The suitability of Environment Management Accounting (EMA) models applied by the German Mittelstand

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Table of Contents

Index of Figures

Index of Tables

Index of Keywords

Accounting, p. 9: An umbrella term for several ways of systematically gathering, calculating, and reporting of monetary and non-monetary information about the organisation that can be used by others. Unless stated otherwise, the reporting can be internal and external, i.e., it can be addressed to internal or external stakeholders.

Activity Based Costing (ABC), p. 40: An accounting method calculating operating costs taking, direct and indirect costs, as well as up-stream and down-stream processes of the actual production process. ABC identifies most environmental costs; it is compatible with management accounting (MA), strategic management accounting (SMA), and environmental management accounting (EMA).

Chemical Abstracts Service (CAS), p. 73: This service for accountants consists out of the so-called CAS registry numbers. The CAS number of a substance reflects the principal degree of its danger for the environment.

Direct Costing, p. 40: An accounting method that traces environmental costs separately by treating fix and variable costs and by separating environmental costs from other costs. Being unable to promote integrated environmental protection activities, it is not used by EMA.

Eco-Efficiency, p. 2: the ratio of a product's economic value per unit and its impact on the environment.

Ecological, Eco-Related, p. 5: same as environmental (in the context of this thesis).

Environmental Management System (EMS) (not to be confused with EMA), p. 14: An environmental management system within SMA helping the management to comply with environmental regulations. Unlike EMA, it is no accounting procedure.

EMAS (ECO-Management and Audit Scheme) (not the same as EMA and EMS), p. 14: one of the three most used standards of EMS, the other two being ISO 14001 and BS 8555/Acorn.

Emergy, p. 80: the energy needed to create a product or to provide a service.

Environmental Assets (also called eco-related assets or eco-efficient assets), p. 87: devices, technologies, materials, and software-applications that ensure eco-efficient production processes.

Environment, p. 1: the natural environment (i.e. the earth's biosphere), opposed to the social environment (i.e. the society).

Environmental, p. 6: degree of a phenomenon's impact on the natural environment; synonyms: ecological, eco-related.

Environmental Accounting (EA), p. 2: A variety of accounting types used to transform the information about a company's negative effects on its environment into environmental costs. Some types of EA concentrate on the company's ecological issues, while others also include social impacts.

Environmental Balanced Scorecard (EBSC), p. 41: A Balanced Scorecard (BSC) used for several EA systems including EMA. An EBSC is based on an eco-efficiency analysis of the company's supply chain and reflects all its environment-related data.

Environmental Cost Accounting (ECA), p. 33: a type of accounting that is exclusively concerned with environmental costs.

Environmental Costs, p. 1: Costs corresponding with the company's internal affairs negatively influencing its natural environment. Environmental costs are caused by the payments for (a) the treatment and purchase of non-product output, (b) the prevention of possible negative impacts on the environment through waste and pollution, (c) insurances or governmental taxes or penalties, plus (d) environment-related earnings and savings.

Environmental Management Accounting (EMA), p. 1: a type of EA exclusively concerned with retrieving, accounting, and internally reporting a company's eco-related information in a way that can be best used by SMA to improve the company's economic and environmental performance.

EMS: see **Environmental Management System**

Financial Accounting (FA), p. 9: The oldest and most basic type of accounting focussing on the changes of a company's economic entities and on the costs/revenues of the company's external and internal affairs. FA solely registers, calculates, and reports monetary phenomena; for that it uses cost accounting and budgeting techniques, as well as financial statements for internal and external stakeholders. Financial accounting provides the management with information that can be used for managerial decisions, but it is not an internal part of the management process.

Flow Cost Accounting, p. 41: A type of accounting referring to material and energy flow analysis. Flow cost accounting identifies the quantities in questions and their corresponding conventional and environmental costs. It also considers the flows of raw materials and wastes/emissions. Therefore, flow cost accounting is compatible with an input/output analysis and EMA.

Full Cost Accounting (FCA), p. 40: An accounting method tracing all direct costs and allocating indirect costs to a product, process, or activity. FCA is compatible with MA, SMA, and EMA.

German Mittelstand (or simply 'Mittelstand'), p. 21: A group of companies that share the following qualitative characteristics: economic and judicial independence; unity of (or at least close relationship of) property, control, and leadership; close interplay of (inherited) business culture, organisational structure, and business strategy. In quantitative respect, Mittelstand companies have a workforce ranging from 10 to 3,000 employees and an annual turnover between 1-300 Mio. €.

Green Accounting, p. 4: umbrella term for EA, EMA, sustainability accounting, and social accounting.

Input/Output Analysis, p. 41: a tool in economic analysis representing the flows of input and output items with a set of linear equations in order to estimate their economic and environmental impacts

Integrated Financial Accounts, p. 23: a software application tracking financial events, summarizing financial information, and standardizing the accounting transactions of this financial information.

Life Cycle Assessment (LCA), p. 40: LCA identifies the environmental aspects and potential impacts of a product throughout its life from raw material acquisition, production, use, and disposal. Not being an actual accounting method, LCA is incompatible with EMA.

Management Accounting (MA), p. 10: A type of accounting that has developed out of financial accounting (FA). MA comprises all principles and techniques of financial accounting; it is, however, also concerned with the identification, calculation, and reporting of information of business factors (like availability of resources or technological developments, which do not principally have a monetary nature). Unlike FA, MA is integrally involved in the management procedures by setting their short to mid-term tactics. MA reports its findings to internal and external stakeholders.

Separate Calculation, p. 39: an accounting method that deals with cost types separately and does not integrate them into MA or SMA; not used by EMA.

Social Accounting, p. 4: a type of accounting covering both environmental and social costs

Social Costs, p. 4: costs arising from the interaction between the company and its social environment; typically not covered by EMA.

Strategic Management Accounting (SMA), p. 2: The latest development of accounting comprising all principles and techniques of MA. Unlike MA, however, SMA is concerned with bringing about a long-term managerial strategy initiating and coordinating all managerial (short to mid-term) tactics and decisions, including the analysis of financial and non-financial data, according to a single strategic plan to achieve long-term organisational success.

Sustainability Accounting, p. 4: umbrella term for EA, EMA, green accounting, and social accounting

Target Costing p. 40: accounting method intending to record environmental impacts and to influence them with volume management and transfer prices; unsuccessful and hardly compatible with EMA.

Wasted Resources, p. 20: amounts of energy, water, and solid input materials consumed by inefficient activities so that they do not add any economic value.

Implementation of Environmental Management Accounting Models in the German Mittelstand

Marcel Kaiser

Abstract

The implementation of environmental management accounting (EMA) in Mittelstand companies is an uncharted area. Therefore, the aim of this study was to identify the ways, benefits, and disadvantages of implementing EMA in such companies. The choice of the approach and method depended on the following reasons: As the observed phenomena took place inside a company and depended on the attitudes of its members, an interpretivist and qualitative research approach was used that regarded a company as a socially constructed entity. The research was executed with a top-down deductive method starting with a literary review (on Mittelstand-like companies using EMA), and leading to hypotheses concerning the research aim. These assumptions were tested in a qualitative case study using a German Mittelstand company from the printing industry. To this end, the study used the company's files, personal notes from management meetings, and interviews with experts from the focal company offering the deepest insight in the focal company.

The analysis found two different results. Mittelstand companies will have trouble with implementing EMA. However, after having done this, they will only experience benefits and no disadvantages. During the EMA implementation there will probably be delays due to lacking expertise, conservative attitudes, and disturbed channels of information among the staff. However, these obstacles can be overcome with external experts guiding the EMA implementation, and with financial resources to pay them. EMA will then enable a Mittelstand company to track the flows of hazardous and harmless physical entities alike and its associated environmental and conventional costs. With this information the strategic management accounting (SMA) will be able to reduce these costs, to develop eco-friendly products, and to increase its resource efficiency, profits and competitiveness. In a Mittelstand company EMA should therefore be placed at the interface of proper accounting and SMA.

FCA, ABC, flow cost accounting, input/output analysis, and EBSC seem to be the optimal methods to track and analyse a company's physical flows and its related conventional and environmental costs. The former cost type depends on the quantities

of the resources, with the latter one depending on the production of waste, the excessive use of water, wood, fuel, electric energy, hazardous chemicals and the process they are used in. To capture these costs it is best to use a set of primary metrics (reflecting the quantities of the resources) and secondary metrics (focussing on the flows and dangers of these resources).

Measuring environmental costs of hazardous substances is difficult, since the production processes they are used in depend on chancy circumstances like accidents. Instead, it is also possible to use an EMA that only calculates the amounts of wood, water, waste, fuel, and electric energy needed for the use of hazardous substances. After multiplying these costs with a numerical and empirically obtained factor, the related environmental costs can now be measured both accurately and easily. Such a simplified EMA seems to be a promising method for Mittelstand companies with low technical skills.

Declaration

I hereby declare that this Ph.D. thesis entitled **“Implementation of Environmental Management Accounting (EMA) Models in the German Mittelstand”** was carried out by me, and only by me, for the degree of Doctor of Philosophy in English under the guidance and supervision of Dr. Tracy Jones and Martin Bennett, The Business School, University of Gloucestershire, United Kingdom. The interpretations put forth are based on my reading and understanding of only the original texts (books, monographs, articles, files, documents, and websites), which I have acknowledged at the respective place in the text. For the present thesis, which I am submitting to the University, no degree or diploma or distinction has been conferred on me before, either in this or in any other University.

Place: Arnsberg (Germany)

Date: 20th October 2017

(Mr. Marcel Kaiser)

Research Student

1 Introduction

For more than 40 years, companies have been forced to diminish their negative effects on the environment. This force is established by imposing related taxes or penalty fees which, from the company's perspective, are commonly regarded as a type of environmental costs. One of the first examples of this kind of force was the U.S. National Environmental Policy Act (NEPA), which was passed in 1969 (CRC Press 2008). As economy involves the use and production of energy, water, materials, and waste, companies affect the environment in various ways and on a large scale: as of 2009, "humans […] extract(ed) and use(d) around 50% more natural resources than only 30 years ago, at about 60 billion tons of raw materials a year" (SERI 2009: 3). The global consumption of energy has also risen drastically, only in the USA it increased from 34.616 quadrillion Btu (1950) to 97.530 quadrillion Btu (2013) (U.S. Energy Information Administration 2014 [a]). The emission of hazardous gases has reached large dimensions, too. As of 2011, China produced 8.979 billion tons of CO_2, a sharp rise compared to 0.738 tons of CO_2 in 2011 (bp.com; Statistical Workbook of World Energy 2014). The situation is similar concerning the production of solid waste as every Irish and US citizen produces 700 kg of waste p.a., compared to 150 kg being the average annual production of waste per capital in less developed countries (bbc.co.uk; Statistical Workbook of World Energy 2014).

Typically, companies are not interested in ecology and in legal compliance, but first of all in their own economic success (Eisestein 2017). First, it was the legal pressure on companies that brought about positive effects, e.g. the production of CO_2 in the UK fell from 0.722 billion tons in 1970 to 0.511 billion tons in 2011 (idem). Therefore, companies need to know, evaluate, justify and manage the potential economic and environmental impacts stemming from their production processes. In order to do so, recording, reporting and evaluation is required by the organisation. As with other forms of company reporting, there are external reporting requirements, i.e. the required external reporting of environmental impact, but also a need for internal reporting to aid management decision-making. This has spurned the development of Environmental Management Accounting (EMA) (Tennenbaum 1988). Apart from that, companies have devised several economic means to counter the judicial pressure to reduce their impact on the environment. Some examples are the input-output analysis (Fresner &

Engelhardt 2004), material flow analysis (Brunner & Rechberger 2004), life-cycle assessment (Günther 2008), environmental impact assessment (Holder 2004), and environmental management system (Florida & Davison 2001). All these measures aim at a moderate use of resources and at a reduction of hazardous wastes and emissions. A supply chain reaching these objectives depends on eco-friendly devices and production methods, but it also involves an integrated chain management (ICM) which coordinates the company's related managerial efforts. On the other hand, companies intending to reach these goals will also need a comprehensive and coherent managerial strategy which does not only orchestrate the above mentioned measures in a systematic way, but also accounts for the related costs, commonly called environmental costs (Fred 2009; Waweru 2010).

Strategic management accounting (SMA) is such a managerial strategy since it (unlike other types of management accounting) coordinates all managerial decisions, including the analysis of financial and non-financial data, according to a single strategic plan to achieve long-term organisational success (Fred 2009). It was, however, not originally designed to deal with environmental tasks and to account for their related costs. On the other hand, its methods have the quality of suiting the demands of eco-efficiency since environmental affairs involve both financial and non-financial information. Therefore, several attempts have been made to modify SMA to meet the additional goal of eco-efficiency. One way of achieving this is to combine SMA with an integrated environmental accounting (EA). To this end, several systems of EA have been developed since the early 1970s with one of them being EMA. The systems of EA differ in respect of their objectives with some of them concentrating on the accounting of environmental issues (Gray 2005) and with others covering the wider social implications of economics (Eugénio et al. 2010). However, the efficacy of all EA systems is either lauded (Thompson & Bebbington 2005) or denied (Spence & Husillos; Correa-Ruiz 2010). Consequently, it remains an open question if and how a company can run its business in an environmental friendly way.

1.1 Background to the Study

The previous section of the text has highlighted the need for a managerial system that both protects the environment and reduces a company's environmental costs. However, EA was initially defined as a mere subset of accounting to serve these ends by only measuring and reporting a company's environmental costs that were directly linked with monetary data. However, present-day EA reaches further than that by regarding many environmental issues, e.g. the toxicity of some materials which do not only involve monetary data. EA also considers, as Bennett et al. (2002) remarked, material-related and energy-related flows involving much “non-financial information to optimise corporate environmental and economic performance and to achieve sustainable business” (Bennett et al. 2002: 1). However, there is still no commonly accepted managerial technique to use the information supplied by EA to reduce these costs and to reach the other goals mentioned above (US Environmental Protection Agency 1995). Therefore, an effective EA must be placed in the structure of an amended SMA that is “a managerial technology which combines knowledge, methodology and practice and applies these to linking environmental management and economic results” (Rikhardson et al. 2006: 2). The combination of EA and SMA is also, as indicated above, obliged to reach “substantial goal approaches, generally described as ecobalance” (Azuma 2007: 153), and which aims at reducing a company’s negative impact on the environment. Opinions are, however, divided if EA should only support the SMA by offering information, or if it should take a more active part in managerial decision-making. EMA has been defined as a type of EA that limits itself of retrieving, accounting, and presenting a company’s eco-related information in a way that can be best used by SMA to improve the company’s economic and environmental performance.

The variety of EA systems has, however, complicated the definition of EMA since some authors identify it with methods borrowed from other EA systems (Owen 2008; Branco & Delgado 2009). Therefore, this section defines certain terms and characteristics related to EA and EMA to facilitate the further analysis. As some of the confusion concerning EA and EMA stems from different definitions of the terms ‘environment’ and ‘environmental costs’, this thesis defines (as e.g. UNDSD 2001) ‘environment’ as the natural environment (i.e. the earth’s biosphere) as distinct from the social one (Gray 2005). Hence, this PhD regards environmental costs as those costs that only arise from a company’s internal affairs having a bearing on the company’s natural environment (UNDSD 2001). This definition of environmental costs is only a preliminary one, which will be further developed in chapter 2. However, it already serves the goal to positively disregard social costs, which might arise from the interaction between the company and its social environment (EPA 1995).

EMA is seen (in line with UNDSD 2000) as an EA-based system concerned with the accounting of environmental costs, whereas social accounting accounts for both the environmental and social costs (Gray 2005; Adams 2004). Consequently, this thesis thereby distances EMA from social accounting, while they are combined in many publications (e.g. Gray 2002; Mathews 2004; Owen 2008; Branco & Delgado 2009). Therefore, chapter 2 will further define these statements by developing a working definition of EMA. Furthermore, this text will not use the expressions 'green accounting' and 'sustainability accounting' since they are regarded as superfluous and confusing synonyms of EA, EMA, and social accounting (Decisions Science Institute 2012; Ditz et al. 1995).

1.2 Statement of the Problem

Analysing EMA and its application in the German economy is hindered by both fundamental and special German problems. As for the fundamental problems, it can be noted that EMA is, despite having "attracted increasing interest and recognition in recent years […], still far from having achieved the position of conventional management accounting as a well-established function in business and management" (Bennett et al. 2002: 1). In addition, there is a lack of systematic approaches to explain the functions of EMA and its implementation in the managerial structures of companies. These difficulties are amplified in the context of the German economy, which largely depends on the so-called German Mittelstand, or more briefly, Mittelstand. Although the expression 'Mittelstand' only appears in German, Austrian, and Swiss literature, the phenomenon behind it can be found in most Western economies. According to the traditional definitions, the Mittelstand is largely identical with the group of small and medium-sized enterprises (SMEs) (Söllner 2014), which cover 99.3% of all German enterprises (destatis.de 2013). Modern research, however, defines the Mittelstand as a group of medium-sized and moderately large enterprises which are independent, owned, and basically controlled by one family and which follow a long-term business strategy depending on the company's individual culture and organisational structure (Damken 2007; Reinemann 2008; Becker 2008; [German] Federal Ministry of Economics and Technology 2010; Deloitte 2011). Enterprises having these characteristics cover about 9% of all German enterprises (statista.de 2014). This thesis will use the latter definition of the Mittelstand since it is based on criteria that are more exact. The environmental impact of the thus defined Mittelstand seems to be significant since it has been proven that Mittelstand companies account for 60-70% of the entire

German pollution (Heras & Arana 2010). Influencing the environment in such a negative way, the Mittelstand is therefore in need of EMA. However, there is no information if and how EMA is used by Mittelstand companies. There are only a few studies on EMA in medium-sized companies from various countries, but these scientific efforts diverge largely in respect of their topics and findings, with some of them dealing with either the implementation, barriers, or benefits of EMA (Lopez-Gamero et al. 2009).

1.3 Main Design and Aim of the Study

In view of the research gap described in section 1.2, this study's aim is to investigate the ways, benefits, and disadvantages of implementing EMA in German Mittelstand companies. Sections 1.1 and 1.2 have shown that the production processes of many Mittelstand companies pollute the environment although there is only little information on how EMA could deal with the associated ecological and economic effects. Therefore, the research objectives of this study are:

- Critical review of the state of art concerning EMA in the Mittelstand
- Critical evaluation of the potential of EMA in the Mittelstand
- Analysis and evaluation of potential obstacles and drivers concerning the implementation of EMA in companies belonging to the Mittelstand

The core of the study is carried out by means of a case study using an actual model company from the German Mittelstand that represents most German Mittelstand companies according to their influence on the environment.

1.4 Research Questions

The research objectives translate into the following research questions concerning the format of the case study:

1. (1.1) How did the company of the German Mittelstand examined in the case study implement EMA? (1.2) How does and did it integrate its environmental costs into its accounting system, and how does this affect its corporate actions? (1.3) Has EMA influenced the company's performance for the better or for the worse? (1.4) Is the current model of EMA suitable for the needs of this Mittelstand company?
2. What were the potential obstacles and drivers for the implementation of EMA in the Mittelstand company of the case study?

3. What generalising conclusions can be drawn from the case study concerning the problems, advantages, and disadvantages of EMA in the context of the German Mittelstand?

1.5 Importance of this Research

Due to the world's widespread pollution caused by industrial companies and the greenhouse effect being a very prominent case in point, it is necessary to find ways to minimise these negative effects. From the viewpoint of economics, however, it is also important to maintain the productivity of the industry. Hence, EMA, as introduced in section 1.2, might help the SMA to solve these two different problems by supplying the necessary data. Analysing EMA in the context of the Mittelstand is a significant assignment for two already mentioned reasons. First, this type of company represents a significant part of companies in the Western hemisphere since family owned enterprises with a Mittelstand-like business strategy are an international phenomenon (Calock et al. 2007). Second, Mittelstand companies are responsible for a major part of the environmental pollution.

1.6 Format of the Thesis

The considerations of the previous sections basically set the exterior structure for this thesis: chapter 2 comprises the literature review where information from recent studies on EMA in general as well as on its implementation in companies from the Mittelstand or in comparable companies has been collected. The findings of the literature review are the basis for the development of the most appropriate research methodology. Furthermore, these findings are used in the main part of the present study to answer the research questions. Chapter 3 develops the methodology of this study, while chapter 4 uses it to determine the research design by also taking into account the specific character of the research object. In chapter 5, this study carries out its own research concerning the implementation of EMA in the German Mittelstand and compares its findings to those obtained from literature review in order to check the reliability of its own research results and of those of the other studies. Chapter 6 summarises all outcomes and analyses them according to the research questions. The concluding chapter 7 then answers the research questions.

1.7 Summary

Present-day companies must not only be economically successful in their market, but they are also forced to minimize environmental costs and to avoid infringements of environmental laws. EMA, a type of environmental accounting, seems to be a managerial technique that meets these disparate challenges. However, EMA and especially the EMA-related benefits and problems in the context of the German Mittelstand have not yet been analysed by economic research. The study at hand will fulfil this assignment by means of a case study.

2 Literature Review

Despite 40 years of research, EMA still suffers from significant problems concerning its definition, its connection to related concepts (e.g. environmental costs), its success (in terms of accounting economic and ecological issues), the drivers and obstacles concerning its implementation into the structures of companies (United Nations 2001; Buritt 2004; Bebbington & Gray 2001). As for the Mittelstand, the situation is even worse since there is no scientific information dealing with EMA within this type of company (German Federal Ministry of Economics and Technology 2010). In view of the uncertainty concerning EMA, forms of accounting, environmental costs, and Mittelstand, the literature review will firstly provide definitions of these notions (section 2.1). To address the aim and research objectives of this PhD, the literature review will proceed in a series of subsequent stages. It will first analyse the problems of conventional management regarding ecological phenomena (section 2.2), then it will present the demands of EMA arising from these problems (section 2.3). Two following sections dealing with the development (section 2.4) and research on EMA (section 2.5) will show to what extent present-day EMA actually meets these demands. Then it will be possible to outline the nature of EMA, i.e. its mechanism, tools and area (section 2.6) as well its methods to account for environmental costs (section 2.7). Based on the information presented in the previous sections, sections 2.8 and 2.9 will finally examine the topic pointed out when discussing the aim and research objectives of this PhD. The former section will generally deal with the characteristics of EMA implementation in Mittelstand companies. The latter section will present the results of case studies of Mittelstand or Mittelstand-like companies having implemented EMA. The final section will then draw the conclusions of the literature review, especially concerning the definition of EMA and the research objectives that will be operationalized by three research hypotheses. For the goals of the literature review, three search strategies were employed:

a) A literature search using electronic journal databases (Emerald Full Text; Econlit; conlit Interscience). Only peer-reviewed journals were selected;
b) A Google Scholar search using the key words *Environmental*, *Accounting* and *Sustainable*;
c) A literature search tracing EMA studies.

2.1 Definitions

Economic science has developed a variety of definitions concerning EMA and Mittelstand. Therefore this section will develop a working definition of EMA, clarify the meaning of related accounting types and that of the Mittelstand. To avoid the pitfalls of social accounting (unclear philosophical concepts at the expense of scientific rigor), these sections will concentrate on the classical approach of EMA combining managerial and financial approaches.

2.1.1 Accounting Systems

2.1.1.1 Accounting and Financial Accounting (FA)

Accounting is the systematic gathering, calculating and reporting of monetary and non-monetary information about an organisation that can be used by internal or external stakeholders (IFAC 1998). Since 1950 accounting has undergone a development of four stages (Waweru 2010): (1) financial accounting (including cost management), (2) management accounting (MA), (3) strategic management accounting (SMA), (4) EMA (IFAC 1998). This and the following sections will develop definitions of the first three accounting types. These definitions and their underlying theories will be used to find an appropriate methodology for this research.

Prior to 1950 accounting was identical with financial accounting (FA), which concentrated on the determination of costs and on the company's external and internal affairs by using cost accounting and budgeting techniques (Waweru 2010). FA also records the flows of economic entities by expressing them in published financial statements (Hansen & Mowen 2006). Classical FA is also designed to provide the firm's external stakeholders with information concerning the financial impact of corporate activities. Therefore, this kind of accounting is governed by standards and regulations concerning the information transfer to external stakeholders (Todea et al. 2010). The group of external stakeholders comprises investors, creditors (e.g. banks and suppliers), and government agencies; they all are actors who may find this information helpful for making financial decisions, such as whether to buy or sell shares of stock or bonds (Hansen & Mowen 2006).

Pure FA follows the dogma that managing a company is primarily achieved by means of control, with the five control principles being "responsibility, evidence, uniformity, comparison and utility" (Waweru 2010: 168; cf. also Urwick 1928). These principles were used to control both the staff and the costs (Fayol 1949). As FA only deals with the costs for classical business transactions (i.e. the purchase or sale of economic entities), and it cannot identify environmental costs.

2.1.1.2 Management Accounting (MA)

Management accounting (MA) focuses on the measurement of financial and non-financial economic data helping decision-makers reach organisational goals (Institute of Management Accountants 2008). As for monetary economic phenomena, MA also embodies the principles of financial accounting, since it heavily relies on “the […] identification, measurement, accumulation, analysis, preparation, interpretation, and communication of financial information [...] to plan, evaluate, and control an organization and to assure appropriate use of and accountability for its resources” (Institute of Management Accountants 2008: 1). Like FA, MA also reports this information to “non-management groups such as shareholders, creditors, regulatory agencies, and tax authorities” (ibid). In contrast to FA, MA also analyses non-monetary phenomena (i.e. business factors); the most important of them are: consumer power, market uncertainties (including competitive pressure), risks and chances of the market environment, availability of resources, technological developments, business needs, business events and business partners (especially their reliability) (Mat 2010; Abdel-Kader & Luther 2008). MA transforms this information into useful knowledge to devise appropriate decisions (Attkinson & Shaffir 1998). MA also employs techniques of performance measures, “decision analysis and responsibility accounting” (ibid: 166) with respect to the members of the company (Mia & Chenhall 1994). Hence, “the management accounting and organization structure” are “both functionally related to the environment” (Waweru 2010: 171) by means of the business factors named above. Unlike SMA, MA does not have an overall conceptual design for its decision-making. Its actions are of a short-term to mid-term tactical nature and do not follow a long-term strategy (Institute of Management Accountants 2008).

2.1.1.3 Strategic Management Accounting (SMA)

As MA relies on tactical considerations that are not based on a long-termed strategy, its decision-making can become erratic if the external business factors of a company rapidly change (Chapman 1997; Khan & Jain 2007). Hence, a company must both be flexible to adapt to external changes and strategically firm to coordinate its performances. SMA is the managerial strategy telling managers what methods and tools must be used when a company is exposed to certain circumstances (Puxty 1993).

SMA does this by coordinating all managerial decisions according to a single strategic plan to achieve organisational success. Most strategic decisions are therefore cross-functional and involve “marketing, finance/accounting, production/ operations, research and development, and information systems” (Fred 2009: 6). Because of that, SMA also considers the company’s resources and the business environment in which it operates (Nag et al. 2007). The creation of the company’s strategy depends on both financial and non-financial information, and proceeds in three stages (Fred 2009). It starts with formulating and finding a strategy, a vision, long-term objectives and competitive benefits or disadvantages, which is often done with a SWAT-analysis (Menon et al. 1999). The second stage involves the definition of the value chain including the identification of cost and value drivers. At a third step, the strategy is evaluated concerning its efficacy (Porter 1985). Therefore, SMA is still rooted in financial and management accounting, but it works more systematically.

2.1.1.4 Environmental Management Accounting (EMA)

EMA has no single, universally accepted definition (IFAC 2005). Numerous attempts have been made to clarify the notion of EMA (UNDSD 2001; Jasch, 2003; Bennett et al., 2003; Dillard et al., 2005; IFAC, 2005; Cullen & Whelan, 2006; Jonäll, 2008; Eugenio et al. 2010; Collins et al. 2011; Jones, 2010; Bowen & Wittneben 2011), but mostly to no avail, since EMA and EA are similar due to overlapping topics and tasks. Another source of confusion is the ambiguous nature of the information to be measured (Alcouffee et al., 2008). Many current EMA-definitions link the financial information, which EMA accounts for, with environmental costs, but these definitions are vague or do not specify the nature of these costs. Table (1) presents some older EMA definitions. Today they only have historic value, but they are still useful to clarify the concept of EMA.

Table 1: Definitions of EMA	
Source	**Definitions of EMA**
Bennett & James, 1998: 33	EMA is "the generation, analysis and use of financial and non-financial information in order to optimise corporate environmental and economic performance and to achieve sustainable business."
Graff, Reiskin, White & Bidwell, 1998: 3-4	"EMA is the way that businesses account for the material use and environmental costs of their business. Materials 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."
IFAC, 2005: 19	"EMA 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, strategic planning for environmental management."
Schaltegger & Burritt, 2000: 89	"EMA 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."
Bennett, Bouma & Wolters, 2002	"EMA is considered as an "interface" which links together two organisational functions and areas of expertise which conventionally and historically are distinct and may initially not seem to have much natural interface."
Buritt, Hahn & Schaltegger, 2002	"EMA both includes monetary and physical accounting which is internal to an organisation and also deals with the integration of ecological and monetary issues."
Jasch, 2003: 668	"EMA, Environmental management accounting, represents a combined approach which provides for the transition of data from financial accounting, cost accounting and material flow balances to increase material efficiency, reduce environmental impact and risk, and reduce costs of environmental protection."
UNDSD, 2000: 8	EMA "represents a combined approach which provides for the transition of data from financial accounting and cost accounting to increase material efficiency, reduce environmental impact and risk and reduce costs of environmental protection."

Schaltegger & Burritt (2000) explicitly mention managers as the parties to whom the reports of EMA are addressed. The other definitions do not include the addressees, but the definition provided by Buritt, Hahn & Schaltegger (2002) makes it clear that EMA is an internal reporting, thus it excludes all external stakeholders (customers, investors and scientists). The majority of the cited definitions implicitly share this view, since they link EMA with ‘organisational functions’ (Bennett, Bouma & Wolters 2002), or with ‘data from financial accounting, cost accounting and material flow balances’ (Jasch 2003), which are typically a part of internal reporting. Despite the vague nature of the definitions, it can be stated that EMA only involves internal reporting that is carried out by accountants and addressed to the management. The cited definitions of EMA also differ in terms of its purpose and in reference to the nature of the information it deals with. Bennett, Bouma & Wolters (2002) are not very clear about the goals of EMA, and Schaltegger & Burritt (2000) only mention managerial decision-making. For Graff et al. (1998), Buritt, Hahn & Schaltegger (2002), the UNDSD (2000) and the IFAC (2005), EMA is a managerial system accounting for economic and ecological issues. By contrast, other authors (i.e. Jasch 2003; Bennett & James 1998) point out that EMA does not only have to account for a company’s economic and ecological issues, but must also improve its environmental and economic performance. The authors in question also give disparate views about the nature of the information that is accounted for (or also improved) by EMA. Bennett, Bouma & Wolters (2002) do not name the nature of this information, whereas the other definitions revolve around the accounting of both financial and non-financial information. These authors link the non-financial information to material flows and their ecological relevance. The definition by Graff et al. (1988) is the only definition that also underlines the connection between this information and the ecological costs.

The characterisations of these techniques offered in these definitions are either vague or non-existent. Bennett & James (1998) refer to the creation, analysis and use of the information outlined above. These authors, however, do not say how this should be done. According to Schaltegger & Burritt (2000) and Buritt, Hahn & Schaltegger (2002), this information is included in EMA; for Jasch (2003) and the UNDSD (2000) EMA provides a transition of this information, but again there is no reference to the corresponding mechanism. The IFAC (2005) and Graff et al. (1998) on the other hand are explicit about the mechanism of EMA. The former definition mentions reporting, auditing, life-cycle costing, full cost accounting, benefits assessment, and strategic planning for environmental management; but there is no reference to the overarching system of EMA and its possible integration in (S)MA. The latter definition outlines the basic procedures of EMA. It is explained that there is an input-output analysis, which spots the material flows and other physical phenomena of ecological relevance, and which allocates the corresponding environmental costs. However, the relationship between EMA and (S)MA remains unexplained.

Later research uncovered that EMA can be defined by means of three dimensions (Spence et al. 2010; Waweru 2010): main addressee(s), main purpose(s) and the means (tools, techniques, and methods) of reaching these purpose(s). As for its main addressee(s) and purpose(s), EMA resembles conventional MA since it provides the organisation's management (distinct from external stakeholders) with relevant and useful information in order to support the management's various responsibilities (planning, decision-making, controlling etc.). However, EMA deals with information concerning ecological issues, which are often physical and financial (Waweru 2010; Schaltegger, Hahn & Buritt 2000; Institute of Management Accountants, 2008; Bennett, Rikhardson & Schaltegger 2003). Unlike conventional MA, there is no consensus concerning the choice of the appropriate EMA tools, techniques, and methods or overall system to identify, collect and analyse the EMA-related information (Spence et al., 2010). Using this information, EMA can be regarded as a systematic set of tools used to inform managers about the environmental costs and to quantify the organisation's environmental effects. More precisely, EMA can be defined as "the generation, analysis and use of financial and non-financial information in order to optimise corporate environmental and economic performance and to achieve sustainable business" (Bennett, Rikhardson & Schaltegger 2003: 1). Hence, EMA is the part of accounting procedures in which non-monetary, physical and quality factors play an integral role. On the basis of these considerations, a plausible working definition of EMA is:

> "EMA is a part of the SMA systematically using methods to report and control the physical flows and their associated environmental costs in order to optimise its environmental and economic performance."

Although most companies did not implement EMA, many use an environmental management system (EMS) within their SMA. EMS is no accounting procedure, and it does not encompass the scope of procedures of either SMA or EMA, but it helps the management to comply with environmental regulations (Darnell & Edwards 2006). The combination of the accounting procedures of SMA and the eco-policy of an EMS can therefore be regarded as a forerunner or precondition of EMA, but also as its insufficient substitute – a view already expressed by the United Nations in 2001 (United Nations 2001). Therefore, this PhD will concentrate on accounting principles taken from SMA and on the standards of EMS, in order to deepen the definition of EMA. Today there are three main EMS-standards in Europe: ISO 14001, BS 8555/Acorn, and EMAS (short for 'Eco-Management and Audit Scheme' and not to be confused with EMA or EMS). EMAS is important, since its diffusion in European companies is an indicator of the corresponding diffusion of EMA (Hillary 2004).

