertaken at the operational level. As argued by Weaver et al (1999), an integrated policy influences the daily activities and decision making. Activities are rarely carried out with the only aim to decrease the environmental impact in the factory neither does environmental concern seem to influence the decision making at this level. Additionally, opposed to one of the characteristics of integration presented by Behnam and MacLean (2011), the employees are not held accountable for improving the environmental performance of the factory. If the environmental initiatives were coupled to the work practice, all areas related to environmental performance would be prioritized to a larger extent. Energy use would be measured at production line level and included as a scorecard parameter and activities that affect the environmental performance would be undertaken regardless of their influence on productivity. Also, there is currently a low focus on indirect material losses in the factory. Such waste is considered in TSAb Local's environmental goals, which is displaying the company's knowledge of its' environmental effects, but the concern is not shown in practice. There are few measures to reduce waste of indirect material and the few ones that have been undertaken have been for reasons of productivity, lower costs, or worker satisfaction. As argued by Sarkis (2001) and Gupta (1995) waste reduction is a crucial aspect when integrating environmental concern at the operational level. Thus, integration of the environmental initiatives in the work practice would imply that more activities concentrated around reducing indirect material losses were carried out.

The present study shows that even though many of the productivity enhancing measures and activities that are undertaken in the factory have an indirect effect on the environmental performance the workers are not aware of it. These activities are not carried out for reason of reducing environmental impact but rather for reasons of efficient production and many of the environmental effects seem to 'just happen'. Hence, the study indicates that many of the factory's activities to improve environmental performance are happening automatically through the aim of having a high efficiency level. This observation suggests that because of the win-win relationship that Hart (1994) as well as Porter and van der Linde II (1995) argue exists between improved environmental performance and an enhanced production process, environmental protection is, to a certain degree, self-regulated.

One can question if it really matters if the workers are aware of it or not as long as their activities are consistent with TSAb's policy to reduce its environmental impact. Is it the intention or the outcome of the activities that matters? At TSAb, the outcome is coupled but the intentions are decoupled. Authors tend to present decoupling and greenwash as the same phenomenon (Egels-Zandén, 2007) however we argue that these concepts are somewhat different. The decoupling literature refers to a separation between policy and practice, hence

the focus is on the work practice in the organization instead of the outcome (Meyer & Rowan, 1977). This implies that an activity that is carried out for reasons of productivity but consequently have a positive environmental outcome is not a sign of the environmental initiatives being coupled to practice.

Greenwashing on the other hand is more focused on the outcome of certain activities. Gillespies (2008) defines greenwash as *"advertising or marketing that misleads the public by stressing the supposed environmental credentials of a person, company or product when these are unsubstantiated or irrelevant"* (p.79). Evident in this definition is that this concept of greenwashing emphasizes two things; the announcement of environmental initiatives or other types of environmentally beneficial actions and the outcome of these actions. As opposed to decoupling, outcome is the signpost and determines whether a company is accused for greenwashing or not. Thus, due to the consequential environmental effects of the efficiency enhancing activities, TSAb cannot be blamed for greenwashing. Evident in the definitions of greenwashing is also the companies' intention to mislead the public (see e.g. The Concise Oxford English Dictionary, 10th Edition, in Lyon & Maxwell, 2011 p.8). Many of the environmental initiatives are expressed by TSAb's top management and regard the whole corporate group while this study only reflects the situation in one factory. However, as indicated in figure 1 and 3 (see sub-chapter 4.1), there has mainly been a reduction in energy use as well as an increase in energy efficiency (2009 serves as an exception which we believe is the result of the financial recession) in the factory during the last five years. This suggests that, in this specific case, TSAb does not mislead the public by providing disinformation and can consequently not be blamed for greenwashing. Also, as mentioned in the empirical findings (sub-chapter 4.1) TSAb has, on group level, managed to annually reduce their emissions substantially.

Thus, we argue that the environmental initiatives are decoupled from the work practice in the studied factory but since the outcome of the operations in terms of environmental performance is rather good (due to the win-win relationship between efficiency and environmental performance) we do not consider TSAb to use actions of greenwashing. Although decoupling was introduced with the aim to in depth explain the characteristics of greenwashing, we have come to realize that decoupling and greenwashing do not necessarily imply the same thing and the two concepts should consequently not always be used together.

