ANALYSIS OF STRENGTHS AND WEAKNESSES OF ENVIRONMENTAL MANAGEMENT ACTIVITIES: THE EXAMPLE OF AN INDUSTRIAL COMPANY

Master’s Thesis

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Danksagung

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Abstract
By means of the growing environmental contamination in the last years and the resulting negative impacts, companies are forced to undertake the responsibility and carry out measures to protect the environment. That in turn, is already seen as an obligation for the companies; especially in terms of higher environmental awareness of the population it is necessary to stay competitive. The operating environmental protection can be implemented by an environmental management system and its basis, namely an eco controlling. This makes it easier for firms to recognize weak points in their e.g. resource utilization and to develop action programs to eradicate these weak points. Subsequently new goals can be defined. To implement this cycle, the eco controlling offers a few functions and instruments. With the idea of a SWOT analysis, the AT&S AG started the process through to become an improved environmental management system by demonstrating the strengths, weaknesses, opportunities and threats in this field. On the basis of this analysis, some strategies to improve the current situation are recognized and the ideality of the company is discernible. The content of the master’s thesis is to address these issues for all six sites. To ascertain the different points of the SWOT, the environmental responsible persons of each site were interviewed. Thereof, the Status Quo of the environmental management system of the AT&S AG was the result and out of this the particular strengths, weaknesses, opportunities and threats derived.

Kurzfassung
resultiert. Die Master-Arbeit behandelt diese Themen für jeden Standort der AT&S AG. Um
die einzelnen Punkte der SWOT herauszufiltern, wurden Experteninterviews mit den
zuständigen Umweltverantwortlichen in den jeweiligen Standorten geführt. Aus den
Aufzeichnungen dieser Interviews ergab sich der Ist-Zustand des Unternehmens hinsichtlich
des Umweltmanagements und daraus ließen sich die Stärken, Schwächen, Möglichkeiten
und Risiken ableiten.
1. Introduction

1.1 Initial Situation

Today’s competition on the market requires high effort in respect of environmentally compatible production. The customer demand is moving more towards sustainable products, which means the firm’s increased responsibility regarding economic, ecological and social issues.

The people’s attitude towards environmental awareness has changed over the last few years in the direction of accepting responsibility for their acting, concerning impacts on the next generation’s way of life. This also results in higher attention on which products are consumed and therefore the aspect of environmentalism has got interesting for economical decisions.

There arises the question for firms, how to implement environmental aspects in the daily way of acting respectively in the company’s whole core strategy. The main difficulty in this context is the measurement of the relevant data, like water consumption, energy consumption etc. which is crucial for establishing an environmental report. To attribute measured flows at an interpretable value, it’s necessary to express these in key figures which imply methods to conceive the amounts of used flows or the needed data. Appropriate methods could be, for example: material flow analysis or in a more extended form, a value stream mapping. Key figure systems are largely important to analyze collected data and therefore for decision making (Möller, 2000, p. 14).

The main topics which outline, among other things, the stated issues are environmental management and eco controlling. The correct implementation of these two items is crucial for a company to realize starting points for improving single processes¹ and also to get the necessary data for the report. Without relevant measurements of flows it’s not possible to change or enhance production stages, which is of course adverse for the firm in question; on the one hand concerning competitiveness and on the other hand to develop and to save costs. But especially the capture of relevant data and the right and uniform interpretation of them represents problems.

To ascertain data, a value stream mapping² can be used to accomplish a monetary and material evaluation i.e. an interpretation of compiled data, environmental information’s systems can be applied. However the correct implementation and the process of this system illustrate a challenge for firms.

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¹ Such as energy consumption, water consumption, sewage clarification etc.
² Also other pertinent methods can be used for data collection, this is just an example.
1.2 Objective Targets
To establish an environmental report in a firm which has no needed data, the already depicted problems have to be vanquished. This is illustrated on the example of the association “Austria Technologie & Systemtechnik Aktiengesellschaft”, briefly AT&S AG, by analyzing the strengths – weaknesses of the organization\(^3\) and opportunities – threats of the environment\(^4\), short SWOT-Analysis.

The aim of this thesis is to demonstrate some possible starting points to improve the firm’s current dealing with the environmental influencing resources by screening the environmental information. In order to introduce this analysis, it’s crucial to find out generally if the environmental aspect is integrated in the business strategy – in other words, if there is already eco management and eco controlling implemented – taking into mind which environmental data are already ascertained and which are lacking; which system for data administration is used, how it works and also if there are different interpretations of the collected data or ensuing key figures concerning the various sites and so on.

Based on this analysis, the AT&S AG has the possibility to realize the strengths and weaknesses of environmental action of the firm and the opportunities and risks of some issues concerning external effects as well.

To obtain the relevant information to implement the analysis, employees of every site\(^5\) were interviewed about:

- Their personal attitude regarding environmental correct action of AT&S AG
- The environmental-friendly operating of AT&S AG
- The internal environmental data system
- The environmental information from suppliers
- The environmental information from customers

There are also open questions to filter out the employees’ opinion concerning the current ecological efficient action of AT&S AG and whether there are any suggestions to improve single processes. The evaluation and the conclusion of the questionnaire follow in chapter 4.

This analysis helps without limitation to recognize operating problems regarding environmental data administration and provides therefore the chance to improve lacking processes or even more, helps to detect the lack of basic operations like, for example the right implementation of an efficient eco controlling.

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\(^3\) Internal view

\(^4\) External view

\(^5\) AT&S has six sites, which are located in Hinterberg/Austria, Fehring/Austria, Klagenfurt/Austria, Nanjangud/India, Shanghai/China and Ansan/South Korea.
1.3 Structure
Chapter 1 shall give an overview about the set targets and the structure of the Master's thesis. The basics of environmental management and eco controlling and the different aims, functions and tools are discussed in chapter 2. This chapter also includes a description of an Environmental Information System.
Chapter 3 describes the analysis of strengths, weaknesses, risks and opportunities which is crucial to know, in view of what the paper is geared towards, in particular to conduct this analysis for AT&S AG’s dealing with environmental data processing.
How a Questionnaire can be constructed is shown in Chapter 4.
Chapter 5 comes up with the practical and main part of the Master’s Thesis, namely the basic SWOT Analysis of AT&S AG as well as the introduction of the AT&S Group with all six sites: Hinterberg/Austria, Klagenfurt/Austria, Fehring/Austria, Nanjangud/India, Shanghai/China and Ansan/South Korea, the Questionnaire with its evaluation and conclusion and the Status Quo which appears from this evaluation.
Chapter 6 describes the consequential ideality of AT&S AG and how this can be achieved by steps to implement an Environmental Management and recommended Eco Controlling procedure.
The summary in Chapter 7 is a résumé and final evaluation with improvement suggestions.
To obtain the necessary information for establishing the SWOT analysis, interviews were started with the environmental responsible persons and one person of the field “production” at each site of AT&S AG. The questions of the interview were given by a specifically designed questionnaire. By evaluating these responded questionnaires, assumptions of the strengths, weaknesses, opportunities and threats of the firm were possible to generate and in succession options for improvements.
The following figure outlines the structure of the thesis.
Figure 1: Structure of the Master’s Thesis
2 Basics of Environmental Management and Eco Controlling

2.1 Environmental Management

It’s now about 20 years that Environmental Management is known, discussed and implemented in companies’ strategies. However, despite all that, there is no international accepted definition for this item.

2.1.1 Perimeter of a definition

Environmental Management Tools like ISO and EMAS tried to find a pertinent definition (Loew et al, 2002, p. 8):

- Environmental Management System (ISO 14001)
  Environmental Management contains organizational structure, planning operations, responsibilities, methods, procedures, processes and resources for development, implementation, compliance, evaluation and maintenance of ecological policy and it is part of the common management system.

- Environmental Management System (EMAS 2)
  Environmental Management contains organizational structure, planning operations, responsibilities, manners, procedures and resources for the establishment, implementation, realization, audit and continuation of environmental policy.

- Management Performance Key Figure (ISO 14031)
  Environmental Performance Key Figure provides information about management activities regarding improvements of environmental performance of an organization.

The above-noted definitions of Environmental Management assist to find a general declaration of this item. Especially ISO 14031 and its definition of a Management Performance Key Figure give an understanding for Environmental Management as special activities in a firm. The term “Management” can be seen as a group of people or as organizational factor. (Loew et al, 2002, p. 9-10). Wöhe (1996, p. 95) also points out the ambiguity of “Management”. On the one hand it describes a circle of people who assign tasks and on the other hand it is a function which is fulfilled from these people. This double conception is also applicable for environmental management. As appears from the EMAS and ISO definitions for environmental management system, the implementation of this system in an organization leads to a continuous monitoring of the environmental relevant action and to the establishment of its procedure and regulations. With this background, Arndt’s (1997, in: Loew et al., 2002, p.9) definition for environmental management seems to be rather a good one: Within the operational environmental protection, environmental
management refers to active implementation of functions and tasks. The management system indicates generally the structure operational organization.

2.1.2 Driving Forces of Environmental Management

The following chapter deals with various inducements which prompt a company to implement an environmental management. There are two different kinds of forces which can be mentioned: internal and external (Montiel and Husted, 2010, p. 350ff).

Internal driving forces or in other words the advantages a company extracts from environmental management systems, such as the ISO 14001 are for example: the possibility to reduce negative environmental impact at their own pace without having to compromise their competitiveness (Bansal and Hunter, 2003, p. 290), the continued improvement of environmental performance (Roome and Wijen, 2006, p. 15) and the enhanced firm’s image (Jiang and Bansal, 2003; in: Bansal and Hunter, 2003, pp. 289). The advantage for firms that are environmental legitimate is to gain possibly competitive advantage through this improved image (Bansal and Hunter, 2003, p. 292). Further on, environmental management is accompanied with the fact of pollution prevention and this can provide a better performance for the company (King and Lenox, 2000, p. 710, 714).

By considering external driving forces, Nishitani (2009, p. 669) mentioned that stakeholder’s environmental pressure can act as important trigger by implementing ISO 14001 in a company. Other motivations for companies to certificate ISO 14001 are the governmental pressure regarding regulations, the improvements of the environment performance (Qi et al., 2011, p. 1254) and the facilitated international trade relations. The last mentioned point is explicable by the increased environmental awareness of the companies and the requirements of certified environmental management systems to suppliers and vice versa. This fact makes it easier for both companies and suppliers to decide their trade relationships (Christmann and Taylor, 2001, p. 445, 449).

Zeng et al. (2003, p. 107ff, in: Zeng, 2010, p.11) divided external driving forces into the government driving force and Kassinis and Vafeas (2006, p. 145ff, in: Zeng, 2010, p. 6) further on into the market driving force and the social driving force (e.g. stakeholders).

In many cases it is hard for companies to meet the mandatory environmental regulations from the government. Therefore it seems to be crucial that government environmental regulations guide environmental management especially to provide a basis for environmental correct action and to avoid environmental penalties, fines and violation costs. To make use of these consequent benefits, companies have to comply with these environmental regulations (Zeng, 2010, p. 7).

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6 Because ISO is voluntary
7 To give one example of environmental information systems
The market driving forces involve the competitors’ and the buyers’ requirements (Shrivastava, 1995, p. 184). Implementing an environmental management brings certainly improvements in processes which can probably lead to reducing manufacturing waste. This is of course an advantage for the company and improves the market competitiveness. Therefore, companies which harm the environment are encouraged\(^8\) to implement environmental policy to improve their competitiveness and social sustainability (Zeng et al., 2008, p. 1095).

Social driving forces include those from public media and certain industrial associations. The awareness of the general public concerning firm’s environmental correct production has increased over the last few years. Consumers say that they are environmental-friendly products and packaging and are even willing to pay more for those eco-friendly products (Shrivastava, 1995, p. 184). Today it is nearly required from companies to act environmental friendly and to show commitment to eco-responsibility which can also help to gain social reputation (Hart, 1995, p. 995-996).

2.1.3 Relationship between Environmental- and Economic Performance

There have been some studies about the relationship between corporate environmental and economic performance which came to different conclusions. Before the link between these two aspects is explained, it is important to clarify the terms “environmental performance” and “economic performance”. Environmental performance is a multifaceted concept. This means that the activities of the company may cause multitude environmental impacts, for example: on resources, lands, pollution in the air, water etc. The more a company is acting in concerns of the environment, the better its environmental performance is. But this doesn’t mean that the company is performing well in all environmental issues. The performance and also the impact can differ from one environmental issue to another. Therefore it is important, by analyzing the environmental- and economic performance, to consider the environmental performance issue by issue. The economic performance is also characterized by a multidimensional concept such as different operational measures capture different aspects, which means that for example some measure of economic performance are indicators for commercial success, like growth, market share and others are indicators for financial success such as profitability. For assessing the environmental-and economic performance link, this results in high expenditure of analyzing these two aspects (Lankoski, 2006, p. 33).

Now, there are some approaches which came up with a positive and some with a negative linkage between environmental-and economic performance. Porter and van der Linde (1995, p. 98) argued that environmental standards can lead to innovation in the company which partially or more than fully offset the costs of complying with them. Therefore

\(^8\) Case of China
environmental regulations could lead to higher competitiveness of companies because these innovations, motivated by environmental regulations, can not only lower the net costs of meeting these regulations, but also lead to absolute advantages over firms in foreign countries which are not subjecting to similar regulations. Therefore strict environmental regulations can increase competitiveness. Sharma and Vredenburg, (1998, p. 735) for example show that improvements in environmental performance like the implementation of new technologies, which brings cost reduction or the production of environmental friendly products, which attracts eco-sensitive customers, lead to higher potential of competitive advantage. Therefore better environmental performance improved the general image of the company concerned. This increases the loyalty of the customers and simultaneously supports sales efforts (Lankoski, 2006, p. 34).

However the positive correlation between corporate environmental and economic performance is not always obvious, for example: needs the implementation of environmental management extra resources, including funds, technologies and human resources, which again involves extra costs. Therefore, the investments for an environmental management may decrease the possibility to invest in other resources and reduce the corporate sustainable competition (Wagner, 2008, p. 300-302).

Environmental performance improvements could also lead to revenue losses by adverse impacts on the product quality. This fact reduces sales volume or sales price. Such negatively impact occur if the new environmental friendly product is perceived to be less attractive for the customer, or less consistent concerning quality etc. (Lankoski, 2006, p. 35). Furthermore the installing of pollution control or implementing of prevention technology is accompanied by costs increases. Here, capital investments such as machinery, equipment etc. and operating costs such as energy, materials are mostly required (Jaffe et al., 1995, p. 132ff; Sprenger, 1996).

Summarized it can be concluded that the relationship between environmental and economic performance can both be a win-win situation but also a win-lose situation. Which of these mentioned possible cases is occurring, whether positive or negative impacts, depends on the situation of the market, the company etc.

2.1.4 Environmental Management Accounting

In respect of the prospective target of AT&S AG, to ascertain the consumptions and the environmental costs of energy, water, waste water treatment, chemical processing and waste disposal\(^9\), this chapter describes the term of environmental management accounting and two characteristics of it.

\(^9\) These two authors are cited from Lankoski, 2006, p. 32ff
\(^{10}\) The five relevant flows for AT&S AG
Environmental Management Accounting, short EMA, is an environmental management tool to gather environmental costs and physical environmental flows. Graff et al. (1998, p. 3-4) defined it as follows: \textit{Environmental management accounting is the way that businesses account for the material use and environmental costs of their business. Material accounting is a means of tracking material flows through a facility in order to characterize inputs and outputs for purposes of evaluating both resource efficiency and environmental improvement opportunities. Environmental cost accounting is how environmental costs…are identified and allocated to the material flows or other physical aspects of a firm’s operations.} 

Another definition from the International Federation of Accountants (IFAC) (2005, p. 19) would be that \textit{[Environmental management accounting is…] the management of environmental and economic performance through the development and implementation of appropriate environment-related accounting systems and practices. While this may include reporting and auditing in some companies, environmental management accounting typically involves life-cycle costing, full cost accounting benefits assessment, and strategic planning for environmental management.}

The last definition which is mentioned here comes from Schaltegger and Burritt (2000, p. 89) who say the following: \textit{…environmental management accounting is defined in a narrower sense to include only the environmentally induced financial aspects of accounting that help managers to make decisions and be accountable for the outcome of their decisions.}

Environmental accounting management is now divided into Monetary Environmental Management Accounting (MEMA) tools and Physical Environmental Management Accounting (PEMA) tools. The advantage of this framework, compared to the conventional management accounting, is that environmental information is separately identified, classified, measured and reported. Especially manager’s decision making is facilitated by this separation and realization of the environmental costs. The conventional management accounting missed this aspect of separation (Burritt and Saka, 2005, p. 1263).

The following table describes some possible points for an environmental management accounting.
Basics of Environmental Management and Eco Controlling

<table>
<thead>
<tr>
<th>MEMA (Monetary Management Accounting)</th>
<th>PEMA (Physical Management Accounting)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short term focus</strong></td>
<td><strong>Long term focus</strong></td>
</tr>
<tr>
<td><strong>Past oriented</strong></td>
<td></td>
</tr>
<tr>
<td>1. Environmental cost accounting (e.g. variable costing, absorption costing and activity based costing)</td>
<td>2. Environmentally capital expenditure and revenues</td>
</tr>
<tr>
<td>5. Material and energy flow accounting (short term impacts on the environment—product, site, division and company levels)</td>
<td>6. Environmental (or natural) capital impact accounting</td>
</tr>
<tr>
<td><strong>Future oriented</strong></td>
<td></td>
</tr>
<tr>
<td>3. Monetary environmental operational budgeting (flows)</td>
<td>4. Environmental long term financial planning</td>
</tr>
<tr>
<td>Monetary environmental capital budgeting (stocks)</td>
<td>7. Physical environmental budgeting (flows and stocks) (e.g. material and energy flow activity based budgeting)</td>
</tr>
<tr>
<td></td>
<td>8. Long term physical environmental planning</td>
</tr>
</tbody>
</table>

Table 1: Comprehensive Framework of environmental management accounting (Burritt and Saka, 2006)

There is a set of reasons why environmental management accounting is getting more interesting for managers (Gray et al., 1993, p. 10; Burritt and Schaltegger, 2001, p. 20-21; Bennett et al., 2003, p. 89, 90; O'Donova, 2002 and Ansari, 1997, in: Burritt and Saka, 2006, p. 1263-1264):

- It is required from companies to observe environmental regulations and environmental information has to be recorded to show the compliance of these regulations.
- An increased number of managers recognize the importance to manage the environmental impacts a company entails. The collection of environmental information is a part of the responsibility accounting process.
- International, national and local government bodies are supporting and promoting environmental management accounting.
- Through environmental management accounting, tools costs and technological barriers can be reduced.

The IFAC outlines as well some benefits of environmental management accounting which come within three areas (IFAC, 2005, p. 23-24):

1. Compliance: EMA ensures environmental protection by cost-efficient compliance of environmental regulations and self-imposed environmental policies.
2. Eco-Efficiency: EMA ensures the environmental protection of a company and reduced costs by more efficient use of resources for internal operations and final products.
3. Strategic Position: EMA ensures a long-term strategic position of the company by evaluating and implementing cost effective and environmental friendly programs.
EMA gets interesting and valuable for the internal management with environmental focus such as cleaner production, supply chain management, environmental management systems etc. EMA becomes more and more important for all management activities and is also used for external reporting purposes.

However, also the fact that the implementation of an EMA improves the eco efficiency should be examined more closely. Therefore the term “eco-efficiency” has to be defined as this has a direct influence on the type of ascertained and provided EMA information (Schaltegger and Burritt, 2000, p. 54, 90).

The general definition of efficiency is the measurement of the relation of input to and output from a process. Now, if output is very high for a given input or input is very low for a given output, the process is efficient. The further this relation of input and output is shifting (according to, the higher the output for a given input or the lower the input for a given output) the more efficient the activity is.

Efficiency on the one hand can be measured in financial terms, like contribution margin percentage, return on sales etc. and in technical terms like output per hour which is measure in kilograms (Burritt and Schaltegger, 2001, p. 6).

As efficiency, in general, is the ratio between output and input, ecological efficiency can be interpreted as the relationship between a measure of output and a measure of environmental impact (see Schaltegger and Sturm, 1992/94, p. 203).

Ecological efficiency = \frac{\text{Output}}{\text{Environmental impact added}}

The term “environmental impact added” describes a measure of all influences on the environment and its assessment is conducted according to their relative environmental impact (Schaltegger et al., 1996; in: Burritt and Schaltegger, 2001, p. 7). There are two different kinds of ecological efficiency measures: ecological product efficiency which means the ratio between a unit of product and the environmental impact which was created over the whole life cycle of the product and the ecological function efficiency which describes the environmental impact which is attributed to the provision of a specific function in each period of time (Schaltegger and Burritt, 2000, p.50). Ecological function efficiency is, therefore, defined as the ratio between a provision of a function and the associated environmental impact added (see Burritt and Saka, 2006, p. 1265). A function could be for instance the amount of solder mask which is needed for one PCB. The less impact a process causes in fulfilling the function the higher the ecological function efficiency is. Improvements for ecological product efficiency can be achieved by the implementation of pollution prevention...
techniques or by end-of-pipe technology. Ecological function efficiency can be increased by replacing products with low efficiency by products with high efficiency; for example by reducing the resources which are used to fulfill the function (Burritt and Saka, 2006, p. 1265). The level on which the efficiency of the two ratios is measured can be variable, such as a unit of a product, a business unit or the whole production.

The cross-efficiency between the economic and ecological dimension – economic-ecological efficiency – is the ratio between the change in value and change in environmental impact added. This economic-ecological efficiency is also often mentioned as eco-efficiency (see Schaltegger ad Burritt, 2000, p. 51).

\[
\text{Eco-efficiency} = \frac{\text{Monetary Value Added}}{\text{Environmental impact added}}
\]

For calculating the numerator, specific financial information is necessary, the same as physical information about the environment for calculating the denominator. The accounting department and the finance staff have the possibility to make this financial information available and link it with physical information which is provided by natural scientists. Therefore, to calculate eco-efficiency measures, it is required to connect conventional accounting and financial management with physical measures (Schaltegger et al., 2000, p. 51).

The number of companies which disclose the results of their environmental management accounting in their environmental reports is increasing. It can be considered that this trend is influenced by the above mentioned advantages of environmental management accounting for a company (Bennett et al., 2003, p. 97).

2.2 Eco Controlling

The term of eco controlling has no generally applicable definition. Especially the distinction between eco controlling and environmental management is hard to define. This is attributed to the disagreement of the term “controlling” in the field of business administration. It is unclear whether controlling is an own branch in business administration. There are two possible attempts at explaining the term (Loew et al. 2002, p. 13-14):

1. “Controlling” is often used as description for accounting and management accounting.

   The aims of controlling according to the BMU (2001, p. 8-9) are:
   - The generation and preservation of the controlling- and reaction function by the establishment of an information system. This system is responsible to inform about the target-performance comparison.
The generation and preservation of the adaptability by allocating information about actual or foreseeable changes of the environment and

- The generation and preservation of the coordinating function by internal target control and coordinating all sections of the company.

2. But in some firms, controlling is defined as a new problem which deals with questions which have not been discussed yet.

Therefore it is hard to define “eco controlling”, if opinions already differ when attempting to explain “controlling”.

BMU (2001, p. 9) defined it as follows: Environmental controlling is a cross-departmental management concept within the environmental management with information-, planning-, management- and controlling function. It is geared to gather material- and energy data, its ecological impact and its legal and societal assessment and, in that context, the costs and proceeds. Environmental controlling is forming the environmental management, processes relevant environmental information and enables the decision-making for environmental issues and the determination of environmental targets through the environmental management.

2.2.1 Aims of Eco Controlling

However, the aim of eco controlling can be defined as a horizontal issue which covers a few sectors in business activities. To ensure a sustainable use of eco controlling, the environmental measures have to be analyzed, planned and controlled in the sense of ecological and economic aspects (Heubach et al., 2003, p. 5). In general, the aim of eco controlling is to support the management to achieve the corporate goals and to contribute on the steady improvement process (BMU, 2001, p. 10). To implement an eco controlling system into a company, the existence of environmental target elements is required; otherwise it is not possible to establish an eco controlling. However, the fact that there are environmental target elements doesn’t give information of the kind of target for environmental protection; on the one hand environmental protection can play a leading role in company’s way of acting, where every decision has to be in line with conservation and on the other hand the company can focus on environmental friendly production, whereas the production of goods is of major focus. Here a distinction between exogenous and endogenous targets can be made. Exogenous targets bear on the adaption on legal regulations, whereas endogenous targets use environmental protection to achieve the overall objective of making profit. This means that companies recognize that environmentalism has potential to success. The requirement for businesses to implement eco controlling is the anchor of environmental protection as an endogenous target. That means, in turn, that planning-, management- and
controlling tasks and the decision making has to be conform to environmental goals as well (Faßbender-Wynands and Seuring, 2001, p. 142-143). Information procurement is provided by different departments and is again provided for other departments in the company to facilitate the decision making.