2.1.2 Environmental Costs

The introduction has already indicated that EMA is concerned with the accounting of environmental costs. However, there is a need for a clear and comprehensive definition of environmental costs for various reasons: Environment-related costs are often neglected by conventional accounting systems and the related information is often hidden in overhead accounts. Such incorrect information can lead to inefficient management decisions and to a wrong pricing of products. Likewise, indirect costs of material and energy flows like machinery depreciation, extra administration costs etc. are often neglected, which can lead to an underestimation of total costs of cost centres and cost objects (Schaltegger & Burrit 2000). Moreover, many companies do not compare their data with the actual consumption rate, but use unrealistic estimates. In addition, the environmental manager often has no access to the company's actual cost accounting documents, whereas the accounting manager (controller) has most of the information, but lacks the knowledge or tools to separate the environmental part from other specific cost categories (Jasch 2003; IFAC 2005). Therefore, a simple adoption of EMA in the conventional accounting system of a company does not ascertain a better environmental performance if there is no standardised definition of environmental costs, if these costs are not detected systematically and if they are not related to the responsible processes and products within the company's accounting system (Iraldo et al. 2009). Therefore this section will elaborate a comprehensive and concise definition of environmental costs using scientific studies and official documents. According to Gale (2006), the UN offers a list of five categories of environmental costs:

- Waste and emission treatment costs
- Prevention and environmental management
- Material purchases value of non-product outputs (waste and emissions)
- Processing costs of non-product outputs (wastes and emissions)
- Environmental revenues

This list does not mention the costs for preventing or reducing a company's negative effects on the environment. These environmental costs are recognised by the ECA (2004, 2005), which defines these two broad cost categories:

- Cost groups related to environmental protection expenditures
- Cost groups related to material flow costs

The IFAC (2005) classification defines 10 categories of environmental costs by containing the previous categories and by adding some new ones. The 10 categories in question are:

- Materials costs of product outputs
- Materials costs of non-product outputs
- Waste and emission control costs
- Waste disposal and emission treatment costs
- Waste material purchase value of non-product output (waste)
- Processing costs of non-product output
- Prevention and other environmental management costs
- Research and development costs
- Less tangible costs
- Environmental revenues

The IFAC framework also explains the listed environmental-related cost categories in a way that can be summarised as follows (IFAC, 2005):

Material costs of product outputs: costs of material-related environmental impact.

Material costs of non-product outputs: costs occurring within an organisation due to waste and emissions. Material processing costs as a subcategory include the processing costs of raw materials up to the point where they are converted into waste and emissions rather than a final product.

Waste and emission control costs: costs for the controlling and treating of all forms of waste and emission (equipment maintenance, internal waste handling, waste and emission treatment, etc.); costs for equipment depreciation, operating materials, water and energy, internal personnel, external services, fees, taxes, permits, fines and insurances as well as remediation and compensation.

Prevention and other environmental management costs: costs associated with efforts to prevent the generation from waste and emissions as well as to implement general environmental management activities not directly related to waste and emission control.

Research and development costs: costs for research and development activities involving environment-related initiatives and issues (like research on the toxicity of raw materials, development of energy-efficient products etc.).

Less tangible costs: These costs cannot be found in a company's information system since they are hard to estimate. Examples are an increase in sales revenues due to a company's positive environmental image or costs of reduced productivity in relation with high-waste operations (Jasch 2003).

Waste disposal and emission treatment costs: This cost category comprises the conventionally defined environmental costs, but also the costs for treatment, disposal and clean-up of waste and emissions including costs for related labour and maintenance materials. A final type of this cost-category includes costs for insurances and provisions linked with environmental liabilities.

Prevention and environmental management: These costs refer to annual costs for the prevention of wastes and emissions, without regarding calculated cost savings or higher costs for low-emission process technologies and the efficiency loss of production equipment by "scrap" percentages. The "scrap" percentages are then added to the environmental costs.

Waste material purchases value of non-product outputs: All material inputs are assessed for their share of non-product output from the material flow balance sheet ("scrap" percentage, efficiency losses). Wasted materials are evaluated by their material purchase value or material consumed value.

Processing costs of non-product outputs: Production costs of non-product outputs are added to the respective production cost charges (labour hours, depreciation of machinery and operating materials) mainly depending on the quality of data and information system available. With activity-based costing accounting and flow cost accounting the costs of non-product outputs are more efficiently determined and allocated to respective cost centres and carriers.

Environmental revenues: Environmental revenues derive from sales of wastes or grants of subsidies, or they are revenues from insurance reimbursements for environment-related claims etc. The abovementioned cost categories appear in all reviewed texts with the exception of 3 categories:

(1) Less tangible costs: This cost type was rejected because of the mentioned difficulties to quantify it.
(2) Material costs of product output: In the reviewed literature these costs are not regarded as environmental costs per se, but serve as a basis in the material flow analysis to quantify the percentage of wasted materials. This PhD will use these costs in the same way.
(3) Waste and emission control costs: This cost category contains various disparate subtypes of environmental costs, which are treated separately in most reviewed texts. This will also be done in this PhD.

On the other hand, the literature review revealed the existence of three other types of environmental costs, which are not mentioned by the IFAC (2005), and which were also rejected in this PhD.

(1) Social costs: Chapter 1 already excluded social costs from the context of EMA, since they (unlike real environmental costs) are not related to phenomena of the natural environment.
(2) External environmental costs: These costs refer to environmental costs caused by a third party while consuming products from the company in question. Hence the company is not liable for the accounting of external environmental costs (Friedrich & Bickel 2001).
(3) Environmental life cycle costs and environmental life cycle costing: Environmental life cycle costing means (in analogy to proper life cycle costing) the accounting of all environmental costs of a product during its planning phase, life time, and disposal. Apart from typically containing external environmental costs, environmental life cycle costs comprise many other different cost types, the environmental part of which is often hard to discern (Geisdoerfer 2009; Joshi 2001).

In addition, according to sources presented in table (1) there are three (or four) other environmental cost types, which were not mentioned by the IFAC (2005), but which are also important for EMA. They are:

(1) Environmental costs due to the reversal of negative effects on the environment (clean up and remediation)
(2) Environmental costs due to packaging and by-products.
(3) Definition of various subtypes of environmental costs concerning the prevention and reduction of environmental damages.
(4) Environmental earnings and savings. Though not actually being costs, earnings and savings are always indispensable to any kind of accounting. Hence,

environmental earnings and savings are treated as de facto (i.e. negative) environmental costs.

In view of these results, table (2) presents all types of environmental costs attributable to EMA according to the findings of the literature review.

Table 2: Categories of Environmental Costs

Main Category Costs for:	Prime Subcategory Costs for (per time unit):	Secondary Subcategory Costs for (per time unit):
Material costs of product outputs		
I Treatment and purchase of non-product output (including waste disposal & emission treatment)	Reversal of negative effects on nature	Clean up, Remediation
	Environmental management	Maintenance
		Services, labour
		Disposal of non-product output
		Emission, wastewater treatment
		Process. of non-product output
	Value of wasted resources	Raw material, merchandise
		Auxiliary & hazardous materials
		Operating materials
		Packaging and by-products
		Water (i.e. wastewater)
		Gases (incl. dust emissions)
		Energy
		Depreciation of equipment
II Prevention	Related services	Internal services, workshops
		External services, workshops
		Prevention management
	Related personal	Internal tutors
		External tutors
	Prevention technologies	Research and development
		Investment in cleaner technologies
III Payments to the state and external organisations	Regular payments	Fees, taxes, charges
	Irregular payments	Fines and penalties
	Insurance for environmental liabilities	Internal environmental liabilities
		External environmental liabilities
IV Environmental revenues and savings	Benefits from external sources	Subsidies, Awards
		Enlarged market share (due to eco-friendly products)
	Benefits from internal sources (cleaner production and accounting of environmental costs)	Avoidance of fines and penalties
		Improved and cheaper treatment of non-product output
		Better and cheaper processing of non-product output
		Reduced amount of wasted resources
		Fewer reversals of negative effects on the environment
Source: IMA (1996); Schaltegger & Burritt (2000); Schaltegger, Hahn & Buritt, (2000); UNDSD (2000/01); Stapleton & Glover (2001); United Nations (2001/03); Bennett, Bouma & Wolters (2002); Bennett, Rikhardsson & Schaltegger (2003); De Palma & Dobes (2003); Jasch (2003); Gibson & Martin (2004); IFAC (2005); Scavone (2006); European Commission (2007); AASHTO (2008); Hendro, Ferreira & Moulang (2008); Schaltegger, Bennett, Burritt & Jasch (2008); Australian Government (2009); Burritt, Schaltegger, Bennett, Pohjola & Csutora (2011); Australian Capital Territory, Canberra (2013); Jasch (2015); Tellus Institute (2015).		

In view of these four categories of environmental costs the most appropriate working definition of a company's environmental costs is as follows: total corporate environmental costs consist of:

(1) Costs for the treatment and purchase of non-product output: These costs include the costs for wasted resources, and the reversal, reduction or compensation of the negative impacts on the environment through waste and pollution;
plus
(2) Costs for the prevention of possible negative impacts on the environment through waste and pollution;
plus
(3) Costs due to payments to the state and external organisations (taxes, penalty fees, insurances charges)
minus
(4) Earnings and savings

2.1.3 Mittelstand

In Germany there is an important class of companies generally called (German) Mittelstand, which is a heterogeneous group of companies varying with respect to their size and turnover. Hence, defining the German Mittelstand has always been difficult, and recently its definitions have been modified. Until about 2000 the Mittelstand has mostly been identified with German SMEs, which predominantly have been defined by means of quantitative criteria. According to the German Institut für Mittelandsforschung (IfM) a company matches both the definition of an SME and the Mittelstand if it has fewer than 500 employees and an annual turnover of less than 50 Mio. € (IfM Bonn 2002). This way of defining the Mittelstand has been criticised as ineffective for the following reasons:

(1) This definition disregards qualitative criteria as e.g. the prevailing managerial strategy. In fact, many Mittelstand companies differ with respect to their management an organisational structure (Hausch 2004; Pfohl 2006; Damken 2007).
(2) According to the quantitative criteria, almost all German companies are SMEs and Mittelstand companies. The corresponding percentages were 99.7% in 2004 (Günterberg & Kayser 2004) and 99.6% in 2013 (statista.de 2015). Hence, using characteristics that almost all German companies share does not make for a useful definition.
(3) Identifying the German Mittelstand with SMEs is not supported by recent scientific evidence. According to a study of the Deloitte Institute (2011) the average annual turnover of a Mittelstand company is 236 Mio. €, and the average number of employees is 1,563 (idem). Other authors like Becker et al.

(2008) argue that a Mittelstand company has up to 3000 employees and an annual turnover of up to 600 Mio. €.

Contemporary definitions of the Mittelstand therefore prefer qualitative criteria. According to present scientific research, a Mittelstand company must have these three qualitative characteristics of the first degree at the same time:

(1) Economic and judicial independence: Mittelstand companies are not a subsidiary of a larger enterprise nor do they belong to a group of companies (Hausch 2004; Pfohl 2006; Damken 2007).
(2) Unity of or at least a close relationship between property, control and leadership: A Mittelstand company is owned, basically controlled and led by the members of one family only. Most of the larger Mittelstand companies have management and controlling departments whose members do not entirely belong to the owner family. These departments have a certain degree of managerial freedom, but the basic business strategy is still outlined by the owner family (Hausch 2004; Reinemann 2008).
(3) Close interplay of (inherited) business culture, organisational structure, and business strategy (Becker et al. 2007): That is why Mittelstand companies follow a long-term business strategy ([German] Federal Ministry of Economics and Technology, 2010).

Apart from that, Mittelstand companies often (but necessarily) display 5 other qualitative features, which have proven useful in identifying these companies and explaining their business strategy. These second-order features are (English et al. 2010; European Commission 2011/2012; Frey et al. 2010; [German] Federal Ministry of Economics and Technology 2010; IMD World Competitiveness Yearbook 2012; Müller & Volery, 2010; Simon, 2012):

(4) Risk aversion in the contexts of financing and projects: Mittelstand companies tend to be cautious when it comes to finance new projects; they rarely accept bank loans (29%), public assistance (11%), or financial resources from external investors (0%). Most Mittelstand companies (54%) prefer to finance new projects from their own equity. Companies from the Mittelstand predominantly focus on producing one or few basic products, from which they develop several variants. Hence, diversification is restricted ([German] Federal Ministry of Economics and Technology 2010; European Commission 2011/2012).
(5) Preference of four classical industrial sectors: Mittelstand companies mostly engage in the production of (1) chemicals, (2) machines and tools, (3) car parts, (4) electrical devices (Erichiello & Zschiesche 2008).
(6) Collaboration with large manufacturers: Mittelstand companies generally work with large manufacturers and (unlike SMEs) hardly work in the B2C segment (Haunschild et al. 2007; Simon 2012).

(7) Exports: Unlike SMEs, Mittelstand companies are export-orientated with many of them having subsidiaries abroad. These companies account for 19% of all German exports (Frey et al. 2010; IMD World Competitiveness Yearbook, 2012; Müller & Volery 2010; Schauf 2009).
(8) Collaborative spirit of the staff: In Mittelstand companies the relationship between employers and employee is intense, which often results in a higher job security not necessarily found in SMEs (English et al. 2010).

Present research on the Mittelstand does not completely ignore quantitative criteria. As for the number of employees it disregards enterprises with less than 10 employees and an annual turnover below 1 Mio. €, because such entities hardly share any of the qualitative Mittelstand characteristics. The upper thresholds are 3000 employees and an annual turnover of 600 Mio. € (Deloitte 2011; Becker 2008). According to these qualitative and quantitative definitions about 9% of the German companies belong to the Mittelstand (statista.de, 2015).

2.2 Problems of MA to Account for Ecological Phenomena

MA is the central tool for most internal management decisions (Institute of Management Accountants 2008; Knese 2013). EMA intends to reduce some deficiencies of this accounting approach, mostly stemming from its failure to recognise environmental impacts. Generally, the environmental-related problems caused by conventional MA are marked by the following features:

a) Performance appraisal techniques are too narrow in their focus.
b) Lack of attention to articulation of stocks and flows.
c) A too narrow focus on manufacturing.
d) Disregard/neglect of environmental issues.

For these points Burritt et al. (2005) have defined the specific issues arising on the part of EMA, specifically in the academic and the practical context:

As to a) Performance appraisal techniques are too narrow in their focus:

There are various approaches with the intention to measure and to quantify a company's effects on the environment. They include the Balanced Scorecard, which can be expanded to an Environmental Balanced Scorecard (EBSC). An ESBC includes non-financial information not only referring to customer satisfaction, but also to the environmental performance of the organisation (Burritt et al. 2005).

As to b) Lack of attention to the articulation of stocks and flows:

Present research tries to solve this problem by articulating stock and flow information via an integrated software account, also called integrated financial account. In fact, only few firms express the relation between stocks and flow information in physical environmental terms (US AID 2008: 2).

As to c) A too narrow focus on manufacturing:
MA fails to recognise the environmental impacts causing problems that are EMA’s main challenges (Burritt et al. 2005):

1) Environmental costs are assumed to be negligible.
2) Certain types of environmental costs are not identified or tracked.
3) Environmental costs are included in general business overheads.
4) Investment appraisal excludes environmental considerations.
5) There is little accounting for environmental issues.

As to c (1) and c (2): A key criticism of conventional MA refers to its assumption that environmental costs are negligible compared to the organisation’s total costs. Therefore these scientific and academic critics aim at exploring the nature and the classes of environmental costs.

As to c (2): The academics respond to this problem mainly by means of studies clarifying the notion of environmental costs, their potential importance, and the ways of classifying them.

As to c (3): In this context and concerning EMA, academics have proposed to identify and measure direct environmental costs with revised allocation bases applying activity-based costing. This measure has the effect of separating environmental costs from other costs (Buritt 2005).

As to c (4): To avoid the exclusion of environmental considerations, the academic position suggests measuring cash flows in order to reflect environmental considerations in discounted cash flow calculations (Buritt 2005).

As to c (5): There is a controversy about a “full cost accounting”-EMA system covering both economic and purely ecological issues, although there is a consensus that accounting still needs its own “Copernican revolution” (Chambers (1999) in Lehmann et al., 2012: 1), so that it meets the theoretical and practical (including implementation-related) demands of EMA.

However, findings presented in other publications deny any economic relevance of EMA: Murray et al. (2006), analysing the 100 largest companies in the UK, found that "their environmental and other social activities [had] no relationship of any kind" (Murray et al. 2006: 2) with their market power. Cooper & Owen (2007) also found that EMA "offer(s) little in the way of opportunity for facilitating action on the part of organisational stakeholders, and cannot therefore be viewed as exercises in accountability" (Cooper & Owen 2007: 649). Recent research in the same field by Solomon & Solomon (2006) supports this view. Additionally, it can be stated that most case studies ignore externalities associated with business environmental impacts. Even when they are calculated, the quality of the subsequent information is low (Buritt 2005).

2.3 Demands on EMA

Most companies do not implement EMA voluntarily. They are rather pressed by external factors to do so (IFAC 2005). This means that they do not primarily implement EMA for strategic reasons (i.e. for reasons that are relevant for SMA including EMA), but much more for tactical and external reasons (i.e. for reasons that are more relevant for FA and EA). These factors (or reasons) are therefore called pressures, which are listed in table (3). The first two factors apply more to SMA and EMA, whereas the latter three ones relate more to FA and EA (hence only indirectly to EMA).

Table 3: Pressures to Adopt EMA [Source: IFAC (2005)]	
Supply chain pressure	Production process of the company must comply with Environmental Management System (EMS) standard.
Regulatory pressures	Governments and international organisations (e.g. the EU) force the company to restrict its use and emission of hazardous substances (including dangerous gases).
Financing pressure	Environmentally responsible costumers make the company invest money in the production of eco-friendly products.
Disclosure pressure	Stakeholders induce the company to report its environmental performance in accounts and reports.
Environmental tax and penalty pressure / cap and trade pressure	Many hazardous production processes involve government- and EU-imposed taxes and penalties. To reduce them the company must turn to eco-friendly production processes.

Therefore, an EMA designed to represent a coherent accounting method has to link economic and ecological cost information. This demand also reflects the tenets of the research concerning SMA, FA and EMA, as shown in section 2.2. To be such an information system, EMA has to meet the following demands to serve as an instrument for economically and ecologically sound decisions:

- Consideration of ecological issues enabling managements to assess the ecological consequences of their decisions (Orbach & Liedtke, 1998; Bartolomeo et al. 1999). Ecological issues should be displayed by a set of indicators. These indicators have to be simple, reproducible and must highlight general tendencies to serve as a basis for the company's (strategic) decisions (Burritt, et al. 2002).
- Consideration of economic aspects. Ecological information alone does not grant eco-efficiency in enterprises. The simultaneous consideration of both the ecological and economic data brings about an overall view of the information concerning the enterprise's decisions and measures as well as of its further consequences (Bennett & James 2000).
- Integration into SMA. In order to bring about coherent solutions, which answer both the ecological and ecological demands of a company, EMA must be fully integrated into its SMA (IFAC 2005).
- Consideration of financial and physical components. Because of its integration in SMA, EMA must share its methodology. SMA is concerned with economic affairs, which often exceed ordinary financial issues, but it always links its procedures and decisions with financial and other numerical data. In fact, several phenomena (as e.g. the environmental tax pressure) EMA has to deal with are also of a financial nature (IFAC 2005). Additionally, EMA has to account for many ecological aspects of the supply chain that are basically physical (as e.g. the flows of matter and energy). Hence, EMA must have techniques to collect this physical information and convert it into a financial one to capture a company's environmental and business performances (Christ et al. 2012).
- Flexibility. For being flexible EMA must merge different cost accounting systems. It should apply the strict accounting procedures of FA to create measurable results, it should use the techniques of MA to adapt its procedures to changing market and environmental conditions, and it ought to work in line with a coherent strategy like SMA (Zvedoc 2012b; Bennett, Schaltegger & Zvedoc 2013).
- Internal reporting: Being concerned with the accounting of sensitive information containing company secrets, EMA must not report its findings to outsiders, but only to internal stakeholders, i.e. mostly to the managers. With an EMA answering these demands, a management should be able to combine its decisions on environmental issues with its overall decision-making procedure, also in terms of the use and integration of the different management systems (Schaltegger et al. 2011).

2.4 Main Developments from EA to EMA

Meeting the demands of environmental accounting has been the quest of research projects starting in the 1970s and leading to the development of EMA.

Phase 1 (1971-1987): Induced by the environmental movement of the 1970s, contemporary American and European economics made the first efforts to incorporate environmental information into accounting, thus setting the basis for EA and EMA (Confederation of British Industry 1971; Meadows et al. 1972; Bauer & Fenn 1973; Associates Annual Report and Social Audit 1974; Ullmann 1976; American Institute of Certified Public Accountants 1977). In the 1970s and in the 1980s, EA began to diverge from social accounting. As both concepts remained vague, it was impossible to repeat research results (Gray et al. 1995). Hence, the early form of EA did not make “it into the orthodoxy of either the profession or of business practice” (Gray 2005: 1).

Phase 2 (1988-1994): In the late 1980s, EA regained a foothold in economics due to new political and economic developments. Several events like e.g. the Exxon Valdez disaster in 1989 brought EA back on the agenda of economic research. When the Exxon Corporation remained silent for a couple of days following this incident, it was obvious that even large companies were unable to deal with the economic implications of their business (Argent, Howel & Beck 2005). In the early 1990s, EA was not implemented in the accounting framework of companies, but much academic and business research was done concerning the accounting of costs, costs savings and revenues related to waste production and waste recycling (Porte & Linde 1995; Milne & Hackston 1996).

Phase 3 (1995-2001): Around 2000 numerous research efforts identified the accounting of environmental costs as one of the major assignments of EA (Gray et al. 1995, 1995b). To this end, Bennett & James outlined a managerial process supposed to collect environmental information (of financial and non-financial nature), and to transform it into data, which proved useful for managerial decisions (Bennett & James 1997, 1998a, 1998b). These attempts answered the demands to combine EA with MA (Howes 1999; Bartolomeo et al. 2000). Since the 1990s, the broader EA concept, encompassing the procedures of FA and MA, has been called EMA (Jonäll, 2008; IFAC, 2005, UNDSD 2001). Around 2000, EMA was already present in three distinct contexts: national accounting, financial accounting, and managerial accounting (United States Environmental Protecting Agency 1995).

Phase 4 (from 2002 onwards): Since 2002 research on EMA has largely widened its scope in two areas: (1) analysis of the way accounting reacts to public and political pressure concerning the demands of ecology; (2) the development of a methodology that combines EA and (traditional) MA (Gray 2002; Schaltegger & Burritt 2010). Burritt et al. (2002) developed these seminal concepts into a prescriptive framework for EMA incorporating the resource productivity approach within a decision-making context (INTOSAI, 2010).

EMA largely disregards ethical and philosophical concerns as well as social audits and eco-justice. It rather focuses on budgeting, investment appraisal, product pricing, costs, savings, and revenues (Bennett & James 1998a; Frost & Wilmhurst 2000). It therefore resembles FA, with the main difference being that EMA also takes into account environmental costs, when it performs the above-mentioned activities (Burritt et al. 2001). This purely financial approach has been criticised for being unable to capture the inherent complexity of a company's social reality (Spence et al. 2010).

To counter this criticism, present-day EMA preserved the framework of FA, but combined it with the techniques of SMA. Jasch (2003) defined EMA as fusion of an environmental information system with a management and FA (Jasch 2003); other authors developed similar definitions, but stressed the strategic character of EMA enabling it to account for non-financial data (Bennett et al. 2003; Dillard et al. 2005; Eugénio et al. 2010; Jones 2010). This approach of EMA has remained fundamentally economic, since it performs two basic tasks only: (1) offering information for tactical and strategic decision-making (Collins et al. 2011; Jonäll 2008); (2) use of methods (e.g. ABC, resource flow costing, and the balanced scorecard) to account for environmental costs (which also includes the compliance with legal prescriptions), to minimize the consumption of resources, and to increase the company's revenue (Collins et al. 2011; Bowen & Wittneben 2011). In fact, some companies use EMA to measure its consumption of water, wastes, materials, and energy by means of financial units, which makes costly legal infringements less likely (Ascui & Lovell 2011; Stechemesser & Guenther 2012; Pellegrino & Lodhia 2012). Therefore the measurement of input-out processes has developed into a basic assignment to both reduce environmental costs, and to measure the company's impact on the environment (Jones 2010; Cullen & Whelan 2006; IFAC 2005; Costura 2001; Parker 2000; UNDSD 2000; Porter & van der Linde 1995).

However, in many other publications social accounting and EA are still not clearly divided (cf. eg. Bartolomeo et al. 2000; Gray 2005; Eugenio et al. 2010). They are either used interchangingly (Gray 2005), or one of them appears as the subset of the other (EPA 1995; Eugenio et al. 2010). Other authors still criticise EMA for three alleged reasons: (1) its greatest part does not dovetail with other fields of MA (Cullen

& Whelan 2006; Goumei et al. 2006; Bouma & Van der Veen 2002); (2) it has failed to achieve its economic and environmental goals (Brown et al. 2009; Bioral 2007); (3) EMA is not clearly distinguished from social accounting (idem). EMA is therefore often accused of being a mere propaganda slogan meant to embellish business affairs with 'corporate posturing', 'deception', or 'corporate green washing' (Brown et al. 2009; Bioral 2007; Laufer 2003; Deegan 2002; Lydenberg 2002; Sparkes 2001).

2.5 Present State of Art concerning EMA in Mittelstand-like Companies

This section will present a general overview of the research done on EMA in Mittelstand(-like) companies. Secondly, it will present the latest case studies on this topic. These case studies are divided into pure studies only dealing with Mittelstand-(like) companies and mixed studies treating Mittelstand(-like) companies and SMEs. Finally, this section will estimate the diffusion of EMA in European Mittelstand-like companies.

2.5.1 Current Research on EMA in Mittelstand-like Companies

For the last two decades, there has been a growing body of academic literature on EMA. However, the number of systematic literature reviews concerning EMA within Mittelstand companies or comparable enterprises is still comparatively small (Schaltegger et al. 2011a; Olson & Jonäll 2008). Brown & Fraser (2006) found that three approaches were used to analyse EMA: the business case approach, the stakeholder-accountability approach and the critical theory approach. To answer the question of how EMA could contribute to the success of a company, Olson & Jonäll (2008) developed a literature review covering 21 academic articles from the period from 1997 to 2007. The main findings were that EMA had the potential to achieve large cost savings and to effect positive strategy reconsideration. However, there still is the question concerning the characteristics of an economically excellent and environmentally sound business performance of EMA. It was proven that the vast majority of studies on EMA lack an explicit theoretical background. As Schaltegger et al. (2011a, b) state, 13% of empirical EMA publications explicitly refer to the type of established academic theories, with the two most applied theories being the neo-institutional theory and contingency theory. There are already quantitative empirical and qualitative studies dealing with the implementation of EMA in companies, but the overall number of such publications concerning Mittelstand companies remains comparatively small (Shields et al. 2011; Elijido-Ten 2011).

Although there is no research explicitly dealing with EMA in Mittelstand companies, some research has been done on EMA on companies sharing basic qualitative and quantitative characteristics with Mittelstand companies. This section will deal with the research on EMA in such companies, which at least share the three qualitative Mittelstand characteristics of the first degree presented in section 2.1. From now on, such companies will be called 'Mittelstand-like'. This section will also draw conclusions concerning the implementation and functionality of EMA. Chapter 5 will use this information to examine the company of the case study, which belongs to the Mittelstand.

In developing countries the implementation of MA in Mittelstand-like companies is practically non-existent (Ahmad, 2012). The situation is better in developed countries of Eastern Asia: Phadoongsitthi (2003) reported that most Thai companies (including Mittelstand-like ones) still focus on financial performance, but more advanced managerial techniques as MA or SMA are neither used in larger or smaller organisations. According to Khalid (2012) a minority of Malaysian Mittelstand-like companies apply simple methods of EA, which are not systematically linked with the company's general management. However, in Malaysia there are no official measures to promote EMA at all (Khalid 2012). In contrast, Japanese companies of a moderate size have been trying to implement EA. Its basic function is to produce environmental accounts within environmental reports, which classify the environmental costs of a company (Miyazaki 2000; Burritt & Saka 2006). "Despite the availability of this information there was [however] little evidence of its use neither by external users or managers within the business" (Abdel-Kader 2011: 65). The application of EMA techniques is also underdeveloped in Korean Mittelstand-like companies, since they are only used to create the following four accounts: "environmental protection expenditure and valuation of environment, asset account of renewable resource, asset account of non-productive resource, environmental degradation" (Zhou et al. 2006: 28). In India, EA is in its early stages concerning every kind of company, since the Indian economy still lacks the "possibilities of introducing environmental data into national accounts" (Green National Accounts in India, 2013). In the USA and China, the accounting practices of Mittelstand-like companies have improved since 2000 by adopting many techniques of MA and SMA, but their objects and objectives are purely of a financial nature, as e.g. "interest rate swaps, recognizing and measuring at fair value intangible assets […], and accounting for uncertain tax positions" (Kodecki &

Bullen 2013: 5). Mittelstand-like companies in Canada and Hong Kong "[also] have very limited resources on which to draw, lacking knowledge of environmental sustainability and the confidence to use their accounting skills in this respect" (Spence et al. 2012: 5). In the EU the use of EMA in Mittelstand-like companies is more frequent. Therefore the number of research efforts is higher, but still limited compared with the number of studies on classical accounting. The research on EMA in European companies (Mittelstand-like or not) is done by means of case studies (e.g. Hofmann & Schönbohm 2012; Pilisi & Venturelli 2005). The objectives are to develop environmental indicators and to analyse the relationship between EMA and EMAS (e.g. Santos et al. 2011; Hillary & Burr 2011; Brammer et al. 2011).

2.5.2 Case Studies on EMA in Mittelstand Companies

Pure Mittelstand Studies

(a) Lithuania: "Environmental management accounting in Lithuania" (Staniskis & Stasiskiene 2006): In 1993-2003 the EU centre of Excellence in Sustainable Industrial Development collaborated with more than 150 Lithuanian Mittelstand-like companies in more than 200 CP projects. According to the findings most decision-makers in the companies often disregarded the economic value of a good environmental performance. Despite being a substantial part of the total costs, eco-costs were often underestimated and summed-up in the general overhead costs. Quite a few Lithuanian companies, however, appreciated the reasons for implementing EMA, advantageous changes of the relative costs and benefits being the most important ones. Moreover, the application of EMA in cleaner production projects at the development stage enabled the companies to perform capital budgeting and to attract investments from financing institutions.

(b) Italy: "Introducing EMA in SMEs" and "EMA in SMEs – 10 Italian case studies" (Burrit et al. 2003): The 60 examined companies were named SMEs, but they shared the 3 qualitative Mittelstand characteristics of the first degree. The aim of the projects was the promotion of integrated management systems and the testing of EMA. The project itself began with a first stage, i.e. the introduction of EMS to these companies, which had already implemented a quality management system. At a second stage these firms implemented EMA. According to the findings of the first stage the companies lacked experience with EMA, interest, time and resources to implement it; in addition, they regarded environmental costs as negligible. Moreover, the results suggested that the companies had only a basic accounting system not linking environmental costs with other cost categories. As stated by the findings of the second stage (i.e. according to the test results after the implementation of EMA), the companies reported two major benefits: better transparency (identifying and monitoring) of environmental costs and the correct allocation to the relevant cost categories enabling the firms to improve their balance sheets. The overall impression was that the companies needed to be convinced to implement EMA with a sound evaluation of the impacts of EMA, with a modification of accounting systems and by being coached during the entire process.

(c) 3 Examples of Pure Mittelstand Studies in Austria:

(c1) Fresner & Engelhardt (2004): The analysis of EMA in two Mittelstand companies revealed that the implementation of EMA had to be regarded as a process of 4 steps: (1) implementing a cleaner production project, (2) installing an EMS, (3) improving the supply chain, and (4) improving the product and service features. Therefore, it was concluded that a cleaner production project would support the management of a Mittelstand company this way: implementation of EMA, explanation of its impact on the management, improvements or preventions of the impacts in question.

(c2) Schwarz et al. (1999) found that Mittelstand companies were motivated to participate in EMA due to image improvements, improved internal and external communication, and due to the fact that EMA was highly promoted in Austria.

(c3) Jasch & Lavicka (2006): This study covered five Mittelstand companies from the car sector and evaluated their environmental costs using EMA. The main benefits of EMA for the participating companies were helpful tools and data background, e.g. for investment appraisal or performance indicators as well as an improved consistency of the information and management systems.

(d) 2 Examples of Pure Mittelstand Studies in Germany:

(d1) IÖW (2003): 14 Mittelstand companies took part in the survey, 7 of which had an EMA or ISO 14001 certification. According to the results, the main drivers for implementing EMA were “market aspects” (66%).

(d2) Heupel & Wendisch (2003): Analysing two German Mittelstand companies, this study aimed at showing the economic and ecological advantages of Environmental

Cost Accounting (ECA) as well as the barriers hindering its implementation. At the beginning of the project corporate data (material and information) was put in a flow model (a production process visualizer) demonstrating that a conventional accounting system did not assign all environmental costs to their specific cost categories. Accordingly, a process-based EA system was installed to modify the accounting. During the next step the corporate data was harmonised so that it could be used by the ECA, allowing the installation of a permanent system solution, a so-called database concept. This newly integrated accounting system provided the companies with improved transparency and comprehension of its intra-firm processes and contexts.

(e) Greece: Abeliotis (2006): This study evaluated and summarised the experience of ten Greek Mittelstand-like companies with EMA. According to the results the drivers for implementing EMA were improved company image, legal compliance, and reduced production costs.

Mixed studies

(a) 2 examples of mixed studies conducted by the EU:

(a1) The EU EVER study (2005): A total of 101 companies were divided into small, medium and large enterprises, with each company-type being analysed separately. The findings were as follows: In every firm EMA played a significant role concerning the stimulation of its environmental improvement, particularly in respect to waste, water and air pollution. The main drivers to implement EMA were always the prospect of enhanced reputation, competitive advantages (customer satisfaction, increased of turnover), the reduction of penalty fees through compliance with legislation, and stakeholder relationships. Barriers hindering the implementation of EMA in most companies were the lack of skills and knowledge, cultural gaps and organisational lags.

(a2) Study on costs and benefits of EMAS for registered organisations of the EU: Vernon et al. (2009). 455 organisations in the EU were examined, 182 (40%) of which were Mittelstand companies. The results were: 86% of the respondents were certified to ISO 14001 and to EMAS. The drivers most frequently mentioned were improvements of resource and production efficiency, internal management approaches, reputation, transparency with stakeholders and legal compliance. The benefits that were mentioned most often were energy and resource savings, improved stakeholder relationship, and increased market opportunities. The most frequently cited barriers were unclear or insufficient benefits, high costs of implementation, and registration of EMA. Several EU members offered Mittelstand-like companies specific support for their EMA implementation.