Even though the win-win relationship between efficient production and environmental performance exists at all levels of the company (production line, factory and group level), the employees' lack of awareness regarding the effects on environmental performance of many of their activities might cause a win-lose situation at group level. If the employees would be aware of the impact of their activities on the factory's environmental performance it could influence the overall environmental spirit among them. Such a spirit could potentially create advantages for TSAb. First, take the example of enhanced reputation and image which the literature claims is being increasingly important (Sims, 2009). Through their way of speaking about the company, the employees have a high influence on TSAb's reputation. If they would be aware of the environmentally beneficial outcomes of their activities they would probably

perceive the company as being more environmentally friendly, consequently helping to spread this view outside the company walls. Thus, the lack of awareness among the employees could potentially hurt the company image and consequently result in financial losses, creating a win-lose situation at group level. Second, an overall environmental spirit in the factory could potentially encourage the employees to more actively think of environmental impact in everything they do. Once the 'low hanging fruits' are harvested, further improvements will require greater efforts (Hart, 1995). If the employees have a high environmental awareness and always keep the importance of reducing environmental impact in mind, they might be of great help for TSAb in its aspiration towards minimized environmental impact.

Relating the win-win argument to the concept of decoupling, the very need to decouple the formal structure from the daily activities is removed. As argued by Meyer and Rowan (1977), decoupling occurs due to a conflict between structures that reflect institutional rules and structures that are efficient. However, since there seems to be a win-win relationship between improved environmental performance and an enhanced production process, one could argue that there is no conflict causing an incentive for decoupling. On the other hand, we argue that TSAb, despite the proved win-win relationship, actually decouple the work practice in the organization's central processes from the company's environmental initiatives. This puts the whole discussion in an interesting light since there seems to be two sides of it. The win-win relationship not only implies that there is no need to decouple the environmental initiatives from work practice but also that there is no need to couple policy and practice since a reduction in environmental impact, to a certain degree occurs automatically.

However, such argument would be a simplification of the problem. At an initial phase, manufacturing companies can reduce their environmental impact through fairly 'small' changes. These changes are important and should absolutely not be underestimated, however, environmental protection will require larger efforts in the long run. The positive trend in economic growth shows no signs of slowing down and production levels are likely to continue increasing, a problem that is further emphasized due to the industrialization in fast developing countries. Thus, significant reductions of environmental impact will be necessary. As indicated in this study, not seeing environmental performance as a side-effect but rather integrate such concerns at operational level could lead to further reductions of environmental performance. Similarly, Simpson and Samson (2010) state that the operation management function uses most natural resources, is responsible for the maintenance of equipment from which pollution is most likely to occur, and generates important innovations and technologies. Hence, they claim that a corporate level environmental strategy must be supported by operational practices in order to have substantial effects on the firm's environmental performance. Thus, we argue that coupling between environmental initiatives and organizational work practice is necessary in order to ensure improvements of environmental performance that are large enough.

6. Conclusion

In this chapter we answer the thesis question and discuss the broader purpose of the study. Furthermore the thesis's contributions to the literature about environmental performance in manufacturing are presented. Finally, we give suggestions for further research as well as some recommendations for how TSAb can reach a higher integration of the environmental initiatives in the factory.

This study aimed to answer the research question *"How are a corporation's environmental initiatives integrated in the work practice of technical personnel in one of its factories?".* Analyzing the empirical findings with the theory of decoupling shows a low degree of integration between the environmental initiatives and work practice in the factory. Even the activities that indicated on coupling between policy and practice, such as the energy education and the recommendation in the manufacturing process developers' manuals, were after further evaluation also considered decoupled. A common expectation is that if environmental initiatives are decoupled from practice the company will not have a positive environmental outcome. Presuming this would be the case, TSAb would have an unimproved environmental impact.

However, the study was conducted through an inductive manner which encouraged an understanding of the full work practice of the technical personnel and not just the activities in line with direct environmental performance which is emphasized in the decoupling theory. Given such deep investigation, the purpose of the study was to provide deeper knowledge regarding environmental performance in manufacturing companies. The results indicate that due to a win-win relationship between an efficient manufacturing process and environmental performance, many of the activities that are carried out in the factory indirectly reduce the environmental impact. As mentioned before, there is a need for studies investigating the connection between operations, strategy and environmental performance. The contribution of this thesis is that strategy and operations do not necessarily need to be coupled to reach environmentally beneficial outcomes.

On the other hand, this study also indicates that although the importance of the indirect environmental effects, these are nothing more than consequences of the daily activities that aim to improve productivity. In case of a conflict between environmental performance and efficiency the latter one is always prioritized. This suggests that coupling between environmental initiatives and work practice is necessary in order for environmental activities to be prioritized to a larger extent, so that substantial environmental improvements can be reached.

Although the environmental initiatives are decoupled from work practice in the factory, TSAb cannot be blamed for greenwashing. Regardless of the intention behind the activities that are carried out in the factory, the outcome in terms of environmental performance is still positive. Decoupling was introduced with the aim to in depth explain the characteristics of greenwashing, however, our result indicates that decoupling and greenwash do not necessarily

imply the same thing and the two concepts should consequently not always be used to describe the same phenomenon.