2.2.2 Functions of Eco Controlling

Eco controlling represents the basis for environmental management and is supporting the corporate governance at planning and controlling of all environmentally relevant activities of the company, at the ecological managing of information and also at coordinating these functions (Arndt et al., 1993, p. 14). Short, the functions of eco controlling are according to some management experts planning, management/coordination, control and information procurement. These functions are explained below:

- **Planning function:** to phrase periodic environmental targets and environmental programs (BMU, 2001, p. 12). The task of planning is to determine an actual state analysis which enables the company to recognize some possible improvements concerning their environmental action, e.g. decrease of needed resources. Within the planning function, a target state-analysis is implemented and future options for action can be defined. Therefore the planning function includes (Faßbender-Wynands and Seuring, 2001, p. 143):
  - The Variance analysis between the current environmental situation in the company and the striven change
  - The understanding of the possible scope of action (e.g. regulations, changes in the market etc.)
  - An overview of the environmental oriented planning projects and the consequential specific ambitions.

- **Control function:** The primary function is a target-performance comparison which refers not just to control the current situation but also to control prospective situations or to recognize earlier a deviation of planning. This has the advantage for the company to react earlier against this deviation of planning and to take countermeasures (Faßbender-Wynands and Seuring, 2001, p. 143; Eschenbach and Neumann, 1995, p. 50). The tasks of the control function are again the establishment of an actual state analysis and the premature cognition of implementation problems and the development of amendment measures (BMU, 2001, p. 13-14).

- **Coordination function:** Like already mentioned, an eco controlling system represents a cross-cutting function and therefore covers more than one sector or function in the business. To make this possible, it is necessary to coordinate the different functions, like planning, control, information procurement and coordination of the control system. The
focus of this function is laid at designing- and preparing analysis and not at definitely determining of actions (Faßbender-Wynands and Seuring, 2001, p. 142).

- Information procurement: in order to complete the above mentioned tasks of eco controlling, it is necessary that it provides information about the environmental performance, the material- and energy flows, all ecological impacts from the company, the condition of the environment, the ecological life cycle of the products and services and about the material and energy costs and the cost which coma along with the environmental protection measures (BMU, 2001, p. 11). This environmental information is compiled from different sectors and functions of the business and is provided in a compressed form to the decision makers. Thereby environmental information system (EIS) provides assistance at the supply of environmental information (Heubach, 2003, p. 5). These systems are explained more precisely in chapter 2.1.4.

2.2.3 Instruments of Eco Controlling

To enable the above mentioned functions, the eco controlling selects instruments in order to operational data, for the implementation. Such instruments can be for example environmental records, environmental key figures or a value stream mapping as comprehensive instrument (energy and material flows from production through to the customer).

The eco controlling instruments have to support the tasks of the environmental management by specific information services. These are (Loew et al., 2002, p. 15):

- To define the relevant environmental issues
- Solution services for environmental pollution in production
- Solution services for environmental pollution at the product life cycle
- Supporting the continuous improvement process
- Supporting of the environmental communication

The link between the aims of environmental management, its tasks and the functions and the instruments of eco controlling, which enable the attainment of these task, is shown in the below mentioned figure.
The base of this figure forms thereby the functions of eco controlling, which were already mentioned, and the instruments of eco controlling. In this paper a few specific instruments are explained:

- **Environmental Records** are understood as an establishment of input- and output quantities in a certain period. Incoming flux (Input) of material, energy and water are compared to outgoing flux (Output) like products, waste, waste water, lost energy and exhaust air (Bundesumweltministerium, 1997, in: Loew et al. 2002, p. 32). These mass and energy balances are therefore the basis for environmental management systems. Without gathering this information it is not possible to establish a comprehensive business ecological policy (Kramer et al., 2003, p. 339).

There are different models for balancing of the amount of substance and their impacts on the environment, like BUIS (Environmental Information Systems)\textsuperscript{11} –Software, Umberto, Audit etc. These different kinds of software systems enable a creation of a presentation of the material flow and its process balance and analysis of costs. This

\textsuperscript{11} See chapter 2.2.4
view of balances should ideally be for the whole product life cycle (Loew et. al., 2002, p. 21-23).

A distinction is made between different elements of environmental records, which are pooled and represented in the figure below.

<table>
<thead>
<tr>
<th>Description of the balance</th>
<th>Object</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process balance</td>
<td>Process (e.g. galvanize, chemical conversion)</td>
<td>A process balance can summarize more consecutive product processes</td>
</tr>
<tr>
<td>Operational environmental record</td>
<td>Site, Company/group with more sites</td>
<td>Partly it’s also called “Input/Output balance”.</td>
</tr>
<tr>
<td>Operational product balance</td>
<td>Manufacturing a product at one site</td>
<td>This individual consideration is comparatively relatively uncommon</td>
</tr>
<tr>
<td>Life cycle assessment/ product life cycle assessment</td>
<td>Product life cycle; also an assessment of environmental impact is made</td>
<td>It was actually mentioned as a product life cycle assessment</td>
</tr>
<tr>
<td>Life cycle inventory</td>
<td>Product life cycle</td>
<td>The life cycle inventory is a part of the life cycle assessment and depicts the input- and output value of the product. Therefore, strictly speaking, just the life cycle inventory is an Input/Output balance.</td>
</tr>
</tbody>
</table>

Table 2: Different elements of environmental records
(Source: Loew et al., 2002; own modification)


- disclose environmental weak points of products and processes,
- to optimize product processes regarding environmental aspects,
- to establish alternative processes by comparing ecological assessment,
- to promote environmentally compatible products and processes and
- to recognize required preventative environmental measures.

A further component of the product life cycle beside the life cycle inventory, is the impact balance which attempts to quantify the impacts of the mass and energy balances (Seuring et al., 2008, p. 118).

The term of life cycle assessment is a matter of products, whereas operational environmental records describe firms and sites and the tool of process balances as an indicator for processes.

For the implementation of environmental records, it is first required to define the boundaries of balance sheets and the level of completeness and the account system.
By defining the boundaries of balance sheets, the division and the time frame are clarified. The account system predetermines which classification is used for the material flow data or balance sheet items for the compilation of material flow- and energy flow data. The account system is at the same time useful for the aggregation of these balance sheet items (Loew et al., 2002, p. 23-24).

The usage of software for spreadsheets has proven to be a good one in creating an operational environmental record (Loew et al., 2002, p. 26). Whereas also automatic process data acquisition or flexible life cycle assessment systems provide a way for the administrating and capturing of data (Seuring et al., 2008, p. 123). By using a spreadsheet first of all, the account sheet is defined and after that the positions of the material flows are created. The result is an operational environmental record which lists the input, - and output values. The better the data availability, the faster the essential data is captured. At the compilation of these data, it is already possible that there turn out some weaknesses e.g. a high consumption of a resource. Environmental records enable the analysis of these irregularities and systematical reaction for prevention (Loew et al., 2002, p. 28).

The advantages of implemented environmental records are mentioned below (BMU, 2001, p. 199ff, in: Loew et al., 2002, p. 28):

- Environmental records are the basis to ascertain specific environmental aspects, which supports the implementation of an environmental management system
- Identification of ecological weak points by preparing the Input and Output of material, - and energy flows.
- Identification of economic weak points by recognizing high consumption and quantities of waste. From this finding it can be deduced that the processes are inefficient.
- Recognition of some trends by establishing constantly environmental records
- Basis for internal and external environmental communication especially for environmental reports

If ecological and economic weak points are identified, it is also crucial to clarify the processes where the high consumption is accruing.

Environmental records are classical beginner instruments for implementing an environmental management system. It enables an overview of all environmental aspects of the site to identify starting points for improvement. For a long-term use of the instrument and the possibility for potential towards optimization, it is necessary to ascertain more detailed information. For this purpose the environmental relevant
material flows and the corresponding processes have to be identified and analyzed (Loew et al., 2002, p. 30).

- **Environmental Key Figures**: Loew and Kottmann defined already 1996 (p. 10-12) the term “environmental key figure” on the basis of Staehele’s (1969, p. 50) key figure definition, as *indirect or direct environmental relevant value in the form of absolute or relative number which describes an operational issue*.

  The “Handbuch Umweltcontrolling” defines the term by means of the ISO 14031 definition. According to that, environmental key figures are unique factors, which provide information about the environmental performance of the company (BMU, 2001, p. 319).

  Key figures can be systematized by different points of view. Differentiation can be made between absolute key figures such as individual figures, sums and mean values and relative key figures which are characterized by a ratio between two absolute figures. With these relative key figures it is possible to establish timer-series comparison with regard to eco efficiency. Absolute key figures demonstrate how heavy the environment is burdened with pollution, whereas relative key figures show if environmental measures are working (Pape et al. 2008, p. 149-150).

  Now, to implement an environmental key figure system, it is first necessary to determine the environmental aspects and building on this system and the material flows and all important environmental issues which are correlating (Kottmann et al., 1999, p. 165ff, in: Loew et al., 2002, p.35). Based on this, environmental key figures have to be identified. Most of the time, firms envisage a lot of key figures, which are reduced to the most significant and these are collected experimentally. Thus it is recognizable whether it’s possible to collect these environmental key figures and how it is possible to collect these key figures. This experience is crucial for later developments of technical and organizational procedures of the environmental key figure system. The significance of the key figures is a selection criterion as well (Loew et al., 2002, p. 36).

  Further it is mostly necessary to develop new procedures for data collection and data administration. There has to be a tool for documentation and the establishment of a key figure report for publishing the results. There should be, for example a check/control once a year whether there are any weak points and whether it is necessary to supplement some key figures. For the implementation, no specific requirements have to be presented. The interpretation of the key figures is mostly

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12 See chapter 2.1.4
distributed to different employees of the firm. The better the available data at the accounting the easier it is to develop key figures (Loew et al., 2002, p. 36-39).

Key figures are especially qualified for applications within the frame of an operational. The ISO 14031 incorporates environmental key figures in a simplified management cycle of eco controlling with the steps “plan, do, check, act” (Pape et al. 2001, p. 189). This cycle is illustrated below.


The first step, namely planning focuses within the ISO 14031 on the selection of the environmental key figures. For this, the relevant environmental aspects have to be identified which are necessary to outline the profile of environmental performance. Further, environmental goals and measures are set to optimize the environmental performance by improving the operational environmental protection. Within the environmental reporting, an environmental program is generated (Pape et al., 2001, p. 189).

If environmental key figures are successfully implemented, the following tasks of the environmental management are supported by it (Landesanstalt für Umweltschutz Baden-Württemberg, 1999, p. 8ff, in: Loew et al., 2002, p. 35):

- Identification of weak points by depicting the singles processes.
- Learning processes by comparing with similar equipment or companies. The comparison makes it possible to recognize some synergies and to improve the relevant processes.
- Supporting improvements continuously by the depiction of target values through environmental key figures for employees.
- Analyzing trends by presenting environmental key figures
- Support of external communication. The already mentioned trends can be depicted over years and therefore offer a great possibility for publishing long term successes.
These functions have therefore the advantage of reducing costs and reducing the ecological damage by better control of the material- and energy flows.

- **Value Stream Mapping**: To define this tool it is first necessary to clarify the term “value stream”. A value stream is all the actions (both value added and non-value added) currently required to bring a product through the main flows essential to every product: (1) the production flow from raw material into the arms of the customer, and (2) the design flow from concept to launch (see Rother and Shook, 2003, p. 3).

This value stream perspective enables an overview of the whole procedure, not just of single processes (Rother and Shook, 2003, p. 4). This perspective offers good approach in view of long term improvements and to facilitate the recognition of the starting points for these improvements. In view of staying competitive, managing these value streams requires the measurement, understanding and improvement of these flows. Therefore it is possible for the company to keep the cost, service and quality competitive. The value stream management provides the opportunity to change production procedures in way of lean manufacturing/production\(^{13}\) in order to impede the companies of falling back to suboptimal patterns of improving inefficiencies (Keyte and Locher, 2004, p. 1).

How a value stream managing can be implemented is shown in the Figure below.

![Steps for Success in Value Stream Management](source: Keyte and Locher, 2004)

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\(^{13}\) To connect all procedures which are needed for value added as efficient as possible. Therefore the aim of lean manufacturing is “doing more with less” (http://www.businessdictionary.com/definition/lean-production.html, 06.09.2011).
 Especially in these times of lean manufacturing a value stream mapping is a powerful technique. It helps companies to understand the flows of material and information within production procedures. Rother and Shook (2003, p. 4) define it this way: *Follow a product’s production path from customer to supplier, and carefully draw a visual representation of every process in the material and information flow. Then as a set of key questions and draw a “future state” map of how values should flow.* Therefore a value stream mapping enables the identification of opportunities to enhance values, eliminate waste and improve flows.

According to the above mentioned PDCA (plan-do-check-act) cycle, a value stream mapping belongs to the step of planning. It allows a company to establish order in a complex set of relationships by documentation, measurement and analyzing the different procedures therefore to plan improved operating strategies.

The steps for implementing a value stream mapping are:

1. Determine the product family: this means that the company has first to identify a specific product from their product line-up which should be analyzed. Therefore it is crucial to focus on one product and not on all products a company is manufacturing. The term product family means a group of products which pass through similar processing steps (Rother and Shook, 2003, p. 6).

2. Drawing the current-state map which provides the required information for developing the future state. Therefore it starts with analyzing the current situation by demonstrating the process which is segmented in categories like “assembly”. The advantage of seeing overall flow through the plant is that the company has the possibility to zoom into the map to have a look on specific steps of the process or to zoom out of the company to see the value stream of the supply chain.

3. Selection of inefficient processes: if the value stream which is required to produce one product category is obvious through the mapping, the firm has the possibility to recognize the weak points of the production process, for example high energy consumption. Therefore the process streams have to be examined if there are any inefficient steps. If this is the case, these steps have to be denoted for modification or deletion.

4. Drawing the future map: If the inefficient steps of production processes are known, some improvement suggestions can be initiated and the value stream...
map can be redrawn as a future state value stream map where the examined wasteful steps are eliminated (http://www.tech-faq.com/value-stream-mapping.html, 07.09.2011).

5. Implementation of improved processes: after planning the necessary improvement procedures by the future map, the process changes have to be implemented (http://www.tech-faq.com/value-stream-mapping.html, 07.09.2011).

2.2.4 Environmental Information System (EIS)
As indicated above, eco controlling is supporting the environmental management in its functions. To make this possible, there has to be an exchange of information which occurs directly from eco controlling to environmental management or per an environmental information system (EIS) which is the basis for a functioning eco controlling (Perl, 2005, p.36). Therefore, environmental management systems are supporting the environmental management (Eschenbach and Neumann, 1995, p. 76)

Defining environmental information:
The requirement to accomplish the tasks of eco controlling (analyzing, planning and controlling the environmental measures) is the provision of information concerning environmental performance or impact which is embedded in an environmental information system (Heubach et al., 2003, p. 7; Haasis et al., 1995, p. 8). This environmental information has a broad interpretation; its principal task is to provide data which should help at decision making by constituting the Status Quo of the company (Fischer-Stabel, 2005, p. 6). The data has to inform about issues of the spatial and organic environment in context with the economy. To use environmental information properly and to distinguish it from traditional operational information, the characteristics of it have to be pointed out (Behrendt, 2000, p. 10, in: Perl, 2005, p. 21-22; Müller-Christ, 2001, p. 355; Fischer-Stabel, 2005, p. 8):

- Interdisciplinary: like already mentioned, eco controlling itself is an interdisciplinary material and therefore also environmental information encompasses a few fields like chemical, physical, organic, social, ecological and economic issues.
- Weak in structure: causal links are mostly not clearly obvious.
- Have ordinarily a spatial component.
- High complexity: environmental information has a complex cause-and-effect relationship. From this it follows that improvement suggestions are hard to submit.
- Different types of presentation: environmental information can be represented in the form of a text, indicators (numerical form) or graphics. However this makes it difficult to join the different types of environmental information together.
- Allocation of instruments
• Detailed allocation: mostly environmental information is scattered in the environmental information system or over a few divisions. This makes it again difficult to accumulate the information into an information system.
• Absence of a monetary evaluation: it is often the case that environmental information is not associated with a monetary value. Therefore it is difficult to use this information for decision making because the comparison between the environmental information is complicated.

Therefore the requirements on environmental information are (Müller-Christ, 2001, p. 355):
• Completeness of environmental information: inclusion of all relevant environmental information
• Reduction of complexity: relevant preparation for decision-making
• Auditability: transparent data collection and evaluation methods
• Actuality: current collection and contemporary integration into the decision process

Based on these characteristics and requirements it is now apparent that the collection, processing, preparation and storage of environmental information should be done by specific instruments\textsuperscript{14} to have the greatest benefit of it.

**Tasks of environmental information:**
Environmental information has to fulfill some tasks and function in a company, namely planning, development, management and controlling of environmental relevant processes. The strategic functions involve planning and controlling of processes in the company. At this, the main task is to support the decision making and to find the right goals and strategies concerning the prevention and reduction of environmental pollution (Haasis et al., 1995, p. 8). Environmental effects are gathered which enables the assessment of the environmental quality of the products and also of the production process (Krinn and Meinholz, 1997, p. 384)

Environmental information which is used for decision making and the daily business falls into the control function. As last internal function, the information function can be mentioned. This function uses monetary and material evaluation for decision making. To make this possible, a material flow analysis has to be implemented. External functions of environmental information involve environmental relevant communication between the company and its environment, like advertisement, environmental statements etc. Addresses for internal information are for example: corporate governance, environmental protection officers, marketing division, R&D services and employees and addresses for external information are customers, suppliers, investors and banks and assurances (Perl, 2005, p. 22-23). Therefore

\textsuperscript{14} Mentioned below
the interest in environmental information or in the environmental behavior of the company is
determined not just by the company itself but also by external parties. These interested
parties can be divided into the public and into authorities and politics. The primary interest of
the public is the prevention, reduction and disposal of the environmental pollution which is
produced by the company. Authorities and politics want to restrict the environmental
pollution. They establish laws and regulation which have to be complied by the company
parties such as assurances, investors, suppliers and customer and consumers. Assurances
have the objective to identify the liability risk of the environmental field. Investors also take
environmental aspects more into consideration, such as suppliers and customers, which
require environmental data from their market partners for a long-term business relationship.
The decision of the customers concerning purchasing a product or not is more and more
dependent from the environmental compatibility of the products.

Now, to process environmental information with maximum effectiveness it has to be
embedded into an information system which recognizes interrelationships. The main task of
such a system is the collection, storage, processing and the communication of this
information (Perl, 2005, p. 26).

Defining environmental information systems:
Like already mentioned in attempting to define environmental management and
environmental controlling, it is again obvious that generally an applicable definition for
environmental information systems doesn’t exist. In this case, Hilty’s and Rautenstrauch’s
(1995, p. 296) definition is probably the most frequently used: an environmental information
system is an organizational-technical system for capture and provision of environmental
relevant information in a company. Its primary purpose is to capture the environmental
pollution caused by the firm’s action and to plan and support environmental measures.
Environmental management systems consist of more than one environmental database with
different environmental stocks (Posch and Tschandl, 2003, p. 160). This is obviously
because EIS’s are geared with other operational information systems, which already save
environmental data, e.g. in production planning- and production scheduling systems
(Rautenstrauch, 1999, p. 11).

Tasks of environmental information systems:
Based on this definition, it is obvious that environmental information systems are instruments
for gathering, processing and providing environmental information in a firm which
subsequently supports the eco controlling and the material flow management (Hilty and
Rautenstrauch, 1997, p.385; Schmidt, 2000, p.149). Therefore these systems fall under the
precautionary principle concerning environmental issues. This means that environmental information systems enable the prevention of environmental damaging processes in a company. With its task of planning and managing environmental measures it is apparent that it has to be involved in the company’s eco controlling system to make specific information available (Perl, 2005, p. 30; Dyckhoff, 2000, p. 148).

Field of competency:
Basically every department of the company can benefit from EIS's. The environmental department can use such systems to coordinate the aspiration of environmental protection or to examine new investments of their environmental compatibility. For the marketing department an EIS offers suggestions for improvement in e.g. production processes concerning prevention of unnecessary packaging, or ecologically damaging side effects of the products (Haasis, et al., 1995, p. 8).
Therefore, based on the fact that eco controlling is an interdisciplinary material it can be concluded that management, processing and maintenance of an environmental information system fall into the remit of more than one department (Perl, 2005, p. 31, 34).

Reasons for implementing environmental information systems:
Environmental information systems support the task to reveal weak spots in the production process and products and help to accomplish correction. Another advantage is the positive image of the company which such an information system brings along. The public gets reliable information about the relationship company-society-environment (Freimann, 1996, p. 435). The advantages of an implemented software-aided\textsuperscript{15} environmental information system are (Harmsen et al., 1998, p. 2; Röhl, 1999, p. 77; Haasis, 1997, p. 5; Schlatter, 2000, p. 16f; Blümel and Gamweger, 1999, p. 310f)\textsuperscript{16}:

- Promotion of environmental protection
- Decreasing of the costs by recognizing the weak point of processing
- Increase of efficiency because of processing environmental information
- Supporting the analysis, visualization and presentation of environmental information
- Makes it easier to document and publishing environmental information
- Increase of availability, completeness and topical of the environmental information
- Increased possibilities of management and consulting concerning environmental protection in the company

\textsuperscript{15} Another option would be a paper-based environmental information system
\textsuperscript{16} This enumeration and the corresponding authors are cited from Perl, 2005, p.31
Requirements of an environmental information system:
To maximize the benefits of the above mentioned advantages it is necessary that the EIS meet some requirements. A specific evaluation of the requirements is indeed only possible if branch or firm is known. However, basic requirements can be defined (Haasis et al., 1995, p. 9-14):

- Flexible modeling of material and energy flow systems: any economically and ecologically assessments require an unvalued description of material and energy flows. Therefore it is necessary that environmental information systems enable the mapping of these material and energy flows. Due to changing variables, such as the width and depth of the balance, the model has to be flexible.
- Documentation and decision support: one of the main tasks of an environmental information system is the determination and description of pollution, generated by the company (Hilty and Rautenstrauch, 1995). The requirements on an EIS, however go beyond these tasks, namely right up to ecological deficiency analysis, the development of alternatives, the assessment of impacts of the planned measures and the target-performance comparison for efficiency review.
- Simulation capability: for assessing alternatives for action, a preferably precise analysis of its impacts is required. It has to be assessed how desirable the effects of a measures will be. For this, a computer simulation can be used.
- Separation of Objective level and assessment level: captured data, for example emission currents have to be assessed in regard to their impact on the environment. A simple addition would be pointless, because every material has different impacts.
- Consideration of different user groups: an EIS has to provide different views on data for different user groups. Operational environmental protection can only be successful if employees get included. With explicit training for employees, operational environmental protection can constitute a high motivating function.
- Supporting for environmental reporting: the preparation of operational environmental information is crucially important for environmental reporting.
- Linkage with other operational information systems: by performing its function of planning and controlling the environmental friendly processes different data networking combinations are appearing. These can be modeled by different levels of system analysis.

Perl (2005, p. 37-41) defined the following requirements for EIS’s:
- Completeness: all environmental information should be gathered.
- Aggregation: consolidation of data
• Examination: the environmental information has to be verifiable and comprehensible and all items have to be defined.

• Comparability: information at the environmental information system has to be comparable, this means that there has to be a valuation standard (Schulz, 1989, p. 56).

• Actuality: information has to be up to date

• Profitability: if the above mentioned requirements are ideally complied the effort for the environmental information system is considerably high. Therefore, to define the profitability it is crucial to take into consideration the degree of conversion of the requirements. However it is not possible to implement all requirements on the highest level, because some of them bar each other.

**Instruments of environmental information systems:**

To increase the complexity of environmental information it is necessary to implement some instruments and methods within the environmental information system:

• Environmental Checklist is a list of aspects/demands/questions which bear on operational environmental issues. The function of these checklists is to ascertain the state of the environment and to identify weak points and following determine measures of (Brauweiler et al., 2003, p. 4). Sietz and Borbemann (1994, p. 51-52) determined checklist items, such as legal requirements and detailed criteria to these items like “Do all responsible persons know about legal requirements?” or “Are all disposal contractors and suppliers registered?” Other checklist items would be for example capture of data (“Is there a detailed cadastre where all materials\(^\text{17}\) are separately ascertained?”) or balancing (“Which kind of features do these materials have and why are they accumulated?”).

The main purpose or advantage of such checklists is that it gives an overview of the main weak points of the company concerning environmental action. The field of application is not limited to environmental issues but also the fields the company is interested in examining (Matschke, 1996, p. 175). Environmental checklists are just suitable for qualitative inventories. Therefore it is not possible to evaluate the data or to compare data with each other, which makes it not qualified to be the only instrument for environmental information systems (Perl, 2005, p. 42-43).

• Material-and Energy Balances are structured comparisons of input and output of material, -and energy flow of a specific subject. These balances are central

\(^{17}\) Waste and recycling material
information systems of the operational environmental management and provide information for internal and external issues (Schaltegger and Sturm, 1994, p. 63). This instrument enables further an actual state analysis of all relevant environmental information. The subject in question can be the whole company, single processes, or the product life cycle of specific products (Haasis et al., 1995, p. 10). Material- and energy flow records also consider the natural environment and its function of supplier of resources and subject of ingesting residuals. The input-output analysis assess specific environmental pollution factors in relation with monetarily values, such as cubic meter or waste water in $m^3$ (Schaltegger and Sturm, 1992, p. 63). Special attention has to get turned to a complete capture of data of input and output to establish the basis for the environmental information system and furthermore for the eco controlling (Perl, 2005, p. 43-44).