(b) Germany: Rennings et al. (2003 & 2006): This study investigated the effects of different EMAS characteristics of a firm's technical environmental innovations and economic performance. Its target group included all EMAS-validated German manufacturing facilities, which (as of 2001) comprised 2,270 Mittelstand and Mittelstand-like companies, 1,277 of which took part in the interviews. These participants reported a positive influence of EMAS on environmental process innovations and product innovations as well as on environmental organisational innovations. More than 55% of the facilities in question also implemented ISO 14001. The environmental process innovations particularly depended on the maturity of EMAS (which in return depended on its age and re-validations as well as on experience concerning the organisation of environmental protection). EMAS had a positive influence on the turnover and exports whereas environmental process innovations had a positive influence on the increase of the number of employees and turnover. This means that a careful design of EMAS was important for both the environmental and economic performance of an organisation. Hence, organisations could improve their economic performance with a better linkage between environmental management and innovation management.

(c) Czech Republic: Hyrslova & Hajek (2006): The study comprised 450 companies that were EMS (ISO 14001 or EMAS) certified in 2003, 195 of which belonged to the Mittelstand. Most of the 450 companies had an ISO 14001 certificate, whereas only 9 had implemented EMAS. According to the study results, EMS tended to be implemented more often by larger companies, as it reportedly did not pay off for small ones. EMA was perceived as an efficient tool for the companies who had already implemented EMS to minimise total costs or environmental costs and to allocate the environmental impact of their activities, products and services. Other benefits brought about by EMA were tracing, tracking, evaluating and controlling of environmental costs. Companies who had already implemented EMS were found to be more aware of environmental costs and to pay more attention to the use of information that supported the decision-making process.

2.5.3 Diffusion of EMA in European Mittelstand-like Companies

There are only vague numbers about European companies (Mittelstand-like ones and others) performing EMA, but as pointed out in section 2.1, there are several EU-based companies that (instead of performing EMA) do use EMS, which is based on the EMAS-standard (Darnell & Edwards 2006; United Nations 2001). According to Hillary (2004), the number of companies using this standard can be seen as a marker for companies performing EMA, which is supposedly somewhat smaller (Hillary, 2004). The most recent statistics on EMA-registered sites and organisations were issued by the European Commission in 2008 and provided the following information: The total number of EMAS-registered sites in the EU was 6,940 (with 248 per country on average) and the total number of EMAS-registered organisations was 3774 (with 135 per country on average). Italy is the country with the highest number of EMAS-registered sites (1,651) and organisations (1,123). At the bottom of the rank are Latvia and Malta with one EMAS-registered site and organisation each. The numbers of EMAS-registered sites and organisations in Germany, Austria and the UK are: Germany (1291 vs. 882), Austria (769 vs. 254), and the UK (263 vs. 51) (European Commission: European Eco-Management and Audit Scheme, EMAS 2008).

In the Germany there are about 2,000 companies in the field of chemistry (90% of which are Mittelstand-like) plus 9,300 companies in the printing industry (43,4% of which are Mittelstand-like (Verband der Chemischen Industrie 2016; MMB 2013). As these industrial sectors are the ones that require EMA (or a substitute) the most, one can conclude that the vast majority of EU-based companies (Mittelstand-like or not) do not regard eco-efficiency and reduction of environmental costs as an important goal – a view that is also supported by Iraldo et al. (2010). This finding is supported by the fact that (at least until 2015) there has only been a comparatively small number of peer-reviewed publications on EMS or EMA in European Mittelstand-like companies. Until 2015 there were 78 publications matching this description, 56 (44) of which were on EM(A)S or on EMA, respectively. There were no such studies explicitly dealing with Mittelstand companies (own research on these journals: Journal of Cleaner Production; Greener Management International; Centre of European Economic Research; Corporate Social Responsibility and Environmental Management; Environmental Quality Management; British Journal of Management; Ecological Economics; European Accounting Review; European Environment; Institute for Ecological Economy Research). These finds are at odds with the fact that Mittelstand-like companies, which cause high collective pollution, nowadays face public and judicial pressure to reduce environmental costs (Burke & Gaughran 2006; Rutherford et al. 2003; Spence & Rinaldi 2010; Williamson et al. 2006). Several authors put forward reasons to explain this contradiction: These companies are less interested in environmental projects (Schaltegger et al. 2008) and do not regard the environment as a key issue for their business practices (Rutherford et al. 2003), as they perceive environmental protection as an unnecessary cost burden (Simpson et al. 2004). In view of this situation the previous section reviewed all known case studies of EU-based Mittelstand companies using EMA or EMS. The special points of interest of this analysis were (a) the benefits and drivers facilitating the implementation of EMA and (b) the barriers impeding such a project.

2.6 Mechanism, Tools and Area of EMA

According to the United Nations Expert Working Group, EMA is concerned with the identification, collection, analysis and use of two types of information for internal decision-making (UNDSD, 2000):

- Physical information concerning the use, flows and destinations of energy, water and materials (including wastes) and
- Financial information on environment-related costs, earnings and savings

Both the physical and monetary information set the basis of the physical and financial component of EMA. Each component has its own area of tasks, and topics disclosed by the internal reporting. These characteristics also outline the goals and roles of EMA within SMA presented in the following table (4):

<table>
<tr><th colspan="3">Table 4: Basic Goals and Roles of EMA in SMA</th></tr>
<tr><th></th><th>Financial Component</th><th>Physical Component</th></tr>
<tr><td>Related Task(s)</td><td>Prevailing accounting type: Cost accounting on financial level</td><td>Prevailing accounting type: SMA on process & product level</td></tr>
<tr><td rowspan="2">Basic Task(s)</td><td>Tracing and accounting of environmental costs</td><td>Treating, tracing, and accounting of flows of material, water, and energy</td></tr>
<tr><td colspan="2">Allocation of environmental costs to related products, production processes, and flows of material, water, and energy</td></tr>
<tr><td>Application</td><td>Statistics and indicators for:
(a) Calculation & budgeting of environmental costs & environmental savings
(b) Calculation of profit margins
(c) Product pricing</td><td>Environmental management:
(a) Evaluation of environmental performance
(b) Investment options
(c) Developing eco-friendly production process, products</td></tr>
<tr><td>Internal Reporting, Disclosure</td><td>Environmental costs (including expenditures, investments, liabilities)</td><td>Performance of environmental management</td></tr>
</table>

Overall financial goals of EMA	Predominant accounting type
"'EMA' serves business managers in making capital investment decisions, costing determinations, process/product design decisions, performance evaluation and a host of other forward-looking business decisions." (UNDSD, 2000: 39)	SMA on every level
Overall financial and physical goal(s) of EMA: Eco-efficiency	
(1) Legal compliance, (2) Improvement of strategic position (i.e. maximal reduction of negative environmental impact and related environmental costs), (3) Compliance (i.e. prevention of negative environmental impact and related environmental costs)	
Sources: same as in table (2)	

Table (5) shows that EMA uses 10 tools and techniques to reach its goals and to play its roles. This PhD only concentrates on these tools and techniques: (1) environmental cost (flow) accounting, (3) interface of EMA, (4) documentation, (5) tracking & reporting of environmental costs, and (9) metrics, since the other tools and techniques are only mentioned by a small minority of publications.

Table 5: Basic Tools and Techniques of EMA

Tool or technique	Execution and goals of tools and techniques
1. Environmental cost (flow) accounting with: measuring, tracking monitoring, of: (a) physical flows (b) storage **(c)** related costs	Measurements, monitoring, checks, tracings help to 1.) identify the company's environmental impact and chances to minimize it, 2.) identify related environmental costs (including their categories, origins) and chances to reduce them 3.) identify related earnings, savings, and chances to increase them 4.) develop measures to reach these goals, 5.) evaluate entire production costs
2. Best practices	Best practices in the context of EMA are measures that proved successful in minimizing the company's environmental impact and its related environmental cost. Best practices are generally used as benchmarks.
3. Interface of EMA:	The company's environmental policy and the accounting of environmental costs correspond to the company's economic targets. EMA supplies data for:

Combination of financial & physical accounting, integration in SMA.	(a) company policy, long-term strategies (b) target setting (c) tactical decisions and quick performance evaluations
4. Documentation	Documents are used to regulate, evaluate and report all financial and physical aspects of EMA.
5. (Tracking & reporting of) Environmental costs	Environmental costs must be clearly declared and separated from other costs, esp. from overhead costs. EMA identifies: (a) production and selling prices (b) environmental costs (c) costs for internal services
6. Environmental Audit (internal)	An internal environmental audit is done by experts of the company. Their task is to "look at every aspect of the properties facilities, equipment, practices and procedures and thoroughly analyse utility and product use during the baseline period" (STEP, 2001: 4).
7. Environmental Walk-Through	An environmental walk-through is generally done by one assessor inspecting the company's facilities to identify several opportunities to improve its eco-efficiency.
8. Management Review	Such a review consists of 2 parts: (1) "a holistic and strategic look at the continuing suitability, adequacy and effectiveness of" EMA", and (2) attempts "to improve [its] system"
9. Metrics: benchmarks, indicators, material codes, units	Metrics are used for checking, measuring, monitoring and tracking both the physical phenomena of the supply chain and their related environmental costs. Metrics are necessary to measure a company's economic and ecological efficiency.
10. Production-planning programme	The production-planning programme takes into account (a) the physical flows, the storage of goods and their related costs; (b) and the difference between the supplied materials (energy) and the consumed materials (energy). Its goal is to evaluate the quantity of non-product output (hazardous /not hazardous) and its related environmental costs.
Sources: same as in table (2)	

The goals and techniques of EMA refer to its main areas and their related objectives, requirements and measures including their physical and financial aspects. By these means, a company can gain the operational and financial control of the main occurrences of environmental importance. Hence, the tracking of the resource flows and the accounting (including tracking and reporting) of the corresponding environmental costs are the main assignments of EMA. Table (6) summarises a company's environmental task areas and its corresponding objectives requirements and further measures to deal with them appropriately, i.e. to minimise the environmental costs and to increase its eco-efficiency concerning the use of water, air, material and energy. Each area has its own physical and financial section to which the corresponding objectives, requirements and measures (tools and techniques) are attributed. Due to its length, this table can be found in the appendix.

2.7 Possible Methods of Accounting Environmental Costs within EMA

In view of the goals, techniques, and areas of EMA (cf. tables 4, 5, 6 respectively), and with respect to the types of environmental costs, the IFAC framework of ECA also offers the best approach to account for environmental costs since it defines these areas and tasks:

- Assessment and disclosure of environment-related financial information in the context of financial accounting and reporting.
- Assessment and use of environment-related physical and monetary information in the context of EMA.
- Estimation of external environmental impacts and costs.
- Accounting of stocks and flows of natural resources in both physical and monetary terms.
- Aggregating and reporting of organisation-level accounting information, and other information for internal and national accounting purposes
- Consideration of environment-related physical and monetary information in the broader context of environmental accounting.

The IFAC (2005) framework obviously matches all demands of EMA with two exceptions: it proposes both internal *and* external reporting; in addition it does not explicitly mention the integration of environmental cost accounting in SMA. Apart from that, there are no commonly agreed accounting and calculation methods for environmental costs. The IFAC and other authorities propose these methods for cost accounting, some of which can also be used for ECA:

1) **Separate Calculations**: This method deals with cost types separately, and does not integrate them into (S)MA (Nielsen 2001). Hence it is inappropriate for an EMA to be integrated in SMA.
2) **Direct Costing**: This method traces environmental costs with a causal relationship. Fixed and variable costs are treated separately. The challenge is to separate environmental costs from other costs. Direct costing does not promote integrated environmental protection activities based on clean production technologies (Röming 1999). It is therefore not suitable for EMA.
3) **Full Cost Accounting (FCA)**: This is the traditional method of cost accounting that traces all direct costs and allocates indirect costs to a product, process or activity. This accounting type is compatible with existing (S)MA systems. The advantage of FCA is that it allocates these costs to the cost drivers. In this context FCA is the commonly accepted device applied to the identification and allocation of a

combined and complex set of conventional costs and environmental costs (IFAC 1998; Bryant 2003). Therefore FCA recommends itself to be used in the framework of EMA to account for static environmental phenomena (e.g. environmental taxes).

4) **Activity-based Costing (ABC):** ABC is based on the calculation of operating costs taking into account direct and indirect costs; it also covers up-stream and down-stream processes of the actual production process. ABC enables firms to allocate all costs, including environmental costs, to the activities of the cost centres and cost drivers (Wahyuni 2009). With ABC it is possible to uncover the major part of environment-related costs such as energy, water, waste disposal commonly recognised as overheads, which are likely to be hidden from managers' evaluation. Thus ABC can create more accurate cost information not only for better product pricing, but also for reducing all costs and supporting pollution prevention projects (Bennett & James 1997). Remembering the definitions of MA and SMA, it is consequently possible to integrate an ABC-based EMA into these systems.
5) **Life Cycle Assessment (LCA):** As mentioned before, LCA "studies the environmental aspects and potential impacts throughout a product's life from raw material acquisition through production, use and disposal." (Hendrickson et al. 2006). However, section 2.1.2 identified LCA as inappropriate for EMA.
6) **Target Costing:** This accounting method records environmental impacts and tries to influence them with volume management and transfer prices. Until now the application of target costing in EMA is limited and has not proved successful (Starck 2013).
7) **Flow Cost Accounting:** Flow cost accounting refers to material and energy flow analysis contending that material flow analysis is basically "intended to define the material and energy flows moving through a value creating system (such as business) over a certain period" (Gibson & Martin 2004: 49). With regard to material flows, the non-productive material inputs as well as the costs for non-productive material outputs (waste and emissions) are considered as cost aspects (Jasch & Stasiskiene 2005). In the same way, external effects due to material extraction, waste and emissions are considered. In respect to the (dynamic) physical aspects of EMA, flow cost accounting appears to be promising, since it includes the "evaluation of cleaner production potential at the plant level, preliminary estimate of waste generation costs, in-depth analysis of selected assessment focuses

(quantification of the volume and composition of various waste and energy streams and emissions […])" (Staniskis & Stasiskiene 2006: 1255).

8) **Input/Output Analysis:** The input-output analysis is a tool in economic analysis, which represents the flows of input and output items with a set of linear equations (Joshi 2000). Economic input−output modelling has been used for environmental systems analysis, with a primary benefit being the estimation of direct and indirect economic and environmental impacts (including the flows of energy and matter) across the entire supply chain of production in an economy (Hawkins et al. 2007).
9) **Environmental Balanced Scorecard (EBSC):** The concept of the Balanced Scorecard (BSC) is based on a measurement system containing a balanced set of financial and nonfinancial measures representing different strategies, requirements, goals, resources, capabilities and the causal relationships between these domains. Consequently, the perspectives of the BSC firstly refer to the company's activities that are critical for its long-term business success, and secondly, they link all related effects to their causes. All objectives and measures, which are formulated in the perspectives of the BSC, are deduced from long-term strategic financial goals in a top-down process. This hierarchical structure of the BSC guarantees that all business activities are linked to the implementation of the business strategy (Figge et al. 2002). The advantage of a modified BSC is its open system facilitating the consideration of environmental issues and the simultaneous achievement of ecological and economic goals (Möller & Schaltegger 2005). Such a BSC that can be called an EBSC requires a new type of data, which is often generated by means of eco-efficiency analysis. This analysis does not only provide a data source for EBSCs, but it also serves as a link between the EBSC and the EMA (Möller & Schaltegger 2005). Several case studies support this view (cf. Sardinha et al. 2003; Engelhardt et al. 2004; Chalmeta & Palomero 2011; Schaltegger & Lüdeke-Freund 2011).

On the basis of this information it is possible to conclude that the ECA is a process-orientated and flow-oriented cost accounting system based on a systematic cause-and-effect and input-output analysis, which allocates the (environmental costs) to their corresponding causes. On the other hand, ECA is only a part of EMA, which can be called internal managerial ecological accounting: It (EMA) collects the information about environmental costs for internal management issues and decisions. These approaches must, however, continually be revised to ensure their efficiency (Wendisch & Heupel 2005).

2.8 Characteristics of EMA Implementation in Mittelstand Companies

2.8.1 Patterns of EMA Implementation in Mittelstand Companies

The comprehensive use of EMA in Mittelstand companies is still relatively rare (Zvedov 2012a). However, a large number of companies report on their environmental performance in accordance with the GRI guidelines (GRI 2006). But there is still a discrepancy between the signals of a company and its actual attempts to manage the phenomena that these signals denote, i.e. the impacts on the environment (Zvedov 2012a). The strategic decision for implementing EMA lies beyond the regulatory requirements, which can generally be considered as “proactive environmental strategies” (Aragón-Correa et al., 2008: 357). For this reason, it seems more important to find the crucial strategic patterns and motivations for the introduction of EMA in Mittelstand companies.

Noci & Verganti (1999) recognise three such strategic patterns: reactive, anticipatory, and innovation-based patterns. Reactive strategies apply to Mittelstand companies that innovate only through reactions to external stimuli by regulators, governments, and other stakeholders. Mittelstand companies that follow an anticipatory strategy consider the environment as a source of future competitive advantage and adopt green technologies by following timing strategies. In contrast, Mittelstand companies with innovation-based strategies consider the environment as the most important competitive priority and translate environmental issues into innovation-based solutions by adopting green technologies and creating new markets for eco-friendly products (Klewitz & Hansen 2012). These innovations include new processes, products, technologies, services and organisational practices that are beneficial to the environment where they reduce or avoid negative environmental impacts (idem).

The relationship between being proactive in environmental issues and firm performance is viewed controversially in the literature: While some studies have documented a positive relationship (Aragon-Correa & Rubio-Lopez 2007; Galdeano-Gomez et al. 2008; Nakao et al. 2007; Wahba 2008), others have not identified a positive impact of a firm’s environmental proactivity on its financial performance (Link & Naveh 2006; Wagner 2005; Watson et al. 2004). The lack of a solid theoretical foundation is the main reason why these empirical studies have not led to knowledge convergence (Lopez-Gamero et al. 2008). Therefore, the question remains open whether a firm that goes beyond regulations and compliance will actually improve its economic performance and competitiveness (Hitchens et al. 2003; Klewitz & Hansen, 2012). This explains why only a small number of companies have implemented EMA (cf. 2.5.3).

According to various studies, EMA displays a large heterogeneity in the group of Mittelstand companies because it depends on the company's individual characteristics, including the drivers and barriers to implement EMA (Klewitz & Hansen 2011; Preuss & Perschke 2010; Moore & Spence 2006; Perrini 2006; Luetkenhorst 2004; Spence 1999; Vyakarnam et al. 1997). The problems a Mittelstand company faces when it implements EMA arise from these shortcomings: lack of staff, lack of developed cost accounting, lack of time and specific knowledge about EMA implementation. These aspects will be deepened in the following section 2.8.2, which examines the implementation level of EMA and the specific barriers precluding the implementation of EMA.

An initial step of an EMA implementation is the inclusion of environmental information within the existing accounting information system to assist the management process (Frost & Wilmshurst 2000). Such an information system may include budgeting, costing, investment appraisal, performance evaluation, internal reporting, and risk assessment. However, the tracking and analysis of environmental information can also make use of the methods proposed in section 2.7 (Todea et al. 2010).

2.8.2 Drivers and Barriers Influencing EMA Implementation

EMA poses various challenges to decision-makers in developing an understanding of the linkages between environmental management and financial performance (Zvezdov 2012b). In this context the literature has widely debated the "efficiency paradox" which refers to the question of why business firms do not undertake investments even though they would be cost-effective from the company's economic perspective. Previous studies have identified a wide range of barriers to explain this paradox (DeCanio 1998).

Barriers that hinder investments in cost-effective, energy efficient practices and technologies can be classified into the following four categories: cultural, financial, informational, and organisational barriers (Kostka et al. 2011). These general factors can be amplified by the disadvantageous characteristics of Mittelstand companies (cf.

2.2), which are resource constraints in terms of a lack of time and personnel (Azzone & Noci 1998; Del Brío et al. 2002; Bos-Brouwers 2010). This may result in a reluctance to invest in and implement innovations related with EMA. Many authors argue that these companies often focus on issues related to economic performance and pursue eco-efficiency improvements (Revell et al. 2010; Suh et al. 2005), only if this strategy brings about immediate positive economic effects (Schaltegger & Synnestvedt 2002; Dyllick & Hockerts 2002; Clausen et al. 2002; Schaltegger & Sturm 1998). However, whenever there are appropriate environmental initiatives and legal regulations, Mittelstand companies will try to adapt their strategy to them. For some authors there is evidence that these regulations improve a companies' competitiveness (Porter & Van der Linde 1995), while others reject this assumption (Cropper & Oates 1992; Jaffee et al. 1995; Eckins & Speck 1998). To explain the decisions this section takes a closer look on the aforementioned barriers.

Cultural Barriers

Some managers are more inclined than others to "internalise the externality" of environmental effects. Such behaviour could result from ethical commitment to the environment per se or to a market structure, which relaxes the constraints on firms to maximise profits and therefore allows for the pursuit of a wider range of management goals. Negative cultural influences on the adoption of EMA systems include the fear of change, management inertia and lack of internal communication. There is a certain conservatism among many enterprises that keeps them from implementing clean technologies or from implementing EMA. These obstacles are the starting point for a deeper understanding of the factors promoting or hindering the introduction of EMA in Mittelstand companies (Hitchens et al. 2003). In addition, owner-managed Mittelstand companies often regard the implications of EMA more sceptically than publicly traded corporations due to their different structure (Behringer & Meyer 2011). These companies are often firmly linked with the person of the owner, who is a major cause and starting point of the specific management culture (idem).

Financial Barriers

Financial barriers stem from the limited access to capital and are often the most important investment barriers. Especially Mittelstand companies do not invest in innovations and efficiency improvements because they cannot access required investment capital. In addition, financial barriers might be higher as banks are biased in favour of larger enterprises and because loan payback times are too long for Mittelstand companies (DeCanio 1998).

Informational Barriers

Informational barriers are caused by high transaction costs. High transaction costs include the costs of gathering, assessing and applying information about energy saving potentials, relevant technologies and/or considering environment-related data in accounting. Studies show that firms do not undertake specific measures because managers are often unaware of pertinent technologies or because they do not recognise the savings potential as they fail to measure energy consumption systematically (Noci & Verganti 1999; Hitchens et al. 2005).

Organizational Barriers Including Knowledge and Skill Barriers

Especially Mittelstand companies lack practical know-how concerning the implementation of eco-efficiency practices since the staff is often poorly trained and technically skilled. Furthermore, the entrepreneurs of such companies often perform multiple roles within a firm (cf. 2.2). As a result, there is no specific person in charge of eco-efficiency management (Noci & Verganti 1999; Hitchens et al. 2005). Given the varying degrees of proactivity and the weak representation of innovation-based strategies, the questions remain how Mittelstand companies can generally be stimulated to engage more in innovation in the context of EMA and what the specific success factors are.

As according to Prowle & Lucas (2016) the structure, culture and hierarchy of medium-sized companies have a pivotal influence on their MA, it seems advisable to consider the abovementioned barriers in the context of EMA and the Mittelstand.

2.9 Conclusions from Literature Review

Conclusions Concerning the Barriers

Especially the mixed studies (cf. 2.5.2) showed that SMEs and Mittelstand-like companies behave similarly when they implement EMA (Rennings et al. 2003 & 2006; Vernon et al. 2009). The main aspects of this implementation are drivers, barriers, and benefits. The main benefits and drivers of an EMA implementation in Mittelstand-like companies are: improved transparency (identification and quantification) of environmental costs and tools, guidance to implement EMA, positive effects on accounting systems and organisational structures, enhanced competitiveness, improved reputation, compliance with legal status, and cost savings (Hyrslova & Hajek 2006). On the other hand, Mittelstand-like companies face the following barriers when they try to implement EMA: lack of support, lack of resources, skills and knowledge, uncertain payoff (benefits & costs). Insecurities concerning the aforementioned payoff are an obstacle keeping many Mittelstand companies from implementing EMA (Staniskis & Stasiskiene 2006). The EMA-related benefits and drivers are not directly linked with market responses but rather with the internal perspective of the company due to their immaterial and non-monetary nature, whereas the EMA-related costs do have a monetary character (idem).

Analysing the previous results, these barriers have to be taken into account to improve the uptake of EMAs by Mittelstand companies. To this end, one must obtain transparent and complete knowledge of the company's material and energy flows since a simple combination of conventional accounting with environmental items does not suffice to solve environmental problems. Therefore, Mittelstand companies need to systematically integrate their accounting procedures into their environmental management system. Moreover, Mittelstand-like companies who deepen the link between EMA and their (S)MA can improve their competiveness, turnover and exports (Rennings et al. 2003, 2006). However, the question still remains how to integrate the environmental data into the accounting so that it can be allocated to specific cost centres.

Conclusions Concerning EMA Implementation in Mittelstand Companies

Sections 2.5 and 2.8 have shown that many Mittelstand companies do not implement EMA in spite of its benefits. The reasons for this "efficiency paradox" are linked to barriers impeding the implementation of EMA. This section therefore presents the definitions of these benefits and barriers, thus summarising the findings derived from the literature review. For a Mittelstand company the benefits of implementing EMA are likely to be:

(1) Improved accounting: Improved identification and quantification of environmental costs, improved investment appraisal of performance indicators, better cost savings, energy and resource savings and efficiency, reduction of costly penalties;

(2) Improved market aspects: larger turnover, enhanced competitiveness, customer satisfaction and market opportunities;

(3) Improved relationships: improved reputation, compliance with legal status, improved stakeholder relationship, improved internal and external communication.

For a Mittelstand company the barriers and disadvantages of implementing EMA are likely to be:

(1) Financial barriers: lack of resources, limited access to capital and lack of appropriate loan conditions;

(2) Informational barriers: costs of gathering, assessing and applying the techniques of implementing EMA, lack of skills, experience and knowledge, lack of knowledge concerning payoff (benefits and costs) arising from the EMAS certification and implementation;

(3) Organisational and cultural barriers: lack of time, lack of a compatible accounting system, lack of personnel, lack of interest due to conservative company philosophy and culture, lack of internal communication.

Revaluation of the EMA Definition

According to the findings of this literature review, EMA is a part of SMA that is concerned with internal reporting and controlling information concerning material flows and their associated costs (i.e. their subsequent environmental costs). So, EMA is decidedly more than an ECA. EMA reports its information to internal stakeholders only, which is an aspect that is missing in the previous definition. An updated version of the EMA definition is therefore as follows:

> EMA is the part of the strategic management accounting, which monitors the company's physical flows, calculates its associated environmental costs, earnings and savings, and reports the related information to internal stakeholders. It does so in order to support and optimise the company's managerial decisions concerning its environmental performance. Its most commonly used methods are FCA, ABC, flow cost accounting, input/output analysis, and EBSC.

Deduction of Research Hypotheses from Research Objectives and Research Questions

To conclude this literature review, three quintessential research hypotheses concerning the relationship between Mittelstand companies and EMA can be formulated based on the information presented in this chapter. They will guide the development of both the research methodology and the execution of the research. The literature review suggests that the relationship between these companies and EMA is characterised by implementation problems, judicial pressure, advantages and disadvantages. Therefore the three research hypotheses are formulated as follows:

1. Mittelstand companies are inexperienced in implementing EMA due to the lack of scientific research. They therefore face many problems.
2. Mittelstand companies are pressed to adopt EMA by laws, and not by economic considerations.
3. Owing to the problems with implementing EMA, the disadvantages of EMA outweigh its advantages, and Mittelstand companies hardly benefits from it, an exception being the avoidance of penalty fees through compliance with eco-related laws.

Chapter 5 will validate or disprove these hypotheses. In addition it will examine if the definition of EMA also holds in the context of Mittelstand companies.

3 Research Methodology

3.1 Determination of Appropriate Methodology

According to Remenyi et al. (2003: 65-66), methodology is the "overall approach to a problem which could be put into practice in a research process, from the theoretical underpinning to the collection and analysis of data". Therefore a research methodology is needed to outline the way in which the research concerning a certain problem must be executed. It is based on special ontological and epistemological assumptions, which are rooted in the research area and the research aim (Burrell & Morgan 1979). As stated in the introduction, the research area of this study is an economic one, namely EMA in Mittelstand companies, whereas the research aim is to examine the implications (ways, benefits and disadvantages) of an EMA implementation into the SMA-structures of such companies. Both the research area and aim will therefore serve as a guideline to find the most appropriate research methodology.

As for the ontological assumptions, a researcher has to decide, if he regards his research area as an objective or subjective phenomenon. Also, a company can either be regarded as an objective or subjective entity depending on the nature of its affairs. Taking a company for an objective thing is best when its relations to external factors are examined. These factors (e.g. market pressure) are pieces of a factual reality the company is forced to accept (Bisman 2010; Bonner et al. 2006; Gaffikin 2007; Parker 2007; Roth & Mehta 2002; Scapens 2006). By contrast, the interior proceedings of a company are mostly subjective phenomena, like the social relationships among the staff, the organisational fields, SMA. They and the internal reporting highly depend on the company's corporate culture, i.e. social norms and conventions created by the company's members. Many of these norms have a long history, and therefore implicitly affect the internal relationships of its staff (Diefenbach 2007; Hopper & Major 2007; Alvesson & Wilmott 2013; Roslender 2013; Russel & Fussilie 2014).

In order to carry out research on a certain phenomenon, epistemology offers two basic approaches, namely the objective and the subjective, also called the positivist and interpretivist approaches respectively (Burrell & Morgan 1979). Positivist (economic) research is based on the assumption that there is a single and external economic reality consisting of objective and observable facts, which are all deterministically governed by laws of cause and effect (Sarantakos 2005). Positivist research therefore aims at discovering these laws (in a defined field of investigation) with objective observations and rational examinations of the observable facts in question (Roth & Mehta 2002). This is done in a neutral and unbiased way, which is not influenced by personal believes (Hudson & Ozanne 1988). Consequently, positivism rejects psychological introspection and any form of value judgment or interpretation (Carson et al. 2001). Whenever humans are part of an experiment (which is the case when companies are analysed), the researcher remains disconnected from them for the sake of objectivity and neutrality (Carson et al. 2001). Positivist research may start with related hypothesis based on previous experience; however, the subsequent results are analysed through logical deductions, which lead to theories, i.e. time and context free generalizations beyond the analysed information (Shankman 1984; Churchill 1996; Lin 1998; Carson et al. 2001). To this end, theories developed with positivist research are judged in terms of parsimony, explanatory power, precision and validity (Bisman 2010; Angus 1986; Marshall 1994). Hence, in the area of economics the positivist researcher tries to collect mostly financial data about his research object by means of experiments and observations, which use quantitative, statistical and mathematical techniques, as e.g. cross-sectional analyses of pay-rolls (Carson et al. 2001). Recent positivist research models often applied in the context of economics are influenced by sociology. They also draw on quantitative data to explain public and judicial influences on the phenomenon of interest, e.g. MA (Scapens 2006).

Unlike positivism, interpretivism holds that there are various (economic) realities, and that they are systematic social constructions devised by several inter-related actors (Berger & Luckman 1966). Interpretivism also assumes that the actors operating within these realities are able to adapt to them and to change them (Hudson & Ozanne 1988). Being therefore subjective, manifold, and potentially instable phenomena, the various economic realities (market segments, companies, departments, teams, etc.) depend on many changeable systems of meanings shared and devised by the actors (Lincoln & Guba 1985). Consequently, economic interpretivism holds that any knowledge about economic realities is also the outcome of a social construction and not the result of objectively examined facts (Hirschman 1985). Economic interpretivism rejects the idea that “human behaviours are deterministic [, but rather] subjective, relativistic or self-referential, and non-material” (Bisman 2010: 5). Therefore, it does not analyse an economic reality with objective observations to find general knowledge about the interplay of cause and effect. It rather seeks to internally experience the investigated reality in order to understand the decisions and habitual behaviour of economic actors.

To this end, economic interpretivism examines the actors' intentions, motives, and reasons as well as the meaning of their actions (Neuman 2000). Consequently, interpretivist economic research applies flexible and collaborative research structures, in which the actors of the investigated economic system act as the researcher's immediate informants (Black 2006). Therefore, case studies are an often-used method of interpretivist economic research (Scapens 2006). Generally, economic interpretivism prefers qualitative methods to quantitative ones, especially "statistical modelling favoured by positivists is excluded" (Bisman 2010: 6). According to interpretivism the reliability and validity of the research results are important, but they are judged in terms of "trustworthiness, credibility, transferability, dependability and conformability" (Bisman 2010: 11).

Until about 2010, accounting-related research was dominated by positivist approaches (cf. e.g. Birnberg et al. 1991; Laughlin 1995; Bonner et al. 2006; Gaffikin 2007; Parker 2007; Bisman 2010; Bhattacherjee 2012). Since the 1980s however, researchers have been applying interpretivist concepts in several research efforts (Chua 1986a, 1986b; Hines 1991, 1992; Broadbent & Guthrie 2008). Presently, academics are unsure which of these two methodologies serves the needs of accounting better (Ryan et al. 2002). As Scapens (2006) points out, each methodology has its strengths and weaknesses, so that either of them works best under certain circumstances of MA. Hence, in order to find out the right methodology for the research of this PhD, it is necessary to fulfil these assignments: (1) to identify the advantages and shortcomings of both methodologies and their related models, (2) to ascertain their bearing on the implementation of EMA in Mittelstand companies. As attested by current research, positivist approaches appropriately describe a company's reaction to external influences, which can be grasped by means of financial data and criteria (Meer-Koistra & Vosselman 2000; Specklé 2001; Bonner et al. 2006; Gaffikin 2007; Parker 2007). New institutional economics, and other neo-classical approaches, which all rely on positivist assumptions, can explain why and how a company organises certain monetary transactions, and how it reacts to changes in the market (Specklé 2001). These approaches can also explain why companies are structured in a hierarchical way, but they fail to explain how and why these structures develop and change (Scapens 2006). Moreover, positivist approaches are unable to account for external influences, which cannot directly be dealt with in monetary terms: e.g. public and legal pressure forcing a company to adopt certain procedures.

In contrast, these phenomena can be well studied with the new institutional sociology using the interpretivist methodology (Bisman 2010; Roth & Mehta 2002). Institutional sociology accounts for many other effects as the adoption of eco-efficient procedures, which are driven by political pressure and judicial concerns (Nee 2003). In addition, this interpretivist approach also explains managerial decisions that were driven by cultural-normative aspects, routines, artefacts, relationships and symbolic systems (Scott 2004). In addition, interpretivist models are the better choice to account for “socio-historical relationships” (Wanderley et al. 2011: 115) between the members of a company. These models explain the interplay of company structures, the behaviour of staff members and structural changes by means of 6 factors:

(1) Time & Path Dependency

As for the time factor, interpretivist models acknowledge that the implementation of new practices is an evolutionary process, and that most “accounting systems are slow to change” (Scapen 2006: 25). The term ‘path dependency’ denotes that the change of management accounting depends on the company and its history. According to interpretivist models economic activities of a company, their development and their impact on (S)MA change are perceived as phenomena that depend on the “habits, rules and routines” taking place within a company (Scapens 2006: 14; cf. also Hodgson 1993a). The way in which the day-to-day activities (i.e. habits, rules and routines) come into existence, determines how or if economic activities and structures develop or change and how they change (S)MA. If the day-to-day activities are devised and controlled by a powerful management, the management will execute the structural changes (Scapens 2006). If, however, the day-to-day activities are a result of assumptions which are taken for granted, the impetus for structural changes is likely to come from intellectual elites and change agents; these actors tend to create an awareness of institutional contradictions among other organisational actors, and trigger institutional changes (Seo & Creed 2002). Generally, changes are easier in power driven companies, and more difficult in companies, whose management is based on taken-for-granted assumptions.