The result of decoupling is surprising considering that TSAb is recognized as sector leader in sustainability. However, they are also sector leader in terms of market shares which is consistent with former arguments about an existing win-win relationship between enhanced production process and improved environmental performance. This implies that the win-win relationship to a certain degree concerns all manufacturing companies since they commonly strive for cost savings and improved productivity. Hence, we argue that at an initial phase, environmental performance can be improved through enhanced efficiency, but once the 'low hanging fruits' are harvested further improvements depend on large investments. However, such investments imply a significant initial cost before the long-term gains can be obtained and this step requires the company to have a higher environmental commitment. Once again, coupling the environmental initiatives to work practice will therefore be necessary.

6.1 Further research

Research about the environmental performance in manufacturing companies has rarely studied the operative activities. The present study indicates that deeper investigations are needed for a complete understanding of the topic. This study is based on one case, however we encourage further research to conduct similar investigations in order to see relationships between manufacturing companies and find more generalizable results.

Also, this study was focused on technical personnel and therefore reflects one side of the picture. It would be interesting and useful to compare the results with studies conducted on management's perceptions in order to obtain a full picture.

Based on the limitations of approaching this subject through the theory of decoupling, we question if decoupling is the most suitable way of studying environmental performance in manufacturing companies. Therefore, we encourage further research to find alternative theories to apply on this kind of studies.

6.2 Recommendations

There are many prioritized areas in the factory but environmental performance does not seem to be one of them. As mentioned by Meyer and Rowan (1977) a company should not only prioritize activities that meet the societal pressure, but also needs to have an efficient production level and a strong financial performance. We agree with this statement, however, in the case of TSAb we argue that environmental activities are not considered as part of the important areas. Our main recommendation is therefore to integrate environmental performance with the other prioritized activities. Given this argument the following recommendations are elaborated:

- Airflow meters need to be implemented in the production lines for energy improvement projects to be carried out. In addition, the scorecard parameters seem to have high impact on what is prioritized and energy use should therefore be a scorecard parameter.

- The decision support system has proven successful in one production line. It could therefore be efficient to implement the support system in the rest of the production lines as well. However, we believe that it is important to educate the machine operators and technicians about how to use the device. It is also important to make sure that the monitoring is followed up and that the trends serve as indications of necessary maintenance activities, to ensure a continued use of the device.

- A drawback in the energy training has been that there are still unrepaired leakages in the machines. In order to reach a successful result in environmental trainings the content of the course must be prioritized in order to signal conformity to the workers in the production lines.

- There is currently a low focus on indirect material losses in the factory. Although, this kind of waste does not have a clear connection to productivity (opposed to direct material) it might be advantageous to put more emphasize into this. If indirect material losses are not prioritized there is risk of a spill-over effect on the attitude towards waste of un-worked units of direct material. Also, working more to reduce all types of material losses increases the overall environmental awareness among the employees.

- There should be stricter requirements about the machines' environmental performance in the technical specification. Today, the recommendations such as using electric engines and minimizing the machines' energy use are not considered to a high extent. Part of the problem seems to be that they are commonly expressed as options, hence for an integration of environmental initiatives we suggest that these features should be standard requirements. Furthermore there is a need for more guidelines and clearer directions with regard to environmentally beneficial solutions.

- We recommend a higher pressure on the suppliers to develop machines that meet TSAb's environmental standards.

- Finally, we recommend the factory management to make sure that the employees receive more information about the environmental initiatives and how they can contribute to an enhanced environmental performance. We further believe that it would be advantageous to increase the employees' awareness of the indirect effect on the environmental performance of their activities.

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Appendix 1 Interview Guides

Interview guide for production line technicians

1. Can you please start by telling us a bit about yourself and about your work role here at the factory?

2. Your work role is partly focused on improvements;
   - How do you work with improvements and what do improvements mean to you?
   - How do you receive information about what to improve and how is this followed-up?

3. Have you taken part of any sort of education in regard to energy use or material losses?

4. A well-performed work – what does that mean to you and when does your manager perceive that you have done a good job?

Which other technicians should we talk to for further information about technicians' work role?

Interview guide for manufacturing process developers

1. Can you please start by telling us a bit about yourself and about your work here at the factory?

2. Have you taken part of any sort of education in regard to energy use or material losses?

3. Do you have any tools or templates that more in depth takes environmental issues into consideration?

4. How is environmental performance part of your daily work practice?

5. Which are the important criterions in a machine purchase and how has these criterions been selected?

6. A well-performed work – what does that mean to you and when does your manager perceive that you have done a good job?

Which other process developers should we talk to for further information about process developers' work role?