Schaltegger and Sturm (1992, p. 63-66) draw a distinction between input-output-analysis and material and energy flow analysis. They assume that material and energy flow analysis refer to particular product life steps and analyze detailed physical and chemical data. The phases of the product life are distinguished in production, distribution, consume and disposal.
2.2.5 Management Cycle of Eco Controlling

The management cycle of eco controlling provides an overview of the single steps which have to be observed for an organizational implementation of the eco controlling system (Loew et al., 2003, p. 15).

The first step, namely the definition of the goals, determines the area which has to be analyzed and which instrument has to be used. Afterwards, the material flows are recorded and their environmental relevance is proved. This analysis enables the starting point to constitute measures to reduce the environmental pollution. The implementation of these measures is reviewed and their success monitored (Loew et al., 2003, p. 15-16).

If these different steps of the management cycle of eco controlling are implemented in the company’s daily acting, which also requires an established tool to gather, process and environmental data, the company can use the benefits which follow from this cycle, namely the recognition of weak points in some fields of production and consequently the continuous improvement of processes.

With this chapter, the main theoretical foundation for this thesis is laid. The knowledge of the functions, instruments and other components of an embedded environmental management
and eco controlling in the business acting, facilitates the understanding of the missing structures and processes are made obvious at the following SWOT analysis in chapter 5. The next chapter gives and overview of how it was possible to recognize these missing aspects, namely by demonstrating the main idea of a SWOT analysis.
3 SWOT Analysis

Many companies are susceptible to pressure for changing their environmental situation. Following this, correct actions have to be set such as the monitoring and assessments related to the future concerning development. This enables the premature recognition of developments and makes it possible to react as soon as possible. To do so, planning is necessary. Planning is characterized by the systematical thinking through of the future and by the determination of strategies, measures and appliances to reach the achieving objectives. The planning level can be defined as a strategic, tactical and operative planning. Strategic planning sets basically the lines of development and the orientation of the company; while tactical and operative planning has the task of the progressively implementation of the strategic framework. Strategic planning provides support for long-term subsistence and profitability of the company. This results in an improvement in the competitive position and profit growth.

The SWOT analysis, as instrument of the strategic management enables the implementation of the above mentioned tasks (Janzen and Matten, 2001, p. 52). Generally, strategic management includes three basic elements which are the formulation of a strategy, the implementation of a strategy and the control and evaluation of the strategy (Hax and Majluf, 1991, in: Houben et al., 1999, p. 126). Before the company can come up with these three elements, an analysis of the internal and external environment\(^\text{18}\) has to be made (Krijnen, 1992, in: Houben et al., 1999, p. 126). Therefore, good performance within a company results from a correct reconcilement or interaction of these internal and external factors with the business management. The SWOT analysis particularly confronts the internal strengths and weaknesses of a company with its external opportunities and threats to generate furthermore possible strategies of improvement (Houben et al., 1999, p. 125-127). To figure out the single strengths, weaknesses opportunities and threats, information from the company, competitors, market and environment has to be gathered by potential -, competitor -, market - and environmental analysis. Therefore, the SWOT analysis offers a combination of these results by delivering helpful information to see the firm’s resources and capacities against the background of the competitive environment in which it operates (see Böhm, 2008, p. 2). The captured information is then summarized and presented in a matrix:

\(^{18}\) Environmental and corporate analysis (Janzen and Matten, 2001, p. 54-58)
This so called TOWS matrix helps to identify the relationships between the threats, opportunities, weaknesses and strengths of a firm. Based on these identified relationships, strategies can be generated (Kurttila et al., 1999, p. 42).

### 3.1 Analysis of the Internal Environment

The corporate analysis or the analysis of the internal environment consists of two fields (Steinmann und Schreyögg, 2000, p. 152-163):

- The analysis of the resources: analysis of the company’s potential and its use
- The analysis of the competitors: for assessing of the own potential in comparison to the potential of the competitors

The information procurement for the corporate environment is easier than for the environmental analysis (Janzen and Matten, 2001, p. 57). The corporate environment consists of variables which are located within the company. The business management has no short-term influence on these variables (Wheeler and Hunger, 1987; In Houben et al., 1999, p. 126). These variables include the company’s structure, culture and resource as well as forming the context in which the work of the company takes place. But the identification of these variables is not particularly simple. Companies mostly have just vague ideas of the source of certain competencies. Therefore it is crucial to have a global overview concerning strengths and weaknesses to devise competitive strategies. By evaluating the performances

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19 Originally called “TOWS” matrix, but now it is better known as “SWOT” matrix.
20 The analysis of the competitors is not irrelevant for this thesis, because the SWOT analysis refer to the environmental management of the AT&S AG and not to economic or costs aspects.
of the past, strengths and weaknesses can also be measured because it shows the factors of success which were achieved by the already implemented strategy. The studying of the competitors, the current strategy, performances from the past, the market possibilities and the market environment enables the recognition of strengths and weaknesses as well (Houben et al., 1999, p. 127). This for example provides information about issues of personnel, facilities, location, products and service (Dyson, 2002, p. 623-633).

3.2 Analysis of the External Environment

The analysis of the opportunities and threats of the company means the analysis of the external environment. This external environment consists of variables which are in a short-term view not under control of the company. The external environment can be subdivided into the direct and indirect environment. The direct environment means all elements or groups which are directly influenced by the company’s actions; for example shareholders or the government and the suppliers; whereas the indirect environment includes elements which have influence on the long-term decisions of the company. These elements can be the economy, socio-cultural aspects, technology and politics (Houben et al., 1999, p. 126). Janzen (1996, p. 4) modeled the corporate environment as follows:

![Diagram of the Corporate Environment](image)

Figure 6: Pattern for Systematization of the Corporate Environment (Source: Janzen, 1996)
This thesis focuses especially on the global environment, namely on the analysis of ecological environment and the connection of the company to the environment by analyzing its implemented environmental management. In this sense, it is not necessary to take the other fields into consideration, but it is important to show the holistic view of this complex interaction.

### 3.3 Formulation of a Strategy

If external and internal variables are defined and therefore the analysis of the strengths, weaknesses, opportunities and threats of the company is concluded, a strategy can be formulated. This is a process for the development of long-term plans to respond to the evaluated SWOT’s. In the TOWS matrix, the various factors are identified and then connected to form strategies; e.g. an opportunity with a strength. In order to implement the evaluated strategies, action programs are developed and budgets and procedures are drawn up. Such action programs can be constituted from a collection of actions which have to be implemented for the execution of the plan. The plan is the link between the strategies and actions, therefore it deduces the actions from the strategy. The budget, in turn, provides an opportunity to predict the detailed costs, therefore translates the program into financial terms. Subsequently, the evaluation and control process follows to compare the actual implementation and the desired. With the information of this comparison, the business management can conduct some corrective actions to solve the evaluated problems. The steps, evaluation and control are the last in the strategic management process and can also be seen as the starting point of the definition of new goals (Houben et al., 1999, p. 126-127).

The focus of this thesis, especially of the practical part is the SWOT analysis. Based on it, strategies for a better environmental management can be developed which anchors the environmental aspects in the AT&S AG’s acting. These strategies which derived from the evaluated strengths, weaknesses, opportunities and threats of the AT&S AG are described in chapter 5. Chapter 6 comes up with the consequential ideality or in other words with improvements which have to be made to achieve a more efficient environmental management.
4 Evaluation Methods

There are different researches which can be used to collect and evaluate data. In this chapter, qualitative and quantitative approaches are described as well as some instruments for data collection and evaluation procedures in this context.

4.1 Qualitative and Quantitative research

A distinction between qualitative and quantitative analysis can be drawn on the basis of different characteristics.

- The type of the data which is used: The data of qualitative research are verbal whereas the data of quantitative research are numerical. However, the difference between both researches refers not just to the kind of processed data but also to the research method, the topic and the scientific understanding (Mayring, 1983, p. 14; Bortz and Döring, 2006, p. 296).
- The level of measurement: these are nominal scale, ordinal scale, interval scale and ratio scale\(^{21}\) (Mayring, 1983, p. 15).
- The distinction between implicit view of science: here, three contrastive pairs can be mentioned:
  - **Understanding vs. Explanation**: The qualitative approach tries not only to analyze topics but also to understand and to emphasize it, whereas quantitative analysis is explanatory science.
  - **Complexity vs. Isolation of Variables**: Qualitative analysis wants to gather the whole complexity of the evaluation topics, whereas quantitative analysis is disassembling the issue in all several components which thereby loses its significance.
  - **Individual Case vs. Representative Sample**: Individual cases occur mostly at qualitative research. This is because quantitative analysis argues with too less generalizability of individual cases. These cases provide only random material (Mayring, 1983, p. 15-16).

Like already mentioned, quantitative approach refers to statistical preparation of measurements. In contrast to this, qualitative approach works with verbalization where data is interpretative evaluated (Mayring, 1983, p. 14).

4.2 Quantitative methods for data collection

The aim of empirical data collection is the depiction of parts of the reality which is interesting for the study and as accurate as possible.

\(^{21}\) Detailed explanation follows below
In this context two methods, which are the most important one for this paper\(^{22}\), are described below (Bortz and Döring, 2006, p. 139-154):

1. Counting: to count the particular characteristics of the examination object, it is necessary to choose these characteristics which are important for the field of evaluation. The quantitative research uses four different levels of measurements which are nominal scale, ordinal scale, interval scale and ratio scale (Paier, 2010, p. 63) Additional to this, the theoretical based assessment of importance of the characteristics has to be defined. Using the example of a driving instructor it would mean that he has to determine the importance of an overlooked priority traffic sign or a dangerous overtaking maneuver. In this context, a distinction must be drawn between qualitative characteristics and quantitative characteristics.

*Qualitative Characteristics* are nominally scaled characteristics with one gradation also called dichotomous characteristics (like male-female) or with more gradations like fields of study (sociology, physics, medicine, psychology) (Bortz and Döring, 2006, p. 140; Mayring, 1983, p. 15).

*Quantitative Characteristics* are then ordinal-, interval- or ratio scaled measurement (Mayring, 1983, p. 15). Here it is necessary to list the individual characteristic values which contain all important information. These characteristics have to be differentiated into categories to identify the form of distribution, for example to compare the intelligence values of students from different schools or to recognize if there is a distinction between the students concerning intelligence. The frequentness in the categories is the basis for further tabulate or graphical description of the data.

Another important application of counting is a *Quantitative Content Analysis* which is aimed to quantify data of words from e.g. documents or interviews. By this analysis the single parts of a text can be assigned to certain categories. The frequentness in the single categories provides information of characteristics in the text in question. In contrast to quantitative content analysis, qualitative content analysis is not counting the parts of the texts but interpreting them (Bortz and Döring, 2006, p. 149). Mayring (1995, p. 14) distinguishes between three strategies of evaluation in this context. The first one is the frequency analysis. In this, the category system consists of just one characteristic which has to be counted per text. For example, to find out if the Know How of the environmental department can be seen as a strength of AT&S AG, the number of indicating “Know How of environmental departments” at the accordingly questions (51 and 57\(^{23}\)) in the questionnaire from the sample has to be counted.

\(^{22}\)The description of all methods would break the mold

\(^{23}\)Obvious at the Appendix
The second method is the valence – and intensity analysis. This analysis deals with ordinal –or interval scaled variables which are quantified by estimation. At this kind of evaluation, the category systems consist of just one list of characteristics. The evaluator estimates the importance of the “Know How of the environmental department” for the environmental situation of the firm on the basis of a rating scale. The last evaluation method is the contingency analysis. Here it is not the frequency of single characteristics which counts but the common appearance of certain characteristics. Therefore it would be just the indication of “Know How of environmental departments” in question 51 and 57 of the questionnaire which is considered but also other interviews.

According to Babbie (2007, p. 10) the two elements “logic” and “consultation” are necessary for the scientific understanding of the world.

2. Consultation is the mostly used survey method at empirical social research. Data collection through standardized consultation can be accomplished by personal, written or telephonic consultation (Paier, 2010, p. 95). Because of their relevance for this thesis, just the data collection via interviews and via questionnaire is described. The main difference between these types of data collection is the situation of elicitation. Written elicitation is more anonymous than interviews and the willingness of the respondents for honest answering is higher. Interviews can be differentiated according to (Bortz and Döring, 2006, p. 238)
− the scale of standardization (structured – semi structured – unstructured)
− the authority of the interviewer (soft - neutral – hard)
− the type of interview contact (directly – by phone - by writing)
− the number of respondents (single interview – group interview – survey)
− the number of interviewers (one interviewer – tandem – hearing)
− the function (for example ascertaining – mediating)

**Standardization:** an interview can be designed with standardized or entirely structured questions which are mandatory for the interviewer. As opposed to this, not standardized interviews can be mentioned. This kind of interview doesn’t preset the questions but the framework of the issues; conversation techniques are therefore open. Standardized consultation is considered, if all questions are asked with the same given categories of answers and in the same given order (Paier, 2010, p. 95). This kind of consultation is characterized by the usage of a questionnaire. In addition to these two types of interviews another form of interview can be mentioned, namely a semi- or partly standardized interview. Here the survey conducts with given
questions which are more or less mandatory for the interviewers (Häder, 2006, p. 192).

**Authority of the interviewer:** like already mentioned, the form of interviews can be differentiated between soft, neutral and hard interviews. Soft interviews require a sensitive, compliant and emotional involved conservation technique. This approach is expecting a more open dialog. In contrast to that, the basis of hard interviews is an authoritative and aggressive conservation technique. This form of interview prevents the efforts of the respondent to avoid some questions (Bortz and Döring, 2006, p. 239). The classification of neutral interviews takes place among these two interview forms and is mostly used at standardized survey techniques (Paier, 2010, p. 95). Here, the searching for information is the main function and respondent and interviewer are on the same level (Anger, 1969, p. 595).

**Type of interview contact:** there can be distinguished between personal interviews, interviews by phone, computer based and written interviews or approach (Bortz and Döring, 2006, p. 239). The personal interviews are also known as “Face to Face” interviews or “Paper-And-Pencil” interviews. At this, other material besides the prepared questionnaire can be used, such as template lists. The interviewer notes the given answers and conveys it to the survey research institute (Häder, 2006, p. 189).

**Number of respondents:** it is possible to conduct an interview with one person or more. Single interviews are used for subject areas which require a certain intervention of the interviewer because these areas are difficult to structure. If the sampling plan allows the survey of natural groups like school classes and if the survey can happen through a structured and concrete questionnaire, the requirements for a group interview are fulfilled (Bortz and Döring, 2006, p. 242).

**Number of the interviewers:** another characteristic which can be differentiated is the number of interviewers; single interviewer (one interviewer) tandem interview (two interviewers) and hearings or boarding interviews (more interviewers). If the knowledge of the respondent is the focus of the interview, one interviewer can be overwhelmed even if this one is not prepared. Therefore, a tandem interview can alternately ask questions (Kincaid and Bright, 1957, p. 304-312). Hearings take place if many persons or a council are interested in getting information from one respondent. This form of interview is preferred because persons get simultaneously informed and have the possibility to ask ancillary (Bortz and Döring, 2006, p. 243).
Functions of interviews: Depending on the aim of an interview is made for, two functions can be distinguished; information ascertaining function or information mediating function (van Koolwijk, 1974, p. 15). The ascertaining function aims a descriptive collection of facts, interviews of witnesses, panel survey (Nehnevajsa, 1967, in: Bortz and Döring, 2006, p. 139ff) and so on. Information mediating interviews are particularly counseling interviews whereby experts provide information concerning a special item.

4.3 Qualitative methods for data collection
This chapter is kept short, because qualitative methods of data collection are not pertinent for this paper. However, these researches should be outlined. As with quantitative forms of data collection, there are also a few methods for collecting qualitative data. In this paper just one type is described, namely narrative consultation - the most noted method (Brüsemeister, 2008, p. 99). The feature of qualitative consultation is that the course of conversation is more controlled by the respondent than by the interviewer. An open conversation has no structuring concerning the target of certain questions and their consequent similar answers among the respondents. The task of the interviewer is just to target the framework of the issue.

Open or semi standardized consultations are, most of the time, verbally accomplished because respondents are more willing to answer verbally than by writing. Written answers are less spontaneous, well-conceived and more exhausting as well. The interviewer of qualitative consultations plays more the role of an interlocutor than of a distanced person who just asks questions. Qualitative data can both be evaluated with quantitative and qualitative content analysis. The aim of qualitative content analysis is the interpretation of the data concerning its social context and field of meaning. Therefore these interpretations have to be understandable conducted and fully exhausted concerning their content.

The particular work steps for a qualitative evaluation are described below (Bortz and Döring, 2006, p. 329-330):

− Text- and source criticism: At the beginning of the valuation a review of the fineness of the qualitative data has to be done.
− Data management: The immense volume of the qualitative data requires a good data management which means the process and administration of the data by means of special computer programs.
− Short case description: to have an overview of the database, case descriptions are drafted which contain social information like age, gender, occupation and so on. Afterwards the most important issues and quotations of the interview are summarized.
− Cases for detailed analysis: if there are too many cases, something specific has to be selected for a detailed analysis.
− Category system: By means of the evaluated data, categories can be formed and each matching passage of the interview text can be allocated to a certain category.
− Coding: this means the allocation of the text passages to categories.
− Description of the particular cases: by means of the category scheme, every particular case can be described.
− Comparison of particular cases: on the basis of the coded particular cases it is possible to compare the cases and probably find similarities which enable the pooling of cases to a group.
− Pooling of particular cases: statements of contents in these category schemes can be made on the basis of the number of cases in the categories. A saturated category scheme means that all categories contain sufficient text examples. If categories are nearly empty, it indicates that the corresponding issue is irrelevant or badly defined.
− Presentation of the result: because of the great quantity of data, it is difficult to present the entire results. The main text should contain short passages of the original material, whereas the description of the cases, the category schemes and definitions etc. should be mentioned in the appendix.

After bringing up the basis for establishing the SWOT analysis, namely the evaluation of the questionnaire which was designed to filter out the strengths, weaknesses, opportunities and threats of AT&S AG, the next chapters start with the practical part of the thesis and therefore constitutes the outcomes of the evaluation and the consequential measures which have to be undertaken.
SWOT Analysis for AT&S AG

To find out now the strengths, weaknesses opportunities and threats of the environmental management of AT&S AG, it is necessary to evaluate the questionnaire which was especially designed for this purpose. By evaluating and comparing the given answers it is possible to ascertain the Status Quo concerning specific environmental conditions. The analysis of the Status Quo enables the recognition of the main strengths and weaknesses and initiates the search for opportunities and possible risks.

In this context it is first required to define the company’s field in which it is acting.

5.1 Introduction of AT&S AG
The AT&S AG was grounded in 1974 with a production site in Fehring/Austria. The company is expanding gradually and takes a leading role in producing printed circuit boards in Europe and India today. Its worldwide positioning in the high technology segment HDI Microvia PCB’s, which is especially brought into action in the field of Media Devices, is very well implemented. Equally successful are the fields of industry- medicine technique and the field of automotive PCB’s (AT&S Homepage, AT&S im Überblick, http://www.ats.net/de/index.php/Unternehmen/c-12751-Unternehmensprofil.html, 28.09.2011).

5.1.1 The Competitors
The market of PCB’s is highly fragmented and there are worldwide about 2.000 producers; in Europe about 290. 1997 AT&S AG was the third biggest producer of PCB’s in Europe but already in the year 2000 it changed its position to number one. This position enlarged further and the company soon realized that the production centers would move from Europe and America to Asia. Therefore AT&S AG acquired in the year 1999 the biggest Indian PCB producer and extended subsequently its capacities. Already in 2002 the first construction works for the site in Shanghai, China were finished. Today this site is not only the biggest site of the whole AT&S group but also the biggest site in China which is specialized in the field of HDI-technology (Business Report 2010/2011, http://www.ats.net/inforum/filedb/j634df8a36a0021d@000000000002924.pdf, 28.09.2011).

5.1.2 The Position
With three sites in Austria (Leoben, Fehring, Klagenfurt) and three in Asia (Shanghai/China, Nanjangud/India, Ansan/Korea) the company employs about 7000 people and generates a total revenue of EUR 488 Million in the accounting year 2010/11.

Austrian sites mainly supply the European but also increasingly the American market. The attention in Europe is paid especially on short cycle times, special applications and the
proximity to the customers. Also India is focusing the European market with double-ended and multilayer PCB’s, as well as Korea with flexible PCB’s and Mobile Devices. The site in Shanghai is specialized on high-volume HDI-technology which is put to use in the fields of automotive and computers (Business Report 2010/2011, http://www.ats.net/inforum/filedb/j634df8a36a0021d@000000000002924.pdf, 28.09.2011).

5.1.3 The Business Portfolio
The three business portfolios of AT&S AG are Mobile Devices, Automotive and Industrial. The field of Mobile Devices like PCB’s for mobile phones, digital cameras, mobile music players etc. is the biggest with a share sale of 55,6%. AT&S AG is the supplier for eight of the ten biggest producers for mobile phones and its position in this field is therefore significant. The field of automotive generates 12, 5% of share sales and industrial is reporting a share sale of 31, 4% on the European market or in other words, satisfies the demand of 500 customers (Business Report 2010/2011, http://www.ats.net/inforum/filedb/j634df8a36a0021d@000000000002924.pdf, 28.09.2011).

5.1.4 The Environment
The environmental management of AT&S AG is mainly based on the management policy which is mentioned in the Figure below. Before operations and investments can get implemented, each of them has to undergo an assessment concerning their effects on the environment and the health and safety as well as their technological standards. Based on the locations at different countries, AT&S AG faces different types of environmental challenges, because of different environmental, health and safety laws and regulations as well as internal and external targets. Therefore each site employs a responsible person for environmental concerns or environmental management and these environmental managers are overviewed and coordinated by a group environmental manager at the locations. The six sites of AT&S AG are certified by ISO 9001, respectively ISO/TS 16949, ISO 14001, OHSAS 18001 and the plants in Hinterberg and Shanghai have a SONY Green Partner Certificate (Sumann, 2009, EHS within AT&S Group, http://www.ats.net/de/index.php/Unternehmen/Umwelt/c-12596-Leitlinie.html, 28.09.2011).
Another distinctive feature of concerning about the environment is the number of implemented projects for an environmental efficiency increase at all sites of AT&S AG. At each site of AT&S AG, some projects or alterations in the use of resources in the fields of production, energy consumption, water consumption, waste water, chemistry, waste disposal were implemented and are started or running\textsuperscript{24}. The site in Hinterberg for example, in the field production they installed a heat pump and decreased the used copper chloride per kg produced PCB. Fehring reduced the ultrapure water and optimized the irrigation system. Klagenfurt installed timers or purchased new machines to reduce the energy consumption. The Asian sites were also working on environmental efficiency increase. Shanghai imposed stricter limits concerning the amount of heavy metal in water on itself. Here the standard would be 1 ppm (parts per million) and the internal limit is 0, 5 ppm. Ansan improved some process lines and has therefore the advantage of longer usage of chemicals, before they have to add new chemicals. The Indian site separates its waste, recycles copper to sell it and its mill waste is used to produce bricks.

\textsuperscript{24} More implemented, started or running projects are mentioned in the Status Quo which is obvious in the Appendix.
5.2 Questionnaire, Status Quo and Evaluation Procedure

The Status Quo of AT&S AG can be deduced from the evaluation of the questionnaire which was mainly realized by so called frequency analysis and the value or relevance of the given answers from the sample. Frequency analysis appertains to the easiest ways of content analytical operations. In this analysis, certain elements of the available material are enumerated and estimated by their frequency, such as words and letters (Merten, 1995, p.107) and their comparison to the occurrence of other elements (Mayring, 1983, p.11). In the case of this evaluation procedure, the elements are not compared to others, but evaluated by their frequency and by the people who sympathize with each other’s views. The second evaluation method regarding the relevance of the answer means: if a given answer is not significant because of its frequency, it will therefore not count as important, but if its relevance or the area of responsibility of the person who answered is meaningful, it is considered and incorporated in the main points of the SWOT Analysis.

The questionnaire consists of 59 questions which are both opened and closed questions and therefore appertains to the evaluation process of quantitative and qualitative research. The closed questions are divided into scaled closed questions, where the respondent has the possibility to choose the answer from a fixed rating scale (1=very important – 5=not important), positive or negative choice of answers (Yes, No, No Answer) and fixed choices of one, two or multiple possible answers (Teach Seam Arbeitstechniken, http://www.teachsam.de/arb/umfrage/arb_umfrage_3_3_2.htm, 25.07.2011).

The questionnaire includes 9 scaled closed questions, 27 questions of positive or negative choice of answering under which 15 are a combination with open questions and 2 with questions of fixed choices of answering and open questions, furthermore there are 6 questions of fixed choices of answering and 15 open questions.

The questions are designed to get information about

- the personal attitude of the sample regarding environmental correct action of AT&S AG
- the environmental-friendly operating of AT&S AG
- the internal environmental data system
- the environmental information from suppliers
- and the environmental information from customers,

as well as the specific personal opinion of the respondents regarding strengths, weaknesses, opportunities and risks of the company’s environmental acting through some open questions.