(2) Compatibility

Interpretivist models hold that new methods must be compatible with the accounting system to ensure their implementation. Scapens (2006) describes the compatibility of an implementation by means of “certain elements of stability within the process of change” (Scapens 2006: 19).

(3) Agency, Trust & Respect

Interpretivist models acknowledge that some members of a company try to reach their selfish goals by using fraudulent measures. However, these models also take into account that respect and “trust facilitate(s) the process of change and the introduction of new accounting systems” (Scapens 2006: 24), whereas lack of trust and respect further the dissociation of groups.

(5) Contingency & Contradictions

The expressions contingency and contradictions stand for external random effects influencing MA. Contingency is a general social phenomenon since “social phenomena by their nature are fragile, so that causal impacts are not fixed but contingent upon their environment” (Healy & Perry 2000: 12). Contingency theory can therefore “explain the diversity of management accounting practices” (Scapens 2006: 5). In addition, institutional contradictions cause conflicts among the actors of an economic system, so that some of them come to see the need of institutional changes (Seo & Creed 2002).

As stated above in this section, this study aims at analysing the implications of EMA being implemented into the SMA-structures of Mittelstand companies. As explained, only an interpretivist methodology can address the whole array of factors facilitating this innovation (political pressure, norms, time, path dependency, compatibility, agency, trust, contingency and contradictions). These factors also reflect the first research question (“How did the company of the German Mittelstand examined in the case study implement EMA?“ etc.). Moreover, the implementation of EMA in Mittelstand companies will probably face barriers, which are rooted in the companies’ internal structures (financial, informational and organisational barriers). Most of these deficits are also caused by special social relationships and assumptions that are taken for granted (e.g. the ‘lack of interest due to conservative company philosophy and culture’; cf. section 2.8). In addition, this fact is linked with the second research question (“What were the potential obstacles and drivers for the implementation of EMA in the Mittelstand company of the case study?”). Finally, it is also noteworthy that (as stated in chapter 2) EMA reports information to internal stakeholders only, and that its implementation of EMA involves comprehensive changes of a company's structures. Consequently, it is most appropriate to regard EMA, and its implementation in a Mittelstand company as a subjectively constructed reality that is best dealt with an interpretivist methodology. Indeed, since 2000 or so the interpretivist methodology has preferably been used to analyse companies, which undergo drastic changes (Stanfield 1999; Parada 2002; Scapens 2006).

3.2 Approach and Research Strategy

To answer the first two research questions, this study will primarily collect and interpret first-hand empirical data. This is done by means of a top-down deductive approach. The research starts with the three hypotheses derived from the literature review (presented in section 2.10). After having interpreted the related empirical data in question, the study will arrive at a conclusion that will either confirm or reject the definition of EMA, the definition of environmental costs, and the three hypotheses. The researcher will also deduce context-free information about the investigated issue (Franke 2002; Collins 2010) that enables him to answer the third research question ("What generalising conclusions can be drawn from the case study concerning the problems, advantages and disadvantages of EMA in the context of the German Mittelstand?").

To combine the interpretivist methodology with the deductive approach, this study comprises a primary and a secondary research. The primary research (informed and guided by the literature review) consists of efforts (including own observations and experience) that render first-hand information concerning the investigated issues. The secondary research consists of documentary evidence from the specific study beyond self-made notes.

As explained in chapter 2, the implementation of EMA triggers changes in social relationships and business routines. This is the case in Mittelstand companies, where personal attitudes and relations affect the business philosophy to a great extent. As these phenomena relate to descriptive factors rather than to a large-scale collection of numeric data (Punch 2005; De Glas 1986), this research will focus on small samples of qualitative data taken from the documentary evidence of the case study.

Collecting the qualitative data was done by means of a case study. According to Roberts & Scapens (1985: 444) "the only way to understand accounting practice is through an understanding of the firm's reality which is the context of accounting, and which is the reality that the accounting systems are designed to account for". This statement supports the use of a case study since it is an "empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin 2003: 13). Case studies have been generally accepted as a way to examine MA, and especially in the context of Mittelstand-like companies (Tsai et al. 2010; Bhasin 2013; Krishna 2013). Presently, the University of Essex, the Brigham Young University (Utah), and the INSEAD (France) share an online learning centre; it teaches MA with the help of case studies, many of which relate to Mittelstand-like companies (Seal 2015). This research study also chose a longitudinal time horizon. In fact, in behavioural studies, a longitudinal time horizon is more common due to the time needed for the observation, data collection and data analysis (Saunders et al. 2009).

3.3 Demands on Research Strategy and their Consequences

An empirical research strategy must have the following five qualities:

I. Internal validity: It warrants the correctness of the drawn causal conclusions (Levine & Parkinson 1994; Bless et al. 2007).
II. External validity: It ascertains the veracity of the research findings, i.e. their time and context free validity (Gravette & Forzano 2012).
III. Reliability: It ascertains the repeatability of the study's results (Golafshani 2003; Fellows & Liu 2008; Beck 2012; Strahonja et al. 2014).
IV. Suitability: It ascertains that the strategy only uses methods that are adequate concerning the research object (Strahonja et al. 2014).
V. Construct validity: It ascertains that a research strategy actually measures what it purports to analyse (Brown 2000; Beck 2012).

Internal Validity and External Validity

A qualitative research in an economic case study is generally carried out by means of (1) observations of persons in their common environment, (2) documentary evidence, and (3) interviews of participants (Shenton 2004; Scapens 2006). This study concentrates on making in-depth interviews because they can give a profound look into the entire organisation, but the researcher also makes observations to have a second source of first-hand information. The internal validity of interviews will be reached by (1) anonymising the interview, (2) choosing a representative sample of interviewees, (3) asking them the same relevant core questions, which have reflected the findings of the literature review, and the contents of the company's documents. To ascertain the external validity of the primary research, the case study will be an instrumental one: The particular case of a Mittelstand company using EMA will not be studied for its own sake, but to examine general problems. To this end, this study chose a larger Mittelstand company of the paper industry, which is environmentally sensitive. Hence, companies, which are active in this field, must plan the use of their resources cautiously (Umweltbundesamt 2015).

Reliability, suitability, and construct validity

The research aims, research objectives, research questions, the hypotheses, the company documents, and the results of the literature review will serve as a guideline for the interview. Therefore, the way of collecting the information will ensure the construct validity of the research, and also partly its reliability. However, this research intends to find out how EMA works in Mittelstand companies, and how it can be implemented in this kind of company. Therefore, this study will not focus on theoretical generalisations. That is why this study will not be completely able to ensure the reliability of its results.

3.4 Research Ethics

To observe the principles of research ethics this research will respect the interviewees' well-being, autonomy and dignity (The British Psychology Society, 2010: 8). This can be achieved by sticking to the following principles (Research Ethics 2008; Wisker 2008; Oliver 2010):

(1) The researcher informs the interviewees about the entire scope of the questions. He does this in written form by sending each interviewee a description of the interview two weeks in advance.
(2) He explains the procedure of the interview to every interviewee.
(3) He asks for the interviewee's freely informed consent.
(4) He executes the interview exactly as explained to the interviewee.
(5) He asks for the interviewee's consent to permit other researchers to use the findings of this interview in similar research projects.
(6) He abstains from any kind of covert or deceptive research.
(7) He strictly concentrates on asking relevant questions concerning the research issues, and avoids asking personal questions.
(8) He keeps the interviews confidential by anonymising them.
(9) He only accepts adults as interviewees.

3.5 Summary

The study will evaluate the EMA implementation in Mittelstand companies. To this end, chapter 3 has outlined its methodology. An interpretivist and deductive research methodology was chosen since it addresses the research issue and the research questions best. On this basis the research will be able to examine the implementation and functioning of EMA in a Mittelstand company with an instrumental case study. The way in which human behaviour affects the implementation of EMA is highly important for the case study. Therefore, it concentrates on obtaining qualitative information by means of interviews and company documents. The interviews will be guided by the results of the literature review, the documents, and the research questions. Based on these decisions, chapter 4 will develop a coherent and effective study design to the ends stated above. The interviews comprised several questions, which the case study sought to investigate

(1) how Mittelstand companies perceive the requirements of EMA,
(2) what is needed to implement EMA in Mittelstand companies,
(3) why Mittelstand companies are reluctant to implement EMA, and
(4) how the organisation of such companies affects the EMA implementation.

Subsequently, the findings of the interviews and the quantitative data from the company documents will be used to test the EMA-related hypotheses from the literature review. These tests will lead to conclusions concerning EMA implantations in Mittelstand companies.

4 Research Structure

4.1 Basic Research Design and Data Collection

To maintain internal and external validity, the research was done on a primary and a secondary level. The primary research was based on interviews with several relevant staff members of the focal company. It rendered first-hand objective facts, but also subjective data (i.e. the interviewees' opinions, reflections, intentions, etc.). These pieces of information were examined by means of a meta-analysis converting the qualitative data into quantitative data and thus allowing for its statistical analysis. The secondary research yielded objective facts, which were obtained from the company's documents and records. The following sections will explain the reasons for choosing this research design.

4.2 Reasons for Analysing Documents

Documents have a high scientific value for several reasons. Unlike oral communications, they are mostly written in a formal (and scientific) style and contain condensed information, which is often free from subjective inferences (e.g. opinions, judgements, etc.). Hence, information on a certain topic derived from documents can serve as an objective basis for further investigation. Comparing the contents of documents with corresponding oral statements can also help to check their veracity (Ellen 2006). Therefore, every accessible company document on the research topic was analysed in order to obtain data, which could serve as a theoretical basis for the expert interviews and their preparation. These documents are presented in table (7), which due to its length is in the appendix. The evaluation of these texts considered

- The reasons for choosing an EMA system.
- The implementation and performance of EMA.
- The background information on the company and reasons for EMA.
- The company's strategy.

This was done by means of

- Performance evaluation of the company related to EMA aspects giving hints for further implementation needs.
- Material flow analysis.
- Analysis of the quality management and eco-related sales procedures.

4.3 Reasons for Carrying out Expert Interviews

Interviews are useful to acquire a participant's experiences since the interviewer can interactively gather in-depth information around the topic (Bennett et al. 2003). Interviews are therefore suitable for exploring new topics whose scope is not fully known prior to the interview, and to maintain reliability. According to the subjective paradigm, the expert interviews were chosen to study the social world in the interpretivist way. Experts are people who have privileged access to information on important people or decision-making processes, and have a high level of specific knowledge that is otherwise difficult to access (Laudel & Glaeser 2010). The purpose of expert interviews is therefore to reconstruct specific knowledge bases and exclusive practices (Pfadenhauer 2005).

4.4 Basic Structure of Expert Interviews

Interviews have exterior and interior aspects. As for the exterior aspects, an interview can be structured, semi-structured or non-structured. Other exterior aspects are the number of the interviewers, the number and professions of the interviewees, and the conduct of the interview. The interior aspects refer to the content and format of the questions. Structured interviews are carried out with a fixed set of questions, while in non-structured interviews the interviewer spontaneously creates them. In semi-structured interviews, there are core questions and categories of questions outlining the content of the interview, i.e. the number, the character and the subjects of the questions. The number of core questions depends on 3 factors: (1) the duration of the interview, (2) the attention span, and (3) the complexity of the interview topic (idem).

4.4.1 Exterior Structure of Expert Interviews

Degree of Interview Structure

Concerning the exterior aspects, a semi-structured interview was carried out, since it allowed the interviewer to ask new questions provoked by the interviewee's previous answers. The interview was done face-to-face while being recorded for the following reasons: the interviewer could read the interviewee's body language, the interviewee could hand over additional documents; the workplace provided insights, a personal and trustful atmosphere of such an interview often made the interviewee disclose additional information (Laudel & Glaeser 2010).

Number and Characteristics of Interviewees

In the context of this case study the interviewees were selected from different departments connected with different aspects of EMA in order to get a comprehensive overview of EMA as it contributes to the organisational effectiveness in Mittelstand companies. The interviewees were experts in their department as they received reliable and relevant information. As some interviewees were part of the management, while others (e.g. the ones concerned with the production) were not, the group of interviewees constituted a cross-sectional sample of case organisation employees who would provide the best insights for this study.

As shown in table (8.1), some interviewees came from the same department, but they still were in charge of different tasks there. They were asked to give first-hand information about EMA and its implementation in the focal company as well as to comment on the experience made by other employees concerning the same issues.

Table (8.1): Code Numbers and Functions of Interviewees

Code Number	Function	Group
XY1, XY9, XY15	Department of Sustainability Management	1
XY2	Head of Department	2
XY14	Managing Director	
XY3, XY8	Controlling	3
XY6	Director of Sales	
XY4, XY10, XY11	Production	4
XY7	Head of Production	
XY13	Chemistry Specialist	
XY5, XY12	Head of Quality Management	5

The interviewees were attributed to five groups according to their functions and according to their involvement in EMA. The interviewees in group 1 and 3 had a comparatively deep involvement in EMA; the members of group 3 were deeply involved with respect to its accounting procedures, and the members of group 1 had in-depth insight into its connection with SMA.

Number of Interviewees

There are reasons for conducting an interview with two interviewers. Two interviewers can share their work, with one of them controlling the technique and procedure of the interview and with the other one keeping the minutes (Laudel & Glaeser 2010). However, within the study, the interviews were conducted by just the researcher himself. Due to its conservative business philosophy the company in question offered business-related information to trusted persons only. The management therefore declined the researcher’s proposal to collaborate with a second interviewee.

Duration of Interview and Number of Questions

In order to cover all aspects of EMA and not to exceed the interviewees’ attention span the average duration of the pilot interview was set to be 60 minutes. An adult’s attention span is defined as the maximum time he can concentrate on a task (Medina 2014; Dukette & Cornish 2009). Estimates about its duration range from ten (Medina 2014) to twenty minutes (Dukette & Cornish 2009). Taking the lower margin of ten minutes, the minimum number of core questions would be six. Respecting the complexity of the topic, the number of core questions was found to be twelve. However, the core questions relating to the technicalities of EMA (and its implementation) were subdivided into sub-questions, because the company at hand used various metrics and procedures to execute its EMA. The number of twelve was accepted, since an average time of five minutes for the discussion of each of the twelve topics would probably not exceed the attention span during an interview lasting 60 minutes.

In view of the exterior aspects, fifteen semi-structured expert interviews (with one participant each) were carried out in the company between February and March 2014, with each of them lasting approximately 60 minutes.

Conduct of Interview

The interview was carried out in two stages with the first one being a pilot interview and the latter one the real study. The pilot interview was a set of three preliminary interviews (carried out with one of three different interviewees each) with the intention to measure the duration of the real interview, to optimise its structure and to enhance the quality of its questions. The results of the pilot interviews validated the basic outline of the real interview, but some of its tactics had to be modified: It was found that the interviewees should be asked to regard the questions as a systematic body, and not as a collection of unrelated questions. While answering one question, the other question should serve as its context helping them to find an answer. On the other hand, the participants were also allowed to give an answer to one question beyond its context, when they were convinced that the other questions gave them a clue to find a reply. This precaution intended to decrease the number of time-consuming counter-questions, and to ascertain the relevance, completeness, coherence and clarity of the answers.

The second stage, i.e. the real study consisted of fifteen expert interviews, in which each interviewee was asked twelve core questions covering the central aspects of the research topics. The questions were open enough to allow the interviewees to give unexpected answers. This gave the interviewer the opportunity to ask counter-questions to obtain as much information from every interview as possible. While the interviewee was talking, the interviewer would listen or encourge the interviewee to talk freely. The interviewer abstained from interrupting and asking the interviewee questions that might lead him/her towards a pre-defined direction that would only confirm the interviewer's preconceived ideas. To ensure the internal validity of the whole analysis, a special method was used after the interview: Each interviewee was confronted with the statements of the other eleven participants, and asked, if he agreed with them. To avoid complications, the permissible answers were only yes or no.

Prior to the start of an expert interview, some formalities had to be done by both the interviewer and the interviewee in order to comply with the standards of research ethics. Two weeks before an expert interview, the interviewer sent the interview guide to the interviewees via email. This message also informed the participants that the interviews would be recorded. This gave them the chance to study the interview guide and to prepare themselves for the interview. Immediately before the expert interview, the interviewer summarised the content of the study, informed the interviewee about the duration, and asked if there were any questions or if more information on the study was needed. Then both sides discussed the research ethics. The interviewee was again reminded that the expert interviews would be recorded. These recordings were explained to be helpful for the interviewer (Mayer 2013). Each interviewee gave his/her consent for the recording. The interviewee was also informed that the expert interrviews were anonymised. The company's conservative business philosophy demanded a deviation from the norms of research ethics. Concerning the recordings and the anonymous nature of the interview, both sides had to sign a formal consent. Each participant had to sign the statement of agreement permitting the recording of the expert interview. But as the anonymous nature of the interviews was only a voluntary issue, the above-mentioned consent offered the interviewee the following two options:

(1) _______By initialling here, I also agree to be identified by name in the project and related materials.
_______By initialling here, I also agree to be identified by photograph in the project and related materials.

After both sides had signed the consent, the interviewee was given a signed copy. The end of the formalities initialised the expert interview. The interviewer used notes instead of fully formulated questions to prevent him from simply reading instead of talking to the interviewee. The notes also served the purpose of ensuring that the questions covered all topics (Reinders 2012; Mayer 2013).

4.4.2 Interior Structure of Expert Interviews

Content of Interview Questions

The research questions and the findings of the literature review were used to develop the interview's interior structure, which depended on core interview questions and an interview guide. The questions reflected the research issues stated above. Due to the study's interpretative character, the core questions were formulated partly in an open and closed form for the comparison of statements made by different interviewees.

There were three core questions concerning the implementation of EMA. Question 1 concerned the ways of implementing EMA, and the reasons for doing so. The sub-questions reflected the results of the literature review that Mittelstand companies are likely to experience benefits from EMA (question 1.1), and that there are barriers keeping many of them from implementing it (question 1.2). Question 2 referred to measures the company did not use in order to implement and to support EMA. With this question, the study at hand wanted to examine if the company's EMA strategy was comprehensive. Question 3 concerned the promptness of the effects of EMA, since especially Mittelstand companies expect a quick success of new measures. The (core) questions 1–3 were:

1. How and why was EMA implemented?

1.1 What were the drivers for doing so?

1.2 What were the obstacles and facilitating factors?

2. What additional measures might support the implementation and the use of EMA?

3. How does (or did) the implementation of EMA influence the accounting process? Were there any negative effects?

Another set of three core questions dealt with the general features of EMA. Question 4 pointed at its overall functioning and strategy. This question also intended to analyse how broad the strategy of the company's EMA was. With the questions 4.1, 4.2, 5 and 6, this survey wanted to examine if this company (unlike many Mittelstand companies) had the technical and organisational expertise to perform its EMA-related measures. The (core) questions 4–6 were:

4. How does EMA work, and how is it integrated in the company's accounting?

4.1 How does EMA account for the flows of material, energy and wastes?

4.2 How does EMA account for the cash flows related to material, energy and wastes?

5. How is the execution of EMA technically organised?

6. Who is involved in the process of EMA, and how are responsibilities organised?

The literature review has revealed that EMA involves the measurement of key indicators. Core question 7 referred to these tools as 'metrics', i.e. in a rather general way. This was done to allow for various different answers. Subtypes of this question referred to the use of the metrics (question 7.1), their object and goal (question 7.2), their relationship with the company's accounting system (question 7.3), and their efficiency (question 7.4). Core question 8 was used to find out if the management had an understanding of the basic concept of environmental costs. So, the questions 7–8 were:

7. Could you describe the use of EMA-related metrics?

7.1 What EMA-related metrics does the company use?

7.2 What do these metrics measure and why?

7.3 How are the metrics incorporated in the overall accounting system?

7.4 Are the metrics efficient?

8. Can you define environmental costs?

Core questions 9–12 intended to test the interviewees' general perception of EMA. These questions also sought to find out if the staff was familiar with EMA, and if it had a coherent understanding of it. Question 9 focused on the impact of EMA concerning the overall company's economic performance, question 10 on the pros and cons of EMA, question 11 on its efficacy and efficiency. As the literature review has also evinced that the term EMA is vague, question 12 asked the participants to define it. So, the core questions 9–12 were:

9. Does or did EMA influence the company's economic performance?

10. What are the benefits and disadvantages of EMA?

11. How would you rate EMA concerning its efficacy and efficiency on a scale ranging from 1 to 10 points?

12. Can you define EMA in your own words?

4.5 Analysis of Expert Interview

The analysis of the interview was based on a category system using seven evaluation categories, which were derived from the same research topics as the interview questions. The function of the above-mentioned system was to help the researcher categorise the interview answers, analyse them and check their relevance. In addition, the evaluation categories supported the researcher's search for causal patterns concerning the EMA implementation in the focal company (Mayring 2002).

Figure (1): Category System	
#	**Category**
1	Definition of EMA
2	Organisational Responsibilities and Technical Execution of EMA
3	Implementation of EMA
4	Influence of EMA on the Company's Performance
5	Benefits and Disadvantages of EMA
6	Efficacy and Efficiency of EMA
7	Definition of EMA

Figure 1: Category System

For analysing the interviews' content, a qualitative content analysis recommended by Mayring (2000, 2002, 2003) was applied. The interviews were transcribed from spoken to written language to facilitate their analysis. First, the recorded audio data were transcribed verbatim in order not to modify the statements made by the interviewees. Afterwards, the transcriptions were revised to eliminate language-related mistakes. During the transcription, pseudonyms were used for the interviewees, and other identifying details were changed as well. The relevant information was summarised by means of extracting the raw data from the transcribed interviews. The extracted raw data was further analysed (Laudel & Glaeser 2010).

Each transcribed interview was reviewed according to the evaluation categories in respect to the relevance of its information. Only the relevant information was then extracted and allocated to a category. The extracted information was linked to the passage in the text in order to control the original text during the analysis. After the extraction of the information, the material was further processed. First, the extracted material was sorted according to the research objectives. In the next step, similar statements were combined with synonymous information (Laudel & Glaeser 2010). Finally, the information gathered in the interviews was analysed in reference to the research goals.

As indicated in section 4.4.1, the interviewees' statements were weighed differently according to their function in the company. The interviewees' statements and their validity were:

Table (8.2): Groups of Interviewees

Code Number	Statement with High Validity on Topic	Group
XY1, XY9, XY15	Connection Between EMA and SMA, Environmental Affairs	1
XY2	Connection Between EMA and SMA, Laws and Taxes	2
XY14		
XY3, XY8	Accounting Affairs of EMA, Laws and Taxes, (to a minor degree) Connection between EMA and SMA	3
XY6		
XY4, XY10, XY11	Connection Between EMA and Production	4
XY7		
XY13		
XY5, XY12	Connection Between EMA and Production, (to a minor degree) Connection Between EMA and SMA	5

5 Focal Company and its Market Segment

5.1 Printing Industry in Germany

The focal company is active in the German printing industry, which is in need of an EMA for several reasons. In recent years, the productivity in the printing industry has risen. Here, the effects of the progressive automation and process streamlining can be observed. The use of a printing machine has numerous environmental implications, which concern noise, colour mist, paper dust, powder, ozone, volatile organic compounds and waste heat (Kleeberg 2008). A printing machine also produces CO_2, whose amounts depend on the paper, the energy, the pressure plates and other auxiliary materials used. The paper production is gas-intensive with a kilogram of produced paper causing average CO_2 emissions of 1.28 kg, leading to 6,400 tons of CO_2 p.a. Some 230 tons of CO_2 emissions are attributable to waste, followed by the printing plates with approx. 200 tons of CO_2, and the paints and coatings responsible for some 100 tons of CO_2 each (MMB 2013). The energy consumption is similarly high. Other factors affecting the environment are the cleaning products, dampening solution additives, alcohol and water. However, the introduction of new production methods has reduced the use of many chemicals. In offset printing, chemistry-free and ozone-free printing plates are the standard, now commonly known as eco-printing, short for ecological printing (Kleeberg 2008).

Printing companies adhere to environmental protection obligations under civil law and criminal law – from the shareholders down to the employees. To minimise the risk of liability, environmental management is a part of modern business management. At the corporate level, a liability insurance against environmental damage and personal injury is mandatory (Kleeberg 2008). This includes for example an integrated product policy. Ethical manufacturing principles are summarised in the EC Green Paper on Integrated Product Policy (IPP) of 2001. It calls for the producer's responsibility for the entire life cycle of their products. This demand is particularly relevant for packaging printers whose products should either have the most environment-friendly properties or participate in reusable or redemption cycles. 'The Product Design for Environment' is another programme developed in the US, which pursues the same goals. The reporting standards in this industry include, among others, the 'Sustainability Report'. It has evolved from the previous annual environmental report, but includes much more indicator areas, according to the 'Global Reporting Initiative' (GRI guidelines 2006). In the paper industry, the Sustainable Green Printing Partnership is also important. This initiative for the environment-friendly use of resources was founded in the US in 2007 by the ‘Printing Industries of America’ and related associations. In order to meet the requirements of EMA in this industry, there are various instruments such as environmental management in general, environmental controlling or material flow management (cf. 2.7). Hence, the printing industry encompasses all central aspects that recommend the use of EMA. Its production processes are energy-intensive, and they affect the environment detrimentally in many ways. Therefore, the printing industry is obliged to run its production procedures according to environmental laws and regulations. Furthermore, the production procedures and the reporting must also conform to international standards, which reflect the international pressure on this industry. In terms of its turnover and number of employees, the printing industry is also economically important. More than 50% of the companies from the paper industry are Mittelstand-like companies (MMB 2013).

5.2 General Characteristics of the Focal Company

The case study refers to a family-owned and family-managed European company working in the field of eco-printing and derived timber products. It has been active in its field for about 125 years. The implementation of EMA took place in 2010, and before that the company did not use any form of EA. In 1969, the company founded a department with focus on the domain of eco-painting, which has developed into the company’s most important operational field. In order to conquer foreign markets with international subsidiaries, the company was converted into the family-managed holding called ACME-Print[1] in 1986. The holding now comprises twelve subsidiaries (one in Germany and eleven abroad) with similar names, namely ACME-Print-Germany, ACME-Print-Brazil, ACME-Print-Italy, etc. They all operate in the field of eco-painting, seven of them have their own production facilities, while the other five are sales and service departments. Both the German subsidiary (ACME-Print-Germany) and the holding (ACME-Print) are headquartered in the same German city and owned by the same family, who has possessed them ever since. In 1986, the newly founded holding ACME-Print (the focal company of this doctoral thesis) was a medium sized firm with 138 employees and an annual turnover of DM50 million. Today it has about 1,200 employees and a turnover of ca. €266 million. Its subsidiaries are

[1] Note: ‘ACME-Print’ is a fictitious name.

found on all continents, except Australia. The German subsidiary has 350 employees and a production capacity of 500 m^2, compared with 1700 m^2 of the entire holding (ACME-Print). ACME-Print only issues one balance sheet containing the aggregated financial data from all subsidiaries (ACME-Print website). Therefore, the focal company of this doctoral thesis is the ACME-Print comprising all subsidiaries. The following figure outlines the management board of the focal company.

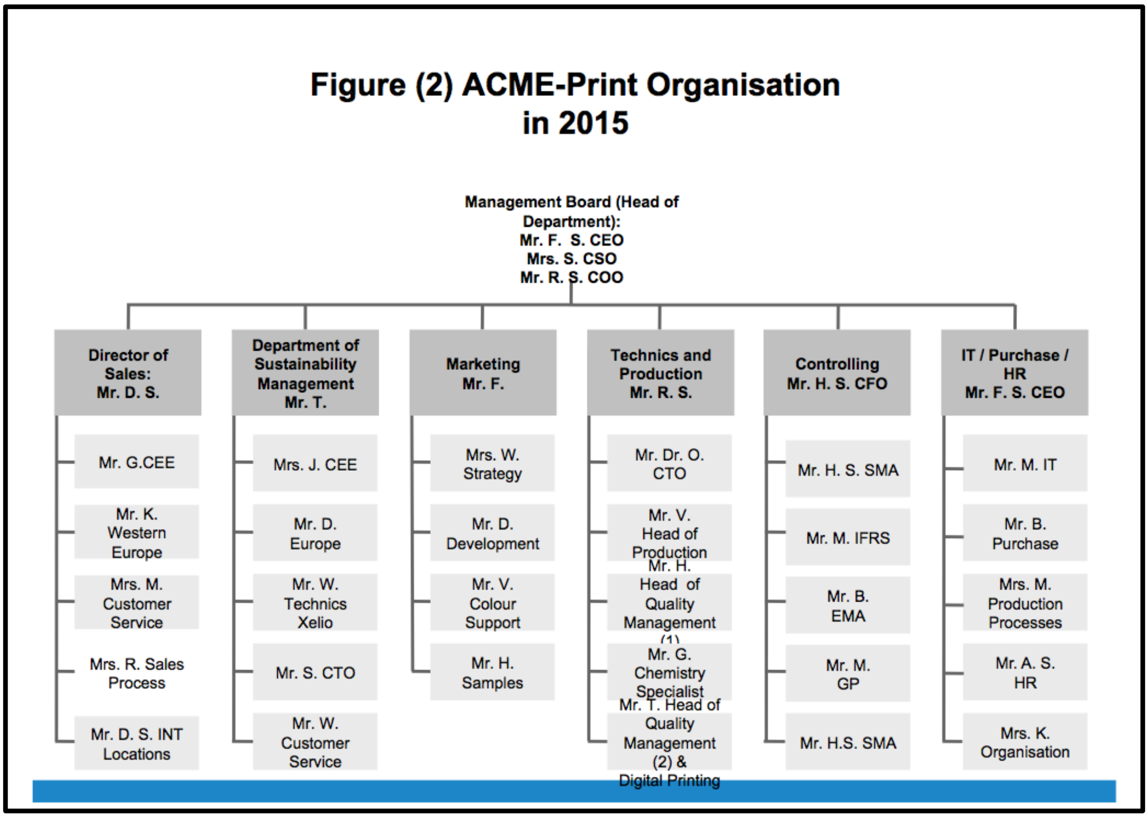

Figure 2: ACME-Print Organisation in 2015

Table (7): Basic Accounting Figures of the ACME-Print				
Position / €	2010	2011	2012	2013
Assets	175,243.00	182,391.00	188,952,00	183,303.00
Turnover	–	234,011,434.36	257,291,584.31	265,738,832.18
Gross profits	–	86,793,301.14	92,327,289.90	97,960,557.09
Net group profits	–	11,735,354.10	11,080,637.22	12,945,705.35
Source: balance sheets of the company at hand				

With respect to its turnover, gross and net profits, the ACME-Print has witnessed a positive development in the last three years as table (7), an abridged version of the balance sheet, shows. Due to its number of employees and turnover ACME-Print is the greatest company in the field of eco-printing. It works with a worldwide total of 29 production machines with an overall capacity of 1.7 billion m². The production compartment (located in the German subsidiary), called ‘business cockpit‘, works with eleven machines, which are defined by these features: the way they are used, the number of covered orders, the speed of production, periods of standstills, volume of output, output per hour, changes of these features per year (Prodreport 2014). ACME-Print is also one of the leading decor printers in the world. It colours and decorates the surfaces of numerous materials in the segment of derived timber products, including living room, kitchen and bathroom furniture, laminate flooring, interior furnishing in trains, ships or in the recreational vehicle industry. Last year’s output was 873 Tm^2, an increase of 7.5% compared to 2012 (annual economy report of 2013). The most important raw materials are décor papers and printing inks. The company’s ink is water-based and organic, the used paper is free from heavy metals and every waste is recycled. Likewise, no heavy metals, solvents or other inorganic compounds are used in the colouring or bonding agents. A materials flow plan details the requirements for storage, processing, handling, and disposal of all dangerous substances used in the company’s laboratory facilities and ancillary departments. ACME-Print separates waste décor paper, packaging material and film so that these items can be recycled. Waste is thermally recycled, while domestic waste and sewage sludge from the wastewater treatment are disposed of conventionally by an outside company (‘Prozessablauf 003’ 2013; ‘Inspiring People’ 2013; ‘Selbstverständnis’ 2013; ACME-Print website 2014).

Based on the findings of section 2.1, the ACME-Print can be identified as a Mittelstand company, namely with two quantitative characteristics (turnover, number of employees) and three qualitative characteristics (independence, unity, and a special business culture). As for the quantitative characteristics, a Mittelstand company must have between 10 and 3,000 employees, and a turnover between €1 million and €600 million, which is the case with the ACME-Print (Deloitte 2011; Becker 2008). The focal company also possesses the three indispensable (‘hard‘) qualitative characteristics:

(1) Economic and judicial independence (Hausch 2004; Pfohl 2006; Damken 2007): The holding ACME-Print belongs to one family only, and is therefore independent in economic and judicial terms.
(2) Unity of (or at least close relationship of) property, control and leadership (Hausch 2004; Reinemann 2008): The management has a “lean structure able to make decisions quickly”, which is furthermore open to innovations. The “mid-sized company philosophy is also strictly applied to the organization” since “at the holding headquarters […] a small team of qualified employees conduct” the

"Strategic Marketing, Business Management/Controlling and Tax/Accounting". For the sake of flexibility, quick decision-making, and "individual entrepreneurial creativity", the management staffs of the company and the other subsidiaries have a certain degree of independence. Strategic decisions, however, are brought about in joint consultation between the management of the holding and its subsidiaries. A "team of experts of the holding […] are always in direct contact with the subsidiaries" (website of the company and its holding). Therefore, one family does not only own the company, but it is also managed by a small circle of people with high expertise, who are mostly members of this family. In addition, one of the two executives of the holding is a member of this family, too.

(3) Close interplay of (inherited) business culture, organisational structure, and long-term business strategy (Becker et al. 2007): The organisational structure of the focal company involves a low level of formality, direct personal contact between internal decision-makers, and short flows of information (idem).

Apart from that the ACME-Print also displays 4 of the 5 "soft" Mittelstand characteristics (only collaboration is not mentioned in the companies' files):

(4) Collaborative Spirit: Despite the large number of employees, the company expects a strong personal commitment, "close employee relationships and motivation" (website of the company and its holding).
(5) Risk Aversion: In spite of the large turnover and profits the ACME-Print acts as though it were a company with limited financial resources, because it pursues "a strategy of solid, sustainable growth" combined with "a strict reinvestment policy within the group […] without the risk of a heavy burden of debt" (idem).
(6) Preference of four industrial sectors: As a company devoted to eco-printing, the ACME-Print works in the sector of chemicals. The supply chain is characterised by "close customer relationships […] orientation, [and] innovation." The company does not concentrate on its local economy cycles, but follows a strategy of internalisation. On the other hand, it does not intend to expand its activities into new business fields, but it sticks to its strategy to "become market leader in its segment" (idem).
(7) Exports: The company is export-oriented with international subsidiaries.

Therefore, the ACME-Print can be regarded as a Mittelstand company with respect to its qualitative and quantitative characteristics and due to its business philosophy – a statement, which can be found on the company's website.

5.3 EMA of the Focal Company

5.3.1 Preliminary Explanation

When this study was performed, the focal company's EMA was undergoing deep changes. So, at that time the company's documents had already been obsolete. Therefore, to give a basic impression of the company's present and future EMA, this section will not only use the company's documents, but also the corresponding information derived from the interviews.

5.3.2 Basic Concept of EMA

In 2009, the company implemented EMA, which became operational on 1st of January 2010, and has been in use ever since. The ACME-Print defines its EMA as the sum of its systematic efforts which apply to the following fields of action: (1) book keeping, identification, accounting and calculation of eco-related cash flows, environmental costs and conventional costs linked with physical flows; (2) accounting and calculation of investment affairs with environmental aspects (e.g. investments into environmentally friendly production processes); (3) accounting and calculation of sale, purchase and marketing of environmental sensitive material (including substances), machines and production software; (4) calculating the environmental impact of production processes and products (through environmental costs), (5) reporting of this information to personnel of the SMA (‘Controlling Vertrieb‘ 2011; ‘Controlling Grundlagen‘ 2013; ‘Inspiring People’ 2013). Therefore, the focal company generally shares the definition of EMA and its goals as shown in the literature review. EMA has to help the SMA to bring about economically and environmentally sound decisions by being executed in 5 steps by 5 groups of internal stakeholders as shown in table (10):

Table (10) EMA-related Duties and their Stakeholders

Stage	Stakeholders	Duty
1	Employees in departments affected by physical flows	Determination of identities and amounts of physical flow components and outstanding occurrences
2	One EMA accountant	Identification degree of dangers of environmentally critical flow components and occurrences
3	Group of senior accountants	Calculation of conventional material costs
4	One chemistry specialist	Calculation of environmental costs concerning the environmentally critical phenomena
5	Management	Use of EMA-Related information for SMA decisions

Cf. XY1 – XY12, q. 6, pp. 33-39.

The environmentally critical phenomena that EMA is concerned with are: critical occurrences (technical failures/accidents and man-made mistakes) and physical phenomena regarded as environmentally hazardous; these phenomena are consumption of water, wood, fuel, and electric energy; production of solid and liquid waste (hazardous or not, including wastewaters), gas emissions, re-used or recycled substances (cf. XY1, q. 7, p. 38-41 / XY5, q. 7, p. 42; with *q* standing for *question*).

The estimation of the conventional and environmental costs of these phenomena is done with five types of metrics called metrics of the first degree, which are based on the standards of ISO 14001 and BS 8555/Acorn. The first two of these metrics are the quantity (or number) of an environmentally critical phenomenon and its price per unit; with these metrics the accountant measures the conventional price of such a phenomenon (cf. 'Controlling Vertrieb' 2011; 'Controlling Grundlagen' 2013; 'Prozessablauf GF 003' 2013; 'Inspiring People' 2013). For estimating the hazardousness (and the environmental costs) of the dangerous entities, there are physical-related, chance-related and law-related metrics (cf. XY1, q. 7, p. 38 / XY2, q. 7, p. 39-40). All kinds of metrics are combined with benchmarks that the measured quantities must not exceed. These benchmarks are the result of a long-lasting process of trial and error (cf. XY1, q. 7, p. 39ff. / XY2, q. 7, p. 41-42 / XY3, q. 7, p. 42-43 / XY4, q. 7, p. 43).

Reflecting section 2.8.1 of the literature review, one can say that these facts do not disclose the strategic pattern of the EMA implementation. On the other hand, it is obvious that the ACME-Print has implemented EMA 'within the existing accounting information system to assist the management process' and that this complex information system now includes 'budgeting, costing, investment appraisal, performance evaluation, internal reporting and risk assessment'.

5.3.3 Measurement of Environmental Costs and Gains

Stage 1: Determining Identities and Quantities of Critical Phenomena

The company uses basically the same definition of environmental costs as defined in the literature review (cf. section 2.8, p. 48; XY1–XY15, q. 8, pp. 50-51). Their calculation comprises the first four of the total five stages. First, the amounts and identities of the physical flow components are determined by the stakeholder group and by means of technical devices. Accountants and the production personnel measure the amount of fuel with the 'Fuel-Charged-to-Power' metric:

$FCP = \frac{F - \frac{Q}{E}}{P}$, here F and Q are the amounts of fuel and heat; E is the efficiency of the power plant, and P its power. As for the amounts of the flows of hazardous chemicals, the ‘Dry Sorbent Injection‘ is used. This method measures the content, and therefore the amounts of pollutants in the exhaust gas stream by making them react with special substances. The energy consumption is measured by the energy consumption device Voltcraft ENERGYCOUNT 3000. The amounts of water are measured conventionally (i.e. with turbines and pipes), while the masses of wood and other harmless solid substances are simply weighed. These measurements are done by the production personnel. The mere amounts (or numbers) of flow components (or occurrences) are called quantity-related metrics (cf. XY5, q. 7, p. 44–45). The outstanding occurrences are counted on a monthly basis (cf. XY1, q. 7, p. 39–40).

Stage 2: Identification Degree of Dangers

In order to identify hazardous flow components (and to estimate the degree of their danger), the EMA accountant uses computer databases and laws; he often also takes advice from third parties like the chemistry specialist, the senior accountants, or the management. The physical-related metrics applied to measure the intrinsic hazardousness of (mostly chemical) substances are based on a computerised database, which lists all chemicals that are present in the physical flows of the company. This database functions according to a system of registry numbers of the chemical abstracts service (CAS), i.e. with the so-called CAS registry numbers. The CAS number of a substance reflects the principal degree of its danger for the environment. However, in many cases, the degree of these perils is amplified in dangerous production processes. Therefore, the EMA often needs the chemistry specialist’s advice to identify the actual environmental hazardousness of a (mostly) chemical substance (XY1, q. 7, p. 3941).

Law-related metrics derived from country’s environmental laws also determine the environmental costs of a certain physical flow component. The German environmental laws are the basis for environmental taxes and penalty charges. Electric energy, fuel, water and wood are also always considered environmentally critical by German environmental laws. They set benchmarks for the use of these entities, determine environmental taxes concerning their acceptable consumption, and define penalties for infringements, i.e. for excessive or wrong use. In the context of law-related benchmarks the EMA accountant is helped by the senior accountant, when legal regulations have changed. Using the physical metrics, the law-related metrics and the benchmarks, the EMA accountant concludes an environmental price per unit of the component in question (cf. XY1, q. 7, p. 39ff. / XY2, q. 7, p. 41–42 / XY3, q. 7, p. 42–43 / XY4, q. 7, p. 43 / XY7, q. 7, p. 46). Waste is always deemed environmentally critical, even when it is not poisonous. Wasted resources are defined as amounts of energy, water and solid input materials consumed by inefficient activities so that they do not add any economic value (Defra, 2011). Similar procedures take place when the EMA accountant has to judge the dangers of outstanding occurrences (XY1–XY12, q. 7, p. 39–50). In addition, the accountant uses chance-related metrics to estimate their hazardousness, the probability of an accident, and what costs might ensue, e.g. for the clean-up. (cf. XY5, q. 7, p. 44).

Stages 3 and 4: Calculation of Conventional and Environmental Costs

The conventional costs of materials and energy are calculated by multiplying their amount with their market price per unit. If the materials were identified as harmless, no environmental costs are calculated. Such components are always solid substances such as salts, natural ingredients, or inflammable oils (cf. XY1, q. 7, p. 39ff.). In a similar way, the accountant multiplies the environmental price per unit of an environmentally critical flow component (or occurrence) by its amount (or number). There are, however, three estimates of the environmental price per unit: reliable, comparatively reliable and vague ones.

Stages 3 and 4: Reliable Estimates of Environmental Costs

Environmental price and cost estimates of a physical entity are considered reliable, if their degree of environmental danger is only calculated with law-related and quantity-related metrics. The environmentally critical effect of these phenomena is proportionally linked with their amount in the measured physical flow. This is especially true for water, wood, fuel and energy but also for waste. The environmental price of water, wood, fuel and energy is their market price per unit plus environmental taxes per unit plus possible penalty fees for infringements (e.g. excessive consumption). The environmental costs then are the conventional material costs (measured amount multiplied by market price per unit) plus taxes, which also depend on the measured amount, plus possibly penalty fees (cf. XY1, q. 7, p. 39–41 / XY5, q. 7, p. 44–45).

Calculating the environmental costs of solid waste and liquid waste (including wastewater) is more complicated, but it still renders reliable figures. In the case of waste, one has to check the costs for its disposal and treatment, which are generally more expensive when the hazardousness of the waste is higher. For estimating the hazardousness of waste, there is the directive of the European Union 91/689/EWG. It lists 839 kinds of solid or liquid wastes, 405 of which are labelled as environmentally dangerous (cf. XY1, q. 7, p. 39–41 / XY5, q. 7, p. 44–45). The degree of the hazardousness of a waste type sets the conditions for its disposal or treatment, which translates into a corresponding environmental price per unit. If this environmental price per unit is multiplied by the amount of the waste, the results are the costs for waste treatment and disposal. The environmental costs of waste then are the costs for its disposal or treatment plus taxes, which also depend on the measured amount, plus possible penalty fees. So, the environmental costs of waste depend on these three factors: (1) amount of solid or liquid waste produced in a production process (or for a product), (2) degree of its hazardousness, (3) price of treatment or disposal (cf. XY1, q. 7, p. 39–41 / XY5, q. 7, p. 44–45). Taxes and penalty fees are the final type of reliable environmental costs. They depend on legal regulations, and are therefore easy to predict. In the focal company, penalty fees occur extremely rarely (cf. idem).

Stages 3 and 4: Comparatively Reliable Estimates of Environmental Costs

Environmental price and cost estimates of a physical flow component are considered comparatively reliable, if the degree of its environmental danger does not only depend on laws and quantities, but also moderately on chancy circumstances. This applies to most hazardous input materials, because their threat to nature depends on their chemical and physical characteristics, but also on the production process they are used in. Production processes of the focal company are often complex and give rise to unpredictable technical accidents or failures and man-made mistakes. The environmental danger of a production process is estimated by means of the number of legal infringements, technical accidents or failures and man-made mistakes that occurred in its history. Therefore, the environmental prices and costs of an environmentally critical substance are estimated higher if it is used in a dangerous process (cf. XY1, q. 7, p. 3941 / XY5, q. 7, p. 4445). The estimation of the environmental costs therefore has to consider the amount and hence the conventional material price of the substance, but also the likelihood of an accident involving costs for remediation. Hence, the EMA accountant consults the management or uses benchmarks, which are the result of trial and error experience (cf. idem). Consequently, the environmental costs of an environmentally critical flow component (other than waste, water, wood, energy, fuel) depends on these three factors: (1) amount of component present in a production process, (2) its principle chemical and physical danger per unit unrelated to the process, (3) the susceptibility of the production process to accidents or mistakes, which entail the likelihood of costs for remediation. Therefore, in this case the EMA accountant has to balance the influences of these three factors to estimate the environmental costs. Usually, the latter two factors translate into the principal environmental price of the flow component in question, which multiplied by its quantity, will result in the environmental costs. However, the EMA accountant uses several benchmarks to perform these estimates (cf. XY1, q. 7, p. 39 / XY2, q. 7, p. 41–42 / XY5, q. 7, p. 44–45 / XY8, q. 7, p. 46–47 / XY10, q. 10, p. 47–48).

In order to improve the reliability of the environmental cost estimates of these substances, the focal company has begun to calculate them in a different way since November of 2015. The environmental costs of the flow components in question now consist of two parts: (1) a comparatively reliable part formerly estimated in the way described above, and (2) a reliable part, which comprises the environmental costs for the production/consumption of waste, electric energy, fuel, water and wood that are connected with the treatment or production of the substance in question. These cost estimates are still calculated as before. As all physical flow components of this company “involve the production of certain amounts of waste, and the consumption of electric energy, fuel, water and wood, it is advisable to use these amounts as indicators for the environmental costs of the examined flow components” (cf. XY1, q. 4, p. 19).

Stages 3 and 4: Vague Estimates of Environmental Costs

Environmental price and cost estimates are considered to be vague whenever the phenomena in question are complex and/or when chance plays an important role. These phenomena are hazardous occurrences, namely technical accidents or failures and man-made mistakes, remediation and prevention efforts. Technical accidents/failures and man-made mistakes are by nature unpredictable and they often also cause unpredictable damages to interior materials and to the environment, and give thus rise to both material and environmental costs. Costs for remediation and prevention are also difficult to measure, since they either relate to unpredictable accidents and mistakes or to changes in the environmental laws. However, environmentally critical occurrences, which have caused substantial environmental costs, have been extremely rare for the last ten years (cf. XY1, q. 7, p. 41 / XY5, q. 7, p. 45). The following table (11) outlines the company's environmental cost estimation.

Since November of 2015, the company's experience has revealed that the reliable part of the environmental costs of the hazardous substances covers at least 90% of their complete environmental costs (cf. XY5, q. 7, p. 45). Hence, the total environmental costs of hazardous substances are increasingly calculated by multiplying the reliable part by the factor 1.1. The company plans to calculate the environmental costs of all hazardous substances this way by the end of 2016 (cf. XY1, q. 7, p. 41 / XY5, q. 7, p. 45 / XY15, q. 5, p. 32).

Stage 5*: *(5) Further Use of EMA-Related Information

The calculations of the conventional material and environmental costs are carried out for each production process and product and for the entire value chain. The accountant then sends this information to the managers, who use it for the managerial decisions mentioned above (cf. XY1–XY12, q. 6, pp. 33-39).

Table (11): Outline of Environmental Cost Estimation

Task, Result	Object				
Determine	Identities and amounts of flow components and outstanding occurrences				
Identified as	Energy Fuel Water, Wood	Waste	Hazardous Input material		Accident Failure Mistake
Calculate	Conventional material costs unrelated to process	Conventional material costs unrelated to process	Conventional material costs unrelated to process		X
Determine	Hazardousness	Hazardousness	Hazardousness		Hazardousness
Apply Metric	Law	Law Chance	Law Chance		Law Chance
Calculate or Estimate Costs for	Taxes, Penalties	Taxes, Penalties, Hazardousness	Energy Fuel Water Wood Waste	Taxes Penalties Hazardousness Remediation	Taxes Penalties Hazardousness Risks Remediation
Determine: Cost Certainty	Reliable	Reliable	Reliable	Comparatively Reliable	Vague
Calculate Estimate: Complete Environmental Costs	Material costs* Taxes Penalties	Costs for disposal or treatment Taxes Penalties	Material Costsº Taxes, penalties Remediation Hazardousness Risks		Material Costsº Taxes Penalties Remediation Hazardousness Risks
Use Main Stakeholder	EMA accountant Senior accountant	EMA accountant Senior accountant	EMA accountant Chemist Senior accountant		EMA accountant Chemist Senior accountant Management

Material costs* = Material costs (including costs for energy) unrelated to production process;
Material costsº = Material costs related to production process

With the knowledge gained from section 5.3 it is now possible to partly answer research question 1.[2] Although it would be premature to present generalising conclusions at this point, one can already state that EMA has brought about many advantages for the focal company. EMA measures the flows and costs of all hazardous entities (i.e. environmental costs), plus the flows and costs of all harmless substances, thus enabling the SMA to optimise the company's overall consumption of resources. However, such a comprehensive accounting system requires much work and expertise in many fields (classical accounting, chemistry, physics and judicial issues). This may, however, become a barrier for Mittelstand companies, which do not have the necessary experts or the financial resources needed to hire them (cf. 2.8).

[2] What generalising conclusions can be drawn from the case study concerning the problems, advantages of EMA in the context of the German Mittelstand?

5.3.4 EMA Beyond the Calculation of Environmental Costs

5.3.4.1 Secondary Metrics

The company also uses purely numerical metrics of the 2nd degree based on the ISO 14001 & BS 8555/Acorn Standards. EMA creates them by dividing environmental costs by important conventional financial figures. These second-degree metrics are:

(1) R_{WA} : Rate of Waste on Operating Assets
(2) R_{WO} : Rate of Waste on Total Output
(3) R_{HWO} : Rate of Hazardous Waste on Operating Assets
(4) R_{HWT} : Rate of Hazardous Waste on Total Output
(5) R_{EO} : Rate of Emissions on Total Output
(6) P_{RR} : Percentage of Renewable Resources to Total Use of Resources
(7) ELR : Environmental Loading Ratio
(8) EIR : Emergy Investment Ratio
(9) ECE : Environmental Costs per Employee
(10) ERE : Environmental Revenues per Employee
(11) ECG : Environmental Costs covered by Grants
(12) ERG : Environmental Revenues covered by Grants
(13) ECP : Environmental Costs per Product
(14) ERP : Environmental Revenue per Product
(15) ECPr : Environmental Costs per Process
(16) ERPr : Environmental Revenue per Process

Some of these metrics require explanation: Emergy is the energy needed to create a product or to provide a service; whereas the environmental loading ratio is total amount of non-renewable and imported energy released per unit of locally renewable resources (Odum 1996). Environmental revenues are environmental earnings and savings (cf. 2.1.2) plus environmental profits. Environmental profits are those profits that are derived from products that are advertised as environmentally friendly (cf. XY2, q. 3; XY12, q. 4). These metrics are used in an environmental balanced scorecard (EBSC) to highlight the company's overall environmental performance and its related trends at a glance. With the exception of the secondary metrics of environmental revenues, smaller figures of secondary metrics indicate a higher environmental performance of the focal company (cf. XY1, q. 7, p. 39 / XY2, q. 7, p. 40 / XY3, q. 7, p. 41 / XY4, q. 7, p. 41 / XY6, q. 7, p. 43 / XY7, q. 7, p. 43).

The use of secondary metrics answers a part of the research question 1.2.[3] As these metrics do not only measure costs, but also revenues and physical phenomena (e.g. waste, energy and resources), it becomes obvious that the focal company intends to

[3] "How does it (= the focal company) integrate its environmental costs into its accounting system and how does this affect its corporate actions?"

use them for managerial decisions that affect the entire production process, and not only cost reductions.

5.3.4.2 General Trends and Actual Products

The EMA of the focal company does not only use techniques for the identification of environmental costs, it also uses methods to analyse them. It thereby produces results that are the basis of managerial decisions to reduce these costs. The observed form of EMA does not employ target costing, direct costing, life cycle analysis, because according to interviewee XY3, this would "complicate the decisions of" the company's "strategic management accounting" (cf. XY3, q. 5, p. 27). The company, however, uses "an input-output analysis, full cost accounting, activity-based costing, flow cost accounting, and an environmental balanced scorecard" (cf. idem). For each product and its related process, the company has an EBSC providing information about the central environmental costs by showing the actual environmental costs or related numbers, e.g. secondary metrics. By doing so, the scorecards also render pivotal information about the environmental quality of a process or product (cf. XY3, q. 5, p. 27 / XY5, q. 5, p. 28). In order to facilitate the identification and accounting of environmental costs, EMA allocates related forms of environmental costs to defined cost categories. The most significant examples of these categories are the costs for electric energy, water, wood, fuel and waste; other environmental categories refer to the costs of prevention and remediation, the costs of environmental taxes and penalty fees (cf. XY1, q. 4, p. 21).

As for the production processes, this case study was not able to obtain the data of all products due to company secrets. It was, however, possible to get the data of the following four product lines and the entire product output in connection with the influence of EMA as shown in table (12). In other words, the SMA helped EMA to launch the following four product lines, because this accounting system could calculate their environmental and conventional costs. These four products are of particular importance, since they include all the environmentally critical substances the focal company uses for its production process.

<table>
<tr><th colspan="4">Table (12): Influence of EMA on Production</th></tr>
<tr><td>Product name</td><td>Product description</td><td>Reduced consumption of substances needed for products:</td><td>Reduced production of:</td></tr>
<tr><td rowspan="2">(0) All products</td><td rowspan="2">–</td><td rowspan="2">water, energy, fuel, formaldehyde</td><td>liquid breakdown products from substances used for final products</td></tr>
<tr><td>CO2, chlorine</td></tr>
<tr><td rowspan="2">(1) Xelio Finish-Foil</td><td rowspan="2">a new artificial coating used to cover floors, tables & desks.</td><td rowspan="2">+ bitumen & polystyrene</td><td>liquid breakdown products from bitumen, polystyrene</td></tr>
<tr><td>CO2-gas, chlorine</td></tr>
<tr><td rowspan="3">(2) Teco-Foil</td><td rowspan="3">a new partly artificial coating used to cover furniture</td><td rowspan="3">+ wood & cellulose</td><td>liquid breakdown products from formaldehyde</td></tr>
<tr><td>solid breakdown products from wood & cellulose</td></tr>
<tr><td>CO2, chlorine</td></tr>
<tr><td rowspan="2">(3) Finish-Flex</td><td rowspan="2">a new partly artificial coating used to cover all kinds of furniture</td><td rowspan="2">+ metals, wood, PVC</td><td>liquid breakdown products from formaldehyde, metals, PVC</td></tr>
<tr><td>CO2, chlorine</td></tr>
<tr><td rowspan="2">(4) Imawell</td><td rowspan="2">a varnish used to cover desks and tables</td><td rowspan="2">+ mineral oil, phenol, polystyrene</td><td>liquid breakdown products from formaldehyde, mineral oil, phenol, polystyrene.</td></tr>
<tr><td>CO2, chlorine</td></tr>
<tr><td colspan="4">Sources: bauschlinnemann.de, 2017; decorfinishfoils,vom 2017; frauenhofer.de 2017; imawell.de 2017; interprint.de, 2017; mediencommunity 2017; schattdecor, 2017; Stein 2014;</td></tr>
</table>

This section and especially table (12) highlight the fact that the focal company uses EMA to optimise its production process by using minor amounts of hazardous substances. This also answers research question 1.3.[4]

5.3.4.3 Ratio Analysis

For every process and product, the company carries out the environmental ratio analysis relying on twelve indicators, i.e. the secondary metrics presented in section 5.3.4.1. “For every index” the company “continuously measure[s] the underlying physical flows connected with the process or product in question. The results are updated every month and are compared with its target value, or in other words its goal” (cf. XY2, q. 5, p. 27). The values of all twelve indicators are written in an EBSC to highlight the company’s overall environmental performance. Table (13) shows the aggregated values of all products before (2010) and after (2015) the EMA introduction. The corresponding EBSCs for each product can be found in the appendix. The Environmental Loading Ratio (ELR) is the ratio of non-renewable resource use to renewable resource use, the Energy Investment Ratio (EIR) is the ratio of imported to indigenous sources, whether renewable or non-renewable. So, considering these

[4] Has EMA influenced the company’s performance for the better or for the worse?

indexes, and the index ‘percentage of renewable resources to total use of resources’ it is obvious that EMA measures the degree of the company’s participation in globalized forms of energy to the degree to which the company seeks locally available resources (cf. XY9, q. 5, p. 30).

Table (13.0): EBSC Values from January 2015 for all Products Before and After EMA Launch

I	R_{WA}	R_{WO}	R_{HWO}	R_{HWT}	R_{EO}	P_{RR}	ELR	EIR	ECE	ECG	ECP	ECPr	Q
R	18%	12%	4%	1.5%	3%	60%	20%	20%	100€	7000€	15€	900	B
	4%	2%	1%	0.5%	1%	80%	10%	10%	30€	3000€	5€	400	A

I – Index/ R – Result/ Q – Quality/ B – before EMA launch/ A – after EMA launch. Source: same as table 12

Table (13.0) reveals that all indicators show an improved environmental performance of the focal company. According to tables (13.1-13.4) this is also true for the four products listed in table (12). This overall positive trend was brought about by these prescriptions: (1) to replace harmful input materials with harmless ones, (2) to use smaller amounts of every input material including water and wood, (3) to use smaller amounts of energy, (4) to optimise the production processes to the same ends, and (5) to develop new and environmentally friendly products. These decisions were made by Mr. F.S., Mrs. S. CSO, and Mr. R.S. COO in late 2009 involving the departments of sustainability management, technics and production, controlling, and purchase. This strategic change used the information calculated by EMA, which showed that producing products in an environmentally friendly way would also be economically promising by cutting both conventional production costs and environmental costs. Exactly for this purpose EMA was implemented in the framework of the company’s SMA. This move and the decisions leading to it are documented in the following reports listed in table (9) in the appendix: Internal protocols (2009), Reports (environmental reports, environment-related press reports, 2009), Input Output Matrix (2009), Brochure ‘Das Selbstverständnis’ (2013), Document on the FSC (Forest Stewardship Council) certification (2010).

These statements again answer the research questions 1.2 and 1.3 in an affirmative way. EMA was obviously implemented at the interface between proper accounting and SMA leading to a decreased use of harmful and conventional resources, which in return reduced the environmental and conventional costs. The company’s corporate actions were changed by EMA, because it made different departments (departments of sustainability management, technics and production, controlling, and purchase) work together.

5.3.4.4 Flow Cost Accounting

The EMA of the company carries out its environmental flow cost accounting in two ways: with an input-output matrix, and with ESBCs for individual input and output materials. With the matrix, EMA measures (for all processes and products) the costs of the hazardous and non-hazardous inputs, and the costs of their hazardous and non-hazardous product outputs. In the identical way EMA measures the costs of hazardous and non-hazardous solid wastes coming from either the hazardous or non-hazardous inputs. Finally, EMA also measure the costs for wastewater and gas emissions created in a certain production process, and consequently also for all processes and products (cf. XY14, q. 5, p. 32). By this means, the company is able to track the flows of environmental costs attributable to all kinds of input and output materials. As this flow cost accounting considers the costs of both hazardous and non-hazardous materials, EMA and the SMA can compare their costs. In addition, this flow cost accounting compares the actual results with their goals offering the SMA the possibility to check if the environmental costs are too high. The main goal of this EBSC is to show the environmental cost-efficiency of a particular process. The company's EMA uses a combination of input-output analysis, and flow cost accounting, which traces (in two directions) the flows from the raw materials to the product output and to the wastes. The results are presented in the form of two EBSCs (cf. XY4, q. 4, p. 21–22 / XY5, q. 4, p. 22 / XY7, q. 4, p. 23 / XY8, q. 4, p. 23 / XY11, q. 4, p. 24 / XY14, q. 4, p. 25 / XY4, q. 5, p. 27–28 / XY5, q. 5, p. 28 / XY6, q. 5, p. 28–29 / XY14, q. 5, p. 32 / XY15, q. 5, p. 32). The corresponding scorecard for a monthly total product output is shown in table (14) before 2010 and after 2015. The scorecards for the other four products are in the appendix. This method does, however, not identify the individual input and output materials.

Table (14.0): EBSC from January 2015 for the Monthly Production of All Products in Million €

P	NHI	HI	Product output (+)		Product output (–)		Solid waste (+)		Solid waste (–)		Liquid waste	Gas	Q
			From NHI	From HI	From NHI	From HI	From NHI	From HI	From NHI	From HI			
R	250	11	200	2	25	3	20	2	3.5	2	15.5	8	B
	325	5	300	3	19	1	2.5	0.5	2,5	0.3	0.6	0.6	A

P: Process/NHI: Non-hazardous Input / HI: Hazardous Input /(+) non-hazardous/(–) hazardous/R – Result /Q–Quality /B–before / A–after / Note: ‘Liquid waste’ does not include waste water! Source: same as table 12

Table (14.0) and tables (14.1–4) in the appendix suggest that the new production strategy backed by EMA had a significant positive impact on ACME’s environmental and economic performance, which again answers research question 1.3 affirmatively. The amounts of the hazardous input materials were reduced just as the amounts of all kinds of wastes and gases. The product Xelio Finish-foil is a special case in point. Before 2010, the focal company had to admit that it was hazardous due to chemical gases it evaporated. After the EMA-implementation in 2015, the same product is now regarded as environmentally harmless. Again, the amounts of the same materials were reduced. Tables (14.0–14.4) also show that the amount of harmless input materials could not be reduced. So, in general (as for all products) and concerning the 4 products in question, EMA helped the SMA to bring about increased amounts of products alongside diminished amounts of hazardous input substances and waste.

Table (15) depicts an abridged version of an EBSC showing the fates of two exemplary hazardous and non-hazardous input materials (water & formaldehyde) and their corresponding costs in all processes. It shows the initial costs of an individual input material (column *Input*), the associated costs of (non-)hazardous product output (i.e. the intended products), and the costs of wastes. It is thus possible to calculate the environmental cost-efficiency of a particular input material and production process, as well the overall cost-efficiency of all production processes. The SMA can use this EBSC to find the most (environmentally) cost-efficient process for a specific input material. According to table (15) and tables (15.1-15.3 in the appendix), all hazardous substances are used in much smaller amounts compared to 2010. They appear now less often in products (both harmless and hazardous), and the quantities of their wastes have also shrunk. This means (thereby answering research questions 1.2 and

1.3) that EMA is valuable for the SMA by exactly tracking all physical flows and by calculating their costs. Again, EMA comes in at the interface of accounting and SMA.

Table (15) EBSC from January 2015 for the Input Materials Water and Formaldehyde								
Input material	+	–	Input	Output (+)	Output (–)	Waste (+)	Waste (–)	P
Water	Yes		5,000	500	0	4,400	100	1
			6,000	700	0	5,200	100	2
			5,000	800	0	4,150	50	3
			10,000	0	6,000	3,900	100	4
			…	…	…	…	…	…
			90,000	10,000	20,000	55,000	5,000	Σ
Formalde-hyde		Yes	20,000	15,000	0	3,500	1,500	1
			30,000	25,500	0	4,000	500	2
			50,000	0	45,000	4,000	1,000	3
			30,000	27,600	0	2,000	400	4
			…	…	…	…	…	…
			1,5 M	600,000	700,000	10,000	190,000	Σ
Explanations: (+) Non-Hazardous / (–) Hazardous / Costs in € / P = Process / M = Million								

In table (15), the numbers 1, 2, 3 and 4 refer to the products of table (12).[5] As shown in table (16), the company's EMA also uses an EBSC, reflecting the cost flows from the perspective of the product, i.e. from the output materials. This EBSC shows the cost-efficiency of the production process (P) of the four products as well as all products (process 1 in 2010) and after (process 2 in 2015) the EMA implementation. The SMA can use this information in order to find the most (environmentally) cost-efficient process for a specific product. A comprehensive version of table (18) reflecting all four products can be found in the appendix.

Table (16) EBSC-Data for Selected Products in 2010 (P 1) and 2015 (P 2)								
Product	+	–	Output	Input +	Input –	Waste +	Waste –	P
Teco-foil	Yes		6,300	9,500	1,000	3,005	2,195	1
			8,000	**9,900**	**400**	**1,900**	**400**	**2**
Imawell		Yes	5,000	3,000	250	1,100	650	1
			4,800	**4,250**	**150**	**330**	**70**	**2**
Finish-Flex	Yes	–	7,200	10,100	900	2,800	1,000	1
			9,300	**10,100**	**200**	**930**	**270**	**2**
Xelo Finish-foil		Yes	5,000	8,950	1,050	3,510	1,220	1
	No		**7,000**	**9,500**	**500**	**2,400**	**300**	**2**
All Products	No		2,002 M	2,002 M	2 M	22 M	29 M	1
		Yes	28 M	25 M	3 M			
	No		**303 M**	**300 M**	**3 M**	**3.0 M**	**2,8 M**	**2**
		Yes	**20 M**	**19 M**	**1 M**			
+ = non-hazardous; – = hazardous / Cost in € / M: Million / P = Process. Source: same as table 13								

[5] Detailed versions of table (15) showing all substances in 2010 and 2015 are in the appendix.

Table (16) also indicates that the focal company has increased its production; Imawell is the only product of the mentioned item group that is produced at slightly smaller amounts. At the same time, the amounts of environmentally friendly products have risen at the expense of hazardous ones. Again, this table shows that the amounts of waste (both hazardous and non-hazardous) have declined. This statement again answers research question 1.3 affirmatively. EMA has not only improved the company's environmental performance, but also its economic one.

5.3.4.5 Full Cost Accounting

The focal company uses three types of environmental accounting, which it calls full cost accounting. The first type (cf. table 17.1) refers to all basic environmental and conventional cost categories of a certain process. The choice of these cost categories was not explained in the interviews. It is nevertheless apparent that the company does not only wish to demonstrate the economic performance of its products and production processes, but also their environmental gains.

Table (17.1): Environmental Cost Categories of Specific Product or Processes (Monthly Costs in January 2015 in Million €)

Type of environmental cost or gain	P_1	P_2	P_3	P_4	All P_i
Complete production costs caused by	0.20	0.25	0.19	0.18	11.0
All environmental costs caused by	0.01	0.01	0.01	0.01	0.11
Environmental costs due to legal reasons caused by	0	0	0	0	0
Used amount of conventional assets for	0.09	0.11	0.08	0.05	4.50
Used amount of environmental assets for	0.03	0.05	0.03	0.02	1.05
Overall turnover caused by	0.55	0.60	0.45	0.40	22.17
Eco-related turnover caused by	0.14	0.15	0.13	0.12	5.33
Overall profits caused by	0.08	0.09	0.08	0.06	1.01
Eco-related profits caused by	0.02	0.03	0.02	0.01	0.23

P: specific process or product (cf. XY2, q. 4, p. 20 / XY10, q. 5, p. 30–31) The corresponding table for 2010 can be found in the appendix. Source: same as table 12

Inversely, the company also measures the various types of environmental costs for non-product output materials and hazardous input materials as seen in table (18.1, type 2). The company obviously does not make any profit with its non-product output. However, the company's EMA detects all environmental costs of the non-product output and assigns it to its cost category. This again underlines the company's thorough management of its environmental costs. However, scorecards (17.1) and (18.1) do not consider the environmental cost categories wood, electric energy, fuel and water.[6] Since November of 2015, the company has been considering these costs for every input/output material and all processes in a new EBSC as shown in table (19, type 3). This scorecard is important, because since then these cost categories have been increasingly used to measure the environmental costs of all hazardous substances (cf. 5.3.3).