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25 Obvious in the Appendix
26 If strength or weakness, doesn’t matter
27 Question 3
28 Question 43
or their suggestions for improving the elicitation and processing of environmental data (summarized at chapter 5.3.3.).

Altogether, 32 people have been interviewed in all six sites of AT&S AG; six for Hinterberg; five for Fehring; four for Klagenfurt; six for Shanghai; five for Ansan and six for Nanjangud. These respondents are responsible persons in the field of environmental management and production\(^{29}\) at the particular sites of AT&S AG.

The interview was a mixture of a semi-standardized and partly standardized interview. This means that the questions were more or less given. In addition to this it was a “face to face” interview or in other words a personal interview which was conducted with always one person (Bortz and Döring, 2006, p. 239, 242, 244) and the function of the interview was an information collection function (van Koolwijk, 1974, p. 15).

On the basis of the questionnaire it was now possible to ascertain the Status Quo which contains the comparison of the 6 sites regarding strengths and weaknesses and the results of most important evaluated questions.

\(^{29}\) One person per site
# SWOT Analysis for AT&S AG

## Detail of Status Quo of AT&S AG
(Effective 2011)

### Strengths

<table>
<thead>
<tr>
<th>Hinterberg</th>
<th>Fehring</th>
<th>Klagenfurt</th>
<th>Shanghai</th>
<th>Ansan</th>
<th>Nanjagund</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commitment from Top Management</td>
<td>A lot of projects</td>
<td>A lot of projects</td>
<td>A lot of action</td>
<td>Commitment is part of management qualification (most commitment on the senior management level)</td>
<td>A lot of projects (own interpretation)</td>
</tr>
<tr>
<td>Choice of machines concerning usage of water is very good → efficient production</td>
<td>Disposal and water treatment works very well</td>
<td>Efficient use of resources is important</td>
<td>Waste water treatment → very advanced system</td>
<td>Water saving → try to use as less water as possible</td>
<td></td>
</tr>
<tr>
<td>Internal guidelines higher than these from government</td>
<td>Lower deviation of limits</td>
<td>Chemical control system to prevent waste of chemicals</td>
<td>Get information from other companies (disposal company) → internal and external connection</td>
<td>Are very concerned about environment; take care of environment, commitment is there</td>
<td></td>
</tr>
<tr>
<td>Steady reduction of resources</td>
<td>Environmental aspect is established for a long time</td>
<td>European standard in environmental protection</td>
<td>Support from management</td>
<td>Support from management</td>
<td></td>
</tr>
<tr>
<td>Plant is very well designed → high standard</td>
<td>Plant in Shanghai very well designed → good isolation</td>
<td>Good training of the responsible person; “right person”</td>
<td>Support from the group</td>
<td>Plant is European standard</td>
<td></td>
</tr>
<tr>
<td>Key figure “global footprint”</td>
<td>Environmental monitoring (key figures requested on site)</td>
<td>Regular checking of the environmental law, to be updated</td>
<td></td>
<td>Monitoring</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No local differences concerning internal environmental regulations</td>
<td>Commitment of environmental department → not only costs in the foreground</td>
<td></td>
<td>Support from the group</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Organizational structure → organized process operation</td>
<td>New processes get reviewed concerning environmental compatibility</td>
<td>Procedure of action very good</td>
<td>Mission of the company and system which is implemented → state of the art</td>
<td></td>
</tr>
</tbody>
</table>
Know How of environmental department very good  
Same understanding of ecological action along supply chain  
Know How of employees  
Know How from environmental department to maintain the systems  
Understanding the reasons why they have to save environment  
Know How of employees very high (knowledge of input, output and quality); qualification, facility very good

| Annual environmental goals which should be reached | Well established management system | Try to reduce resources year by year | Good communication in environmental department | Meetings to find the best solution |

Table 4: Detail of Status Quo of AT&S AG - Strengths
(Source: own image)
### Weaknesses

<table>
<thead>
<tr>
<th>Hinterberg</th>
<th>Fehring</th>
<th>Klagenfurt</th>
<th>Shanghai</th>
<th>Ansan</th>
<th>Nanjungud</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaknesses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### A central administrative system for environmental data is missing (no uniform reporting tool, key figures not transparent)
- Need more analysis of the data
- Transmission of values from the board is missing
- “Water reclaim project” → end of pipe technology; water should directly be saved at the source
- Goals of projects are small

#### No eco controlling
- Costs have more priority than environmental issues
- Costs have priority; first production, then safety and last comes the environment
- Efficiency of production and costs are more important than the environmental aspect
- Costs have priority → economy vs. ecology (profit based)

#### Communication between sites is missing (don’t know projects which are implemented at other sites)
- Less information between employees
- Communication → information is not shared between sites
- Less awareness from production side → not only PUT&EHS should be responsible; Less support from other departments
- Less discussion and communication between departments

#### Missing resources (time, people, money)
- Missing resources (time, people, money)
- Missing resources (time)
- Limit of budget for projects
- Money is missing to implement projects (no environmental budget which is available for the year)
- Missing resources (trained people, money)

#### Insufficient marketing
- Insufficient marketing
- Insufficient marketing, no environmental report
- Ecological efficient action should be more visible, more high lightened (internal)
- Awareness of environmental issues is not strong enough (workers are not supporting environmental issues → no waste separation)
- Insufficient marketing

#### Absence of a Management-Review-Cycle
- Absence of project management
- Less attention on chemical processing
- Lack of commitment of everybody; to accept change → cultural problem
- Not all people are involved; only a few people work on projects

---

30 To improve single processes it’s necessary to measure data
<table>
<thead>
<tr>
<th>Problem at the preparation of customer data; also awareness of customer is missing</th>
<th>Missing key figures</th>
<th>Too many key figures (probably not the right ones and different definitions)</th>
<th>Lot of waste water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding of the employees is partly missing</td>
<td>Absence of training of employees</td>
<td>Awareness of employees is missing</td>
<td>Arrogance; “feel that we are so good”</td>
</tr>
<tr>
<td>Internal communication is missing as well → employees have too little information</td>
<td></td>
<td></td>
<td>Motivation of people get less and less after a time</td>
</tr>
<tr>
<td>Environmental awareness is not grounded in the company’s strategy</td>
<td>Different allocation of commitment</td>
<td>Innovation is not strong enough; too slow in implementation</td>
<td>Outsourcing supplier to treat waste water for AT&amp;S it is hard to comprehend whether the supplier satisfies the internal standards of environmental protection</td>
</tr>
<tr>
<td></td>
<td>High energy use</td>
<td>High amount of chemicals</td>
<td>“Do we know all regulations?”; no foresight concerning environmental regulations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Have only one responsible person → need more people</td>
</tr>
</tbody>
</table>

Table 5: Detail of Status Quo of AT&S AG-Weaknesses
(Source: Own image)

---

31 Have to arrange with the suppliers
32 Don’t have to possibility to get information from homepage → inefficient marketing
33 Environmental department don’t have the ability to raise awareness
This overview of the strengths and weaknesses of AT&S AG contains all given answers of the respondents for question 20, 51, 52, 57 and 58. Some fields of the table have the same color to make coherences between the sites more recognizable. For example “The Know How or knowledge of the environmental department” or “The same understanding (of the employees) for environmental relevant action” as strength of the firm was at least mentioned by one person\(^{34}\) per site for question 51 (“What do you think are the main strengths of your firm concerning ecological efficient action?"), or/and 57 (“What do you think are the main strengths of the environmental department?”). The “Missing marketing” and the “missing awareness / motivation / understanding of the employees regarding environmental relevant action” as weaknesses of AT&S AG, was a common answer for question 52 (“What do you think are the main weaknesses of your firm concerning ecological efficient action?”). The explicitly evaluation process for the main strengths and weaknesses of the company is explained in chapter 5.3.

Table 3 shows now the contrasted information of all six sites regarding their environmental information system.

\(^{34}\) Actually 13 people of the whole sample answered “Know How of environmental department” as strength of AT&S AG (see 5.3.1.).
# Environmental Information System

<table>
<thead>
<tr>
<th>Administrative System for environmental data (Question 25)</th>
<th>Hinterberg</th>
<th>Fehring</th>
<th>Klagenfurt</th>
<th>Shanghai</th>
<th>Ansan</th>
<th>Nanjangud</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dashboard</td>
<td>MIS</td>
<td>MIS</td>
<td>EHS monthly report</td>
<td>Dashboard for group; Intranet</td>
<td>Monthly report of KPI's, DPI's</td>
<td></td>
</tr>
</tbody>
</table>

**How often is data collected (Question 23)**

| No clear answer | Every month | Collected every day, published every month | Energy: monthly; water: monthly; waste water: monthly; chemical: daily; waste disposal: monthly | Daily and reported monthly |

**Which data is collected**

- Waste water
- Gas
- Chemical analysis
- CO₂
- Water usage

- Water balance absolute
- Energy balance absolute
- Water balance relative
- Energy balance relative
- Pre-cleaning/laminating
- Vertical electroplating
- Horizontal electroplating
- Cast line
- Alkaline etching
- Acid etching
- HAL-tinning

- Water consumption: DI/City/EH per etched area in m³/m²
- Energy consumption: compressed air/power/heat per etched area in kWh/m²
- Copper in waste water in mg/m³
- pH-value in waste water
- Emission value HCl in ppm
- Main waste absolute in kg
- Main waste relative per etched area kg/m²
- Gas absolute
- Power absolute
- CO₂ emissions absolute
- Gas relative
- Power relative
- CO₂ emissions relative
- City water absolute
- Process water absolute
- City water relative
- Process water relative
- Waste absolute
- Waste relative
- Waste water absolute
- Waste water relative
- COD
- Cu/Ni concentration
- Waste water
- Gas
- Chemical analysis
- CO₂
- Water usage
- Raw Water consumption (m³)/day
- Waste Water Discharge (m³)/day and costs (Rs/m³)
- Sewage Water Discharge (m³)/day
- Specific Water Consumption (m³/m²)
- Conductivity in de-ionized water (µS/cm)
- Total bacteria count (CFU/ml) in DI water
- DI water consumption (m³/day) and costs (Rs/m³)
- Soft water consumption (m³/day) and costs (Rs/m³)
### SWOT Analysis for AT&S AG

#### Who collects internal environmental data (Question 24)

<table>
<thead>
<tr>
<th>EHS, PUT³⁵</th>
<th>EHS³⁶</th>
<th>EHS³⁷</th>
<th>PUT, EHS, Facility³⁸</th>
<th>EHS, Facility³⁹</th>
<th>PUT, EHS³⁰</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy cons.: factory based</td>
<td>Energy cons.: all machines and whole factory</td>
<td>Energy cons.: factory based</td>
<td>Energy cons.: factory based</td>
<td>Energy cons.: factory based</td>
<td>Energy cons.: factory based</td>
</tr>
<tr>
<td>Water cons.: factory based</td>
<td>Water cons.: factory based</td>
<td>Water cons.: factory based</td>
<td>Water cons.: factory based</td>
<td>Water cons.: factory based</td>
<td>Water cons.: factory based</td>
</tr>
<tr>
<td>Chem. proc.: cost centre or division based</td>
<td>Chem. proc.: cost centre based</td>
<td>Chemical processing: cost centre based</td>
<td>Chemical proc.: cost centre based</td>
<td>Chemical proc.: cost centre based</td>
<td>Chemical proc.: cost centre based</td>
</tr>
</tbody>
</table>

#### On which level is data collected (Question 27)

| Energy cons.: all machines and whole factory | Water cons.: factory based |
| Water cons.: all machines and whole factory | Waste water treatment: factory based |
| Waste water treatment: factory based | Chemical proc.: no clear answer |
| Waste water treatment: cost centre based | Waste disposal: factory based |
| Chemical processing: cost centre based | Waste disposal: factory based |
| Waste disposal: factory based | Waste disposal: factory based |

#### Who knows about Dashboard (Question 25)

<table>
<thead>
<tr>
<th>3 people answered YES</th>
<th>Nobody answered &quot;Dashboard&quot;: just 3 said MIS and 2 answered NO central system</th>
<th>Nobody answered &quot;Dashboard&quot;: 1 said MIS, 1 NO, 2 NO ANSWER</th>
<th>4 people answered &quot;Dashboard&quot;: (one of them also said IQS), 1 said SAP, 1 said excel file</th>
<th>3 people answered &quot;Dashboard&quot;: 1 MIS, EHS folder, 1 NO</th>
<th>1 person answered &quot;Dashboard&quot; for group and KPI's and DPI's for site, 3 monthly report and 1 of them KPI's and DPI's on monthly report, 1 KPI'S reported, 1 NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Dashboard&quot;: 2 NO, 1 NO ANSWER</td>
<td>Nobody answered &quot;Dashboard&quot;: just 3 said MIS and 2 answered NO central system</td>
<td>Nobody answered &quot;Dashboard&quot;: 1 said MIS, 1 NO, 2 NO ANSWER</td>
<td>4 people answered &quot;Dashboard&quot;: (one of them also said IQS), 1 said SAP, 1 said excel file</td>
<td>3 people answered &quot;Dashboard&quot;: 1 MIS, EHS folder, 1 NO</td>
<td>1 person answered &quot;Dashboard&quot; for group and KPI's and DPI's for site, 3 monthly report and 1 of them KPI's and DPI's on monthly report, 1 KPI'S reported, 1 NO</td>
</tr>
</tbody>
</table>

**Table 6: Detail of Status Quo of AT&S AG-Environmental Information System**
(Source: Own image)

³⁵ 3 EHS, PUT, Facility; 1 EHS and PUT; 1 EHS
³⁶ 3 EHS, 1 of them also PUT and Facility; 2 Facility
³⁷ 3 EHS, one of them said also Production, Facility and Others → 2 other plants, and just one boiler house; 1 Facility and Others → Quality
³⁸ 3 PUT, EHS and facility, 1 PUT, EHS, production, facility and controlling, 1 PUT and EHS and 1 PUT, EHS, production and facility
³⁹ 2 EHS; 2 EHS, production and facility; 1 EHS and facility
⁴⁰ 2 PUT and EHS; 1 PUT, EHS, production, controlling, facility; 1 EHS; 1 PUT, EHS, production, facility; 1 EHS, facility
⁴¹ “Cons.” stands for “consumption”; abbreviated because of the lack of space
The evaluation for the Status Quo was mostly made by frequency analysis. How this concretely happened is explained as follows:

**Administrative System for environmental data**

Question 25 was worded to get some information about the administrative system for environmental data;

25. *Is there a central administrative system for environmental data?*
   
   a) ☐ Yes ☐ No ☐ No answer

   b) If Yes, which one?
   
   c) Any improvement suggestions?

The evaluation of the questionnaire in *Hinterberg/Austria* revealed the Dashboard as central administrative system for environmental data which was considered by three of six people. Two of the remaining three people answered "No" and one abstained. The Dashboard can be defined as tool for decision making assistance by providing up to date information. In the case of AT&S AG the information consists of environmental key figures like waste water or gas consumption.

At the site in *Fehring/Austria* three of five people answered “Yes” regarding the existence of a central administrative system and mentioned the MIS as the data administration system. Two of the sample stated that there is no central administration system. The Management Information System or short MIS is defined as “a system to convert data from internal and external sources into information and to communicate that information, in an appropriate form, to managers at all levels in all functions to enable them to make timely and effective decisions for planning, directing and controlling the activities for which they are responsible” (see Lucey, 2005, p. 2).

*Klagenfurt/Austria* was difficult to evaluate because just one of four persons answered in the affirmative. Two said “No” to a central system for data administration and one person had no independent opinion to this question. Nonetheless the Status Quo contains the “MIS” for the data administration system of Klagenfurt. This is referring to the E-Mail from the 14th of July which was sent from the environmental responsible person from Klagenfurt and the content defines the MIS as the system for environmental data administration. Therefore the significance of the assertion that MIS is the implemented system is just given by one person, but it is substantiated by the environmental responsibility and the associated knowledge of this person concerning ecological issues of the company or in this case of the site in Klagenfurt.

The current situation in *Shanghai/China* in this context results also from the evaluation of the questionnaire. Five of six people answered “Yes” for question 25a and one suggested
“No”. From these five respondents, three stated the EHS (Environmental, Health and Safety) monthly report as the tool for environmental data administration, one the SAP and another one the Dashboard. Therefore the EHS monthly report represents the data administration system in Shanghai which can be described as an excel sheet where all relevant environmental data is defined and the particular consumption is listed.

Three people of the sample in Ansan/Korea agreed with the fact that there is a central administrative system and two disagreed. The majority determined the Dashboard as given system.

The last site in Nanjangud/India uses, according to five of six people the monthly report which contains the KPI’s (Key Performance Indicators) and DPI’s (Department Performance Indicators) as a tool for administrating environmental data.

How often is data collected?

23. How often is internal environmental data in the following fields collected? (information in months)

   a) energy consumption
   b) water consumption
   c) waste water treatment
   d) chemical processing
   e) waste disposal

Opinions between the respondents differ on this question. For example, the evaluation in Hinterberg didn’t come to a clear answer. Two people stated that all mentioned data are collected every month. One answered that data of energy consumption (a.) and water consumption (b.) is collected monthly; waste water treatment (c.) and chemical processing (d.) daily and waste disposal (e.) is collected according to the amount of waste. Another one suggested that a), b) and c) is collected monthly, for d) the person had no answer and e) is collected every year. According to another one’s opinion, the data collection at a) and b) is implemented every month, for c) and d) this person had no opinion and e) is currently collected. The last one of the sample attributed for a), b), c) and e) a monthly collection and for d) a biannual collection.

The evaluation for Fehring was more conclusive. Three of the respondents stated that data of all five fields is collected monthly. One person assumed for a), b) and c) a monthly collection and for d) and e) a quarterly collection. Another one abstained. Therefore the environmental data collection in the above mentioned fields is supposed to be every month.

The respondents in Klagenfurt were also indecisive with regard to this question of data collection. One person considered that all data is collected monthly. On the other hand two
people said that just a) and b) are collected monthly, c) constantly and for d) and e) they had no answer. The last one mentioned also for a) and b) a monthly data collection and for c) a constant collection and d) is partly collected per quarter and per year. Consequently the energy and water consumption is collected monthly; waste water continuously and regarding the other fields there is no clear answer.

The data collection for Shanghai takes place every day and is summarized and published every month in the monthly report. This follows from the statements of the respondents where two of six people of the sample answered that data is collected every month, another one said every day and two considered that the data collection happens every day and that data is published every month. One person had no answer for the question.

In Ansan the environmental data of energy consumption (a.), water consumption (b.), waste water treatment (c.) and waste disposal (e.) is updated every month and chemical processing (d.) every day. To come to this conclusion it was also necessary to analyze the answers the sample gave. The assumption that energy consumption is collected every day was grounded by four people; one said data is collected daily and reported monthly. Monthly collection of the amount of water consumption was affirmed by three people (one said weekly, one mentioned data is collected daily and reported monthly), waste water treatment by two respondents (one argued weekly; one stated data is, again, collected daily and reported monthly; one had no opinion to this question) and waste disposal also by three people (one believed that data is collected daily and reported monthly; one had no answer). The last field, namely chemical processing, is collected daily which was asserted by just one person. Another one believed that data is collected daily and reported monthly; one mentioned a monthly collection of the data; one stated that data is monitored but not summarized and reported and the last one had no opinion to this question.

The last site in Nanjangud came to a clearer conclusion concerning environmental data collection. The data is updated every day and reported every month. This statement was confirmed by all six respondents, there was just one person who didn’t agree with the monthly reporting of the data.

On the basis of this table it is obvious that the sites have different systems for environmental data administration implemented. Not just how data is collected also which data is collected differ between the sites.

**Which data is collected?**
The data which is listed in table 3 was mainly obtained by monthly reports of the respective sites and by contents of E-Mails of responsible persons for environmental issues.
Who collects the data?

24. Who collects the internal environmental data?

☐ PUT  ☐ EHS  ☐ production  ☐ facility  ☐ others

In most cases the PUT (Process Utility) and EHS (Environmental, Health and Safety) departments are responsible for environmental data collection.

For Hinterberg the evaluation revealed exactly these two departments, because again most of the respondents answered PUT and EHS for the task of environmental data collection. To be exact, three people stated EHS, PUT and Facility, one answered EHS and PUT and another one attributes the task only to the EHS department, which is applicable to the site in Fehring where three of the sample indicates the EHS department for data collection, whereby one of these three people also answered “PUT and Facility”; two of the respondents submitted that Facility is the responsible department.

The sample in Klagenfurt came to the same conclusion in particular that EHS is the data collection department. Again, three of the respondents answered “EHS” whereby one also stated “Production”, “Facility” and “Others” (which relates to two other factories, because AT&S shares their boiler house with these two factories). Another respondent considered “Facility” and “Others” which applies for “Quality”, as departments for data collection.

According to the respondents in Shanghai, environmental data is collected by PUT, EHS and facility. This assertion is apparent from the statements of the sample where three people answered for question 24 “PUT”, “EHS” and “Facility”. Each of the other three had similar opinions but not exactly the same. One considered it to be by PUT, EHS, Production, Facility and Controlling for environmental data collection departments; another one stated as well PUT and EHS and the last one answered again PUT, EHS, Production and Facility as responsible departments.

The site in Ansan collects their environmental data by the EHS department and by Facility. This statement is grounded by two people who answered “EHS”, another two who stated “EHS”, “Production” and “Facility” and the last one who said again “EHS” and “Facility”.

In Nanjangud data is collected by EHS and PUT departments, which is attributable to the assertions of the respondents where two answered “PUT” and “EHS”; one considered “PUT”, “EHS”, “Production”, “Controlling” and “Facility”; another one answered only “EHS” as responsible department; again one stated “PUT”, “EHS”, “Production”, and “Facility” and the last one mentioned “EHS” and “Facility” for this task.
On which level is data collected?

Another interesting point is the level of data collection. The below mentioned question applies not only for energy consumption, which is the case here because of the lack of space, but also for the other four fields, namely water consumption, waste water treatment, chemical processing and waste disposal.

27. On which level of the following fields, is data collected? (just one opportunity to answer)

a) In energy consumption:
   - machine based
   - cost center based
   - division based
   - factory based

For Hinterberg, as is apparent from the Status Quo, energy consumption is collected on the “factory level”. This means that the amount of used energy is known for the whole factory but not for lower levels, like per machine. To get to this information it is necessary to break the information down into the lower levels. Again, this statement occurs from the answers of the sample to question 27. Here, four people mentioned that data collection is “factory based”; one said “cost center based” and another one considered it to be “division based”. Therefore the majority of the respondents agreed with factory based data collection for energy consumption. The level of collected data for water consumption is also “factory based” and for the foundation of this statement the evaluation revealed the same result as for energy consumption. The same is applicable for waste water treatment where four of the respondents answered “factory based” and two “division based”. The definition of the level of data collection is not clear for chemical processing. Exactly the same amount of people answered on the one hand “cost center based” and on the other hand “division based”. Therefore it is not clear on which level chemical processing is collected. The last field, the data for waste disposal, is again collected on the “factory based level”. This was confirmed by four people whereby two answered “cost center based”.

Fehring also collects the data for energy consumption on the “factory level”, according to the answers of three people. One considered it to be “cost center based” and another one “machine based”. For the level of water consumption, the evaluation didn’t come to a clear answer. Again, there was no majority which indicates an answer. Two people answered “machine based”, another two “cost center based” and one mentioned “factory based” as the level of data collection. The question about the level of data of waste water treatment came to a more obvious answer. Three of the sample suggested a “cost center based” data collection, which means that data is known per cost center, and two of them, a “factory
based” collection. The level of chemical processing was a clear answer as well, which was grounded by four statements which confirmed a “cost center level” data collection, whereby one mentioned “machine based”. The evaluation of the level of waste disposal data collection was again unclear, which becomes apparent by different answers from the respondents. Two of the sample answered “cost center based”; another two “factory based” and the last one had no opinion to this question.

**Klagenfurt** collects the data for energy consumption on the one hand for all machines and on the other hand for the whole factory. This is confirmed by two people, whereas one considered it to be on the “cost center level” and partly the “machine based level” and another one stated the “factory level”. The level for water consumption and the answers of the respondents are the same as for energy consumption. The situation is different for the data collection of waste water treatment. Here, the evaluation revealed the “factory level”, which is confirmed by the answer of three people and negated by one person who stated the “cost center level”. The data for chemical processing are collected on the “cost center level” which is affirmed by two respondents; one suggested “factory based” and another one had no opinion in this case. The last field of waste disposal is again a “cost center based” data collection and again confirmed by two people. One of the sample meant it is a combination of “division based” and “factory based” and the last one had no answer for this question.

The data collection for energy consumption in **Shanghai** takes place on the “factory level”. This was confirmed by four people of the sample; one said “cost center based” and the other one had no answer. According to five people, the data collection for water consumption is again on the “factory level”. One person didn’t know the answer. The result of the evaluation concerning waste water treatment was a “factory based” data collection as well, which was the opinion of three people of the sample, whereby one answered “divisions based”; one, “cost center based” and another one didn’t have an answer. The level of data collection for the field of chemical processing is unclear to define because two respondents considered it to be on a “cost center based level” and another two had no answer for this question. Therefore no answer is significant because of its majority. There was also one person who had the opinion that data collection of chemical processing is on the “factory based level” and another one considered that the level is dependent on the ID number of the chemical or its material or because of the chemical itself. The last field for environmental data collection, namely waste disposal, is collected on the “factory level”. This statement is confirmed by four people and unconfirmed by one person who believed data is collected on the “machine level” and another one who didn’t know an answer.