Table (18.1): Environmental Costs of Non-Product Output and Hazardous Input in January 2015 in Million €									
Environmental Cost type	**Entity**								
	Input (–)	Waste (–)	Waste (+)	Waste-water	Gas	Ground-water	Effects on biosphere	Health care	Σ
Treatment	0.01	0.04	0.05	0.03	0.02	0.01	0	0	0.16
Prevention	0	0.01	0.01	0.01	0.01	0.01	0.01	0	0.06
Insurance	0	0	0	0.01	0.01	0.01	0.01	0.01	0.05
Merchandise	0.02	0	0.01	0	0	0	0	0	0.03
Materials	0	0	0.01	0	0	0	0	0	0.01
Remediation	0	0.01	0	0	0	0	0	0	0.01
Packaging	0	0	0.02	0	0	0	0	0	0.02
Purchase val.	0	0	0.03	0	0	0	0	0	0.03
Process costs	0.05	0.02	0.01	0.01	0.02	0	0	0	0.11
Tax, penalty	0	0.02	0.01	0.01	0.02	0	0	0	0.06
All expenses	0.08	0.10	0.15	0.07	0.08	0.03	0.02	0.01	0.54
Revenues	0	0	0	0	0	0	0	0	0
Overall result	0.08	0.10	0.15	0.07	0.08	0.03	0.02	0.01	0.54
Processes	0.06	0	0	0	0	0	0	0	0.06
Σ	0.14	0.10	0.15	0.07	0.08	0.03	0.02	0.01	0.60
X2, q. 4, p. 20 / X3, q. 4, p. 21 / X5, q. 4, p. 20 / X5, q. 4, p. 22 / XY10, q. 5, p. 30-31/ val.: value / M = Million € / The corresponding table for 2015 can be found in in the appendix. Source: same as table 12									

[6] Corresponding versions of tables (17.1) and (18.1) for the year 2010 are in the appendix as tables (17.2) and (18.2=.

Table (19.1): Special EBSC of Most Important Environmental Cost Categories								
Material or Process	Electric Energy	Fuel	Wood	Waste (–)	Waste (+)	Wastewater (+)	Wastewater (–)	Σ
Input $material_1$								
Input $material_{...}$								
Input $material_n$								
All input materials								
Output $material_1$								
Output $material_{...}$								
Output $material_n$								
All output materials								
$Process_1$								
$Process_{...}$								
$Process_n$								
Σ								
cf. XY3, q. 4, p. 20 / XY15, q. 5, p. 32. Waste = solid waste								

As this system is still in its early stages only the data for all input and output materials for January 2010 and 2015 are available.

Table (19.2): Special EBSC for Input and Output Materials in January 2010/2015								
Material	Electric Energy	Fuel	Wood	Waste (–)	Waste (+)	Waste-water (+)	Waste-water (–)	Σ
All Input Materials (0)*	2.05	0.50	0.20	0.45	0.50	0.05	0.02	3.77
All input Materials (5)*	0.80	0.20	0.10	0.16	0.10	0.01	0.00	1.46
All Output Materials (0)	5.50	1.50	1.80	1.05	1.60	0.15	0.05	12.1
All output materials (5)	2.20	0.78	1.40	0.36	0.44	0.05	0.02	5.25
Source: same as table 12; * (0) stands for 2010; (5) stands for 2015.								

The scorecard in table (19.2) can be understood this way: In 2010, the production of all output materials (i.e. the intended products) involved energy costs of €5.5 million. However, prior to the production processes the treatment and the preliminary production of the input materials already required energy that cost €2.05 million, even before these input materials entered the real production process of the output materials.

Table (17.1) and (17.2 in the appendix) as well as tables (18.1) and (18.2 in the appendix) highlight the fact that the new production strategy led to a significant reduction of the environmental costs in view of drastically dropped amounts of wastes and hazardous input substances. The new strategy to produce environmentally friendly goods, which is supported by EMA, has obviously paid off, because eco-related profits and overall profits have risen (cf. same tables). Table (19.2), though incomplete, shows that the production and use of waste and of the central resources – electric energy, fuel, wood, and water – has clearly dropped, which again explains the sinking costs (both environmental and conventional) and the rising profit. These explanations again answer the research questions 1.2 and 1.3 in a way mentioned already several times.

This new scorecard was motivated by the company's analysis of its environmental costs. It found that the previous methods to measure conventional and environmental costs had been inappropriate. For some years, the company's "payments for prevention, remediation and penalty fees" (cf. XY15, q. 5, p. 32) had almost been "negligible" because it had always intended not to infringe the severe German laws on environmental issues. By contrast, "the costs of electricity, (…) an environmental issue in Germany and elsewhere, cover[ed] 58% of" the "environmental costs" (idem) The other important environmental cost categories were consumption of fuel (22%), hazardous and non-hazardous waste (12%), contaminated wastewater and pure wastewater (7% and 3%, respectively) (cf. idem). The company still uses all forms of full cost accounting. This statement can be regarded as an answer to the research question 1.4.[7] The initial form of EMA had been an appropriate tool to track all physical flows and their costs. On the other hand, the other cost categories (especially costs for prevention, remediation and penalty fees) proved to be useless. In addition, the cumbersome tracking of all physical flows can seemingly be simplified by tracking only five marker entities (electric energy, fuel, wood, waste, wastewater). In order to support their full cost accounting, EMA measures the value of all assets, from which it identifies the amounts and percentages of the economic assets and of environmental assets each day. The focal company's EMA recognises these components of the environmental assets (cf. XY11, q. 5, p. 21):

(1) Machines, materials, substances and applications used for a cleaner production
(2) Capital uses for cleaner production, plus

[7] "Is the current model suitable for the needs of this Mittelstand company?"

(3) Profits from cleaner production, minus
(4) Environmental costs

The environmental assets are listed on the company's balance sheet (cf. table 21 in the appendix).

5.3.4.6 Activity-based Costing (ABC)

The EMA of the focal company employs an ABC combined with the cash-flow analysis of a certain production process to identify its complete costs, environmental costs, and its product prices. In the framework of ABC, EMA supports the SMA, when it develops a new production process by calculating the costs and product prices. EMA calculates the costs and prices from the amount of used resources and the amounts of the final outputs (XY7, q. 5, p. 29-30 / XY8, q. 5, p. 30). This also partly answers research question 1.2 as to how EMA affects the focal company's corporate actions. The company's ABC comprises six steps, the last four of which are supported by EMA. The six steps in question are:

1st step: defining the main process

2nd step: dividing the main process in sub-processes.

3rd step: measuring the time of every sub process

4th step: identifying the cost drivers of each sub process by determining the identities, quantities and costs of the input and output materials.

5th step: identifying the costs for each sub process and the material and energy flows.

6th step: determining the product price of the process in question.

5.3.4.7 EMA-related Machinery and Assets

The EMA implementation was backed by the computer programme Lean Six Sigma 5 S responsible for the time management of the printing machines. Controlling the effective cleaning and decontamination of the machines, the Lean Six Sigma 5 S programme reduces both the amount of chemical cleaning agents and the time the machines have to stand still. Apart from that Lean Six Sigma 5 S also traces all related costs. It minimizes the time for

1. Cleaning and decontamination of the machines
2. Repairs and adaption of the machines
3. Waiting times (needed by personnel to use the appropriate machine)
4. Search times (needed by the personal to find the appropriate machine)

5. Idle time (machines standing still for various reasons)
6. Operating the machine by the personnel
7. The entire automatic printing process

Table (20) shows that the programme reduced the time needed in all the areas mentioned above as well as the related costs.

Table 20: Average Time and Environmental Management for Machinery p.a.

Programme Introduction	Average Time for	Total / hrs.	Per order	Costs per order / €
Before	Repair of machines	550	1h 3min	1.12
After		480	52min	0.98
Before	Cleaning & decontamination of machines	600	1h 5min	0.96
After		400	46min	0.75
Before	Adaption of machines	2421	4h 38min	2.36
After		2105	4h 2min	2.05
Before	Operation of machines	791	1h 51min	1.55
After		698	1h 20min	1.34
Before	Printing process	3068	5h 52min	3.56
After		2802	5h 22min	3.25
Before	Search for right machine	24	3min	0.15
After		8	1min	0.05
Before	Waiting time for right machine	220	24min	1.45
After		84	10min	0.55
Before	Idle time of machines due to damages	120	13min	0.79
After		80	9min	0.50
Before	Idle time of machines due to dirt or contamination	240	26min	1.58
After		150	16min	0.99
Before	Idle time of machines for other reasons (e.g. no orders or no personnel)	180	20min	1.19
After		90	10min	0.59
Before	Annual costs for cleaning agent per order	0.35		
After		0.15		
Total cost reduction per order due to programme Lean Six Sigma 5 S				3.26
Total annual cost reduction per order due EMA-related aspects of programme				1.00
Source: File (1): 5 S – Shine & Sustain - Nachhaltige Sauberkeit				

In 2014, the focal company bought a new digital printing machine that is more environmentally friendly than conventional printing machines in terms of energy efficiency and use of chemicals. The German ministry for environmental affairs supported this investment (€2.147 million) with subvention payments (€1.644 million). Table (21), however, shows that the EMA-related items (devices, procedures, programmes) were not valuable assets of the focal company. The eco-related assets (machines, devices and programmes linked with EMA) had a total value of €3.5 million, only a small fraction of all assets, eco-related liabilities (due payments for damages of the environment) were almost negligible. The only significant exceptions were devices for decontamination (amounting to between €7.140 and €8.451 million in the period 2010–13). However, they were already used before the implementation of EMA, as can be seen in table (21). As this table largely contains irrelevant information, it can be found in the appendix.

As for answering the research questions 1.2 and 1.3, the almost negligible use of EMA-related items shows that EMA only affected the focal company's actions to a minor extent, despite its positive influence. Obviously, the company still does not use EMA to its full advantage. As the new environmental printing machine was mostly paid by the German state, one can conclude that the company was (at least in the beginning) reluctant to invest much money in EMA.

5.3.4.8 EMA-related Environmentally Friendly Purchase System

The focal company has an environmentally friendly purchase and production system that is based on certain environmental regulations, and its integration in the company's general controlling. The company's adherence to specified environmental regulations, which have a bearing on its EMA procedures, is shown by the FSC certificate. With this certificate, the company declares that it will "not be directly or indirectly involved in any of the following actions":

(1) Illegal logging or the trade in illegal wood or forestry products.
(2) Violation of traditional and human rights in forestry operations.
(3) Destruction of high conservation values in forestry operations.
(4) Significant conversion of forests to plantations or non-forest use.
(5) Introduction of genetically modified organisms in forestry operations.
(6) Violation of any of the ILO Core Conventions" (Instructions FSC, 2011:2).

The compliance with this certificate also involves EMA accounting methods, as also stated in the documents Input Output Matrix (2009), Brochure 'Das Selbstverständnis' (2013), Document on the FSC (Forest Stewardship Council) certification (2010). When a staff member does the regular and environmental accounting with a computer, the site in question displays a special 'Customer Material Info' record (ibid.). It has a field in the classification to indicate if the customer requires the FSC paper for this décor material. When this FSC required flag is set to *Yes*, the Order Acknowledgement will print the FSC number. This flag also allows the printing of FSC numbers on the Customer Delivery Note and Customer Invoice (ibid.). An audit point states that the company "cannot print our FSC numbers on these 2 documents, unless the customer is FSC certified" (ibid: 4). If a purchase reaches the "FSC Supplier", the system will copy the "supplier FSC number from the Vendor Master and Purchasing Info Record" of the purchased item. The FSC programme also makes sure that the flows of all labelled materials and their costs are registered and calculated within EMA (cf. ibid: 5–9). Hence, in view of research questions 1.2 and 1.3 one can conclude that EMA has also had a positive influence on the focal company's environment-friendly purchase system.

5.3.4.9 Influence of EMA on Costs and Revenues

Tables (22) and (23) show the company's main economic metrics and economic data reflecting its economic development 2007–13. According to table (22), the focal company had not implemented any environmental metrics until 2009. Lacking any kind of environmental information, this table is only presented in the appendix. As the comparison of tables (23) and (24) shows, ACME-Print added the new EMA-related techniques and metrics to SMA after the EMA implementation in 2010, while it maintained the procedures of conventional financial accounting. Five of the secondary indicators of the EBSC mentioned in section 5.3.4.1 also appear in table (24). This reflects the importance of EMA for the focal company. The expressions 'eco-related turnover' and 'eco-related income' correspond with the term 'eco-related profit'. Eco-related turnover and eco-related income are the turnover and income stemming from sold products that were advertised as environmentally friendly; the term 'eco-related write-off' stands for the damages and costs attributable to accidents with hazardous substances (Meeting with the management of the focal company on 3 November, 2015). In the same meeting, the management also confirmed that the eco-related income, turnover and profits had risen due to EMA, which had also helped to reduce the waste of resources, water, the output of emissions, and hazardous substances (cf. table 23). The version of this table shown is abridged, because it only shows the data concerning environmental affairs. The complete table (23) can be seen in the appendix.

Table 23.1: Main Economic Metrics and Data of ACME-Print in the Period 2010–2012 as Presented by the Deutsche Bundesbank						
Year	**2010**		**2011**		**2012**	
Economic metric in per cent	Firm	X_M	Firm	X_M	Firm	X_M
Rate of wasted resources on operating assets	18.4	16.8	14.21	15.0	10.80	13.5
Rate on eco-related turnover on total turnover	0.00	2.0	9.4	5.0	15.0	7.6
Rate of waste + water on total output	5.38	4.0	3.43	3.5	2.27	3.0
Rate of hazardous waste on total output	1.43	1.0	0.85	0.75	0.52	0.70
Rate of emissions on total output	2.70	2.0	1.86	1.5	1.39	1.4
Rate of wasted resources on total output	6.77	5.0	4.51	4.5	2.27	3.5
Economic data in million €	Firm	X_M	Firm	X_M	Firm	X_M
Eco-related net profit	0.4	0.5	2,99	1.0	5.12	1.5
Eco-related write-off	2.1	1.5	1.24	1.3	0.76	1.2
Eco-related income	0.0	0.1	1.0	0.1	1,8	0.2
Symbol *: Liabilities / X_M : Median of the firm's branch; Faktenblatt Deutsche Bundesbank (2012)						

The profit and loss accounts and their corresponding tables (24–26) evidence two things: (1) The company measures a variety of environmental costs and revenues, most of which correspond with the conventional ones. (2) The strategy of avoiding hazardous input substances and wastes, which is monitored by EMA, increasingly improved the company's economic and environmental performance. Consequently, these conclusions were also confirmed by the management during the aforementioned meeting, as well as by two interviewees (cf. q. 3, XY2; q. 4, XY12). Tables (17.1) and (17.2) and the cited reports have already proven that EMA was able to support a company strategy that improves eco-related and conventional profits by using less hazardous substances and by producing fewer wastes. Tables (24–26) permit a deeper insight into this matter. These tables have a right and left part; the left one shows the basic data concerning the focal company's overall benefits and losses (costs), the right one shows the corresponding portion of the EMA-related cost or benefit type. The trends are as follows: Most environmental costs (including the value of wasted resources) incurred in the period 2011–2013. By contrast, the gross profit with eco-related products, procedures and the total annual EMA-related profit have risen more quickly than the related overall profits. The shares of gross profit with eco-related products in the overall profits were 9.5% (2011), 15.0% (2012), 22.0% (2013). The corresponding EMA-related profits were 9.5% (2011), 15.0% (2012), 22.0% (2013). These identical trends at least indicate that EMA is to a significant extent responsible for the improved environmental performance of the focal company. These statements answer the research questions 1.2 and 1.3 affirmatively. EMA supplied the SMA with useful information on all physical flows (incl. the hazardous ones). The SMA used this information to reduce its environmental costs, thereby augmenting the profits. As profit is the most fundamental criterion for economic success, the advantages of the EMA (used by the focal company) obviously outweigh its shortcomings. Because of that, it is possible to conclude that EMA (with the reservations made in section 5.3.4.7) suits the needs of this Mittelstand company as mentioned in research question 1.4.

Table 24: Profit and Loss Account of ACME-Print in 2011

Economic data in €	Total costs or benefits in mn €	EMA portion of cost or benefit in mn €	Type of EMA-related cost or benefit
Turnover	234.011	22.023	Eco-related products
Change in stock of finished goods and work in progress	4.788	0.053	Change in stock of eco-friendly finished goods & work in progress
Total output	238.799	21.970	Eco-related products
Cost of purchased service	1.180	0.753	Cost of purchased EMA tutorials
Cost of resources (materials, cars, machines, energy, and water)	152.004	83.403	Costs for used materials & energy (cf. table 23)
		3.200	Consumption of water
Gross profit	86.795	8.245	Gross profit with eco-related products, procedures
Wages and salaries	29.456	4.435	Staff costs for eco-related issues
Pensions costs	5.920	X	
Depreciation of tangible and intangible fixed assets	14.607	1.347	Depreciation of raw material and hazardous substances*
Other operating charges	24.382	1.255	Costs for clean-up, remediation
		1.546	Environmental management
		8.526	Value of wasted resources**
		1,435	Waste disposal & treatment
		0.325	Prevention technology & service
		13.086	All EMA operating charges
Other operating income	4.268		
Income from participating interests	0.00		
Other interest receivable & similar income	0.171		
Amounts of written off investments	0.00	X	
Interest payable & similar charges	2.290		
Profit or loss on ordinary activities	14.579		
Extraordinary income/charges	0.106	0.00	Eco-related subsidies
Tax on profit	2.280	0.457	Eco-related taxes and fees
Annual group profit	11.735	1.112	EMA-related group profit p.a.
Shares of profits or losses allocated to other shareholders	–0.889	–0.806	Shares of losses allocated to lost shareholders due to EMA
Total annual group profit	10.846	1.030	Total annual profit due to EMA

Symbols: *: Without wasted resources / **: raw material (mostly paper), colours (and other auxiliary material), merchandise, packaging, energy. Source: see title of table

Table 25: Profit and Loss Account of ACME-Print in 2012 in €			
Economic data in €	Total costs in mn €	EMA portion of cost or benefit in mn €	Type of EMA-related cost or benefit
Turnover	257.292	38.594	Eco-related products
Change in stock of finished goods & work in progress	0.904	0.127	Change in stock of eco-friendly finished goods & work in progress
Total output	258.196	38.467	Eco-related products
Cost of purchased service	1.272	0.983	Cost of purchased EMA tutorials
Cost of resources (materials, cars, machines, energy, and water)	165.868	75.780	Costs for used materials & energy (cf. table 23)
		2.407	Consumption of water
Gross profit	92.327	13.849	Gross profit with eco-related products, procedures
Wages and salaries	33.430	5.898	Staff costs for eco-related issues
Pensions costs	6.342	X	
Depreciation of tangible and intangible fixed assets	14.953	0.844	Depreciation of raw material and hazardous substances*
Other operating charges	21.854	0.785	Costs for clean-up, remediation
		0.987	Environmental management
		6.480	Value of wasted resources**
		0.944	Waste disposal & treatment
		0.437	Prevention technology & service
		9.634	All EMA operating charges
Other operating income	4.418	X	
Other interest receivable & similar income	0.206		
Amounts of written off investments	2.504		
Interest payable & similar charges	2.014		
Profit or loss on ordinary activities	15.855		
Extraordinary income/charges	0.106	0,050	Eco-related subsidies
Tax on profit	4.067	0,061	Eco-related taxes and fees
Annual group profit	11.081	1.662	EMA-related group profit p.a.
Shares of profits or losses allocated to other (lost) shareholders	–0.836	–0.710	Shares of losses allocated to lost shareholders due to EMA
Total annual group profit	10.245	1.537	Total annual profit due to EMA
Symbols: same as in table 24			

Table 26: Profit and Loss Account of ACME-Print in 2013 in €

Economic data	Total Costs in mn €	EMA portion of cost or benefit in mn €	Type of EMA-related cost or benefit
Turnover	265.739	63.777	Eco-related products
Change in stock of finished goods & work in progress	1.360	0.324	Change in stock of eco-friendly finished goods & work in progress
Total output	267.098	63.453	Eco-related products
Cost of purchased service	1.424	1.236	Cost of purchased EMA tutorials
Cost of resources (materials, cars, machines, energy, and water)	169.138	69.700	Costs for used materials & energy (cf. table 23)
		1.503	Consumption of water
Gross profit	97.961	21.551	Gross profit with eco-related products, procedures
Wages and salaries	34.903	6.894	Staff costs for eco-related issues
Pensions costs	6.723	X	
Depreciation of tangible and intangible fixed assets	14.500	0.523	Depreciation of raw material and hazardous substances
Other operating charges	26.499	0.534	Costs for clean-up, remediation
		0.605	Environmental management
		4.352	Value of wasted resources**
		0.753	Waste disposal & treatment
		0.454	Prevention technology & service
		6.164	All EMA operating charges
Other operating income	5.046	X	
Other interest receivable and similar income	0.218		
Interest payable & similar charges	2.044		
Profit or loss on ordinary activities	18.555		
Extraordinary income/charges	0.106	0.106	Eco-related subsidies
Tax on profit	4.936	0.007	Eco-related taxes and fees
Annual group profit	12.946	2.978	EMA-related group profit p.a.
Shares of profits or losses allocated to other shareholders	–0.703	–0.659	Shares of losses allocated to lost shareholders due to EMA
Total annual profit	12.243	2.693	Total annual profit due to EMA
Symbols: same as in table 24			

Table (27) presents extra information on costs for used material and energy concerning the use of EMA in the company, which is (partly) shown in the tables (24–26). As supported by the quoted documents and by the brochure 'Inspiring People' (2013) the company's business strategy using EMA to calculate the amounts of all materials and every amount of energy brought about a declining use of central resources. This conclusion was also confirmed in the aforementioned meeting. It also confirms the statements made above with respect to the research questions 1.2–1.4.

Table 27: Costs for Used Material & Energy of the ACME-Print (2010 to 2014) in Million €					
Material	2010	2011	2012	2013	2014
Paper	63.414	58.345	53.120	49.200	47.421
Colours	18.776	15.546	13.002	11.416	10.213
Chemicals and other auxiliary materials	2.769	2.030	1.678	1.223	0.915
Merchandise	3.346	4.078	4.989	5.226	8.032
Packaging	0.865	0.643	0.535	0.414	0.372
Energy	3.325	2.761	2.456	2.221	2.206
All costs	92.495	83.403	75.780	69.700	69.159
Source: cf. tables 21–22, and file 'costs for material and energy (2010–2014)'					

As for the reserves of raw materials and other operating materials, which are paper and hazardous substances (colours, chemicals and other auxiliary substances), EMA has also lead to a significant reduction, as can be seen in table (28) (cf. brochure 'Inspiring People' (2013) and the meeting mentioned above).

Table 28: Amount of Reserves of the ACME-Print (2010 to 2014) in Million €					
Raw materials & operating materials	2010	2011	2012	2013	2014
Paper	7.232	6.578	5.845	4.978	3.401
Colours	4.345	2.978	2.245	0.958	1.340
Chemicals and other auxiliary materials	2.452	1,875	0,945	0.543	0.651
Total amount of raw & operating materials	14.029	11.431	9.035	6.475	5.392
Objects					
Merchandise used for production	0.956	1.234	0.834	0,651	1.164
Finished products	29.585	41.425	47.301	11.291	11.291
All costs	44.57	54.09	57.17	18.085	17.847
Source: file 'reserves'.					

Table (29) shows the core data of the focal company's cost flow accounting. As for the emissions, the focal company did not distinguish between liquid, gas, hazardous or non-hazardous emissions. In the period 2010–2014, the costs of most environmentally critical flow components have drastically dropped, which is especially true for the costs of the non-product output. The management has confirmed at the meetings on the 3rd of November 2015, and 13 November 2015, that these trends are also attributable to the influence of EMA on the SMA. Additional support can be found in these documents: brochure 'Inspiring People' (2013), Internal protocols (2009), Reports (environmental reports, environment-related press reports, 2009), Input Output Matrix (2009), Brochure 'Das Selbstverständnis' (2013), Document on the FSC (Forest Stewardship Council) certification (2010).

Table 29: Input Output Matrix in Million €: Used and Wasted Resources of the ACME-Print						
Input	Year	Costs of Input	Costs (worth) for corresponding output			
			Finished products	Non-product output		
				Hazardous[1]	Non hazardous[1]	Emission[2]
Raw material (except colours, mostly paper)	2010	63.414	59.083	0.250	3.981	0.100
	2011	58.345	54.840	0.128	3.287	0.090
	2012	53.120	50.316	0.098	2.613	0.075
	2013	49.200	47.802	0.046	1.322	0.053
	2014	47.421	46.099	0.012	1.302	0.008
Colours	2010	18.776	16.035	1.845	0.751	0.145
	2011	15.546	13.592	1,298	0.553	0.103
	2012	13.002	12.000	0.678	0.291	0.053
	2013	11.416	10.764	0.422	0.198	0.032
	2014	10.213	9.907	0.202	0.096	0.008
Chemicals (& other auxiliary materials)	2010	2.769	1.505	0.744	0.175	0.345
	2011	2.030	1.185	0.568	0.157	0.120
	2012	1.678	0.977	0.453	0.150	0.098
	2013	1.223	0.627	0.378	0.148	0.080
	2014	0.915	0.399	0.311	0.145	0.060
Merchandise	2010	3.346	3.050	0.104	0.192	0.000
	2011	4.078	3.863	0.650	0.180	0.000
	2012	4.989	4.811	0.112	0.103	0.000
	2013	5.226	5.048	0.089	0.089	0.000
	2014	8.032	7.887	0.065	0.080	0.000
Packaging	2010	0.865	0.804	0.000	0.061	0.000
	2011	0.643	0.602	0.000	0.041	0.000
	2012	0.535	0.498	0.000	0.037	0.000
	2013	0.414	0.405	0.000	0.009	0.000
	2014	0.372	0.369	0.000	0.003	0.000
Water	2010	3.650	1.205	0.000	0.000	2.445
	2011	3.200	1.004	0.000	0.000	2.196
	2012	2.407	0.753	0.000	0.000	1.657
	2013	1.503	0.471	0.000	0.000	1.032
	2014	1.200	0.377	0.000	0.000	0.823
Energy	2010	3.325	0.980	0.000	0.000	2.345
	2011	2.761	0.825	0.000	0.000	1.936
	2012	2.456	0.756	0.000	0.000	1.700
	2013	2.221	0.712	0.000	0.000	1.509
	2014	2.206	0.725	0.000	0.000	1.481
Symbol: 1 (only solid material), 2 (either liquid or gas; either hazardous or not hazardous).						
Source: 'Input Output Matrix'						

The significant decline of most environmentally hazardous (e.g. chemicals) and sensitive (e.g. water) substances again underlines that 'EMA influenced the company's performance for the better" and not for the worse (cf. research question 1.3). As the use of merchandise has increased, one can deduce that the positive influence of EMA is far from being complete, as already evinced in section 5.3.4.9.

6 Analysis of Results Obtained from Expert Interviews

6.1 Preliminary Remarks Concerning Interview Analysis

This section presents and analyses the answers from the fifteen expert interviews concerning the twelve questions presented in section 4.2.2.2. The analysis uses the seven categories of the category system as proposed in the same section. They are: (1) Definition of Environmental Costs; (2) Organisational Responsibilities and Technical Execution of EMA; (3) Implementation of EMA; (4) Influence of EMA on the Company's Performances; (5) Benefits and Disadvantages of EMA; (6) Efficacy and Efficiency of EMA; (7) Definition of EMA.

As explained in section 4.2.2.2, each interviewee was asked if he agreed with the statements of the other eleven participants. This measure rendered the following results: With the exception of interviewee XY13 (Chemistry Specialist) there was a general consensus among the interviewees concerning the categories (1), (2), (3), (6), (7), and about the goals and benefits of EMA. The chemistry specialist's statement was not taken as valid, since he had little knowledge of these issues. Opinions largely varied in reference to the disadvantages and to the assessment of EMA's efficacy and efficiency. The statements offered by interviewee XY13 did not contradict the ones held by the majority, but again it was found that his knowledge concerning EMA was too restricted to render valuable insights.

6.2 Category I – Definition of Environmental Costs

The environmental costs were treated in the context of the 8th interview question.[8] Most interviewees with the exception of interviewee XY13 defined environmental costs this way (cf. XY1–XY15, q. 8, pp. 50-51): Environmental costs are those costs that arise from the environmental hazardousness of the company's products and production processes. In the company there are five categories of environmental costs. The cost categories in question in declining importance are:

(1) Costs for the consumption or use of electric energy, fuel, water, and wood.
(2) Costs for the treatment, disposal, and storage of solid waste and gas emissions.
(3) Costs for eco-related taxes and insurances.
(4) Costs for prevention measures, including tutorials and measures to treat hazardous input materials adequately.

[8] "Can you define EMA?"

(5) Costs for remediation, including penalty fees and the remediation costs caused by technical accidents/failures and manmade mistakes
(6) Environmental gains and revenues, negative costs; they are almost completely caused by reduced consumption of electricity and fuel, to a minor degree caused by the reduced production of non-product output or the reduced use of hazardous input substances

Interviewee XY13 (Chemistry Specialist) only referred to the environmental costs attributable to hazardous input materials. This statement was taken as valid, because this issue belonged to his domain.

All interviewees, with the exception of the interviewees YX10 (Production), XY11 (Production), and XY13, also named environmental gains and revenues as a sixth category of environmental costs. These cost were always labelled as negative costs by all twelve interviewees, who mentioned the existence of environmental gains and revenues. According to them, these gains and revenues were almost completely caused by the reduced use of fuel and electric energy, and only by a minor degree by the reduced production of non-product output or the reduced use of hazardous input substances. Interviewees YX10 and XY11 (Production) acknowledged the existence of environmental gains, but did not label them as costs. This statement was not taken as valid, because this issue did not belong to their domain. All other statements were regarded as valid, because they were supported by the interviewees XY3, YX6, XY8, who came from the domains of controlling and sale. These findings generally mirror the information on the environmental costs of the literature review in section 2.1.2. The interviewees largely identified the same cost categories, but were unable to give a clear und comprehensive definition of environmental costs. As environmental costs are fundamental for EMA, one can conclude that many staff members had only a blurred understanding of EMA. As predicted in the literature review (2.8.2), there are probably organisation barriers hindering the flow of information concerning EMA, and there seem to be institutional contradictions within the company (cf. 3.1 [methodology]).

6.3 Category II – Organisational Responsibilities and Technical Execution of EMA

The technical execution of EMA was dealt with in the questions 4 to 7. The findings of the interview corresponding with this section have almost completely been presented in section 5.3. The interviewees’ opinions on the reliability of the metrics are, however, noteworthy. All interviewees regarded the metrics (i.e. the quantity-related metrics), which determine the amounts of the physical flow components, as effective and efficient. The same unanimous view is held in respect to the law-related metrics meant to identify the environmental costs of electric energy, water, wood, and fuel. As this opinion was unanimous, it was labelled as reliable. The opinions concerning the efficacy and efficiency of the chance-related metrics are less positive. These estimates are thought to be less accurate (cf. XY1–XY12, q. 7, pp. 39-50). Since this view is supported by a strong majority of the interviewees including both controllers (XY3 & XY8), it can also be seen as valid. Thus, the interviewees confirmed the literature review in section 2.6 and 2.7 dealing with the physical flows and the tasks of EMA. The interviewees' knowledge was even more specific about metrics, since they knew metrics of the first and second order (cf. 6.1), which were not mentioned in the literature review.

6.4 Category III – Implementation of EMA

6.4.1 Preliminary Remarks

Category III explicitly addressed the research questions 1.1[9], 1.3[10] and 2[11]. The aspects of the EMA implementation were discussed and analysed in the context of the first 3 questions. By answering the first interview question[12], the fifteen interviewees explained the implementation of EMA by describing the reasons for implementing EMA, its methods, barriers, and facilitating factors. As for the methods and reasons, there was a common consensus among the interviewees. Although the majority of them did not name all of them, each interviewee later confirmed the other participants' statements about the topics in question. This can also be regarded as a sign of validity. On the other hand, opinions were divided concerning the factors that impeded or facilitated the implementation of EMA. First, the analysis of these four aspects will present the interviewees' statements in special tables. The controversial statements will be shaded in red. Then all of them will be examined on the basis of the research questions and research objectives. Question 2 dealt with the means and methods the company had not used to implement EMA, in order to show how thorough and systematic the actual implementation was. Question 3 was about the immediate effects of the EMA implementation, to show how much the company's flow cost accounting

[9] "How did the company of the German Mittelstand examined in the case study implement EMA"
[10] "Has EMA influenced the company's performance for the better or for the worse?"
[11] "What were the potential obstacles and drivers for the implementation of EMA in the Mittelstand company of the case study?"
[12] "How and why was EMA implemented?"

was actually influenced by EMA. The results of these questions will be presented in the sections 6.4.5 and 6.4.6, respectively.

6.4.2 Reasons to Implement EMA

6.4.2.1 Presentation of Interview Data

Answering question 1, all interviewees identified eight reasons why the focal company implemented EMA. They are presented in the following table (j1). The tables (i1-8) showing the corresponding statements are in the appendix.

Table (j1): Reasons to Implement EMA	
1	High costs because of excessive consumption of fuel and electric energy
2	Environmental costs of other physical flow components
3	Possible risk of co-related penalty fees and high environmental taxes
4	Optimisation of resource and energy efficiency
5	Presence in foreign markets
6	Improved tracking of physical flows and accounting of related costs
7	Consideration of long term effects
8	Help management with decision-making

6.4.2.2 Interpretation of Interview Data

The interviewees presented eight reasons accounting for the implementation of EMA. Especially the first five of them related to external pressures that worked as motives to implement EMA. They all were directly or indirectly linked to price pressures. The company turned to EMA due to high costs of (1) excessive consumption of fuel and electric energy, (2) other physical flow components, and (3) penalty fees and high environmental taxes. These three motives to adopt EMA were directly linked with the prices. Two other motives, i.e. the company's inefficient use of (material) resources and energy, and its presence in foreign markets, were indirectly linked to prices pressures.

First Reason: Reduction of Consumption of Fuel and Electric Energy

All fifteen interviewees labelled the company's formerly excessive consumption of fuel and electric energy as the strongest motive to adopt EMA, since it reportedly "made the production too expensive" (cf. XY2, q. 1, p. 3). Some of the interviewees called these costs simply 'costs' (cf. idem), while others referred to them as 'environmental costs' (cf. XY6, q. 1, p. 6). In the case of the focal company, this divergence of views was negligible since for energy and fuel the environmental and conventional costs were almost identical. Theoretically, the environmental costs for energy and fuel exceed the conventional ones due to the additional environmental taxes and penalties. These environmental costs were small in the focal company (cf. 5.2). Because of these reasons, these statements were regarded as valid.

Second Reason: Reduction of other Physical Flow Components

Table (i2) lists other physical flow components, whose high costs made the management implement EMA; the components and their associated costs were: "costs for (…) all kinds of physical flow components" (cf. XY1, q. 1, p. 2), "costs for treating and disposing waste" (cf. XY4, q. 1, p.), "costs (…) concerning (…) the use or production of hazardous substances" (cf. XY6, q. 1, p. 6), "many dangerous substances (…) [with] costs stemming from the nature of these substances and their production processes" (cf. XY7, q. 1, p. 6), "costs for producing, treating and disposing of waste and hazardous input and output substances" (cf. XY9, q. 1, p. 8), "[costs to] deal with dangerous substances" (cf. XY12, q. 1, p. 9), and "the prices concerning the treatment of the chemicals" (cf. XY13, q. 1, p. 10). The general consensus was that the other significant cost drivers to implement EMA were the treatment and disposal of waste as well as the production and treatment of hazardous input and output substances. This general conclusion was also confirmed by all fifteen interviewees; consequently, it can be seen as reliable.

Third Reason: Reduction of Penalty Fees and High Environmental Taxes

Reducing penalty fees and environmental taxes was of a minor importance for all interviewees (cf. table i3). After an initial analysis the company had realised that there was no need to implement EMA because of German environmental laws, since the company "had not violated any laws" (cf. XY2, q. 1, p. 3) of that kind. Observing environmental laws more efficiently by means of EMA was mostly a preventive measure and a side effect of other considerations. Firstly, as for the preventive measure, the company installed EMA to minimise the mere "risk (…) [of] costs for eco-related taxes and penalty fees" (cf. XY2, q. 1, p. 2). As the company has subsidiaries in many countries, this risk was regarded as significant, because, as interviewee XY10 put it, "the environmental laws in different countries often differ dramatically, and they also tend to change frequently" (cf. XY10, q. 1, p. 8). Secondly, as for the side effect, the company hoped that the effect of EMA "to reduce energy and fuel costs" would also minimise "other environmental costs including the fees for infringing environmental laws" (cf. XY5, q. 1, p. 5). As interviewee XY1 had pointed out, "the excessive consumption [of energy and fuel] also meant the risk to raise our costs for eco-related taxes and penalty fees" (cf. XY2, q. 1, p. 2). Although some interviewees did not have an expertise in accounting (e.g. XY4, head of quality management 1), interviewee XY6 (Director of Sales, and therefore an expert in accounting) supported their view by saying that EMA was implemented "to make sure that our energy and fuel consumption does not break any laws, which might cause additional costs" (XY6, q. 1, p. 6). Because of that, these statements can be regarded as trustworthy.

Fourth Reason: Optimisation of Resource and Energy Efficiency

The 4th reason, 'optimisation of resource and energy efficiency' (explicitly named by XY1, XY2, XY3, pp. 2-5; table i4), was of an interferential nature since a minimised use of fuel, energy, hazardous substances, and waste means the same as optimising the resource efficiency. According to section 5.2, other important materials like water and wood also considerably affected the company's resource efficiency, but they were not named in the context of question 1. However, all interviewees agreed after the interview that resource efficiency was an important driver to adopt EMA. As the interviewees XY1, XY2, XY3 are part of the management and the controlling, their views can be seen as reliable.

Fifth Reason: Presence in Foreign Markets

The 5th reason refers to the company's involvement in foreign markets through its subsidiaries (table i5). It is also of an interferential nature. Firstly, it considers, as mentioned above, the risks of misjudging the "different regulations concerning dangerous materials and the use of energy" (cf. XY6, q. 1, p. 6). This reason also accounts for the "financial speculations on the international stock markets" (cf. XY10, q. 1, p. 8) that might affect the company's ability "to allocate, control and account for all material flows and its accompanying costs" (cf. XY4, q. 1, p. 4). The fifth reason already indicated why exactly EMA had been chosen as a tool to support the management's efforts meant to create the positive effects that were expressed in the reasons 1 to 5. Reasons 6 to 8 referred to the functioning and technical aspects to produce (or help producing) the positive effects in question. As the interviewee XY5 (Director of Sales) is an expert in market affairs, his view on this issue can be labelled as valid.

Sixth Reason: Improved Tracking of Physical Flows and Accounting of Related Costs

Twelve out of fifteen interviewees stated that, unlike the previous accounting system, EMA was able to help improving the company's material and energy efficiency by tracking its physical flows and by accounting its related costs (table i6). Three interviewees (XY7, XY10, and XY15) initially did not make any statement with respect to this topic. The interviewees XY7 and XY15 later acknowledged their colleagues' opinions. Interviewee XY7 failed to give any information in this context due to lacking knowledge about accounting affairs. Hence, there is also a unanimous consensus concerning the ability of EMA to identify the physical flows and their associated costs. Using EMA was also seen as a precondition of minimising the company's environmental costs by identifying their cost drivers (cf. XY1, q. 1, p. 2 / XY3, q. 1, p. 4 / XY6, q. 1, p. 6. / XY8, q. 1, p. 7). As interviewee XY6 (Director of sales) supported this opinion, it can be seen as trustworthy. Interviewee XY8 stated that the cost drivers were the "quantities and costs" of the flow of the components (c.f. XY8, q. 1, p. 7). This statement was also confirmed by all other interviewees (except XY15), who commented on accounting issues. As interviewee XY15 (a member of the sustainability management) is not an expert of accounting, this quasi consensus can be regarded as a sign of trustworthiness.

Seventh Reason: Consideration of Long Term Effects

The 7th reason shows that EMA was not only adopted to trigger quick and short-termed effects on resource and energy efficiency (table i6). By contrast, EMA was adopted to improve the focal company's accounting, whose positive effects were expected to last for a long time (cf. XY1, q. 1, p. 2 / XY2, q. 1, p. 4.). The seventh reason was also an intermediary one. By giving this reason, the interviewees also expressed the view that EMA had reached these positive long-term effects by having improved the company's SMA (cf. XY3, q. 1, p. 4 / XY5, q. 1, p. 5.). This aspect of EMA directly leads to the eighth and last reason to implement EMA. As the interviewees XY1, XY2, and XY3 come from the management and controlling departments, their opinions are highly trustworthy.

Eighth Reason: Help Management with Decision-Making

The interviewees expressed the view that EMA was not thought as a tool to bring about the wanted effects by its own (table i8). The individual quality of EMA to track the components of the company's physical flows was seen as an indispensable help for the SMA to find ways of minimising the company's environmental costs (cf. XY1, q. 1, p. 2), and especially those of the "expensive energy and fuel consumption" (cf. XY3, q. 1, p. 4). All fifteen interviewees confirmed these views. As one explicit and supporting statement was made by interviewee XY1 (see quote above), who belongs to the sustainability department, this view can again be regarded as valid.

Taken together, these eight reasons, and especially the latter three ones, support the working definition of EMA in the literature review (cf. 2.9). When the company implemented EMA, it understood this method as a 'part of the SMA, which monitors the company's physical flows, calculates their associated environmental costs (…) in order to support and optimise their managerial decisions concerning the company's environmental performance' (cf. 2.11). These interview results are insofar important since they uncovered new reasons to implement EMA, whereas the literature review only stated tax-related and environmental reasons. This conclusion also relates to the research aim and research question 1.3, since the reason to implement EMA was the prospect of financial and managerial benefits, and not judicial pressure.

6.4.3 Implementation of EMA – Main Procedure and Measures

6.4.3.1 Presentation of Interview Data

The statements on this topic made by the interviewees can be found in the tables (ii1) and (ii2), which are presented in the appendix because of their length.

6.4.3.2 Interpretation of Interview Data

The bulk of the information on the implementation of EMA was supplied by the interviewees XY1, XY2, YX4, XY8, and XY14, especially when it came to outline the stages of the EMA implementation. As these interviewees were also actively involved in the implementation of EMA, their statements can be viewed as reliable. The interviewees XY3, XY6, XY9, XY10, XY11, XY13, and XY15 could not offer any important information with respect to the latter point, because they were not familiar with accounting or because they were not present when the EMA implementation took place. The other three interviewees (XY5, XY7, and XY12) were able to confirm all statements made by the first five interviewees. So again, it can be concluded that the statements reflect the company's common view concerning the implementation of EMA.

The implementation of EMA was a sequential process passing six consecutive stages based on ISO 14001 and BS 8555/Acorn standards (table ii1). The implementation was initially led by “a team comprising experts from all accounting departments and from the departments that are responsible for the supply chain” (cf. XY2, q. 1, p. 3). The idea behind this decision was “to have skilled project team leaders” (cf. idem) and to combine these departments in the implementation of EMA from where it would get its information (cf. idem). However, this team proved inexperienced to perform the necessary assignments, so the management collaborated with external experts and tutors; this enlarged team carried out the greatest part of the EMA implementation (cf. XY1, XY2, YX4, XY5, XY8, XY12, and XY14, q. 1, pp. 2-11).

Stage 1 of EMA Implementation: Discussion and Decision

In the beginning of the EMA implementation, the management discussed the necessity to implement EMA. It informed itself about it and looked for specific reasons to implement it, which have already been presented in the previous section. These reasons to implement EMA also helped the management to define the goals and the operational field of this sort of accounting. The first stage was concluded by the management decision to implement EMA (cf. XY1, XY2, YX4, XY8, and XY14, q.1, pp. 2-11; table ii2)).

Stage 2 of EMA Implementation: Definitions of Goals and Fields

The 2nd stage of the EMA implementation was, as mentioned above, devoted to the finding and defining of the fields and goals of EMA (table ii2). They were described as “the tracking and the identification of environmental costs” (cf. XY8, q.1, p. 7) and as a tool of “reducing environmental costs” (cf. XY4, q.1, p. 5).

Stage 3 of EMA Implementation: Definition of Measures and Tools

The 3rd stage of the implementation was the critical one (table ii2). Firstly, the collaborators defined the measures and tools to bring about the EMA implementation (cf. XY1, XY2, YX4, XY8, XY14, q.1, pp. 2-11). Thereafter the management informed the staff members, whose work was normally affected by the decisions of the SMA, about the organisational changes brought about by the future EMA implementation (cf. idem). About the same time, the leading team of the implementation broadened its knowledge about EMA and learned “how to measure the flows of material and energy, and how to translate this physical data into information that could be used by” their “accounting techniques” (cf. XY2, q.1, p. 3). This phase of the EMA implementation, which lasted a month, only led to “futile attempts” (cf. XY1, q.1, p. 2), and the management hired external experts and tutors to help them with the work to define the appropriate implementation tools (cf. XY1, XY2, YX4, XY5, XY8, XY14, q.1, pp. 2-11). These tools were largely software-based, which the manager and other internal experts of the company were not able to deal with (cf. XY14, q. 1, p. 11).

Stage 4 of EMA Implementation: Actual Implementation

The 4th stage marked the actual implementation of EMA (cf. XY1, XY2, YX4, XY8, XY14, q.1, pp. 2-11; table ii2). This was done with “new IT technologies, with which the various costs types [of EMA and the previous accounting system] were combined and aggregated” (cf. XY14, q.1, p. 11). The computer software therefore had to combine the typical EMA-related indicators and benchmarks with those of the previous accounting system (cf. idem).

Stages 5 and 6 of EMA Implementation: Review and Confirmation

When the implementation ended, i.e. at the 5th stage, the entire system of EMA was reviewed to find mistakes (table ii2). No negative results were found (cf. XY1, XY2, YX4, XY8, XY14, q.1, pp. 2-11). At the 6th and final stage “the management unanimously confirmed the use of EMA” (cf. XY14, q. 1, p. 11).

Concluding Remarks

Answering the first research question, one can say that the way the company implemented EMA shows that it acted systematically, and it therefore had a basic knowledge of sophisticated accounting techniques. The company's expertise concerning EMA however proved insufficient and it had to avail itself of the help of external experts and tutors. There are also indicators that the company’s internal organisation and communication had significant deficits. Even after it had decided to implement EMA, and also after it had informed the relevant staff members about this decision, the management was still in the process of learning the basic details of EMA. In addition, it took the management one month to realise that it was not able to carry out the EMA implementation completely on its own. These results confirm the case studies of the literature review, and especially the case study by Burrit et al. (2003)

reporting on the difficulties Mittelstand-like companies have with implementing EMA (cf. 2.5.2). In addition, these occurrences confirm the statements in section 3.1 (‘Determination of Appropriate Methodology’) on the time and path dependency. When staff members of a company are confronted with changes, they often (as in the case study) stick to old ‘habits, rules and routines’, thus only complicating the situation. As the company obviously faced obstacles impeding the EMA implementation (i.e. lack of expertise), these findings also answered research question 2.[13] Finally, it is also possible to answer research questions 1.4[14] and 3[15] by saying that the current model of EMA is not likely to meet the needs of a Mittelstand company with a low technical expertise

6.4.4 Barriers and Drivers of EMA Implementation

6.4.4.1 Presentation of Interview Data

The interviewees’ statements on the barriers impeding the EMA implementation and on the drivers facilitating it are presented in the tables (iii1) and (iii2), respectively. As both tables are very long, they are presented in the appendix.

6.4.4.2 Interpretation of Interview Data

Barriers Impeding the Implementation of EMA (Table iii1)

The interviewees did not agree upon all barriers and facilitating factors concerning the implementation of EMA. Its “long duration, [and] technical complexity” (cf. XY14, q.1, p. 11) were widely accepted as barriers impeding the implementation of EMA. Interviewee XY9 was the only participant who did not explicitly support this view; on the other hand he did not state a contradictory view, either. Another barrier concerning the majority of the interviewees was the lack of experienced staff members. This circumstance was also regarded as a reason for the long duration of the project. Interviewee XY12 stated that “the introduction of EMA proved difficult and time-consuming, because no one of the “staff had the necessary skills to do so” (cf. XY12, q. 1, p. 10). Both views were accepted by most other interviewees. The sole exception was again interviewee XY9, and again he did not put forward a contradictory opinion. So, this assessment can be regarded as trustworthy.

[13] „What were the potential obstacles and drivers for the implementation of EMA in the Mittelstand company of the case study?“
[14] “Is the current model of EMA suitable for the needs of this Mittelstand company?”
[15] “What generalising conclusions can be drawn from the case study concerning the problems, advantages and disadvantages of EMA in the context of the German Mittelstand?”

On the other hand, several interviewees pointed out two other barriers, whose existence was not commonly accepted by all interviewees. Interviewee XY7 mentioned that “some managers were already at the point of losing their patience” (cf. XY7, q. 1, p. 7) when the EMA implementation did not progress. The interviewee could however not remember the managers’ identities and the circumstances of this incident. As interviewee XY7 had not participated in the EMA implementation, and as all other interviewees explicitly denied having witnessed impatient managers, this statement was labelled as unreliable.

Another controversial barrier was the alleged internal and temporary resistance against the implementation of EMA. Interviewees XY1, XY2, XY4, XY8, and XY14 mentioned “some” or a “few members of the company” (cf. XY1, q. 1, p. 3 / XY2, q. 1, p. 4 / XY4, q. 1, p. 5) who initially refused to support the implementation of EMA, since they thought that the company “had already been doing enough for the environment” (cf. XY2, q. 1, p. 4). This resistance however faltered since the management had convinced the opponents of the necessity to implement EMA. The interviewees XY1, XY2, XY4, XY8, and XY14 mutually confirmed their statements, but they still were not sure if there was “some internal resistance” (cf. XY2, q. 1, p. 4), or “a minor one” (cf. XY14, q. 1, p. 11). These five interviewees could not tell the number of the opponents and still used the expressions ‘some‘ and ‘a few’. The alleged existence of an internal resistance concerning the implementation of EMA was explicitly denied by the interviewees XY7, XY9, XY10, XY11, and XY15, who reported that the implementation of EMA was met with widespread approval (cf. XY7, XY9, XY10, XY11, XY15, q. 1, pp. 7-11).

Drivers Facilitating the Implementation of EMA

Several interviewees also reported factors facilitating the implementation of EMA. Some of these factors appeared to be more reliable than others. One alleged supporting factor was the widespread approval of the EMA implementation among the staff. According to the mentioned five interviewees, there was “widespread determination” (cf. XY15, q. 1, p. 11) among the staff to implement EMA. On closer inspection these statements betrayed themselves as incoherent. Claiming that a project was supported by a “vast majority” (cf. XY7, q. 1, p. 7) or by “almost all participants” (cf. XY10, q. 1, p. 9) or by a “widespread determination”, and not by an omnipresent one, does not exclude the possibility of an internal resistance, it rather admits that there was one. Moreover, the interviewees XY7, XY9, XY10, XY11, and XY15 had not taken part in the implementation of EMA, two of them had not been members of the company at that time (cf. XY9) or were no experts of accounting (cf. XY11). By contrast, the interviewees XY1, XY2, XY4, XY8, and XY14 had taken part in the implementation of EMA and were able to describe it in a detailed way. That is why their statements concerning the internal resistance appear to be more reliable. They were labelled as probably reliable, and the contrary ones as unreliable.

This dissension gives rise to the conclusion that the manners of the internal communication were disturbed. Obviously, still now there are divided opinions concerning the implementation of EMA among the top ranks of the company's management. At least one of the opposing interviewee groups must be still badly informed. The reliable statements concerning the internal resistance also indicate that the organisational structure was or is (at least at the time of the EMA implementation) significantly disturbed.

On the basis of these conclusions one can also reject the view as unreliable that the company benefitted from its organisational and communicative expertise claimed by the interviewees XY5 and XY11 (cf. XY5, q. 1, p. 6 / XY11, q. 1, p. 9). These interviewees had not participated in the EMA implementation. Additionally, the disastrous start of the EMA implementation and the delayed use of external experts rather bespeak the company's organisational and communicative shortcomings (cf. 'Concluding Remarks' in section 6.4.3.2). Interviewee XY3 was the only participant reporting that the company had an expertise concerning "ecological issues and the laws connected with them" (cf. XY2, q. 1, p. 4). The other interviewees did not corroborate this statement, but they did not deny it either. In support of this statement it can be said that the company actually found adequate reasons for implementing EMA, which shows a certain degree of knowledge of ecological issues (cf. 6.4.2). Therefore this statement was labelled as probably reliable.

The only facilitating factor of the EMA implementation, whose existence can be regarded as certain, was the company's financial resources. The interviewees XY1, XY2, XY6, XY8, XY12, and XY14 reported that "the company had the financial means to carry out the implementation of EMA" (cf. XY8, q. 1, p. 8) and, especially, "to pay the external tutors and experts" (cf. XY2, q. 1, p. 3 / cf. also XY1, q. 1, p. 2; XY6, q. 1,

p. 6; XY12, q. 1, p. 10; XY14, q. 1, p. 11). This view was confirmed by the other interviewees after the interview.

Concluding Remarks

On the basis of the previous analysis one can deduce that the statements on the alleged barriers and positive factors concerning the EMA implementation had a different degree of reliability ranging from certain to reliable and unreliable. The following table (iii3) summarises these findings.

<table>
<tr><th colspan="4">Table (iii3): Allegedly Experienced Barriers and Drivers of EMA Implementation</th></tr>
<tr><th rowspan="2">Factor</th><th colspan="3">Reliability of Statement (concerning the existence of factors)</th></tr>
<tr><td>Very High (Certain)</td><td>High (Reliable)</td><td>Low (Unreliable)</td></tr>
<tr><td rowspan="2">Barrier: Negative Factor</td><td>Long Duration & Complexity of Project</td><td rowspan="2">Internal Resistance</td><td rowspan="2">Impatience among Management</td></tr>
<tr><td>Lack of Technical Expertise among Personnel</td></tr>
<tr><td rowspan="2">Driver: Positive Factor</td><td rowspan="2">Sufficient Financial Resources</td><td rowspan="2">Expertise Concerning Ecological and Judicial Issues</td><td>Organisational and Communicative Expertise</td></tr>
<tr><td>Positive Attitude of Staff (Determination, Motivation, Patience, Support)</td></tr>
</table>

To answer research question 2, it can be said that the company hypothetically witnessed both four barriers and drivers impeding or promoting the implementation, respectively. However, if one only considers the certain and reliable statements, the company faced three barriers and two drivers. These results confirm the remarks about barriers impeding the implementation of EMA made in the literature review (cf. 2.8.2 & 2.9). However, the results of the interview indicate that there are more certain barriers than drivers for a Mittelstand company when it tries to implement EMA, something that cannot be found in the literature review. These conclusions also corroborate the statements on the six factors determining structural changes in a company (found in section 3.1 of the chapter on methodology). First, the delayed EMA implementation again confirms the path dependency of this change. Secondly, EMA initially proved incompatible with the previous company structures. The company had to avail itself of experts who brought certain 'elements of stability within the process of change'. Thirdly, there were sizable contradictions and lack of trust among the staff members during the

EMA implementation. In the beginning, the implementation of EMA was (according to some interviewers) opposed by some staff members, whereas other interviewers denied this or were not sure about it. It is also noteworthy that in this context more interviewees made unreliable statements than in other contexts. This again highlights the fact that there are contradictions in the staff and a disturbed internal communication. As this chaotic episode only lasted one month, the period of the change was rather quick. This is the rule for power-driven companies, as pointed out in section 3.1. As a matter of fact, the changes in question were brought about by the management. Referring to research question 1.1 and the study's aim, one can therefore say that the implementation of EMA was carried out successfully despite initial complications. The most important complicating factors were the long duration of the project, its complexity, and lack of expertise among the staff. The main facilitating factor were the financial resources with which the company could hire experts. Therefore, one can again answer research questions 1.4 and 3 by saying that this model of EMA is probably inappropriate for Mittelstand companies with a low technical expertise and restricted financial resources.

6.4.5 Potential and Additional Drivers of EMA Implementation

6.4.5.1 <u>Presentation of Interview Data</u>

As an answer to the second question, the interviewees named three basic measures that would have facilitated the implementation of EMA: (1) Analytical comparison of EMA and the company's previous accounting system; (2) earlier and improved tutorials; (3) search for alternatives of EMA. Each of the measures had their own sub-measures that followed individual criteria. They are listed in the following tables (iv1), (iv2), and (iv3). As they span four pages, they were moved to the appendix.

6.4.5.2 <u>Interpretation of Interview Data</u>

Criteria of Analytical Comparison of EMA and Previous Accounting System (Table iv1)

The interviewees' statements about possible additional measures to facilitate the EMA implementation were almost unanimously confirmed, either during or after the main interview. That is why these statements can be regarded as reliable evidence. The only exception was the statement made by XY15 that the focal company "would have picked an accounting system that is easier to implement" (cf. XY15, q.2, p. 15) than EMA if it had been better informed. Most interviewees (except XY8, XY12, and XY14) explained that before the EMA implementation the company should have compared it with its previous accounting system. In this context they stated four criteria for this critical comparison. As for EMA and the previous accounting system, the analysis in question ought to have identified and compared (1) their accounting structures and tools, (2) their goals and interests of the stakeholders (i.e. accountants and managers), (3) their accounting objects, (4) their mutual fit (cf. X1-X15, q. 2., p. 12-15, except XY8, XY12, and XY14).

Identifying and Comparing Accounting Structures & Tools (Table iv1)

In reference to the accounting structures and tools, the interviews remarked that the comparison should have been carried out thoroughly and correctly. The structure elements and tools of interests were the display of results (cf. XY14, q. 1, p. 15, who is a reliable source since he is the managing director), tracking and accounting of physical flows and related environmental costs (cf. XY1, q. 12, p. 6; XY4, q. 2, p. 13; XY6, q. 2, p. 13; XY7, q. 2, p. 14; XY13, q. 2, p. 15) as well as “cost-related delimitation, allocation and apportionment” (cf. XY7, q. 2, p. 14). This assessment can also be regarded as reliable because it is supported by a member of the sustainability management (XY1) and by a member of the controlling (XY3). According to interviewee XY11, the comparison should have followed the goal to find advantages of EMA that made it able “to identify some costs, which the existing type of accounting cannot spot” (cf. XY11, q. 2, p. 14-15). However, as this interviewee is only concerned with the production, his opinion is hardly reliable.

Identifying and Comparing Goals and Interests (Table iv1)

The interviewees agreed that the company should have checked beforehand if EMA and the company’s previous accounting system shared the common goals and interests (cf. XY3, q. 2, p. 12). By contrast, the interviewees also stated that the management should have also checked if the EMA fulfilled some other goals that the previously accounting system was not able to do (cf. XY1, q. 2, p. 12; XY11, q. 2, p. 14; XY13, q. 2, p. 15). Both systems should have therefore reported the findings to the same managers. This mission was defined as to support “the management with the development of environmental friendly processes technologies and products” (cf. XY9, q. 2, p. 13), “with [the] reduction of environmental costs and with the creation of environmental revenues” (cf. XY11, q. 2, p. 14-15), and with improving “the material efficiency of the company” (cf. idem). In addition, the management should have checked if EMA “brings about some extra benefits, which the old one cannot do” (cf. XY13, q. 2, p. 15). An example was “the reduction of environmental costs [by means of] identify[ing] some costs, which the existing type of accounting cannot spot” (cf. XY11, q. 2, p. 14-15). The interviewees argued that the management should have examined EMA if and how it “account[s] for the material and energy flows” (cf. XY5, q. 2, p. 13) and “tracks and measures all kinds of environmental costs correctly” (cf. XY10, q. 2, p. 14). Therefore, the interviewees demanded that the management should not have only checked and compared the goals of both accounting systems, but also the objects they identified, measured and reported. Most of the cited interviewees had little or nothing to do with accounting. However, the statement made by interviewee XY3 (a controller familiar with accounting) was regarded as trustworthy and as an evidence that the ‘company should have checked beforehand if EMA and the company’s previous accounting system shared the common goals and interests’.

Identifying and Comparing Accounting Objects (Table iv1)

The interviewees agreed that the management should have examined and compared EMA and its previous accounting system concerning the ways of tracking the company’s physical flows and the ways of identifying its related environmental costs (cf. XY1, q. 2, p. 12; XY4, q. 4, p. 13; XY5, q. 2, p. 13; XY6, q. 2, p. 13; XY7, q. 2, p. 13; XY11, q. 2, p. 14-15; XY13, q. 2, p. 15). In this context, the interviewees named special criteria, namely the completeness and correctness of the accounting procedures (cf. XY13, q. 2, p. 15), especially with respect to “the quantities, the values and the costs of the material and energy flows” (cf. XY7, q. 2, p. 13). Given the fact that interviewee XY6 (the director of sales) generally shared this view, it was taken as valid evidence.

Identification of Fit (Table iv1)

The interviewees were convinced that the management should have checked if EMA “fit[ted] in the structures of” the company’s “strategic management accounting” (cf. XY1, q. 2, p. 12; cf. also XY2, q. 2, p. 12; XY3, q. 2, p. 12; XY4, q. 2, p. 13; XY10, q. 2, p. 14) in terms of “the internal stakeholders, the goals and the means to reach them” (cf. XY2, q. 2, p. 12; cf. also XY3, q. 2, p. 12.). As for the internal stakeholders and the goals, the interviewees agreed that the implementation of EMA would be successful if the stakeholders were convinced that it actually could support “the management with the development of environmentally friendly processes, technologies and products” (cf. XY9, q. 2, p. 13). As for the measures, the interviewees found that it would have been helpful to know if the compared “general accounting principles” were “more or less identical” (cf. XY6, q. 2, p. 13). This basic similarity referred to “the ways of accounting for assets, costs and gains in terms of various asset and liability sub groups, turnover, gross profits, net group profits, capital and cash flows, outputs and inputs (…)” (cf. XY4, q. 2, p. 13). The interviewees also wished the management had checked if the previous accounting system and EMA drew their “information from different databases” (cf. XY6, q. 2, p. 16) to ascertain that this “type of accounting deliver(s) results the other is not able to” (cf. idem). Some of the cited interviewees (XY2, the head of department; XY3, a controller; XY6, the director of sales) had an expertise in terms of accounting and cash flows; hence their statements were taken as trustworthy.

Earlier and Improved Tutorials (Table iv2)

The interviewees agreed that early and improved tutorials would have facilitated the implementation of EMA significantly (cf. XY12, q. 2, p. 14; XY13, q. 2, p. 15; XY14, q. 2, p. 15). They proposed “high-profile tutorials carried out by external experts” (cf. XY14, q. 2, p. 15) [that should have lasted] “from the beginning to the end of the implementation [of EMA]” (cf. XY13, q. 2, p. 15). Such tutorials would have helped “to analyse the new type of accounting and the previous one in order to find ways to combine them” (cf. XY14, q. 2, p. 15). Therefore, the tutorials should have taught the staff members “how these accounting systems analyse the databases, and how they display their results” (idem). As this view was also supported by the managing director (XY14), it was taken as valid.

Search for Alternatives of EMA Implementation (Table iv3)

Three interviewees (i.e. XY2, q. 2, p. 12; XY8, q. 2, p. 14; XY15, q. 2, p. 15) held the view that it would have been helpful to look for alternatives before implementing EMA. These opinions were supported by most of the other interviewers. The only exception was, as already mentioned, the opinion held by interviewee XY15, who said that the company might have also chosen a substitute for EMA (XY15, q. 2, p. 15). Interviewees XY8 and XY15 defined the criteria for such a search. With respect to the goals, an alternative ought to have “a comprehensive internal reporting covering all environmentally relevant aspects of the material and energy flows" (XY8, q. 2, p. 14) that "help[s] to reduce environmental costs and bring about the environmental benefits [and that] help[s] to achieve an enhanced material efficiency" (idem). The technical criteria of finding an alternative to EMA were "transparency, accountability and reporting modalities, structure, internal stakeholders, correctness and feasibility of accounting activities, objectives and mission" (XY15, q. 2, p. 15). This means that the criteria for choosing EMA or an alternative were the same. The general opinion about checking alternatives of EMA was regarded as true because it was shared by the head of the department (XY2) and by a member of the controlling (XY). The singular opinion concerning substitutes of EMA put forward by interviewee XY15 (a member of the sustainability dept.) was dismissed because this person had little knowledge of accounting.

Concluding remarks

The interviewees proposed certain techniques and methods to facilitate the implementation of EMA. As the company did not use them, they can be labelled as 'missed chances' to carry out the EMA implementation in a quicker and more efficient way. Two conclusions can be drawn: Firstly, the company had to find a trade-off between the demands of the fit between EMA and the structure of SMA (Identity of Internal stakeholders, goals, and means to reach them) and the aim to gain extra advantages with EMA. Secondly, as shown in section 6.4.2, the management judged the reasons for implementing EMA correctly. However, it performed the EMA implementation in an inappropriate way since it disregarded some useful methods for an in-depth investigation of EMA and its relation to the SMA. This superficial attitude led to the problems explained in section 6.4.3. Therefore, it is plausible to deduce that the company suffered from organisational deficiencies and from a lacking technical expertise. The following table (iv4) summarises the techniques and methods in question:

<table>
<tr><th colspan="7">Table (iv4) Potential and Additional Drivers of EMA Implementation</th></tr>
<tr><td>MEASURE</td><td colspan="4">Comparison of EMA and Previous Accounting System</td><td>Tutorials</td><td>Search for Alternatives of EMA</td></tr>
<tr><td rowspan="2">ASPECTS</td><td>Structures Tools</td><td>Identity of Goals & Stakeholders</td><td>Object of Accounting</td><td>Fit</td><td rowspan="2">Time & Quality</td><td rowspan="2">Same as Comparison of EMA & Previous Accounting System</td></tr>
<tr><td>Track Physical Flows & Account Related Eco- costs</td><td>Track Physical Flows & Account Related Eco-costs</td><td>Physical Flows & Related Eco-costs</td><td>Identity of Internal Stakeholders Goals Means to reach them</td></tr>
<tr><td rowspan="5">CRITERIA</td><td>Cost Delimitation</td><td rowspan="2">Developing Eco-friendly Processes, Technologies Products</td><td rowspan="2">Complete & Correct Tracking of Physical Flows</td><td>Developing Eco-friendly Processes, Technologies, Products</td><td rowspan="2">Use of First Class External Experts</td><td rowspan="5">Same as Comparison of EMA & Previous Accounting System</td></tr>
<tr><td>Cost Allocation</td><td>Creation of Benefits</td></tr>
<tr><td>Cost Apportionment</td><td rowspan="3">Creation of Benefits</td><td rowspan="3">Complete & Correct Accounting of Eco-costs</td><td>Similar Accounting Techniques & Tools</td><td rowspan="3">Duration from Start to End of Implementa tion</td></tr>
<tr><td rowspan="2">Ability to Bring about Extra Benefits</td><td>Use of Different Databases</td></tr>
<tr><td>Trade-off Between Similarity & Extra Benefit</td></tr>
</table>

The results are without parallel in the literature review. They show that a large part of the staff was disinclined to implement EMA and would have also accepted an alternative type of accounting. On the other hand, these phenomena were predicted in section 3.1 in the chapter on methodology. As shown, varying degrees of expertise among the staff led to contradicting views concerning EMA and its implementation. A minority of the staff still had doubts if EMA fitted the company's SMA perfectly, which refers to research question 1.2 and 1.3 dealing with the fit of EMA and its benefits. Therefore, and to answer research question 2, the lack of expertise and a disturbed internal information policy were obviously the greatest obstacles delaying the implementation of EMA. That 'some managers were already at the point of losing their patience' can be regarded as an additional (contingent) barrier, which is hard to anticipate. To overcome these problems, the company could (as proposed by some interviewees) hire tutors who teach the staff members the necessary knowledge and skills concerning EMA. This is, however, a costly method, not affordable for all Mittelstand companies. That is also an answer to research question 3.

6.4.6 Influence of EMA Implementation on Accounting Process

6.4.6.1 Presentation of Interview Data

The following table (v1) displays the interviewees' answers concerning question 3 dealing with the immediate effects of EMA on the company's accounting procedures. As for the effects, the interviewees named various instances, but they did not give detailed information concerning the related measures of EMA. Most interviewees referred to EMA in general. This lengthy table can be found in the appendix.

6.4.6.2 Interpretation of Interview Data

Most interviewees referred to EMA in general when they explained its effects. No one stated any negative effects, everyone referred to positive ones only. To facilitate the analysis of the statements in table (v1), they are summarised and aggregated in table (v2, next page). As for the effects of EMA (or its measures), this table distinguishes between the effects on accounting (and tracking of physical flows) and the effects on SMA. The former group of effects only concerns the field of EMA, whereas the latter one concerns an outside area, i.e. decisions of environmental importance. After the interview all interviewees mutually confirmed the following statements. Therefore, these statements can be regarded as a trustworthy piece of evidence (cf. table v2).

Referring to the research objectives concerning the state of art of EMA and its potential, it can be said that the company's EMA (despite the initial resistance carried out by some staff members) is already well developed. By means of various techniques, it has a direct influence on the accounting and an indirect one on the SMA, which improved the company's economic and ecological performance. This section will show that (in almost all kinds of tracking and measuring the physical flows) the related environmental and conventional costs were only attributable to the implementation of EMA. The only prominent categories of environmental costs, which are missing in this table, are the costs for technical accidents or failures and manmade mistakes, and for taxes and penalties fees. This again indicates that the interviewees attributed a negligible importance to these costs.