According to two people of the sample in **Ansan**, data for energy consumption is collected on the “factory level” as well. Another person answered “cost center based”; one said “division based” and the last one had no answer. The result of the evaluation for water
consumption is also “factory based” which arises from the acknowledgement of three respondents; one answered “division based” and another considered the level of data collection to be “machine based”. The evaluation the question for waste water treatment came to the same conclusion as the energy and water consumption. Again, three people mentioned “factory based”; one, “division based” and another one didn’t have an opinion to this question. For the level of chemical processing, the evaluation didn’t come to a clear answer. Each of the four respondents gave another answer; one stated “machine based”; one, “cost center based”; one, “division based”; one, “factory based” and the last one had no answer. The level of waste disposal data collection came to a clearer answer, which is again “factory based”. This result is again apparent from the given answers where three of the sample answered “factory based”. The other two respondents had on the hand the opinion of a cost center based data collection and on the other hand no opinion to this question.

The sample at the last site in Nanjangud had different opinions to the level of data collection for energy consumption or to be more accurate, three of them considered it to be “machine based” and the other three “cost center based”. Therefore, it is not obvious on which level the site in India collects its data for energy consumption. The result of the evaluation for water consumption is, according to all respondents, a machine based data collection. There is again an unclear result concerning waste water treatment. Environmental data could be collected on the “cost center level” or on the “factory level”. This was stated by two people, whereby one answered “division based” and the other one didn’t have an answer. The evaluation revealed a machine level for collected data of chemical processing, which is confirmed by three people and unconfirmed by two respondents who mentioned “cost center based” and one who said “division based”. The data for the amount of waste disposal is, according to two people of the sample, collected on the “cost center level”. Each of the others had a different opinion; one considered “machine based”; one “division based”; one “factory based” and another one had no answer.
Overview of evaluation of relevant questions

<table>
<thead>
<tr>
<th>Value stream mapping (Question 34-38)</th>
<th>No value stream mapping in all 5 fields</th>
<th>No value stream mapping in the field of water consumption and waste disposal</th>
<th>No value stream mapping in all 5 fields</th>
<th>No value stream mapping in all 5 fields</th>
<th>Value stream mapping in the field of water consumption</th>
<th>No value stream mapping; unclear answer in the field of water consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projects (Question 4-9)</td>
<td>In all 6 fields</td>
<td>In 5 of 6 fields (not in energy consumption)</td>
<td>In 5 of 6 fields (not in chemical processing)</td>
<td>In all 6 fields</td>
<td>In all 6 fields</td>
<td>In all 6 fields</td>
</tr>
<tr>
<td>Environmental audits (Question 43 and 44)</td>
<td>All 3 years at suppliers and disposal contractors</td>
<td>No clear answer</td>
<td>No clear answer</td>
<td>Once a year at suppliers and disposal contractors</td>
<td>No audits at suppliers and disposal contractors</td>
<td>Every 2nd year at suppliers and disposal contractors</td>
</tr>
<tr>
<td>Environmental Information (Question 45 and 46)</td>
<td>Demand from internal and external customers</td>
<td>No demand from internal but from external customers</td>
<td>No demand from internal customers, no clear answer concerning external customers</td>
<td>Demand from internal and external customers</td>
<td>Demand from internal and external customers</td>
<td>Demand from internal and external customers</td>
</tr>
</tbody>
</table>

Table 7: Detail of Status Quo of AT&S AG-Evaluation of relevant questions
(Source: Own image)

Table 4 gives an overview about some interesting results of the evaluation of some questions from the questionnaire.

Value Stream Mapping:
With regard to the following implementation of value stream mappings for the five fields mentioned, it was important get some information about the preceding action of the AT&S AG concerning this situation.
Again, the below mentioned question 34 applies also for water consumption, waste water treatment, chemical processing and waste disposal (question 35-38), but they are not listed here because of the lack of space.
34. Do you know if there has already been a value stream mapping for energy consumption?
   □ Yes □ No □ No answer

The site in Hinterberg never implemented a value stream mapping in the five fields in the past. This statement is confirmed by all respondents of the site.

---

42 3 Yes, 1 No, 2 No answer
43 Production, energy, -water consumption, waste water treatment, chemical processing and waste disposal
According to three people, Fehring have already implemented a value stream mapping in the fields of water consumption and waste disposal. The evaluation revealed that two people of the sample agreed with the fact that there has been a value stream mapping at all mentioned fields and one respondent considered this for water consumption and waste disposal but had no opinion to the other three fields. Another person didn’t have an answer for the questions 34-38 and the last one disagreed with having an implemented value stream mapping in the past for these fields.

The situation in Klagenfurt is difficult to assess. According to the sample, there hasn’t been an implemented value stream mapping for these fields, but the statements are unclear; 2 people answered for energy consumption “No” and two “No answer”, for water consumption one, “No”, one, “Yes” and two had no answer; for waste water treatment again two, “No” and two had no answer; for chemical processing the same answers applied as for energy consumption and waste water treatment and for the field of waste disposal, two people stated „Yes” and two, „no answer”.

There were also no established value stream mappings at the site in Shanghai. This is apparent from the given answers of the sample. In the field of energy consumption one person answered “No” in regard to an implemented value stream mapping in the past and five respondents abstained; for water consumption, three people stated “Yes” and another three had no answer; for waste water treatment two respondents answered “Yes”, one, “No” and three didn’t have an opinion to this question; for chemical processing one said “Yes”, one, “No” and four, “No answer” and for waste disposal two respondents answered “Yes”, one, “No” and another one had no answer.

The evaluation revealed an implemented value stream mapping in the field of water consumption for Ansan which was confirmed by four people of the sample, whereby one didn’t agree. The other four fields came to the same result as before, namely that there was no value stream mapping established. This becomes apparent by the given answers of the sample; in the field of energy consumption one respondent answered “Yes”, three said “No” and one had no answer; the answers for waste water treatment were: “Yes” by one person, “No” by three respondents and one “No answer”; for chemical processing, four people said “No” and one didn’t have an opinion; the last field, waste disposal, came to the same result as chemical processing.

The evaluation for the site in Nanjangud comes again to the conclusion that no value stream mappings in the five mentioned fields have been implemented yet. However, there was no clear answer concerning the field of water consumption because three of the respondents stated an already implemented value stream mapping in this field, one didn’t agree with that and said that there wasn’t, and the other two didn’t give an answer for the question. In regard to the other fields, the result seems quite clear; in the field of energy
consumption one person answered “Yes”, one, “No” and four didn’t have an opinion; regarding to waste water treatment, two of the sample stated “Yes”, and four, “no answer”; for chemical processing one person mentioned “Yes” and five didn’t have an answer; and the last field of waste disposal was answered the same as the question about waste water treatment.

Projects:
The number of implemented projects for an environmental efficiency increase is very high. Nearly every site of AT&S AG started projects in the mentioned six fields of energy, - water consumption, waste water treatment, chemicals processing and This conclusion was also confirmed by the majority of the sample and therefore also counts towards frequency analysis. The evaluation contains the questions 4-9 of the questionnaire which can be recognized in the appendix.
The given answers in detail for every site can be seen in the following way:

In Hinterberg three people of the sample agreed that there have already been projects in all six fields. Three of them (anonymous) had a dissenting view, namely one person didn’t give an answer to question 9\textsuperscript{44}, one person denied projects in the field of “waste water treatment” and “waste disposal” and another said “No” to projects again in the field of “waste water treatment” and “chemical processing”.
This evaluation supports the conclusion of implemented projects in all fields, because the majority of the sample agreed with this.

Fehring looks a bit different. In five of six fields, projects have been implemented except the field of “energy consumption”. The fact is that the respondents have been in agreement about there having been projects to increase the ecological efficiency in “production”, “water consumption”, “waste water treatment and waste disposal”. Concerning projects in the field of “energy consumption”, the opinions differ. One person meant that there have been some improvements and the other four said “No” to any projects; also the field of “chemical processing” lead to obscurities. Three of the respondents agreed with the fact that there has been an increase in ecological efficiency and two disagreed.

The situation in Klagenfurt concerning projects is unclear. There have already been some improvements in the field of “water consumption” which was replied unanimously and in the field of “production” where three people said “Yes” to projects and two, “No”. The other fields don’t allow a clear conclusion because the given answers are difficult to allocate to a certain preference\textsuperscript{45}.

\textsuperscript{44} Have there already been some projects in the field of waste disposal?
\textsuperscript{45} Projects? Yes or No?
The site in Shanghai seems quite concerned in view of environmental saving production. There have been projects to increase ecological efficiency in all 6 fields. The sample of six people agreed on projects concerning “energy consumption” and “water consumption”. Four of them agreed as well on “production”, “chemical processing” and “waste disposal” and five on “waste water treatment”. These answers draw a quite clear conclusion and imply that there have been projects for an ecological efficiency increase in all six fields through frequency of the given answers.

The Korean site in Ansan is also concerned about improvements in ecological friendly procedures. The evaluation revealed a really clear conclusion; that there have been projects for more efficiency in the environmental aspect in all six fields. The sample contains five people where all five agreed about the implementation of projects in the field of “production”, “energy consumption” and “water consumption”. Projects in the other fields seemed to be more unclear for the respondents, because their opinions differed; four people gave the answer “Yes” for projects on waste water treatment and one person negated. On chemical processing and waste disposal, three each affirmed the taking place of projects.

The last site in Nanjungud submitted a few projects to decrease environmental pollution as well. All mentioned fields are affected and the fact that there have been projects on “production”, “energy consumption” and “waste disposal” was confirmed by all respondents. In the fields of “water consumption” and “waste water treatment” five each considered that there have been improvements and four of the sample in “chemical processing”.

Environmental Audits at suppliers and waste contractors:

43. Are there environmental audits at suppliers?
   a) □ Yes □ No □ No answer

   b) If there are environmental audits at suppliers, how often are these carried out?
      many times a year □ once a year □ every 2nd year □ less often □ more often □

   c) Who carries out environmental audits at suppliers?

The wording of this question is the same as for question 44 but only with the difference that it relates not to suppliers but to disposal contractors. Therefore question 44 is not extra demonstrated because of the lack of space, but the following paragraphs contain the evaluation of both questions not only of question 43.

In the case of the site in Hinterberg it was visible that audits are carried out at suppliers. This was confirmed by all six people who were interviewed. Concerning audits at
disposal contractors, the result was almost the same as for suppliers, but not all respondents agreed with that; three mentioned “Yes” for sub item a), one, “No” and two, “No answer”. The temporal aspect which is addressed in point b) is three years both for suppliers and for disposal contractors. This statement was again confirmed by the majority of the given answers of the sample.

The evaluation in Fehring didn’t reveal a clear result for both questions. The answers of the sample conflict each other. Two of them stated that there are no audits at suppliers; two again confirmed that there are audits and one didn’t answer. Nearly the same answers were given for question 44, with the difference that two of the respondents didn’t have an answer and one mentioned “No”.

The same unclear result came out for the site in Klagenfurt. Again, the sample didn’t agree with their answers; two mentioned that audits are carried out for suppliers and again two said “No” to audits. With regard to audits at disposal contractors, two people stated “No” for sub item a) and another two “No answer”.

At the site in Shanghai, environmental audits at suppliers are carried out once a year. This was confirmed by all six respondents; also regarding sub item b), five of six mentioned “once a year” except of one person who said “twice a year”. In the case of audits at disposal contractors, the result was the same with the only difference that all of the six people agreed with the time frame of once a year.

For Ansan the situation is exactly the opposite. There are neither audits at suppliers nor at disposal contractors. This is the result of evaluating the given answers of the sample which were three times “No” for audits at suppliers and two “No answer”; two times “Yes” for disposal contractors but just for those of the waste water treatment, again two times “No” and one “No answer”.

The last mentioned site in Nanjangud has implemented audits at suppliers and disposal contractors. This fact was confirmed, on the one hand by five of six people for the case of suppliers, on the other hand by four people for the disposal contractors. Regarding the time frame of the audits, the respondents have different opinions and no clear answer appeared; for both, suppliers and disposal contractors, two people mentioned a time frame of every 2nd year for audits, one said “once a year” and another two didn’t have an opinion.

Environmental Information:

45. Is there demand from internal customers to ascertain environmental information?

   a) □ Yes □ No □ No answer

Question 46 concerns demand from external customers and the results of the evaluation are also mentioned in the next paragraph.
Environmental information in **Hinterberg** is in demand from internal (other departments within the site) and external customers. This fact is grounded by the sample where four people agreed with demand of internal and all of them with demand of external customers.

The case in **Fehring** looks a bit different. There is no clear answer concerning demand among departments within the site (four stated to have no opinion) but there is demand from external customers, which was confirmed by four people.

The result for **Klagenfurt** is that there is no demand from internal customers, which was confirmed by three people whereby two disagreed with the fact of demand from internal customers and one had no answer. The answer concerning demand from external customers is not clear, because two of the respondents mentioned “Yes” and two, “No”.

The evaluation revealed for the site in **Shanghai** both demand from internal and from external customers. Five of six people of the sample answered in both cases “Yes”.

In **Ansan** there is demand for environmental information from internal and external customers. The internal demand is stated by four people and external demand by three respondents.

**Nanjangud** indicates demand from both kinds of customers as well, which was the result of four affirmations of the sample for demand from internal customers and six for external customers.

### 5.3 Basic SWOT Analysis

To continue with the basic SWOT Analysis, it is crucial to define the purpose of this analysis which is approximately apparent from chapter 1 and its description of the general conditions of this master’s thesis, namely to address the environmental relevant aspects of the firm’s action. Therefore, the contemplated system or the focus of the SWOT analysis is the environmental management system of the AT&S AG.

The analysis is designed to realize the environmental conditions of the company and to figure out basic approaches for improvement. The below depicted graph or SWOT Analysis demonstrates some interesting points which deduce from the evaluation of the Questionnaire. The analysis is divided into Strengths, Weaknesses, Opportunities and Threats and the ensuing strategies of these four categories.
SWOT Analysis

The particular sub items within the strengths, weaknesses, opportunities and threats emerged from qualitative and quantitative profound research and are also apparent from the detail of the Status Quo. The explanation of these points is discussed below.

5.3.1 Explication of the S / W / O / T:

The strengths and weaknesses concern the internal environment of AT&S AG.

**Strengths:**

1. According to 13 of 32 people who were interviewed, the Know How of the environmental department is one of the main strengths of AT&S AG.

The evaluation method for this question is again the frequency analysis. As already assumed, the elements of the available material are not compared to others, but evaluated by their frequency. Therefore, the amount of the response “Know How of the environmental department” as strength of the company at question 51 and 57.

46 Question 51: “What do you think are the strengths of your firm concerning ecological efficient action?” and question 57: “What do you think are the main strengths of the environmental department?“.

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**Table 8: Matrix of the SWOT analysis of AT&S AG**

(Source: Weihrich, 1982; own modification)

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ALIVH</td>
<td>1. Know How of Employees</td>
<td>1. No Eco Controlling</td>
</tr>
<tr>
<td>3. Awareness-raising of Customers</td>
<td>3. A lot of Action</td>
<td>3. Audits</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SO-strategies</th>
<th>Opportunities</th>
<th>ST-strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Training of Employees</td>
<td>1. ALIVH</td>
<td>1. Continuous updating concerning Regulations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WO-strategies</th>
<th>Opportunities</th>
<th>WT-strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Establishment of an Environmental Control System</td>
<td>1. Regulations</td>
<td>1. Establishment of an Environmental Control System</td>
</tr>
<tr>
<td>2. Better Communication within/between Sites</td>
<td>2. Local Conditions</td>
<td>2. Training of Employees establish Awareness</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Threats</th>
<th>Opportunities</th>
<th>ST-strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Regulations</td>
<td>1. ALIVH</td>
<td>1. Continuous updating concerning Regulations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WT-strategies</th>
<th>Opportunities</th>
<th>ST-strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Establishment of an Environmental Control System</td>
<td>1. Regulations</td>
<td>1. Continuous updating concerning Regulations</td>
</tr>
<tr>
<td>2. Training of Employees establish Awareness</td>
<td>2. Local Conditions</td>
<td>2. State of the Art Technology</td>
</tr>
</tbody>
</table>
was counted for the evaluation and the field of competence of the respondent falls also within the valuation procedure.

13 people constitute 40.625% of the whole sample, which is not even the half, but the responsibility in the company concerning environmental acting which is assigned to these people makes the statements more meaningful. Therefore their answer has more relevance and a higher value for the conclusion. The evaluation or inclusion of the "Know How of environmental department" relies on these facts and consequently counts to the strengths of AT&S AG.

2. The people’s awareness, commitment and support regarding environmental issues are very high and the understanding of the importance of environmental saving production is obvious. This is first explicable by the amount of projects which have been implemented to increase the ecological efficiency (see below mentioned sub item 3) and also by the amount of people who explicitly count environmental awareness, commitment and support, especially from environmental department and top management, to the strengths of the firm.

16 of the sample answered for question 51 and/or question 57 as strength "Commitment from Managers and environmental department", “Support from Top Management and group”, “Environmental awareness is existent”, “Efficient use of resources lies at the heart” and “Concerned about environment”.

Again, frequency analysis can be consulted for the evaluation and 50% of the respondents consider the priority of environment as strength of AT&S AG.

3. The Status Quo makes it obvious that AT&S AG implemented, started or proposed projects in the fields of production, energy consumption, water consumption, waste water treatment, chemical processing and waste disposal in nearly all six sites. The exceptions are Fehring in the field of energy consumption and Klagenfurt in the field of chemical processing.

This fact shows the commitment of the environmental department regarding eco-friendly production and draws the conclusion that the Know How and the effort to improve constantly environmental influencing processes are high. This is connected to the above mentioned strengths and shows that AT&S AG is successful in establishing the European eco standard also in their Asian sites.

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47 The topic called “Priority of Environment” in the SWOT Analysis
48 Which is obvious, because it is in the responsibility of the environmental department to be aware and committed to the environment?!
49 However this fact is just established at the higher levels of the organization (see weaknesses)
Weaknesses:

1. The missing aspects of an eco controlling probably constitute the main weakness of AT&S AG.

   This case leans onto a logical conclusion regarding some sub items of the analysis of weaknesses for example, the lack of an efficient Environmental Information System or the obscurities concerning audits at suppliers and waste contractors. This assumption is funded by the fact that two sites didn’t give a clear answer about audits at suppliers and waste contractors and that one site doesn’t carry out audits (see point 7).

   The deductive strategies especially the SO, WO and WT strategies, of the analysis demonstrate urgent demand of an environmental control system. How these missing aspects of an eco controlling can be eliminated or rather implemented is shown in chapter 6.

2. The system for environmental data administration causes some difficulties which are described in the followed points:

   - First of all it has to be mentioned that every site uses another system for data administration; so there is no unique system implemented for the whole AT&S AG. This involves different data which are collected and if the same environmental data is collected, the definition of these data is possibly different, so there is no unique definition of environmental data. Therefore the opportunity to compare the sites with each other and to use synergy effects is missing. This fact is attributed to the different sizes of the sites and also to the interpretation of the environmental responsible persons concerning the collected data and its importance.

   This conclusion is attributable to the given answers of the sample for question 25. It proved that Hinterberg uses the Dashboard (executive information system), Fehring and Klagenfurt the MIS (Management Information System), Shanghai the EHS (Environmental, Health and Safety) monthly report, Ansan the Dashboard in group’s view and the Intranet in site’s view and Nanjangud the monthly report of KPI’s (Key Performance Indicators) and DPI’s (Department Performance Indicators) – In order to come to these answers, the already depicted frequency analysis was used. Therefore the conclusion is the product of the knowledge of the majority of the sample.

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50 This aspect is also connected to the above mentioned fact of a missing eco controlling because the functions of this involve an information procurement which stands for an Environmental Information System.
• The Dashboard represents the actual defined system for AT&S’ data administration, but every site has additional systems which contain different data. There are just 11 of 32 interviewees who know about the Dashboard. Some reasons could be:
  − The lack of use. This means that the preparation of the data is probably not meaningful enough to work with it. Therefore it would be meaningful to use more graphs for the description of the data and not just statistics. The graphs could for example, illustrate the consumptions per month to outline all value streams.
  − That the employees have no knowledge about the system exactly because they have no use for it (which implicates the above mentioned assumption).
  − Or there is no communication between employees – some of them have information about it and probably also use it and others don’t (21 people of 32).51
• The sample had the opportunity at question 50 to mention their improvement suggestions for the current data administration system and there was also the argument to increase the collection of environmental data and key figures.
• Another difference is the level of the data collection. Every site of the AT&S AG collects their data on different levels such as machine based, cost centre based, division based or factory based. Energy consumption is the only field where data is collected at the same level: a factory based data collection. However, there is not even a clear answer from India, because the sample differs in their opinion whether energy consumption is a machine based or factory based data collection.
• PUT, EHS and facility are according to the sample, the three main departments for data collection, which has to be allocated to just one main department52.

3. Insufficient Communication: internal and external communication and communication between AT&S AG and its customers, is not adequate. Internal communication defines communication between the departments of one site and external communication in this context describes communication between the different sites of AT&S AG. The missing internal communication was mentioned from respondents at the site in Fehring, Shanghai and Ansan. People stated “less information between employees” in Fehring, “less awareness from the production side and less support

51 These three sub items are own considerations and have therefore no theoretical foundation or are profound through results of the evaluation.
52 Of course, coordination between a few departments has to occur, because eco controlling is an interdisciplinary issue.
from other departments” in Shanghai and “less discussion and communication between departments” in Ansan. The evaluation of question 45 also revealed the missing aspect of demand from internal customers to ascertain environmental information, especially in the sites of Fehring and Klagenfurt. This was confirmed by three denials or abstentions from the sample in Klagenfurt and by four people in Fehring who didn’t have an opinion to this question, thus the demand for environmental information from other departments within the site does not exist.

The lack of external communication or communication between the six sites appears also in the list of weaknesses in the SWOT Analysis and therefore results from the evaluation of the questionnaire. Respondents from the site in Hinterberg and Klagenfurt agreed with this statement and mentioned that “communication between sites is missing”, which also has the consequence that, for example, the implementation of projects for increasing environmental efficiency and the conclusions from these implementations stay in the site where they were established. This also results in the missing advantage of synergy effects and exchange of experience.

The lack of communication between AT&S AG and their customers was at least mentioned by one person, which is not enough to count as important in accordance with frequency analysis, but seems nonetheless in regard to its impact very important to bring up. The advantage of communicating with its customers is that arrangements concerning ecological efficient production can come up and thus costs can be reduced and simultaneously also the impact on the environment.

4. Missing resources: time, trained people and money is missing to implement projects for an ecological efficiency increase. These missing resources pervade every site of AT&S AG. There are differences concerning which one of these three items is missing. At some sites it is a question of money, in others, a question of trained people or of time. For example, in Hinterberg the sample stated that employees get too many functions and too little time to implement projects in the field of environment.

5. Inefficient Marketing can be seen as consequence of too little interest from the marketing’s side or of the absence of available data which could be published. In the case of AT&S AG, the second point will be the answer of the missing activities of the

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53 Two respondents answered “No” for demand of environmental information from internal customers and one person had no answer for this question.

54 Concerning the environmental aspect of AT&S AG
marketing in the context of publishing environmental action of AT&S AG (which occurs from point two of the weaknesses). Therefore an Environmental Information System is missing which makes the relevant information available.

The lack in marketing interests was recognized by seven of 32 persons who were interviewed. The answer occurred at question 20, 52, 54, 55 and 58 which depicted the weaknesses of AT&S AG.

This fact was mostly mentioned by the Austrian sample; in Asia just one person pointed out a missing marketing.

6. The environmental awareness of employees is one of the main weaknesses of the company. 16 people answered in question 20, 52, 56, 58 and 59, which are about the weaknesses of the company and of the environmental department that the awareness of the employees is missing. Therefore half of the sample mentioned this fact as a weakness of AT&S AG. However, this is not just the case in Asia, where the expectation of missing awareness concerning the environment is actually higher than in Austria\textsuperscript{55}, but also seven people in the Austrian sites gave the lack of awareness as an answer. The sample stated that “Motivation of the people gets less and less after time concerning the implementation of projects.” The Asian sites also have “a lot of misunderstanding” which is attributed to a language problem. Therefore employees don’t understand their given task or the importance of the implementation of the environmental aspect and cannot properly fulfill the requests. It’s a Top Down process which has to be changed because “information gets lost towards the operator level”\textsuperscript{56}.

7. Audits: there is no clear answer from Fehring and Klagenfurt concerning audits at suppliers and disposal contractors; and there are no audits in Korea. This fact shows on the one hand, especially with the example of Fehring and Klagenfurt, that the internal communication is missing and on the other hand that there is no implemented standard for auditing at all sites of AT&S AG. There should be a uniform system which contains the responsible persons or department and the period of auditing.

The opportunities and threats concern, as already mentioned in chapter 3.2 the external environment of the company. This means for example the influence of shareholders, the economy, the market or the customers. In the case of the AT&S AG, the SWOT analysis is designed to get information about the company’s environmental management design. That

\textsuperscript{55} This is associated with the conditions of the respective countries. The environmental standard in Austria is much higher than in Asia, which is the consequence of the regulations of the government and the rising environmental awareness of the citizens.

\textsuperscript{56} Everything which is marked with quotes was mentioned by persons who were interviewed.
implies that also internally, opportunities and threats which are not emerging from the environmental department, are part of the analysis and not solely external influences.

**Opportunities:**

1. ALIVH (Any Layer Interstitial via Hole) represents a new technology for multilayer PCB’s. This also includes the advantage of a more environmentally saving production and less cycle time. AT&S AG already obtains a license from Panasonic Electronic Devices Co., Ltd. for the ALIVH technology.

   Due to the constantly growing market of smartphones and with the start of mobile communication standards Long Term Evolution (LTE), it can be assumed that the market growth in this field is stimulated. Therefore multilayer PCB’s are required.


2. The awareness-raising of customers would provide the opportunity for an increase in ecological efficient action. If the customers would be content to come to a compromise regarding the design\(^{57}\) of PCB’s, the co-production would decrease. This means that the PCB’s can be designed in the way that waste is minimized. To make it more visible, the Figure below shows nine unilateral PCB’s which are located on one sheet.

\(^{57}\) Size of the PCB edge
If customers would now be willing to change their precept by, for example minimizing the sheet or maximizing it, to use the space to its full capacity, waste would be reduced (the sheet constitutes the waste). Therefore it would be an opportunity to improve the environmental situation of AT&S AG, if customer’s environmental awareness rose and arrangements could be made to find the most efficient ecological solution for producing PCB’s. However, that requires environmental awareness from customers and the company as well.

3. A better reputation regarding environmental friendly production is very important for a company to stay in competition, especially today, where environmental awareness is rising. This aspect would be of primary importance for AT&S AG to improve. The requirements to do so are an efficient marketing and especially the provision of enough available environmental data for publishing. Therefore it is necessary to lay the groundwork for that, which means the implementation of an efficient Environmental Information System (EIS) or an eco controlling in general.

Threats:
1. The constantly changing regulations regarding environment protection could turn out to be a threat for the company. Therefore, it is crucial to be up to date to prevent an unexpected reform of regulations. According to at least one person in the Korean site, AT&S is not sure whether all environmental regulations are always known. However, the main problem is not the risk to overlook new regulations from the government, but more the consequences of these regulations for the company and the previous
working processes, what has to be changed to stick to these standards or which effort has to be made to optimize it. These efforts are mostly connected with high costs, which could be reduced by a steady approach to the new standards which is again achievable by an anticipatory way of working.

2. It is a quite common effect in companies that there is a conflict between costs and environmental standards; therefore the fundamental conflict between economic and ecological issues. For most of the companies the aspect of drawing profit is the more desirable than to protect the environment. Therefore some projects which have the goal to make processes more efficient concerning the environment are probably not implemented because of its costs. However, at this time where the environmental awareness is getting more important for people, companies have also got pressure from their customers to implement environmental friendly production. To stay in competition, companies are really forced from the outside to act in this way. As already assumed at chapter 2.1.3., there can also be positive correlation between corporate environmental and economic performance. Also in the case of AT&S AG, this mentioned risk can occur, even if the evaluation revealed the priority of the environment and the employee’s awareness as strengths of the firm.

3. The local conditions, especially in Asia, can pose a barrier or threat for increasing environmental efficient action. The environmental awareness of the citizens and consequently of the government is missing and partly within the company itself as well. Thus the risk of having no eco-conscious suppliers is higher than in Austria where more and more companies reorganize their production in way of environmental awareness and therefore the opportunities for AT&S AG to choose the most efficient supplier regarding environmental action are rising.

5.3.2 Deductive Strategies

SO-strategy

1. Training of Employees: The Know How of the employees as a strength and the new technology ALIVH as an opportunity requires trainings for employees or wanting to get started by the individual initiative of the employees. It is important to learn how to handle a new technology/process like this, also to extract all advantages from it and to ensure that there are no delays in production attributed to inexperience.

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58 This is also the case in Austria, but the regulations from the government and the general environmental awareness of the masses are higher.
2. Expansion of Marketing’s Interest: By using the Know How of the environmental department and the opportunity of creating a better reputation of the company regarding environmental action, the marketing should first expand their environmental interest and after this has happened, build up their communication to the environmental department to get the relevant data to publish. This requires an Environmental Information System which contains all the relevant data; this forwards to the next point, in particular

3. To establish an eco controlling depicts the basis of environmental relevant action in a company. An eco controlling offers also functions and instruments which regulate the collection and handling with environmental data and demonstrates consequential improvements. The advantages which arise as a result are mentioned in chapter 6.

WO-strategy:
1. Establishment of an environmental control system: This strategy arises of course from the fact that there is no established eco controlling and can be associated with the opportunities of the “Awareness-raising of Customers” and a “Better Reputation”. To achieve rising awareness of customers, it is crucial to establish first environmental awareness in the company’s strategy. Therefore the implementation of an eco controlling/environmental control system is required. Regarding achieving a better reputation, the implementation of an eco controlling is also recommendable because of the needed environmental data to publish.

2. Better Communication within/between sites: this strategy is based on the weakness of the “Inefficient Communication” and the opportunity of a “Better Reputation”. AT&S AG is seen as a group which implicates the connection of all six sites. Therefore, to achieve a better reputation, it would be advantageous to improve the communication within the sites and between the sites to generate advantages from exchanging experiences and using synergy effects. This again would result in better environmental performances at all sites and these data could be published. However, this assumes a uniform data administration and collection as well as of having a better record of the sites among each other and the possibility of comparison. Thus the situation of the whole AT&S AG is obvious.

3. Establish Customer-and Employee Awareness: this strategy deduces from the weakness “Missing Awareness of Employees” and the opportunity “Awareness-
raising of Customers”. The aspect of environmental awareness among employees is the basis for an environmental correct action within a company. If this is not the case, it is barely possible to call themselves an eco-friendly company, even if the production itself complies with these requirements. Therefore it has to be ensured that employees take environmental correct action seriously, even if it’s just the simple activity of waste separation. This is possible by demonstrating the advantages of these actions and the consequences if they don’t meet the requirements for environmental saving action. It is crucial to make them understand the importance of this issue, especially today when general environmental awareness is increasing which is accompanied by the knowledge that scarce resources are overused and the limit of environmental capacity is in some places soon exceeded. If environmental awareness is implemented in the company, the requirement is to start communicating this aspect also to the customers.

ST-strategy:

1. Continuous updating concerning Regulations: the Know How of the employees as a strength and regulations as a threat lets one draw the conclusion that it is particularly necessary to make the continuous updating regarding regulations possible. This is needed to ensure that AT&S AG is not taken by surprise when the reform of environmental regulations is being implemented. This can lead to high investments, if for example special production processes have to be adapted to the new requirements.

2. Another point to prevent the above mentioned situation is the establishment of State of the Art Technology according to environmental saving. This strategy arises again from the Know How of employees and the possible threat of new regulations from the government. It can also be regarded as a precautionary principle which describes a method to prevent environmental damage in advance. This strategy has the advantage of environmental protection on the one hand and as a consequence thereof the insouciance for new environmental regulations on the other hand. Therefore high efforts of implementing new environmental friendly processes are prevented.

3. Uniform Audits at Suppliers: especially in Asia (Korea), the local conditions can pose a barrier or threat for increasing environmental efficient action. With the Know How of the environmental department, audits at suppliers can be started to ensure that the products are also produced with high environmental standard. Therefore it is
crucial to implement a standardized auditing system for suppliers as well as for waste contractors for the whole AT&S group. This strategy is elaborated at point 6.1.5.

**WT-strategy:**

1. Establishment of an Environmental Control System: The fact is that there is no established eco controlling and the threat of new regulations demands the implementation of an Environmental Control System, which is assisted by functions and instruments of an eco controlling and therefore offers the possibility to recognize potential for improvements regarding environmental issues. This again contributes that limits are observed and new regulations don’t require high efforts in implementation.

2. Training of Employees to raise awareness: The missing environmental awareness of the employees is one of the main weaknesses of AT&S AG. Now, if there is the threat of regulations concerning permitted environmental action and the missing environmental awareness of the employees, it could constitute a problem. Therefore the necessity of environmental awareness-raising by trainings is obvious; first to prevent the remittal of unexpected environmental regulations or and second to know about improvement in respect of environmental protecting production.

It is now obvious, that AT&S AG’s potential for a better environmental management is high and the evaluated strategies can help to improve this current environmental situation. After evaluating the strengths, weaknesses, opportunities and threats of the company and these consequent strategies, the next chapter deals with the particular steps to reach a better environmental management.
6 Consequential Ideality of AT&S AG

The following chapter describes the consequential ideality of AT&S AG deduced from the deductive strategies of the SWOT analysis. Obscurities concerning Environmental Management have to be resolved and based on this improvement, the management cycle of eco controlling and process can be planned. This procedure is evident in chapter 6.1 and 6.2.

6.1 Steps to implement Environmental Management

To reach this ideality it is necessary for AT&S AG to improve their environmental action or their consistent Environmental Management. Question 50 of the Questionnaire affords an opportunity for the sample to express some ideas or improvement suggestions for the administration of the environmental data.

These condensed internal suggestions are listed below:

- Increase of data; now just gas, power and water are collected, more key figures
- Output is too small; need more key figures or more surveys of data; just data which is interesting for Top Management
- Data has to get better available → need too much time
- Evaluation has to be easy, like SAP
- Standardization
- Advantage of comparison with companies in the same branch
- Need a standardized calculation of key figures → different understanding of the key figures
- Need a central administrative system; tool to put in all the data
- Need a clear definition data. Need to know which key figures are needed, how to collect them, how often and who collects them
- Method of calculation and reporting guideline is missing for the same understanding
- General view is missing
- First a sustainable map should be implemented; after that, define metrics and the incorporate
- Need to know which data we need
- Only one position which is responsible for data processing
- Has to be more specific → like machine specific or hall specific
- Data base has to be more completed (has to ask facility or quality for information)
- Data has to be more available and visible → highlighting importance of it
- No waste disposal and chemical usage in Dashboard (copper sludge, packaging)
• Making data more meaningful with graphs → more visible
• Not data for air emissions

But these internal suggestions just refer to improvements of the administration system of environmental data and omit the other weak points of the company. Therefore the next point describes external suggestions for improving environmental action or to give some examples how to eradicate the weaknesses which result from the SWOT Analysis.

6.1.1 Implementation of an eco controlling
The starting point for improving the company’s environmental action is the implementation of an eco controlling which is the basis for a functioning Environmental Management. If we use again figure 2 in chapter 2, it is obvious that the functions and instruments of an eco controlling supports the tasks of an Environmental Management and as a result also the goals. At exactly the base, namely functions and instruments of eco controlling constitute the fundamental problem of AT&S AG, where the middle level or the tasks of Environmental Management are well implemented in the company’s daily acting (see meeting 16.06.2011).

This begs the question to how AT&S AG can implement these missing aspects in the company’s strategy and what is actually really missing.

The functions are again (Loew et al., 2002):
• Information Procurement (Environmental Information System)*
• Analysis Function
• Supporting by Homing
• Planning- and Control Function
• External Communication Function

These functions can be implemented by eco controlling instruments like environmental records, environmental key figures, accounting of flows, investigation of costs of environment protection, ecological evaluation and so on.

To find out the weaknesses of the process it seems to be mostly useful to implement environmental records to list input- and output quantities within a certain period. Incoming flux (Input) of material, energy, water and so on are compared to outgoing flux (Output) like products, waste, waste water, lost energy and exhaust air (Loew et. al, 2002, p. 23). This instrument could also be comparable with a value stream mapping which was the actual target instrument of AT&S AG to implement and therefore can be seen as an alternative to environmental records. However, the “Output”, namely to point out eventual weaknesses in the process and the
Consequential Ideality of AT&S AG

consequential losses in water, energy etc. are demonstrated with both instruments; how the firm is presenting the outcomes is its own device.\(^{59}\)

The requirement to list these input- and output quantities is the definition of the data which has to be recorded. As already mentioned in the SWOT analysis under point 2 of the weaknesses, every site has different data and its own definition of the collected data. To make data more meaningful between the sites and to use some synergetic effects by comparing the collected data and making mutual support available, it would be of primary importance to make the data unique. Therefore every site has to collect the same data and also to have the same definition. Thereafter, the data has to be separated into Input factors and Output factors.

In the case of AT&S AG, the collected environmental data could be seen as follows:\(^{60}\):

### Input

<table>
<thead>
<tr>
<th>Energy Use</th>
<th>Water resource</th>
<th>Base Material</th>
<th>Other components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas absolute</td>
<td>MWh</td>
<td>Domestic water absolute</td>
<td>m(^3)</td>
</tr>
<tr>
<td>Gas relative</td>
<td>MWh/m(^2)</td>
<td>Domestic water relative</td>
<td>m(^3)/m(^2)</td>
</tr>
<tr>
<td>Power absolute</td>
<td>KWh</td>
<td>City water absolute</td>
<td>m(^3)</td>
</tr>
<tr>
<td>Power relative</td>
<td>KWh/m(^2)</td>
<td>City water relative</td>
<td>m(^3)/m(^2)</td>
</tr>
<tr>
<td>Process water absolute</td>
<td>m(^3)</td>
<td>Solder-mask</td>
<td>kg</td>
</tr>
<tr>
<td>Process water relative</td>
<td>m(^3)/m(^2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soft water consumption + additional information</td>
<td>m(^3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DI water consumption + additional information</td>
<td>m(^3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treated water + additional information</td>
<td>thousand m(^3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paint</td>
<td>kg</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 9: Input factors for producing a PCB at AT&S AG

\(^{59}\) For example monthly reports or software programs which are accessible by all employees who are interested in this information.

\(^{60}\) The following tables are by way of illustration and therefore data can be supplemented

\(^{61}\) Additional information is mentioned below
## Output

<table>
<thead>
<tr>
<th>Waste</th>
<th>Atmosphere</th>
<th>Waste Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste absolute</td>
<td>Ton</td>
<td>CO₂ emissions absolute</td>
</tr>
<tr>
<td>Waste relative</td>
<td>ton/m²</td>
<td>CO₂ emissions relative</td>
</tr>
<tr>
<td>Hazard waste absolute</td>
<td>ton</td>
<td>NOx absolute</td>
</tr>
<tr>
<td>Hazard waste relative</td>
<td>kg/m²</td>
<td>NOx relative</td>
</tr>
<tr>
<td>Waste recycling (external) absolute</td>
<td>ton</td>
<td>CO absolute</td>
</tr>
<tr>
<td>Waste recycling (external) relative</td>
<td>kg/m²</td>
<td>CO relative</td>
</tr>
<tr>
<td>Paper consumption absolute</td>
<td>ton</td>
<td></td>
</tr>
<tr>
<td>Paper consumption relative</td>
<td>kg/m²</td>
<td></td>
</tr>
<tr>
<td>Pasteboard consumption absolute</td>
<td>ton</td>
<td></td>
</tr>
<tr>
<td>Pasteboard consumption relative</td>
<td>kg/m²</td>
<td></td>
</tr>
<tr>
<td>Harmful waste absolute</td>
<td>ton</td>
<td></td>
</tr>
<tr>
<td>Harmful waste relative</td>
<td>kg/m²</td>
<td></td>
</tr>
<tr>
<td>Copper chloride</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Galvanic Sludge, Iron hydroxide</td>
<td>ton</td>
<td></td>
</tr>
<tr>
<td>Organic Waste absolute</td>
<td>ton</td>
<td></td>
</tr>
<tr>
<td>Organic waste relative</td>
<td>kg/m²</td>
<td></td>
</tr>
<tr>
<td>Normal garbage absolute</td>
<td>ton</td>
<td></td>
</tr>
<tr>
<td>Normal garbage relative</td>
<td>kg/m²</td>
<td></td>
</tr>
<tr>
<td>Plastic waste absolute</td>
<td>ton</td>
<td></td>
</tr>
<tr>
<td>Plastic waste relative</td>
<td>kg/m²</td>
<td></td>
</tr>
<tr>
<td>-Copper</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Hazard waste absolute   | ton                 | NOx absolute           | kg      | Reuse back to process | m³ |
| Hazard waste relative   | kg/m²               | NOx relative           | kg/m²   | Treated waste water + additional information | m³ |

### Table 10: Output factors for producing a PCB at AT&S AG


The calculation and Definition of the specific Input units:

**Energy Use**
- Gas absolute: natural gas consumption of whole plant per month
- Gas relative: natural gas consumption per m² PCB per month
- Power absolute: power consumption of the whole plant per month
- Power relative: power consumption per m² PCB per month

**Water resource** (Maruthi⁶³, E-Mail from 15.07.2011)

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⁶² Colony-forming units per milliliter
⁶³ Head Environment, Environmental Protection (ETP)
• City water absolute: city water consumption of whole plant per month
• City water relative: city water consumption per m² PCB per month
• Process water absolute: process water amount of whole plant per month
• Process water relative: process water amount per m² PCB per month
  (See environmental monthly report definitions Shanghai, E-Mail 05.05.2011)
• Soft water consumption + additional information
  - soft water amount of whole plant per month
  - conductivity (µS/cm)
  - Total dissolved solids (TDS; mg/l)
  - total bacteria count (CFU/ml)
• DI (de-ionized) water consumption + additional information (Maruthi, E-Mail from 15.07.2011):
  - DI water consumption of whole plant per month
  - conductivity (µS/cm)
  - Total dissolved solids (TDS; mg/l)
  - total bacteria count (CFU/ml)
• Treated water + additional information (Maruthi, DPI_March_India, E-Mail from 04.06.2011):
  - Amount of treated water per month
  - Compliance w.r.t. copper: is the maximum value of copper concentration in ppm in the treated water discharge

**Base material**
Amount of the single components (mentioned below) of the base material (Frey, E-Mail from 12.06.2011)
  - Laminate

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− RCC foil
− Copper foil

• Copper
• Resist
• Total chemistry
• Hydrochloric Acid
• Natron-Alka. Techn. Pure
• Hydrogen-peroxide
• Salt for soft water filter regeneration
• Iron-III-Chloride
• Calcium-chloride sol.
• Total chemistry: amount of chemistry of whole plant per month
• Paint
• Sulfuric Acid

The calculation and definition for the specific Output units:

Waste
• Waste absolute: solid waste amount per month
• Waste relative: solid waste amount per m² PCB per month
• Solid waste: amount of copper waste per month
• Dangerous waste absolute: amount of dangerous waste of the whole plant amount per month
• Dangerous waste relative: amount of dangerous waste per m² PCB per month

Definition of dangerous waste:
• Waste recycling (external) absolute: amount of recycled waste⁶⁵ per month from external firms (Rossmann, EHS Managementbericht_Fehring, E-Mail, 14.07.2011)
• Waste recycling (external) relative: amount of recycled waste per m² PCB per month from external firms

⁶⁵ Waste can probably be sold or used again in any process
• Paper consumption absolute: paper consumption of the whole plant per month
• Paper consumption relative: paper consumption per m² PCB per month
• Pasteboard waste absolute: pasteboard consumption of the whole plant per month
• Pasteboard waste relative: pasteboard consumption per m² PCB per month
• Harmful waste absolute: amount of harmful waste of the whole plant
• Harmful waste relative: amount of harmful waste per m² PCB per month
• Copper chloride
• Galvanic sludge, Iron hydroxide
• Organic waste absolute: amount of organic waste of the whole plant per month
• Organic waste relative: amount of organic waste per m² PCB per month
• Normal garbage absolute: amount of normal garbage of the whole plant per month
• Normal garbage relative: amount of normal garbage per m² PCB per month
• Plastic waste absolute: amount of plastic waste of the whole plant per month
• Plastic waste relative: amount of plastic waste per m² PCB per month

• CO₂ emission absolute: according to Gas & Power data (1KWh Power = 788⁶⁶g, 1 KWh Gas = 202g²⁷)
• CO₂ emissions relative: according to Gas & Power data (1 KWh Power = 788²⁷g, 1 KWh Gas = 202²⁷g)
  (See environmental monthly report definitions Shanghai, E-Mail 05.05.2011)
• NOₓ emissions absolute: according to Gas & Power data
• NOₓ emissions relative: according to Gas & Power data
• CO emissions absolute: according to Gas & Power data
• CO emissions relative: according to Gas & Power data

Waste Water
• Waste water absolute: waste water amount of whole plant per month
• Waste water relative: waste water amount per m² PCB per month
  (See environmental monthly report definitions Shanghai, E-Mail 05.05.2011)
• Reuse back to process: amount of treated waste water back as process water
• Treated waste water + additional information (Maruthi, E-Mail from 15.07.2011):
  – amount of treated waste water

⁶⁶ This is no number of relevance, it is just to make the example more visible
The collection of the same environmental data is also important for an environmental report because not every site has to be considered individually but AT&S AG as a whole.

6.1.2 Timeframe of data collection
How often the environmental data is collected leaves every site free to decide. However, there has to be a value which is comparable, like the value per month or quarter. If sites collect the environmental data daily, which was the case in Shanghai and Nanjangud, they have to calculate the data for a month/quarter. Therefore the sites don’t have to change their way of collection, they just have to find a comparable unit.

6.1.3 Level of data collection
Another important issue to make the collected data comparable between the different sites is the level in which the data is collected. As it was obvious from the evaluation of the questionnaire, every site has its own way of collecting data and therefore also different levels where data is collected. The level of collecting energy consumption is the only field which is collected on the factory level, but even in Nanjangud/India it is not clear if it’s on the factory based level or on the machine based level. Therefore, the problem occurs that the six sites are again not comparable concerning specific data and cannot use synergetic effects. The only way is to sum up all data of energy consumption, water consumption, waste water, chemical processing and waste disposal on the highest level, namely the factory level. By doing so, it is possible to have a value which can be compared among the six sites. However, the detailed analysis fails to appear. Therefore it would be advantageous if the levels are unique among the AT&S group.

6.1.4 Responsible department for data collection
The next point which has to be unified is the responsible person or department for environmental data collection. The evaluation revealed EHS (Environmental, Health and
Consequential Ideality of AT&S AG

Safety), PUT (Production Utility) and facility as responsible departments. Therefore three different establishments collect different environmental data which is again saved at different systems or hard disks. This requires high effort to find needed data. A more useful way is to delegate the responsibility for processing collected data to one department instead of three departments. As already mentioned at chapter 2, the management, processing and maintenance of the environmental information system should not be done by just one department because of the interdisciplinary eco controlling (Perl, 2005). This means that the different departments have to cooperate to make data available for all employees or to gather data, but there should be just one department which has the function to process the collected data and to distribute the information to all interested people/departments. Therefore, the relevant information/data is easily available because there is just one system and one server where data is saved. To find the right department, the current distribution of responsibilities has to be examined. The department which collects and processes most of the data and which has the most use of it seems therefore to have the required qualifications to take on this task. In the case of AT&S AG, the EHS department seems to meet these requirements. The tasks of the EHS in the company concern the production activity, resource demand and the production planning as well as legal and economic requirements. In this context its area of responsibility relates to evaluating the environmental aspects, handling and evaluating of work place hazards, legal and customer requirements for environment and safety, environmental and safety relevant changes and emergency management (Sumann, 2009).

6.1.5 Environmental information system

The next step, after collecting environmental data by many departments and processing it by the one responsible department, data has to be administrated and analyzed by an environmental information system which is the basis for an efficient Eco Controlling (Perl, 2005, p.35). This function of information procurement is assumed by the Dashboard which represents the information system for the whole AT&S AG group. However, the evaluation of the questionnaire revealed some faults of the system which was already mentioned at point 2 of the weaknesses of the SWOT (chapter 5). Based on these faults, the system has to be changed concerning a few constitutions.

- The Dashboard has to become more meaningful for the employees. This can be achieved by restructuring the description of the environmental data which is now a pure statistic definition into a graphical description.
- It has to be an instrument to support planning and managing of environmental measures (Perl, 2005, p.36).

67 Because demands of environmental data span just one department
• It has to be involved in the company’s eco controlling system to make specific information available (Perl, 2005, p.35).
• It has to fulfill the requirements of completeness, aggregation, examination, comparability, actuality, profitability (Schulz, 1989, p.56; Perl, 2005, p.37-41).

6.1.6 Auditing System

Another important point is to improve the Planning- and Control Function by establishing a uniform audit system at suppliers and waste contractors. Implementing these audits ensures an environmental correct production along the whole supply chain of AT&S AG and secures also the compliance of the given requirements to act as suppliers and waste contractors of AT&S AG.

The Status Quo clearly describes the disagreement of auditing in the sites of Fehring and Klagenfurt. It is also obvious that the site in Korea doesn’t implement audits at suppliers and waste contractors. To reach the same ecological standard, it is crucial to establish the same auditing system at all sites. Otherwise, the AT&S AG cannot be considered as one company but rather as an assembly of six sites in three different countries. With a view to the final product of this project, namely the implementation of an environmental report, the perception of entireness comes to the foreground. This is explained in the fact that an environmental report depicts environmental action and thereof acquired key figures of the whole company. Therefore AT&S AG has to become an entirety.

A uniform auditing system has to include the definition of the responsible person and the timeframe of the audits. The assignment of this task should be deliberate which requires a separation of quality- and environmental manager as was the case at the time (according to statements of the sample in Hinterberg).

6.1.7 Internal and external communication

One aspect to reach the above mentioned entirety is to improve internal and external communication. Employees in one site, for example Hinterberg have too little information about planned or implemented projects for environmental efficiency increase in, let’s say, Shanghai. If information exchange would occur, the site in Hinterberg would have the possibility to implement similar or same projects with the advantage of less effort for implementation. Without this communication, there is no possibility to use synergetic effects.

Another point which makes the lack of external communication more visible is the establishment of different systems for data administration. Every site has its own environmental information system and its own key figures and data. This reduces the possibility to exchange experience as well.
The lack of internal communication results from analyzing question 45. This evaluation revealed that demand for environmental information of internal customers\(^{68}\) is missing, especially in Klagenfurt and Fehring which means that the communication between departments is missing. In addition to that, at least one person at the sites in Fehring, Shanghai and Ansan stated the lack of communication between the different departments. To change the current situation of communication, it is crucial to demonstrate these advantages to the employees and show the simplified working processing as another consequence.

### 6.1.8 Environmental awareness of the employees

The basic requirement to improve the company’s environmental action and to implement this aspect permanently in the strategy is to change the employees’ basic attitude of environmental friendly action by increasing their awareness of this subject. This may be achieved on the one hand with trainings for employees or with a more basic approach, namely to anchor the environmental aspect more in the company’s core strategy. As a result, the employees become aware of the importance of this aspect and that it is embedded in the company’s philosophy to respect the environment. As it was mentioned in the weaknesses of the SWOT matrix, the planning process is a Top Down procedure which can also be associated with the missing environmental awareness of the lower levels. If employees have the possibility to participate in decision making, it probably would increase their commitment for the issue in question.

### 6.1.9 Resources

If employees are willing to be committed for implementing projects for environmental efficiency increase, it is very often failing due to missing resources like time, money or trained people. Therefore AT&S AG has to ensure that these missing resources are provided. All will to commitment is worthless, if employees don’t have the possibility to become involved.

### 6.1.10 Marketing’s interest

If the above mentioned points are successfully implemented in the operating procedure, especially the availability of sufficient and effective data and easy access to this data, it is the marketing’s task to highlight environmental action of AT&S AG. Therefore it is the purpose of the marketing department to demonstrate AT&S’ commitment for the environment issues on their homepage.

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\(^{68}\) Means the demand of information between different departments within the site
The implementation of the mentioned functions and instruments of an eco controlling has the advantage of a controlled procedure or cycle as indicated at point 2.2.1., or shown in the next chapter.

6.2 Recommended Eco Controlling
In regard to the above mentioned steps to implement a complete environmental management - in the sense that also the supportive functions and instruments of an eco controlling are included - this chapter summarizes the main points of an eco controlling for AT&S AG and the management cycle of eco controlling.

The figure mentioned below shows the cycle from problem identification via analysis like the Value Stream Mapping and the development of opportunities of optimizing through to action planning, implementation and controlling. To extract the advantages of this process it is first necessary to eliminate the mentioned weaknesses and obscurities which were resulting from the SWOT analysis.
The management cycle of eco controlling starts with the definition of the goals which are in the case of AT&S AG an environmental report with all relevant data like usage of resources including the costs. To reach this goal, first relevant data has to be collected within a value stream mapping. This leads to the possibility to realize weak points by for example high amount of used energy at some steps of process. To work on these weak points, opportunities of optimization have to be developed. At this step some ideas are created how this exemplary high amount of water can be minimized or if there are some alternatives. After this, a concrete action planning follows by developing processes which have to be changed or improved. If this is done, new processes or projects can be implemented and have to be controlled within a certain time frame. This can be done by internal audits, which means by employees of the AT&S AG.
To eliminate the current obscurities of the eco controlling system of AT&S AG the different steps which have to be implemented are again explained and visualized below. Step one to step 4 describe the main process of the eco controlling, while step 5 shows an opportunity to back up the collected environmental data with their costs.

1. Which instrument is used to support the functions of an eco controlling?
2. Which department has the task of environmental data collection?
3. How often is environmental data collected?
4. Which software for data administration has to be used?
5. How it is possible to combine the data with its costs?

EHS department arranges with the controlling department to get the information of the costs of the environmental data, which are also put into the Dashboard in order to have, on the one hand an overview of the amount of the resources which were used and on the other hand the costs of the used resources.

<table>
<thead>
<tr>
<th>Eco Controlling</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Instrument</strong></td>
</tr>
<tr>
<td><strong>Department for Environmental Data Administration</strong></td>
</tr>
<tr>
<td><strong>Time frame of Data Collection</strong></td>
</tr>
<tr>
<td><strong>Software for Data Administration</strong></td>
</tr>
<tr>
<td><strong>Costs of Environmental Data</strong></td>
</tr>
</tbody>
</table>

Table 11: Uniform defined points of an Eco Controlling for AT&S AG
(Source: Own image)
How these above mentioned points are put together in a process is shown in the figure below.

1. Phase

![Diagram of Eco Controlling Process of AT&S AG](Source: Own image)

The dark blue boxes describe fixed implemented systems or departments, whereas the light blue boxes represent information flows or processes.

This figure starts with the first phase where EHS Department as the main department for processing environmental data with support from other departments, use a Value Stream Mapping as an instrument to make Input and Output flows of energy consumption, water consumption, waste water treatment, chemical processing and waste disposal visible.

To do so, the departments have to collect these data per day, month or quarter. The time frame for data collection depends on the data itself and every site can take their own choices concerning this point. The only requirement to fulfill is the guarantee of a value which can be compared to the other sites. This means that for example the data collection per quarter is the highest value a site is allowed to collect; therefore every site of AT&S AG has the possibility to collect all their data per quarter or to add up their data which is collected at a lower value to the value per quarter.

After environmental data is collected, it has to be inserted into the Dashboard, which is defined as the administrative data software system for AT&S AG.
The second phase includes the arrangement between the EHS Department and the Controlling Department to also get the costs for the amounts of the resources which were used. This information is again inserted into the Dashboard to have the overall view of the five flows.

The data collection in the first phase and the allocation of costs in the second phase can be defined as environmental management accounting or again in monetary environmental management accounting and physical environmental management accounting as it was mentioned in chapter 2.
7 Summary

Today's responsibility of companies concerning environmental protection and the consequential shutdown of some production processes is getting higher and higher. The pressure is kind of pulling the companies towards improvements, on the one side to satisfy the demands of the customers and to stay in competition and on the other side to follow the regulations of the government.

A remedy for this would be the implementation of an environmental management system into the daily business of the company. This tool enables with an eco controlling as a basis, the systematically environmental protection by recognizing the weak points of the production processes and offering instruments and functions to eradicate these weaknesses. The evaluation of the questionnaire identifies the missing eco controlling as the main weak spot of AT&S AG. Therefore, the company cannot take the advantage of the regulated eco controlling procedure or cycle, at least not with the same execution of the steps: defining a goal, analyzing, developing opportunities of optimization, planning some actions, implementing and controlling.

By enabling this master’s thesis, the AT&S AG started the first step in direction of improving their environmental situation. The accomplishment of a SWOT analysis enabled the definition of strategies to improve the environmental management system of the company. As a review or overview of this work, it is to say that on the basis of this analysis, some weaknesses appear which have to taken into the company's consideration concerning its future actions.

The results of this master’s thesis are:

- The evaluation of the Status Quo for all six sites of the AT&S AG and the consequential recognition of the differences between the sites.
- The knowledge of the strengths, weaknesses, opportunities and threats of the firm’s daily business and suggestions of possible strategies to make their actions more efficient.
- The proposal of steps to implement an environmental management and in this way all the way to better processes in regard to environmental protection.
Bibliography


Arndt, H.-K./Ankele, K. (1993): Erprobtes Muster: Das Umwelt-Controlling erfüllt in weiten Bereichen die Anforderungen des Umwelt-Audits. in: Müllmagazin 1, Jg. 6, pp. 14ff

AT&S Homepage:


BMU (2001): Handbuch Umweltcontrolling für die öffentliche Hand, UBA (Hrsg.), Verlag Vahlen München, pp. 7-21, 159-177

BMU; UBA (Hrsg.): Handbuch Umweltcontrolling, 2. Auflage, München, 2001, S. 199ff


Bundesumweltministerium; Umweltbundesamt (Hrsg.) (1997): Leitfaden betriebliche Umweltkennzahlen, Bonn; Berlin


Faßbender-Wynands E., Seuring S.A. (2001); Grundlagen des Umweltcontrolling-Aufgaben, Instrumente, Organisation; in: Baumast A., Pape J. (Hrsg.), Betriebliches Umweltmanagement, Theoretische Grundlagen Praxisbeispiele, pp. 139-153


Kassinis, G., Vafeas, N. (2006); Stakeholder pressures and environmental performance; Academy of Management Journal 49 (1), pp. 145-159


Rother, M., Shook, J. (2003): Learning to See, value stream mapping to create value and eliminate muda; The Lean Enterprise Institute, Inc. One Cambridge Center; Cambridge, pp. 3ff


Smart Draw: Easy Value Stream Mapping, „What is a Value Stream Map (VSM) and how can it help you, http://www.smartdraw.com/specials/value-stream-mapping.htm?id=328924&gclid=CKHM2PehiKsCFcq-zAod21h81w, (06.09.2011)

Sprenger, R.-U. (1996): Environmental Policies and Competitiveness


Zeng, S.W. (2010): Ways of environmental driving forces affecting environmental and economic performance of SMEs, Journal of Cleaner Production, pp. 3-18
Questionnaire

Survey about the environmental management system of the AT&S AG in view of implementing an analysis of strengths, weaknesses, opportunities and threats

Galler Lisa-Maria

Name of Respondent:
Personal attitude:

1. How important is an environmentally correct production for you?

   Very important  1  2  3  4  5  Not important
   □  □  □  □  □  □

2. How would you define environmentally correct action in your company?

3. Would you be willing to initiate and to be responsible for a project to improve environmental-friendly operating procedures?

   a) □ Yes  □ No  □ No answer

   b) If Yes, why?

   c) If No, why not?
Environmental-friendly operating in your company:

4. Have there already been some projects for an ecological efficiency increase in production?
   a) □ Yes □ No □ No answer

   b) If Yes, which one?

   c) If Yes, who was the initiator?

5. Have there already been some projects for an ecological efficiency increase in the field of energy consumptions?
   a) □ Yes □ No □ No answer

   b) If Yes, which one?

   c) If Yes, who was the initiator?

6. Have there already been some projects for an ecological efficiency increase in the field of water consumption?
   a) □ Yes □ No □ No answer

   b) If Yes, which one?

   c) If Yes, who was the initiator?

7. Have there already been some projects for an ecological efficiency increase in the field of waste water treatment?
   a) □ Yes □ No □ No answer

   b) If Yes, which one?

   c) If Yes, who was the initiator?
8. Have there already been some projects for an ecological efficiency increase in the field of chemical processing?
   a) ☐ Yes ☐ No ☐ No answer

   b) If Yes, which one?

   c) If Yes, who was the initiator?

9. Have there already been some projects for an ecological efficiency increase in the field of waste disposal?
   a) ☐ Yes ☐ No ☐ No answer

   b) If Yes, which one?

   c) If Yes, who was the initiator?

10. Is everyone jointly responsible concerning projects for an ecological efficiency increase?
    a) ☐ Yes ☐ No ☐ No answer

    b) If Yes, how do you recognize this?

    c) If No, why not?

11. Do you get enough support when implementing projects for an ecological efficiency increase concerning budget/resources?
    a) ☐ Yes ☐ No ☐ No answer

    b) If Yes, how do you recognize this?

    c) If No, why not?
12. Has your superior demonstrated an exemplary function when implementing projects for an ecological efficiency increase?
   a) □ Yes □ No □ No answer

   b) If Yes, how do you recognize this?

   c) If No, why not?

13. How motivated are your employees when implementing environmental projects?
   Very motivated 1 2 3 4 5 Not motivated
   □ □ □ □ □

14. Which of the following fields would be of primary importance when implementing more efficient operating procedures? (2 opportunities to answer)
   a) Energy consumption □
   b) Water consumption □
   c) Waste water treatment □
   d) Chemical processing □
   e) Waste disposal □

15. Do you think that opportunities to save in energy consumption are high or low?
   High 1 2 3 4 5 Low
   □ □ □ □ □

16. Do you think that opportunities to save in water consumption are high or low?
   High 1 2 3 4 5 Low
   □ □ □ □ □

17. Do you think that opportunities to save in waste water treatment are high or low?
   High 1 2 3 4 5 Low
   □ □ □ □ □

18. Do you think that saving opportunities in chemical processing are high or low?
   High 1 2 3 4 5 Low
   □ □ □ □ □
19. Do you think that saving opportunities in waste disposal are high or low?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Low</th>
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</table>

20. Which aspect is missing to implement environmentally relevant projects in your firm?
Internal environmental data:

21. How important is an environmental information system for you?
   Very important 1 2 3 4 5 Not important
   □ □ □ □ □

22. Did you already have some experience with the following environmental topics? (multiple answers possible)
   a) energy flow □
   b) water consumption □
   c) waste water treatment □
   d) chemical processing □
   e) waste disposal □

23. How often is internal environmental data in the following fields collected? (information in months)
   f) energy consumption
   g) water consumption
   h) waste water treatment
   i) chemical processing
   j) waste disposal

24. Who collects the internal environmental data?
   □ PUT □ EHS □ production □ facility □ others

25. Is there a central administrative system for environmental data?
   d) □ Yes □ No □ No answer
   e) If Yes, which one?
   f) Any improvement suggestions?

26. Who gets the information about internal environmental data?
27. On which level of the following fields, is data collected? (just one opportunity to answer)

b) At energy consumption:
   - machine based
   - cost centre based
   - division based
   - factory based

c) At water consumption:
   - machine based
   - cost centre based
   - division based
   - factory based

d) At waste water treatment:
   - machine based
   - cost centre based
   - division based
   - factory based

e) At chemical processing:
   - machine based
   - cost centre based
   - division based
   - factory based

f) At waste disposal:
   - machine based
   - cost centre based
   - division based
   - factory based

28. Do you know the costs of energy consumption?
   ☐ Yes ☐ No
29. Do you know the costs of water consumption?
   □ Yes □ No

30. Do you know the costs of waste water treatment?
   □ Yes □ No

31. Do you know the costs of chemical processing?
   □ Yes □ No

32. Do you know the costs of waste disposal?
   □ Yes □ No

33. Do you know what a value stream mapping is?
   □ Yes □ No □ No answer

34. Do you know if there has already been a value stream mapping for energy consumption?
   □ Yes □ No □ No answer

35. Do you know if there has already been a value stream mapping for water consumption?
   □ Yes □ No □ No answer

36. Do you know if there has already been a value stream mapping for waste water treatment?
   □ Yes □ No □ No answer

37. Do you know if there has already been a value stream mapping for chemical processing?
   □ Yes □ No □ No answer

38. Do you know if there has already been a value stream mapping for waste disposal?
   □ Yes □ No □ No answer

39. In your opinion what is the main purpose of a value stream mapping?
Environmental information from suppliers:

40. How important do you think environmental information is from suppliers?
   Very important 1 2 3 4 5 Not important
   □ □ □ □ □

41. Which environmentally relevant data from suppliers are important for you?

42. Which of the following suppliers is particularly important concerning environmental information?(2 opportunities to answer)
   a) chemistry □
   b) base material □
   c) coating □
   d) disposal contractor □
   e) others □ Which one?........

43. Are there environmental audits at suppliers?
   d) □ Yes □ No □ No answer
   e) If there are environmental audits at suppliers, how often are these carried out?
      many times a year once a year every 2nd year less often more often
      □ □ □ □ □
   f) Who carries out environmental audits at suppliers?

44. Are there environmental audits at your disposal contractor?
   a) □ Yes □ No □ No answer
   b) If there are environmental audits at your disposal contractor, how often are these carried out?
      many times a year once a year every 2nd year less often more often
      □ □ □ □ □
   c) Who carries out environmental audits at suppliers?
Appendix 1

Environmental information from customers:

45. Is there demand from internal customers to ascertain environmental information?
   b)  □ Yes  □ No  □ No answer

   c) If there is demand from internal customers to ascertain environmental information, who demands it?

46. Is there demand from external customers to ascertain environmental information?
   a)  □ Yes  □ No  □ No answer

   b) If there is demand from external customers to ascertain environmental information, who demands it?

47. Do you have simple access to data to answer external customer enquiries?
   a)  □ Yes  □ No  □ No answer

   b) If No, where are the problems in data acquisition?

49. Is there demand from stakeholders to ascertain environmental information?
   a)  □ Yes  □ No  □ No answer

   b) If there is demand from stakeholders to ascertain environmental information, who demands it?
Open Questions:

50. Do you see potential of improvement regarding elicitation and processing of environmental data? And which potential?

51. What do you think are the strengths of your firm concerning ecological efficient action?

52. What do you think are the weaknesses of your firm concerning ecological efficient action?

53. What do you think are the opportunities of your firm concerning ecological efficient action?

54. What do you think are the risks of your firm concerning ecological efficient action?

55. How would you describe the firm’s environmental position compared to other firms of the same size?

56. How would you improve the annual environmental programme?

57. What do you think are the main strengths of the environmental department?

58. What do you think are the main weaknesses of the environmental department?

59. If I could I would......
Appendix 2

Status Quo

Summer Term
2011

Status Quo of
AT&S AG

In View of

Master’s Thesis
Analysis of strengths and weaknesses on the example of the environmental management of AT&S AG

GALLER, Lisa-Maria

Graz, 17. Mai 2011
## Appendix 2: Strengths

<table>
<thead>
<tr>
<th></th>
<th>Hinterberg</th>
<th>Fehring</th>
<th>Klagenfurt</th>
<th>Shanghai</th>
<th>Ansan</th>
<th>Nanjangud</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Commitment from Top Management</strong></td>
<td>A lot of projects</td>
<td>A lot of projects</td>
<td>A lot of action</td>
<td>Commitment is part of management qualification (most commitment on the senior management level)</td>
<td>Lot of projects (own interpretation)</td>
<td></td>
</tr>
<tr>
<td><strong>Choice of machines concerning usage of water very good → efficient production</strong></td>
<td>Disposal and water treatment works very well</td>
<td>Efficient use of resources is important</td>
<td>Waste water treatment → very advanced system</td>
<td>Water saving → try to use as less water as possible</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Internal guidelines higher than these from government</strong></td>
<td>Lower deviation of limits</td>
<td>Chemical control system to prevent waste of chemicals</td>
<td>Get information from other companies (disposal company) → internal and external connection</td>
<td>Are very concerned about environment; take care of environment; commitment is there</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Steady reduction of resources</strong></td>
<td>Environmental aspect is established for a long time</td>
<td>European standard in environmental protection</td>
<td>Support from management</td>
<td>Support from management</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Plant is very well designed → high standard</strong></td>
<td>Key figure “global footprint”</td>
<td>Plant in Shanghai very well designed → good isolation</td>
<td>Good training of the responsible person; “right person”</td>
<td>Plant is European standard</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Organization structure → organized process operation</strong></td>
<td>Environmental monitoring (key figures requested on site)</td>
<td>Regular checking of the environmental law, to be updated</td>
<td>Support from the group</td>
<td>Support from the group</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>New processes get reviewed concerning environmental compatibility</strong></td>
<td>No local differences concerning internal environmental regulations</td>
<td>Commitment of environmental department → not only costs in the foreground</td>
<td>Mission of the company and system which is implemented → state of the art</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Know How of environmental department very good</td>
<td>Same understanding of ecological action along supply chain</td>
<td>Know How of employees</td>
<td>Know How from environmental department to maintain the systems</td>
<td>Understanding the reasons why they have to save environment</td>
<td>Know How of employees very high (knowledge of input, output and quality); qualification, facility very good</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>----------------------------------------------------------</td>
<td>-----------------------</td>
<td>-------------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Annual environmental goals which should be reached</td>
<td>Well established management system</td>
<td>Try to reduce resources year by year</td>
<td>Good communication in environmental department</td>
<td>Meetings to find the best solution</td>
<td></td>
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</tbody>
</table>
## Weaknesses

<table>
<thead>
<tr>
<th>Hinterberg</th>
<th>Fehring</th>
<th>Klagenfurt</th>
<th>Shanghai</th>
<th>Ansan</th>
<th>Nanjangud</th>
</tr>
</thead>
<tbody>
<tr>
<td>A central administrative system for environmental data is missing (no uniform reporting tool, key figures not transparent)</td>
<td>Need more analysis of the data</td>
<td>Transmission of values from the board is missing</td>
<td>“Water reclaim project” → end of pipe technology; water should directly be saved at the source</td>
<td>Goals of projects are small</td>
<td></td>
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<tr>
<td>No eco controlling</td>
<td>No eco controlling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costs have more priority than environmental issues</td>
<td>Costs have priority; first production, then safety and last comes the environment</td>
<td>Efficiency of production and costs are more important than the environmental aspect</td>
<td>Costs have priority → economy vs. ecology (profit based)</td>
<td>Costs have priority (1 person)</td>
<td></td>
</tr>
<tr>
<td>Communication between sites is missing (don’t know projects which are implemented at other sites)</td>
<td>Less information between employees</td>
<td>Communication → information is not shared between sites</td>
<td>Less awareness from production side → not only PUT&amp;EHS should be responsible; Less support from other departments</td>
<td>Less discussion and communication between departments</td>
<td></td>
</tr>
<tr>
<td>Missing resources (time, people)</td>
<td>Missing resources (time, people, money)</td>
<td>Missing resources (time)</td>
<td>Limit of budget for projects</td>
<td>Money is missing to implement projects (no environmental budget which is available for the year)</td>
<td>Missing resources (trained people, money)</td>
</tr>
<tr>
<td>Insufficient marketing</td>
<td>Insufficient marketing</td>
<td>Insufficient marketing, no environmental report</td>
<td>Ecological efficient action should be more visible, more high lightened (internal)</td>
<td>Awareness of environmental issues not strong enough (workers are not supporting env. issues → no waste separation)</td>
<td>Insufficient marketing</td>
</tr>
<tr>
<td>Absence of a Management-Review-Cycle</td>
<td>Absence of project management</td>
<td>Less attention on chemical processing</td>
<td>Lack of commitment of everybody; to accept change → cultural problem</td>
<td>Not all people are involved; only a few people work on projects</td>
<td></td>
</tr>
</tbody>
</table>

69 To improve single processes it’s necessary to measure data
<table>
<thead>
<tr>
<th>Problem at the preparation of customer data; also awareness of customer is missing</th>
<th>Missing of key figures</th>
<th>Too many key figures (probably not the right ones and different definitions)</th>
<th>Lot of waste water</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding of the employees is partly missing</td>
<td>Absence of training of employees</td>
<td>Awareness of employees is missing</td>
<td>Arrogance; “feel that we are so good”</td>
<td>Motivation of people get less and less after a time</td>
</tr>
<tr>
<td>Internal communication is missing as well → employees have too little information</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental awareness is not grounded in company’s strategy</td>
<td>Different allocation of commitment</td>
<td>Innovation is not strong enough; too slow in implementation</td>
<td>Outsourcing supplier to treat waste water for AT&amp;S it is hard to comprehend whether the supplier satisfies the internal standards of environmental protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High energy use</td>
<td>High amount of chemicals</td>
<td>“Do we know all regulations?”; no foresight concerning environmental regulations</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Have only one responsible person → need more people</td>
<td></td>
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</tbody>
</table>
## Environmental Information System

<table>
<thead>
<tr>
<th>Administrative System for environmental data (Question 25)</th>
<th>Hinterberg</th>
<th>Fehring</th>
<th>Klagenfurt</th>
<th>Shanghai</th>
<th>Ansan</th>
<th>Nanjangud</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dashboard</td>
<td>MIS</td>
<td>MIS</td>
<td>EHS monthly report</td>
<td>Dashboard for group; Intranet</td>
<td>Monthly report of KPI’s, DPI’s</td>
<td></td>
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</table>

| How often is data collected (Question 23)                | No clear answer | Every month | Collected every day, published every month | Energy: monthly; water: monthly; waste water: monthly; chemical: daily; waste disposal: monthly | Daily and reported monthly |

| Which data is collected | Waste water | Gas | Chemical analysis | CO₂ | Water usage⁷³ | Water balance absolute Energy balance absolute Water balance relative Energy balance relative Precleaning/g/laminating Vertical electroplating Horizontal electroplating Cast line Alkaline etching Acid etching Hal-tinning⁷⁴ | Water consumption: Di/City/EH per etched area in m³/m² | Energy consumption: compressed air/power/heat per etched area in kWh/m² | Copper in waste water in mg/m³ | pH-value in waste water | Emission value HCl in ppm | Main waste absolute in kg | Main waste relative per etched area kg/m² | Waste absolute in kg | Waste relative per etched area kg/m²⁷⁵ | Gas absolute | Power absolute | CO₂ emissions absolute | Gas relative | Power relative | CO₂ emissions relative | City water absolute | Process water absolute | City water relative | Process water relative | Waste absolute | Waste relative | Waste water absolute | Waste water relative | COD | Cu/Ni concentration⁷⁶ | Waste water | Gas | Chemical analysis | CO₂ | Water usage⁷⁷ | Raw Water consumption (m³)/day | Waste Water Discharge (m³)/day and costs (Rs/m³) | Sewage Water Discharge (m³)/day | Specific Water Consumption (m³/m²) | Conductivity in deionised water (µS/cm) | Total bacteria count (CFU/ml) in DI water | DI water consumption m³/day and costs (Rs/m³) | Soft water consumption (m³/day) and costs (Rs/m³)⁷⁸ |

⁷³ Values from Dashboard
⁷⁴ See Lamprecht (2010/2011): Managementbericht Umwelt & Sicherheit, Quartalsbericht
⁷⁵ See Starzacher, A., E-Mail from 11.10.2011
⁷⁶ See EHS monthly report
### Who collects internal environmental Data (Question 24)

<table>
<thead>
<tr>
<th>EHS, PUT</th>
<th>EHS</th>
<th>PUT, EHS, Facility</th>
<th>EHS, Facility</th>
<th>PUT, EHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy cons.: factory based</td>
<td>Energy cons.: factory based</td>
<td>Energy cons.: all machines and whole factory</td>
<td>Energy cons.: factory based</td>
<td>Energy cons.: machine based or factory based</td>
</tr>
<tr>
<td>Water cons.: factory based</td>
<td>Water cons.: factory based</td>
<td>Water cons.: whole factory</td>
<td>Water cons.: factory based</td>
<td>Water cons.: factory based</td>
</tr>
<tr>
<td>Chem. proc.: cost centre based</td>
<td>Chem. proc.: cost centre based</td>
<td>Chemical proc.: cost centre based</td>
<td>Chemical proc.: no clear answer</td>
<td>Chemical proc.: machine based</td>
</tr>
<tr>
<td>Waste dispo.: factory based</td>
<td>Waste dispo.: cost centre based</td>
<td>Waste dispo.: cost centre based</td>
<td>Waste dispo.: cost centre based</td>
<td>Waste dispo.: cost centre based</td>
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</tbody>
</table>

### On which level is data collected (Question 27)

- Energy cons.: factory based
- Water cons.: factory based
- Waste water treatment: factory based
- Chem. proc.: cost centre or division based
- Waste dispo.: factory based

### Who knows about Dashboard (Question 25)

- 3 people answered YES “Dashboard”; 2 NO, 1 NO ANSWER
- Nobody answered “Dashboard”, 1 said MIS, 2 NO ANSWER
- 4 people answered “Dashboard” (one of them also said IQS), 1 said SAP, 1 said Excel file
- 3 people answered “Dashboard”; 1 MIS, EHS folder, 1 NO
- 1 person answered “Dashboard” for group and KPI’s and DPI’s for site, 3 monthly report and 1 of them KPI’s and DPI’s on monthly report, 1 KPI’S reported, 1 NO

### Value stream mapping (Question 34-38)

- No value stream mapping in all 5 fields
- No clear answer
- No value stream mapping in all 5 fields
- Value stream mapping in the field of water consumption
- No value stream mapping; unclear answer in the field of water consumption

---

77 Values from Dashboard
78 See Performance Indicator Review, 2011, Environment, Supply & Waste
79 3 people answered “EHS, PUT, Facility”; 1 answered “EHS and PUT”; 1 answered “EHS”
80 3 people answered “EHS”, 1 of them also said “PUT and Facility”; 2 answered “Facility”
81 3 people answered “EHS”, one of them also said “Production, Facility and Others” → 2 other plants, and just one boiler house; 1 answered “Facility and Others” → Quality
82 3 people answered “PUT, EHS and Facility”, 1 answered “PUT, EHS, Production, Facility and Controlling”, 1 said “PUT and EHS” and 1 answered “PUT, EHS, Production and Facility”
83 2 people answered “EHS”; 2 said “EHS, Production and Facility”; 1 answered “EHS and Facility”
84 2 people answered “PUT and EHS”; 1 answered “PUT, EHS, Production, Controlling, Facility”; 1 said “EHS”; 1 answered “PUT, EHS, Production, Facility”; 1 said “EHS and Facility”
85 3 answered “Yes”, 1 said “No”, 2 had no answer

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<table>
<thead>
<tr>
<th>Projects (Question 4-9)</th>
<th>In all 6 fields(^{86})</th>
<th>In 5 of 6 fields (not at energy consumption)</th>
<th>In 5 of 6 fields (not at chemical processing)</th>
<th>In all 6 fields</th>
<th>In all 6 fields</th>
<th>In all 6 fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental audits (Question 43 and 44)</td>
<td>All 3 years at suppliers and disposal contractors</td>
<td>No clear answer</td>
<td>No clear answer</td>
<td>Once a year at suppliers and disposal contractors</td>
<td>No audits at suppliers and disposal contractors</td>
<td>Every 2(^{nd}) year at suppliers and disposal contractors</td>
</tr>
<tr>
<td>Environmental Information (Question 45 and 46)</td>
<td>Demand from internal and external customers</td>
<td>No demand from internal but from external customers</td>
<td>No demand from internal and no clear answer from external customers</td>
<td>Demand from internal and external customers</td>
<td>Demand from internal and external customers</td>
<td>Demand from internal and external customers</td>
</tr>
<tr>
<td>Improvement suggestions regarding administrative system (Question 25 c. and 50)</td>
<td>- Increase of data, just gas, power and water are collected - Output too small, just data which is interesting for Top Management - Data has to get better available (\rightarrow) need too much time - Evaluation has to be easy, like SAP - No standardized reporting tool - Advantage of comparison with companies at the same branch - Need a standardized calculation of key figures (\rightarrow) different understanding of the key figures - Need a central administrative system - Need a clear definition of the key figures and how often and who collects them - Method of processing</td>
<td>- To make a central administrative system - Standardization - More key figures or more surveys of data - Central survey and tool to put in all the data - Need to know which data we need</td>
<td>- To make a central administrative system, not local solutions - Central system has to be available for everybody - Definition of data in a standardized form - Clear definition of data - Need to know which key figures are needed and how to collect them - Need tools to collect data - Only one position which is responsible for data processing - Has to be more specific (\rightarrow) like machine specific or hall specific</td>
<td>- Need to do some analysis to this data - Standardization of environmental key figures - More key figures - Data base has to be more completed (has to ask facility or quality for information) - Data has to be more available and visible (\rightarrow) highlighting importance of it</td>
<td>- No waste disposal and chemical usage in Dashboard (copper sludge, packaging) - Making data more meaningful with graphs (\rightarrow) more visible - Not data for air</td>
<td>- Need more data at the Dashboard - Consumption per month (\rightarrow) how much is really going into the process (\rightarrow) More analysis of the process - Need of a software, where you can catch data online - No information about the consumption of the separate departments</td>
</tr>
</tbody>
</table>

---

\(^{86}\) Production, energy, -water consumption, waste water treatment, chemical processing and waste disposal
<table>
<thead>
<tr>
<th>Calculation and reporting guideline is missing for the same understanding.</th>
</tr>
</thead>
<tbody>
<tr>
<td>General view is missing.</td>
</tr>
<tr>
<td>First a sustainable map should be implemented; after that define metrics and the incorporate.</td>
</tr>
</tbody>
</table>
## Evaluation of the questions

<table>
<thead>
<tr>
<th>Hinterberg</th>
<th>Fehring</th>
<th>Klagenfurt</th>
<th>Shanghai</th>
<th>Ansan</th>
<th>Nanjangud</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 4-9</td>
<td>“Have there already been some projects in the following fields and which one?”</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Production</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Decrease of water (galvanic)</td>
<td>- Substitution of refrigerant to a more efficient refrigerant</td>
<td>- Increase of the occupancy rate</td>
<td>- Optimization of copper content</td>
<td>- Recording of use of chemicals, energy etc. per m² → potential for savings</td>
<td></td>
</tr>
<tr>
<td>- Decrease of compression air</td>
<td>- Facilities are operated more efficiently</td>
<td>- Optimized copper content</td>
<td>- Recording of use of chemicals, energy etc. per m² → potential for savings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Improvements at sewage works, “Feed and Bleed”</td>
<td>- Heat recovery → storage area is heated with waste heat</td>
<td>- Recording of use of chemicals, energy etc. per m² → potential for savings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Double-page printing</td>
<td>- New machines</td>
<td>- Recording of use of chemicals, energy etc. per m² → potential for savings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Install of a heat pump</td>
<td>- Better monitoring</td>
<td>- Recording of use of chemicals, energy etc. per m² → potential for savings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Decrease of rinse water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Less usage of chemistry</td>
<td>- Program to minimize energy use (already implemented)</td>
<td>- Savings of compressed air</td>
<td>- Changing lights in the night → 50 kWh to 20 kWh</td>
<td>- Reduce the use of lights instead of two glow sticks just one; turning off the lights</td>
<td></td>
</tr>
<tr>
<td>- Cooperation with ATOTECH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Recycling of synthetic rolls</td>
<td>- Savings of power → new machines</td>
<td>- Good isolation of the building</td>
<td>- Shut off the processes which are</td>
<td>- Energy consumption pump</td>
<td></td>
</tr>
<tr>
<td>- Decrease of resources</td>
<td>- Savings of light → timer Awareness-raising (switch-off the lights)</td>
<td>- Doors close automatically</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Decrease of used copper chloride per kg per produced PCB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Usage of light is optimized</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Process of equipment selection is ecological improved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

87 Projects in the field of “production” are overlapping with projects in the other fields. Therefore they are not mentioned twice.
<table>
<thead>
<tr>
<th>Water consumption</th>
<th></th>
<th>Waste water treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease of water usage</td>
<td>Decrease of water treatment</td>
<td>usage of chemicals decreased at neutralization</td>
</tr>
<tr>
<td>Water recycling project</td>
<td>- Elimination of substances which are hazardous to the environment (at chemical tin bath)</td>
<td></td>
</tr>
<tr>
<td>Decrease of rinse water in production</td>
<td>- Issue of frothing at releasing waste water into the river</td>
<td>Usage of used leach</td>
</tr>
<tr>
<td>Better filtration</td>
<td>- Raab</td>
<td>Discharging of sodium sulfide</td>
</tr>
<tr>
<td>Different flow rate tube</td>
<td>- Reduction of pollution by</td>
<td>- Decreased waste water because of decreased water</td>
</tr>
<tr>
<td>Prior art</td>
<td></td>
<td>- Recycling of gold bring it back to production</td>
</tr>
<tr>
<td>Changed irrigation system (Spülsystem)</td>
<td>Conservation of water → multiple usage of water</td>
<td>- Recycling of silver and copper sell it</td>
</tr>
<tr>
<td>(Spülsystem): “want to be cheaper”</td>
<td>Optimized rinses by cascade rinses</td>
<td>- New waste water treatment plant</td>
</tr>
<tr>
<td>Starts at the point where they buy the machines</td>
<td>Implementation of a flow meter for exact dosing of the water</td>
<td>- Reuse of waste water</td>
</tr>
<tr>
<td>choice of machines → sparing water consumption (1/5 usage)</td>
<td>- Water saving by reusing it</td>
<td></td>
</tr>
<tr>
<td>Chemical processing</td>
<td>Waste disposal</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------</td>
<td></td>
</tr>
<tr>
<td>- Usage of used leach</td>
<td>- Filter waste is better arranged</td>
<td></td>
</tr>
<tr>
<td>- Usage of used acid (10% HCl)</td>
<td>- Change to 50% paper instead of wood plates/melamine (residual waste)</td>
<td></td>
</tr>
<tr>
<td>- Substitute chemicals by other chemicals</td>
<td>- Reduction of packaging waste Efficient share of plastics as possible</td>
<td></td>
</tr>
<tr>
<td>- “Feed and Bleed” → recycling of chemistry → water has not to be changed that often → cost point positive</td>
<td>- Reuse of waste Waste classification Paper and carton is sold to contractor 90% is recycled</td>
<td></td>
</tr>
<tr>
<td>- Decrease of chemical consumption</td>
<td>- Waste water sludge → copper recycling by contractors</td>
<td></td>
</tr>
<tr>
<td>- About 10 times less gold-chemistry has to be used</td>
<td>- Recycle paper Separating by categories</td>
<td></td>
</tr>
<tr>
<td>- Decrease of effectiveness → continuous improving</td>
<td>- Recycling hazardous waste</td>
<td></td>
</tr>
<tr>
<td>- Controlling computer system → reduce chemical consumption Recycling of chemicals less chemicals which have to be added</td>
<td>- Recycling the copper (20%) and sell it</td>
<td></td>
</tr>
<tr>
<td>- Less use of chemicals for the same performance (soda lye) Less use of muriatic acid</td>
<td>- Save chemicals for water treatment improvements in production to consume less chemicals</td>
<td></td>
</tr>
<tr>
<td>- Decreased chemical use Separation of the different chemicals not stored in one area Increasing life if the baths can use the chemicals more often before they are exchanged to new chemicals</td>
<td>- Copper recovery</td>
<td></td>
</tr>
<tr>
<td>- Reducing the effective share of chemicals for the same performance (soda lye) Less use of muriatic acid</td>
<td>- 96% savings of hydrogen peroxide</td>
<td></td>
</tr>
<tr>
<td>- Recycling of chemicals less chemicals which have to be added</td>
<td>- Plan to recycle the etching liquid</td>
<td></td>
</tr>
<tr>
<td>- Change to 50% paper instead of wood plates/melamine (residual waste)</td>
<td>- Recycling waste (get separated) and sell it</td>
<td></td>
</tr>
<tr>
<td>- Reduction of 8 tons of commercial waste per year Recycling → packaging waste goes back to producer Recycling of gold and copper Recycling of copper sludge → copper recovery</td>
<td>- Pricks are produced from the cutting waste</td>
<td></td>
</tr>
<tr>
<td>- Recycling of gold and copper Recycling of copper sludge → copper recovery</td>
<td>- Recycling the copper (20%) and sell it</td>
<td></td>
</tr>
</tbody>
</table>

- Correct metering of chemicals (pH-value) and new pipework
- Less water consumption → less waste water
- Reclaim project → recovery rate about 50%
- Requirements from government 3 ppm
- Water → back to production
- Less water consumption → less waste water
- Water reclaim project recovery rate about 50%
- Positive
- Decrease of effectiveness → continuous improving
- About 10 times less gold-chemistry has to be used
- Decreased chemical use Separation of the different chemicals not stored in one area Increasing life if the baths can use the chemicals more often before they are exchanged to new chemicals
- Save chemicals for water treatment improvements in production to consume less chemicals
- Copper recovery
- 96% savings of hydrogen peroxide
- Plan to recycle the etching liquid
- Change to 50% paper instead of wood plates/melamine (residual waste)
- Recycling → packaging waste goes back to producer Recycling of gold and copper Recycling of copper sludge → copper recovery
- Recycling of packaging waste Efficient share of plastics as possible
- Reuse of waste Waste classification Paper and carton is sold to contractor 90% is recycled
- Waste water sludge → copper recycling by contractors
- Recycle paper Separating by categories
- Recycling waste (get separated) and sell it
- Pricks are produced from the cutting waste Recycling of hazardous waste Recycling the copper (20%) and sell it
### Question 10
“Is everyone jointly responsible concerning projects for an ecological efficiency increase?”

<table>
<thead>
<tr>
<th>Answer</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>3 Yes, 2 No, 1 No Answer</td>
</tr>
<tr>
<td>Yes</td>
<td>4 Yes, 1 No</td>
</tr>
<tr>
<td>Yes</td>
<td>3 Yes, 1 No</td>
</tr>
<tr>
<td>Yes</td>
<td>4 Yes, 1 No</td>
</tr>
<tr>
<td>Yes</td>
<td>3 Yes, 2 No</td>
</tr>
</tbody>
</table>

### Question 11
“Do you get enough support when implementing projects for an ecological efficiency increase concerning budget/resources?”

<table>
<thead>
<tr>
<th>Answer</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>3 Yes, 2 budget Yes and resources No, 1 No Answer</td>
</tr>
<tr>
<td>Yes</td>
<td>5 Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>2 Yes, 1 No, 1 No Answer</td>
</tr>
<tr>
<td>Yes</td>
<td>6 Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>3 Yes, 2 No</td>
</tr>
</tbody>
</table>

### Question 12
“Has your superior an exemplary function when implementing projects for an ecological efficiency increase?”

<table>
<thead>
<tr>
<th>Answer</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>5 Yes, 1 No Answer</td>
</tr>
<tr>
<td>Yes</td>
<td>5 Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>3 Yes, 1 No</td>
</tr>
<tr>
<td>Yes</td>
<td>5 Yes, 1 No Answer</td>
</tr>
<tr>
<td>Yes</td>
<td>3 Yes, 2 No</td>
</tr>
</tbody>
</table>

### Question 13
“How motivated are your employees when implementing environmental projects?”

<table>
<thead>
<tr>
<th>Score</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.4</td>
<td>88 (1 No Answer)</td>
</tr>
<tr>
<td>2.2</td>
<td>89</td>
</tr>
<tr>
<td>2.25</td>
<td>90</td>
</tr>
<tr>
<td>2.083</td>
<td>91</td>
</tr>
<tr>
<td>2.4</td>
<td>92</td>
</tr>
</tbody>
</table>

### Question 14
“Which of the following fields would be of primary importance when implementing more efficient operating procedures?”

<table>
<thead>
<tr>
<th>Field</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy consumption, chemistry processing</td>
<td>89</td>
</tr>
<tr>
<td>Energy consumption, chemistry processing</td>
<td>90</td>
</tr>
<tr>
<td>Energy consumption</td>
<td>91</td>
</tr>
<tr>
<td>Chemistry processing, water consumption, energy consumption, waste disposal</td>
<td>92</td>
</tr>
<tr>
<td>Energy consumption, water consumption</td>
<td>93</td>
</tr>
<tr>
<td>Energy consumption, water consumption</td>
<td>94</td>
</tr>
</tbody>
</table>

---

88 Average value of a scale from 1-5 (1=best, 5=worst)
89 5 energy consumption, 1 chemistry processing, 2 water consumption, 1 waste water, 1 waste disposal
90 4 energy consumption, 3 chemistry processing, 1 water consumption, 2 waste disposal
91 4 energy consumption, 1 chemistry processing, 1 water consumption, 1 waste disposal
92 3 chemistry processing, 2 energy consumption, 2 water consumption, 1 waste water, 2 waste disposal
93 3 energy consumption, 2 energy consumption, 1 waste water, 1 chemistry processing, 1 waste disposal
94 3 energy consumption, 4 water consumption, 2 waste water treatment, 1 chemical processing, 2 waste disposal
<table>
<thead>
<tr>
<th>Question 15</th>
<th>“Do you think that opportunities to save in energy consumption are high or low?”</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.16`</td>
<td>2.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 16</th>
<th>“Do you think that opportunities to save in water consumption are high or low?”</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.6`</td>
<td>3.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 17</th>
<th>“Do you think that opportunities to save in waste water treatment are high or low?”</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.16`</td>
<td>3.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 18</th>
<th>“Do you think that opportunities to save in chemical processing are high or low?”</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 19</th>
<th>“Do you think that opportunities to save in waste disposal are high or low?”</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 21</th>
<th>“How important is an environmental information system for you?”</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 28</th>
<th>“Do you know the costs of energy consumption?”</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 of 6 people know the costs (4 Yes, 2 No)</td>
<td>All 5 people know the costs</td>
</tr>
<tr>
<td>All 4 people know the costs</td>
<td>All 6 people know the costs</td>
</tr>
<tr>
<td>4 of 5 people know the costs (4 Yes, 1 No)</td>
<td>All 6 people know the costs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 29</th>
<th>“Do you know the costs of water consumption?”</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 of 6 people know the costs (4 Yes, 2 No)</td>
<td>All 5 people know the costs</td>
</tr>
<tr>
<td>All 4 people know the costs</td>
<td>3 of 4 know the costs (3 Yes, 1 No)</td>
</tr>
<tr>
<td>All 6 people know the costs</td>
<td>4 of 5 people know the costs (4 Yes, 1 No)</td>
</tr>
<tr>
<td>All 6 people know the costs</td>
<td>All 6 people know the costs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 30</th>
<th>“Do you know the costs of waste water treatment?”</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 of 6 people know the costs (2 Yes, 4 No)</td>
<td>All 5 people know the costs</td>
</tr>
<tr>
<td>Nobody knows the costs (all 4 No)</td>
<td>5 of 6 people know the costs (5 Yes, 1 No)</td>
</tr>
<tr>
<td>3 of 5 people know the costs (3 Yes, 2 No)</td>
<td>5 of 6 people know the costs (5 Yes, 1 No)</td>
</tr>
</tbody>
</table>
### Question 31

“Do you know the costs of chemical processing?”

<table>
<thead>
<tr>
<th>1 of 6 people knows the costs (1 Yes, 5 No)</th>
<th>3 of 5 people know the costs (3 Yes, 2 No)</th>
<th>1 of 4 people know the costs (1 Yes, 3 No)</th>
<th>4 of 6 people know the costs (4 Yes, 1 No)</th>
<th>2 of 5 people know the costs (2 Yes, 3 No)</th>
<th>5 of 6 people know the costs (5 Yes, 1 No)</th>
</tr>
</thead>
</table>

### Question 32

“Do you know the costs of waste disposal?”

<table>
<thead>
<tr>
<th>1 of 6 people knows the costs (1 Yes, 5 No)</th>
<th>All 5 people know the costs</th>
<th>1 of 4 people know the costs (1 yes, 3 No)</th>
<th>5 of 6 people know the costs (5 Yes, 1 No)</th>
<th>2 of 5 people know the costs (2 Yes, 3 No)</th>
<th>4 of 6 people know the costs (4 Yes, 1 No, 1 No answer)</th>
</tr>
</thead>
</table>

### Question 40

“How important do you think environmental information is from suppliers?”

| 1.6 | 1.6 | 1.75 | 1.5 | 1.2 | 1.83 |

### Question 41

“Which environmentally relevant data from suppliers are important for you?”

- Where is waste disposed?
- Compliance with all regulations (chemistry law), also for Asian products (suppliers has to be informed)
- Contents of base material of the PCB
- MSDS
- How is the supplier producing?
- Should have the ISO 14001
- Are there any problems with NGO’s?
- How is the image of the supplier?
- Are there any environmental relevant projects?

- List of prohibition which contents in products
- Which certifications? are suppliers environmentally friendly?
- Environmental friendly action at production?

- Which certifications? should have at least ISO 14001
- List of prohibition
- Which contents in products
- How is waste disposed?
- Are there constantly innovations/development
- Information about, which actions have to be set at an specific accident?
- Industrial safety (practice regulations)

- Row material no restricted material
- Chemicals and energy used in their process
- Which contents are in their products?

- MSDS (risks)
- Disposal procedures
- Pollution in air, water factor
- REACH requires/ requires/ law
- What kind of chemicals they use to produce
- Energy consumption

- Amount of consumption
- Are there any improvements?
- Management policy and vision
- Power consumption, energy consumption, water consumption
- Material data sheets (treatment of chemicals)
- Waste management information system

---

95 Information has to be transparent; importance of the whole supply chain
96 Get information at audits
<table>
<thead>
<tr>
<th>System audits</th>
<th>Process audits</th>
<th>Product audits</th>
<th>CO2 emissions</th>
<th>Which certifications?</th>
</tr>
</thead>
</table>

**Question 42**

“Which of the following suppliers is particularly important concerning environmental information?”

<table>
<thead>
<tr>
<th>Chemistry and base material</th>
<th>Chemistry, disposal contractor and coating</th>
<th>Coating and chemistry</th>
<th>Base material and disposal contractor</th>
<th>Chemistry and base material</th>
<th>Chemistry and base material</th>
</tr>
</thead>
</table>

**Question 47**

“Do you have simple access to data to answer external customer enquiries?”

<table>
<thead>
<tr>
<th>No</th>
<th>No</th>
<th>No clear answer</th>
<th>Yes</th>
<th>Yes</th>
<th>Yes</th>
</tr>
</thead>
</table>

---

97 Would be also an interesting information
98 health and safety data sheet → which chemicals and base materials are in the product (concentration, keeping, handling, safety, physical condition)
99 Need people to measure → suppliers are often very small size companies and therefore are not able to measure or control environmental relevant data
100 5 people answered “chemistry”, 4 said “base material”, 2 answered “disposal contractor”, 1 said “coating”
101 3 people answered “chemistry”, 2 answered “disposal contractor”, 2 said “coating”, 1 answered “base material” (2 people gave just one answer)
102 3 people answered “coating”, 3 said “chemistry”, 2 answered “base material”
103 5 people answered “base material”, 3 answered “disposal contractor”, 2 said “coating”, 2 answered “chemistry”
104 5 people answered “chemistry”, 3 said “base material”, 2 answered “coating”
105 6 people answered “chemistry”, 3 answered “base material”, 1 said “coating”, 2 answered “disposal contractor”
106 5 of 6 people said “No”, 1 had no answer
107 2 of 5 people said “No”, 2 had no answer, 1 said “Yes”
108 2 of 4 people said “No”, 2 answered “Yes”
109 5 of 6 people said “Yes”, 1 had no answer
110 4 of 5 people said “Yes”, 1 had no answer
111 5 of 6 people said “Yes”, 1 had no answer