Table (v2): Changes in the Company Due to EMA Implementation		
Measure	Direct Effect on Accounting	Indirect Effect Through SMA
EMA in General (Primary Metrics of Eco-Efficiency)	– Accurate tracking of all flow components in all affected departments, – Accurate identification of all flow related environmental costs via material and related cost categories – Accurate identification of all flow related conventional costs via material and related cost categories – Report of information to management	Reduced Environmental costs
		Eco-friendly purchase and production system
		Increased Material & Energy efficiency
		Increased Material Efficiency with little ecological aspects
		Increased Benefits
		Better Eco-Efficiency
		Improved Cost Efficiency
		Low Fuel & Energy Use
	Accurate identification and report of – Eco-related profits, – Losses and – Liabilities (all related to environmental processes & products)	Increased Material & Energy Efficiency
		Reduced Environmental Costs
		Development of Eco-Efficient Products
	Link with cleaner production efforts (unexplained)	Eco-Efficient Use of Machines
Environmental Loss and Profit Account	Accurate identification and report of – Eco-related profits and – Losses (both related to environmental processes and products)	Reduced Environmental Costs
		Increased Material & Energy efficiency
		Development of Eco-efficient Products
Secondary Metrics of Eco-Efficiency	Correct Measurement of eco-profit,s eco-losses	– Measurement of Influence on Environment – Improved Waste Efficiency
	Identification of environmental cost for all raw materials, operating materials and used materials	
	Accurate measurement of costs of output, distinguishing between costs for finished products and non-product output (i. e. waste)	
	Adequate cost types for emissions, for hazardous output and non-hazardous out put	
	No relation to accounting procedures	Low Carbon footprint
		Development of Eco-efficient Products
		Increased Material & Energy efficiency
		Reduction of Environmental costs

Answering research question 1.2, it can be said that EMA is a type of accounting that identifies and calculates (or at least estimates) the costs of all physical entities and outstanding events that might affect the environment. On the other hand, EMA also tracks (with the primary, secondary metrics and several other accounting techniques like the EBSC) the flows of these entities. Being connected with the SMA, EMA supplies it with this information to bring about managerial decisions that are both environmentally friendly and in the interest of the company. To answer research question 1.2, table (v2) also shows that ‘EMA influenced the company’s performance for the better’ by reducing its (a) negative impact on the environment, (b) its environmental costs, and (c) its use of material and energy. Hence, EMA improved both the ecological and economic performance of the company.

6.4.7 Comparison of Interview Results with other Findings

This section compares the results of the interviews concerning EMA and its implementation with the findings supplied by the literature review and the company’s files on this topic. Section 6.4.2 disclosed the company’s reason to implement EMA. The strongest motive was the reduction of costs caused by excessive use of fuel, energy and other physical flow components, namely hazardous input materials and waste. Accepting the methodological basis offered in table 3 (‘Pressures to Adopt EMA’, section 2.3), the company answered the supply chain pressure. But it did not so, because the “production process of the company” had to “comply with Environmental Management System (EMS) standard of the International Standardization Organization” (cf. idem). The motives were economic ones. The environmental tax and penalty pressure was weak. It was only a secondary aspect of economic considerations concerning the company’s international standing and the excessive costs on energy, fuel and mother materials. As the findings of the interviews suggest, there were no other forms of pressures that made the company adopt EMA.

According to the findings of section 6.4.2, the company judged the reasons and motives to adopt EMA correctly, but its implementation was hampered by several barriers (cf. 6.4.4 & 2.10.3 of lit. review). It mostly suffered from “organisational barriers including knowledge and skill barriers” (2.8.2). Although the management had some “expertise concerning ecological and judicial issues” (table iii.3 in section 6.4.4.2), it did not suffice to meet the “complexity of [the] project”. Just as outlined in section 2.8.2, “there” was “a lack of practical know-how concerning the implementation of eco-efficiency practices since the staff” was “less well trained and less technically skilled”.

The interview also suggests that there was some internal resistance against the introduction of EMA. So, using the nomenclature of the literature review, the implementation of EMA was most likely hindered by “cultural and philosophical barriers” that triggered among some staff members the “fear of change following the introduction and implementation of new technologies and new organisational patterns” (2.8.2). The fact that some interviewees denied any form of internal resistance bespeaks the existence of informational barriers. These barriers, however, still exist within the company and obstruct the flow of information between the several departments. In addition, there were also informational barriers between the company and the external world since the company obviously lacked the knowledge of “gathering, assessing and applying information about (…) relevant technologies” (idem) to implement EMA. As shown in section 6.4.5, the company only had the knowledge of them after it had learnt them in tutorials and after the EMA implementation had been completed. This lacking knowledge mostly concerned central characteristics of EMA, i.e. its structure and tools, its accounting objects, and its further goals as a supporter of managerial decisions (c. table iv4 in 6.4.5.2). On the other hand, the company did not face any financial barriers.

The implementation of EMA meant a deep change of the focal company’s accounting principles and procedures. The results presented in section 6.4.6 suggest that several accounting techniques are recent innovations only attributable to the implementation of EMA. These techniques are the accurate tracking of all physical flow components, the accurate identification of all flow related environmental and conventional costs by means of material and related cost categories, and also the reports of this information to the management (cf. table v2 in 6.4.6.2).

According to section 6.3.2.2, the focal company has elaborate methods to track the identities, quantities, directions, and fates of their physical flow components. To this end and to account the corresponding environmental costs, the company’s EMA uses the standard methods proposed in section 2.7 of the literature review. It uses the methods of FCA, flow cost accounting, ABC, and an input-output-analysis. These methods are backed with special EBSCs and a ratio analysis relying on at least one of twelve indicators (cf. section 6.3.3). This set of various methods allows the company to track the flows of individual input and output components and to create aggregated values for the entire supply chain.

With respect to the secondary indicators (used in the ratio analysis), there are some inconsistencies between the findings of the interviews and the original files of the company. The EBSC (table 13.0 in 5.3.4.3) lists the two indicators ‘Rate of Waste on Operating Assets’ and ‘Rate of Waste on Total Output’ that nominally do not appear in table (23) (cf. 5.3.4.9). The management informed me (3 November, 2015) that these two indicators are called ‘Rate of Waste Resources on Operating Assets’ and ‘Rate of

Waste Resources on Total Output' in table (23). In addition, there are three environmental indicators in the same table that do not appear in the EBSC of the ratio analysis of table (13.0). These indicators are 'eco-related net-profit', 'eco-related write-off', and 'eco-related income'. The indicators 'eco-related net-profits' and 'eco-related income' were mentioned by the interviewees in the context of FCA, where they were called 'eco-related profits' and 'eco-related turnover' (table 23). The indicator 'eco-related write-off' was not mentioned by any interviewee.

Presently the company uses cost categories that are not completely consistent with the ones found in the literature review. Theoretically, it uses the four fundamental cost categories (cf. table (2) in section 2.1.2); they are: (1) treatment and purchase of non-product output (including remediation efforts, waste disposal, and emission treatment), (2) prevention, (3) payments to the state and external organisations, (4) environmental revenues and savings. Obviously, the focal company's EMA uses the equivalents of the first and fourth category. However, it only accounts for the treatment and disposal of waste. In addition, it regards the costs for hazardous input materials, wood, water, electric energy, and fuel as main categories of environmental costs (cf. tables 18.1 & 19.1/19.2 in 5.3.4.5). For these cost types it also considers the amounts and conventional material costs. To this end it uses sophisticated methods of tracking physical flows. Presently, the company's EMA begins to express the environmental costs of most physical flow components of environmental concern in terms of its associated costs for wood, water, electric energy, and fuel. The company's EMA also regards eco-related profits and turnover rates and relates these figures to the conventional profits and turnover rates, respectively.

In contrast to that, the focal company now hardly considers the third cost category ('environmental taxes' and 'penalty fees') since its environmental taxes are stable and low, and the penalty fees are negligible due to eco-friendly production processes. The second category is present in the company's EMA, but only formally as 'costs for prevention and remediation'. In fact, these costs play a minor role because the company's eco-friendly production processes have reduced them as well (cf. 5.2).

The company's EMA covers all four assignment areas presented in table (6) of the literature review (cf. 2.6/appendix). In fact, the examined EMA has a water management, air management, material management, and energy management. All these four types of management are executed in a physical and financial way since the company intends to reduce the amounts and costs for the physical entities in question. On the other hand there are no specific cost categories for gas emissions in the newly reformed EMA. As a result, there are two contradictory trends in the company's flow cost accounting: (1) a strong focus on the identities, quantities, directions, and fates of the flow components, (2) a simplification of the environmental cost categories. This contradiction can be bridged by the assumption that the company essentially uses EMA for economic reasons. This conclusion can be supported by the interviewees' statements that the company implemented EMA mostly for economic reasons.

Because of these reasons and due to the fact that the examined EMA only acts as a supporter of the management, its basic tools are rather restricted in comparison to those presented in table (5) of the literature review (cf. 2.6). The EMA of the focal company does not, unlike some forms of EA or social accounting, develop production planning programmes or management reviews, nor does it do and any kinds of walkthrough or audits. In contrast to that, it performs the environmental cost (flow) accounting by measuring, monitoring, tracking the physical flows and its related conventional and environmental costs. It tracks, identifies, reports and documents the environmental costs by ascertaining the related material prices and environmental costs. The EMA at hand does this with the help of benchmarks and indicators. Again in contrast to some forms of EA or social accounting, it does not "develop measures to reach the abovementioned goals" (cf. idem). To this end, the company's EMA acts at the interface between its financial-physical accounting and SMA. The interviewees referred to EMA as helping the management with "tactical decisions and quick performance evaluations" (cf. table 5 in 2.6, and table i7 in 6.4.2.1/appendix). They also spoke of EMA influencing the long-termed effects of the production (cf. table i8 in 6.4.2.1/appendix). From this, one can conclude that EMA also influences the company's target setting and long-term strategy.

For the reasons stated above, the EMA at hand has a more restricted scope of goals and roles than displayed in table (4) of the literature review (cf. 2.6). The examined EMA has both a financial and physical component. The financial component is equal to the one described in table (4) with respect to its tasks, applications, and reporting procedures. As for the physical component there are differences. EMA only helps the SMA (by supplying the necessary information) with the "(a) evaluation of environmental performance, (b) investment options [and with] (c) developing eco-friendly production process, products" (table 5). The EMA at hand therefore basically relies on indicators serving internal uses and economic goals as calculating savings, budgeting and investment appraisal of eco-costs. Comparing these findings with the information of section 2.8.2, one can conclude that EMA was implemented on the business level but without serving any external or national reporting aims.

6.5 Category IV – Influence of EMA on the Company's Performance

6.5.1 Presentation of Interview Data

Answering question 9, the interviewees commented on the effects on the company's environmental and economic performance. After the interview they mutually confirmed their statements concerning almost all topics. The only exception was the point if EMA was able to calculate (or at least estimate) all environmental cost correctly. With the exception of the interviewees XY1 and XY3 every interviewee only stated positive effects of EMA on the company's performance. The interviewees named eleven positive effects on the company's performance attributable to the influence of EMA. Two of them referred to the flow cost accounting, the other eight referred to improved managerial decisions in economic or ecological respect. Table (vi1) lists the positive effects, while table (vi2) lists the instances of negative effects. Due to their enormous length, these tables are in the appendix.

6.5.2 Interpretation of Interview Data

6.5.2.1 Qualitative Analysis

According to findings of table (vi3), the interviewees found that EMA had caused the following performance improvements, thereby answering research question 1.3[16] in a more detailed way than before.

Table (vi3) Performance Improvements attributed to EMA	
Intrinsic EMA-Effects	Indirect EMA-Effects through SMA
(1) Correct Description of physical flows	(4) Improved Performance in General (5) Greater Number of Eco-Friendly Products (6) Improved Competiveness

[16] "Has EMA influenced the company's performance for the better or for the worse?"

(2) Completeness of Cost Calculation (3) Correctness of Cost Calculation	(7) Improved Resource and Energy Efficiency (8) Reduction of Environmental Costs (9) Reduction of Costs for Production and Products (10) Reduction of Taxes and Penalty Fees (11) Reduction of Waste and Hazardous Substances

The three performance improvements listed in the left side of the table were regarded as intrinsically EMA-related. The other 8 performance improvements were seen as the result of managerial decisions supported by EMA-related information on the physical flows and their information. As for the first three performances, all interviewees agreed that EMA thoroughly and correctly measured the amounts of all physical flows. All of them also agreed that the accounting of the environmental and conventional costs carried out by EMA was complete. In other words, it attributed to every environmentally critical flow component an amount of environmental price and finally its related amount of environmental costs. Opinions varied, however, if the environmental costs were always correct. Most interviewees remarked that they were mostly correct or mostly adequate, while the interviewees XY9 (dept. of sustainability management), XY13 (chemistry specialist), and XY15 (head of quality management) claimed them to be adequate. As they were no experts of accounting, their opinions were regarded as irrelevant. As for the other eight performance improvements, all interviewees stated that they were characteristically related to each other, as shown in table (vi4). To reduce the space of this table, the following abbreviations were used: C (competitiveness), CPP (costs for production and products), EC (environmental costs), EFP (environmentally friendly products), REE (Resource & Energy Efficiency), WHS (waste and hazardous substances), X (no comment), I (correct description of the company's physical flows), II (completeness of cost calculation), III (correctness of cost calculation), XY (interviewee).

Unlike all other interviewees, XY4 and XY10 (both members of the production) did not comment on the initial consequence, intermediate consequences and goals of EMA (cf. table vi4). This again shows that these interviewees were not reliable commentators of EMA. The analysis of table (vi4) mostly relies on the fully trustworthy interviewees XY3, XY6, and XY8 since they were experts of accounting and controlling. Their code numbers appear in a big and bold typeface. To a minor extent, the analysis also referred to the statements made by interviewees XY1, XY9, and XY15, because they (as members of the sustainability management) were concerned with the material consequences of EMA. Therefore, they were regarded as moderately reliable. Their code numbers appear in a small and bold typeface.

Table (vi4) Qualitative Relationship of EMA-related Effects

EMA	Effect on Strategic Management Accounting: Initial Consequences	Intermediate Consequence	Final Goal	**XY**
I II III	(7) Improved REE; (8) Reduced EC; (11) Reduced WHS	(9) Reduced CPP	(6) Improved C	**1**
I II III	(7) Improved REE; (8) Reduced EC	X	(6) Improved C	2
I II III	(8) Reduced EC; (11) Reduced WHS	(5) More EFP; (9) Reduced CPP	(6) Improved C	**3**
X	(8) Reduced EC	(9) Reduced CPP	X	4
I II III	(8) Reduced EC	(5) More EFP	X	5
X	(7) Improved REE; (11) Reduced WHS	(5) More EFP	(6) Improved C	**6**
I II III	(7) Improved REE; (8) Reduction of EC	(5) More EFP; (9) Reduced CPP	(6) Improved C	7
I II III	(7) Improved REE	(5) More EFP; (9) Reduced CPP	(6) Improved C	**8**
I II III	(8) Reduced EC	X	X	**9**
X	(7) Improved REE	X	X	10
1 2 3	(7) Improved REE	X	X	11
X	(7) Improved REE; (11) Reduced WHS	(9) Reduced CPP	(6) Improved C	12
I II III	(11) Reduced WHC	X	X	13
I II III	(7) Improved REE; (8) Reduced EC	(5) More EFP; (9) Reduced CPP	(6) Improved C	14
I II III	(8) Reduced EC; (7) Improved REE; (11) Reduced WHS	(5) More EFP; (9) Reduced CPP	(6) Improved C	**15**

Table (vi4) gives additional information related to table (vi3) and research question 1.3 because it tells how the improvements were created. According to this table, the interviewees held the view that the management used the EMA-related information to improve the company's performance in three steps. Firstly, the management reduced the amount of waste and hazardous substances; it directly improved the resource and energy efficiency of the supply chain. These two primary effects meant a substantial reduction of environmental costs. On a second or intermediary stage the management used the thus improved supply chain to develop eco-friendly products and to reduce their prices. The management then tried to achieve greater market shares with these products. As for the first stage, every interviewee named at least one of the performance improvements (7), (8), and (11). The groups of the fully and moderately trustworthy interviewees named them all. With respect to the second and final stage, the trustworthy interviewees named the improvements (5) and (9) (interviewees XY3 and XY8 named them both, while interviewee XY6 only named improvement (5)). In reference to the final stage (i.e. goals), all fully reliable interviewees confirmed the existence of the improvement (6). Two performance improvements were disregarded by all interviewees: (4) 'Improved Performance in General', and (10) 'Reduction of Taxes and Penalty Fees'. The performance improvement (4) was considered too vague to deserve a further analysis. The performance improvement (10) was named by one interviewee only (XY2). The other interviewees confirmed this performance improvement, but they also explained that it was negligible. Therefore, one can conclude that the improvements (4) and (10) did not play a major role in the company.

These findings confirm the existence of most benefits presented in the literature review in the context of research on Mittelstand companies (cf. 2.5.2). These benefits were "improved transparency (identification and quantification) of environmental costs and tools, (…), positive effects on accounting systems and organisational structures, enhanced competitiveness, improved reputation, compliance with legal status, and cost savings" (cf. idem). The two exceptions are 'compliance with legal status' (i.e. minimisation of eco-taxes and penalty fees), and 'improved reputation' (i.e. image), which were not regarded as important by the interviewees.

These results answer research questions 1.2 and 1.3 positively: EMA influenced both the accounting and the SMA for the better by supplying it with information about the physical flows and the associated costs.

6.5.2.2 Quantitative Analysis

The quantitative analysis will be carried out by comparing the interview results with the information provided by the company's documents. The following table (30) is a modified version of table (23) in section 5.3.4.9. It shows the company's performance changes due to EMA confirmed by the management during the aforementioned meetings. That this uptake was backed by EMA is explained in the documents quoted in section 5.3.4.3. The company's eco-efficiency in terms of waste production and uses of hazardous substances has indeed improved since the implementation of EMA in 2010. As of 2012, the values of all metrics were under the corresponding average values of the company's market sector.

Table (30) Environmental Indicators for Waste and Hazardous Materials					
Year	**2010**		**2012**		**Change**
Economic Metric in Per Cent	Firm	X_M	Firm	X_M	Per Cent
Rate of Wasted Resources on Operating Assets	18.40	16.8	10.80	13.5	–41%
Rate of waste (+ water) on total output	5.38	4.0	2.27	3.0	–44%
Rate of hazardous waste on total output	1.43	1.0	0.52	0.70	–51%
Rate of emissions on total output	2.70	2.0	1.39	1.4	–49%
Rate of wasted resources on total output	6.77	5.0	2.27	3.5	–66%

The following table (31) uses the figures from the tables (27) and (28) in section 5.3.4.9. They show (as confirmed during the meetings) that the company's material efficiency, except the one for merchandise, has improved from 2010 to 2014.

Table (31): Costs for used Material and Energy of the ACME-Print (2010 to 2014) in Mio. €			
Material	2010	2014	Change (%)
Paper (made of wood by company)	63.414	47.421	–25%
Colours	18.776	10.213	–46%
Chemicals and other auxiliary materials	2.769	0.915	–67%
Merchandise	3.346	8.032	+140%
Packaging	0.865	0.372	–57%
Energy	3.325	2.206	–34%
Gas Emissions	0.100	0.008	–93%
Water	2.445	0.823	–66%
All costs	95.040	69.990	–68%

The following table (32) contains information from table (23). It shows that the figures for eco-related profits, write-offs, income, assets, and turnover grew faster than their conventional counterparts. Again, these financial figures scored better than the corresponding average values from companies of the same market sector. The abovementioned documents prove that this positive trend was also supported by EMA. The sole exception is the section 'Eco-related Reserves', whose figures have declined over the years.

Table (32) Indicators for EMA-related Economic Performance					
Year	**2010**		**2012**		**Change**
Economic Data in Million €	Firm	X_M	Firm	X_M	Percent

Net Profit	26.68	7.1	35.12	8.7	+32%
Eco-related Net Profit	0.4	0.5	5.12	1.5	+1180%
Write-Off	14.69	7.4	14.95	4.3	+2%
Eco-related Write-off	2.1	1.5	0.76	1.2	–64%
Net Income	6.45	1.1	11.08	1.3	+72%
Eco-related Income	0.0	0.1	1,8	0.2	+80% (cf. to 2011)
Tangible Assets	85.27	34.1	85.49	39.1	0,3%
Eco-related Assets (various kinds)	0.0	0.1	2.1	0.3	+75% (cf. to 2011)
Reserves	44.57	10.4	57.17	11.9	+28%
Eco-related Reserves (cf. table 24)	14.03	13.5	9.04	11.2	–36%
Rate of eco-related Turnover on Total Turnover	0.00	2.0	15.0	7.6	+60% (cf. to 2011)

The following table (33) is a simplified merger of the tables (25) and (26) in section 5.3.4.9 showing the main categories of environmental costs and revenues. It reveals that from 2012 to 2013 all environmental gains have significantly risen, whereas almost all environmental costs have fallen. The three exceptions are the costs for purchased EMA tutorials, staff costs for eco-related issues, and prevention technology & service. Obviously, the company invested substantial sums of money in educational efforts to raise its expertise in EMA. The EMA-related profits (i.e. profits gained with eco-friendly products) have been rising since 2011 (cf. table 24-26 in section 5.3.4.9) and constitute a growing and substantial part of the overall profits. Again, these positive trends were connected with the use of EMA as witnessed by the quoted documents.

Both the qualitative and the quantitative analysis have supported the idea that EMA actually offers valuable help for managerial decision-making, both in ecological and economic respect. In view of the second research objective, one can now assert that EMA has a high economic and ecological potential for the focal company. Therefore, again both the research questions 1.3 and 1.4 can be answered in the affirmative.

Table (33): Profit and Loss Account of ACME-Print in 2012 and 2013 in Mio. €			
Conventional Economic Data	Portion of EMA cost or benefit		Type of EMA-related cost or benefit
	2012	2013	
Turnover	38.594	63.777	Eco-related products
Change in stock of finished goods & work in progress	0.127	0.324	Eco-friendly finished goods & work in progress
Total Output	38.467	63.453	Eco-related products
Cost of purchased service	0.983	0.236	EMA tutorials

Cost of resources	75.780	69.700	Hazardous materials, machines, energy, fuel, wood
	2,406,578.09	1,503,465.00	Consumption of water
Gross profit	13.849	21.551	Eco-related products & procedures
Wages and salaries	5.898	6.894	Staff costs for eco-related issues
Depreciation of tangible and intangible fixed assets	0.844	0.523	Depreciation of raw material and hazardous substances
Other operating charges	0.785	0.534	Costs for clean-up, remediation
	0.987	0.605	Environmental management
	6.480	4.352	Value of wasted resources
	0.944	0.753	Waste disposal & treatment
	0.437	0.454	Prevention technology & service
	9.633	6.164	All EMA operating charges
Extraordinary income/charges	0.050	0.106	Eco-related subsidies
Tax on profit	0.061	0.007	Eco-related taxes and fees
Annual group profit	1.662	2.978	EMA-related group profit p.a.
Shares of profits or losses allocated to other shareholders	–0.710	–0.659	Shares of losses allocated to lost shareholders due to EMA
–	1.537	2.693	Total EMA-related profit p.a.
Total annual profit	10.245	12.242	–
–	15.0%	22.0%	EMA-related percentage

6.6 Category V – Benefits and Disadvantages of EMA

6.6.1 Presentation of Interview Data

With question 10 the thesis tried to explore the benefits and drawbacks of EMA. The fifteen interviewees named the following benefits and disadvantages of EMA.

Table (vii1): Benefits and Disadvantages of EMA (Question 10)		
Benefits	XY	P
Clear structuring of data and files	1	54
	3	55
	6	56
	8	57
	9	57
	13	58

	15	59
Clear and adequate description of physical flows within company	All	
Clear and adequate identification of corresponding environmental costs (in most cases)	All	
Help for the strategic management accounting by providing useful information concerning the reduction in terms of economic and environmental performance	All	
Useful/effective metrics for the estimation of environmental costs and its overall environmental performance	All	
Disadvantage	XY	P
Confusion & Incoherence of accounting and presentation of environmental costs due to many pieces of diverse information	2	54
	4	55
	5	56
	7	56
	10	57
	11	58
	12	58
	14	59
Continuous check of the physical flows	1	53
	6	55
	7	55
	9	57
	12	59
Difficult implementation	All	
Some / several / occasional uncertain environmental cost estimates	All	

6.6.2 Interpretation of Interview Data

6.6.2.1 <u>Internal Analysis</u>

The interviewees agreed on the existence of some benefits and disadvantages, whereas they disagreed on others. As for the benefits, there was common agreement about these points: EMA uses effective metrics with which it adequately describes the physical flows, and in most cases it can account for its related environmental costs correctly. With respect to the disadvantages, all interviewees agreed that the implementation of EMA was difficult and that some cost estimates were vague. However, there were two points upon which there was no consensus. Firstly, five interviewees (XY1, XY6, XY7, XY9, and XY12) stated that they found the constant checks annoying. When the other interviewees had to judge this opinion, they showed a rather neutral attitude in this respect. The other point of contention was the way EMA dealt with the cost accounting and how it presented its results. Here the interviewees were split in almost two equally large groups. While one group (group A) found this methodology effective and efficient, the other one (group B) berated its incoherence. The opposing views and their supporters are listed in table (vii2):

Table (vii): Opposing Views on Accounting Structure of EMA			
Clear & efficient structure of EMA		Confusing structure of EMA	
XY	Individual Opinion	Individual Opinion	XY
1	The immediate benefit [of EMA] is the clear structuring of data and files.	EMA (…) creates many pieces of diverse information, which are often confusing and hard to combine.	2
3	[EMA] helps to structure our files in a clear way.	EMA relies on different approaches to measure environmental costs. So the results are often difficult to combine.	4
6	The immediate benefits [of EMA] are a clear and succinct structure and presentation of data.	The cons of EMA are (…) sometimes large amounts of incoherent information due to different approaches to measure environmental costs.	5
9	The advantages of EMA are: simplified data files on environmental issues, overall improvement of file creation, (…)	This accounting creates many pieces of diverse information, which are often confusing and hard to combine. EMA relies on different approaches to identify environmental costs.	7
8	The good thing about EMA is that it (…) simplifies the files on physical flows.	The main disadvantage(s) of EMA [is] that it produces a large amount of data from disparate sources, which is hard to aggregate.	11
13	The benefits of EMA are as follows: It provides conclusive data and files about the physical flows and their environmental costs.	EMA (…) uses many different approaches and metrics to measure the environmental costs. This complicates the overall analysis.	10
15	The direct advantages of EMA can be summarised as follows: creation of clear files on the physical flows and all their costs, (…).	The negative thing about EMA is that it draws on large amounts of data from different sources. Consequently, the calculation is difficult and time consuming.	12
		The other negative aspect of EMA is its use of different approaches to present and calculate environmental costs.	14

The existence of these conflicting views can be explained with two assumptions: Firstly, the group of fully and moderately trustworthy interviewees unanimously stated positive views on the benefits of EMA, while the interviewees who were not familiar with accounting affairs only mentioned disadvantages. From this one can once more deduce that judgements about EMA are highly correlated with the interviewee's relevant expertise. Secondly, there still seem to be internal informational barriers that favour different views on EMA (already mentioned in the concluding remarks of 6.4.5.2).

Therefore, it is plausible to argue that some staff members lack their colleagues' expertise to understand EMA correctly. Accepting the statements made by the trustworthy interviewees, one can conclude that the benefits of EMA largely outweigh its disadvantages.

6.6.2.2 External Analysis

The benefits of the company's EMA can be validated by comparing them to the results of the twelve studies from section 2.5.2 (linking EMA to certain advantages).

Table 34: Benefits of EMA according to the 15 Interviews and the selected 12 Studies

Study S naming benefit		Named benefit	Interviewees agree?
Total number of studies	Individual Study S		
12	All 12	Improved accounting of eco-costs	Yes
4	1 / 7 / 8 / 10	Cost reduction (Including reduction of penalty fees)	Environmental costs: Yes Production costs: Yes
4	5 / 8 / 9 / 10	Increased market share / exports / competitive advantage	Yes
4	4 / 6 / 9 / 12	Improved (process) management	Yes
4	1 / 8 / 8 / 9	Attraction of investors, improved relationship with investors	Unconfirmed
3	7 / 8 / 9	Improved company image	Unconfirmed
3	7 / 8 / 9	Legal compliance	Negligible
3	3 / 4 / 9	Improved internal and external communication	Internal only
2	2 / 12	Step-by-step framework	Yes (for implementation)
2	8 / 10	Increased turnover	Yes
1	9	Resource efficiency	Yes
1	10	Improved team spirit of staff	Unconfirmed
1	4	EMA indicators	Yes
0	**None**	Environment protection	Yes

The 12 studies quoted in chapter 2.6.3 naming at least one benefit attributed to EMA are:
S1: Staniskis & Stasiskiene (2006) / **S2:** Burrit & et al. (2003) / **S3:** Schwarz et al. (1999)
S4: & Lavicka (2006) / **S5:** IÖW (2003) / **S6:** Heupel & Wendisch (2003) / **S7:** Abeliotis (2006) **S8**: EU EVER study (2005) / **S9:** Vernon et al. (2009) / **S10:** Rennings et al. (2003 and 2006) / **S11:** Hyrslova & Hajek (2006: 440ff.) / **S12:** Fresner & Engelhardt (2004)

Table (37) shows (thereby referring to the study's aim)[17] that the company's EMA (unlike social accounting and some forms of EA) was completely concerned with internal affairs. It also reveals that the company's EMA was more successful in economic respect since (apart from the reduction of environmental costs) only

[17] "(…) to investigate the ways, benefits and disadvantages of implementing EMA in German Mittelstand companies."

minorities of the studies mentioned positive economic effects like cost reduction, increased market share or increased turnover.

6.7 Category VI – Efficacy and Efficiency of EMA

6.7.1 Presentation of Interview Data

In question 11 the interviewees were asked to describe the efficacy and efficiency of EMA and to rate them on a scale ranging from 1 to 10. This question also recommends itself since the interviewees already disagreed with respect to the functionality of EMA. The efficacy of EMA is understood as its basic concept; its efficiency is regarded as its factual execution. The interviewees' descriptions of the efficacy and efficiency of EMA essentially reiterated the previous statements concerning its benefits, disadvantages, and its influence on the company's economic and ecological performance. Therefore, this section limits itself with presenting the scores ranging from 1 to 10. The scores of group A are shaded in grey.

Table (viii1): Ratings of Efficacy and Efficiency of EMA		
Efficacy	Efficiency	XY
9	9	1
8	6	2
10	10	3
9	7	4
8	7	5
10	9	6
8	7	7
10	9	8
10	9	9
7	6	10
7	6	11
7	7	12
10	10	13
8	7	14
10	10	15
8.73	7.92	Overall Mean

The corresponding values for group A and B are presented in table (viii2):

Table (viii2): Diverging Views on the Efficacy and Efficiency of EMA		
Efficacy	**Efficiency**	**Mean**
9.86	9.43	Group A
7.75	6.63	Group B
8.73	7.92	Overall

2.11	2.80	Difference between Group A and B

6.7.2 Interpretation of Interview Data

This table shows that the efficacy and efficiency of EMA were rated significantly higher by members from group A than from group B. The members were:

Table (viii3): Subgroups of Interviewees concerning their Views on EMA	
Group A	**Group B**
XY1: Department of Sustainability Management	**XY2:** Head of Department
XY3: Controlling	**XY4:** Production
XY6: Director of Sales	**XY5:** Head of Quality Management 1
XY8: Controlling	**XY7:** Head of Production
XY9: Department of Sustainability Management	**XY10:** Production
XY13: Chemistry Specialist	**XY11**: Production
XY15: Department of Sustainability Management	**XY12:** Head of Quality Management
–	**XY14:** Managing Director

The members' distribution indicates a certain pattern. The three members of the sustainability management belong to group A, and so do the two members of the controlling department. On the other hand, the two members of the quality management and all four members of the production department belong to group B. The two leading staff members (Head of Department and Managing Director) also belong to this group. So, there is an indication that the departments of sustainability and controlling are more familiar with EMA than the other departments. Apart from interviewee XY13 (chemistry specialist) all members of group A are fully or moderately trustworthy, whereas no such interviewee can be found in group B. This spilt corroborates the conclusions made at the end of section 6.6.2.1. Remembering research question 1.3 one can state this: The influence of EMA was (as mentioned above) positive. However, many staff members do not seem to realise that due to lacking expertise and informational barriers.

6.8 Category VII – Definition of EMA

6.8.1 Presentation of Interview Data

In question twelve the interviewees were asked to define EMA in their own words, thereby answering research questions 1.2 and 1.3. Every interviewee, except the interviewees XY10, XY11, and XY13, defined EMA this way:

> EMA is concerned with identifying the quantities of all physical flows components of a company, and with identifying their conventional material costs and associated environmental costs alike. EMA offers this information to the company's management to support its decisions that might improve the company's economic and ecological performance.

Interviewee XY13 (Chemistry Specialist) was not able to define EMA.

Interviewees XY10 (Production) and XY11 (Production) explicitly mentioned environmental gains as a defining characteristic of EMA, which they defined as:

> EMA is concerned with identifying the quantities of all physical flows components of a company, and with identifying their conventional material costs, associated environmental costs, environmental gains and savings alike. EMA offers this information to the company's management to support its decisions that might improve the company's economic and ecological performance.

6.8.2 Interpretation of Interview Data

The two definitions offered by the fifteen interviewees are actually the same since the interviewees XY10 and XY11 did not regard environmental gains as a type of environmental costs, whereas the others did. No interviewee explicitly referred to the methods of EMA in the context of defining it. The preliminary EMA definition in section 2.9 of the literature review was:

> 'EMA is the part of the strategic management accounting, which monitors the company's physical flows, calculates their associated environmental costs, earnings and savings, and reports the related information to internal stakeholders. It does so, in order to support and optimise their managerial decisions concerning the company's environmental performance. Its most commonly used methods are FCA, ABC, flow cost accounting, input/output analysis, and EBSC.'

With respect to the methods of EMA, the definition offered by the interviewees is more general since it does not refer to the methods but rather to the results by calling them 'identifying'. By contrast, the definition of the literature review explicitly mentions the methods of 'monitoring' and 'calculating'. In both definitions the objects of EMA are not identical. The interviewees' definition refers to 'conventional material costs, associated environmental costs and environmental gains', whereas the other definition refers to an EMA that only deals with 'environmental costs, earnings and savings'. The objects of the interviewees' definition also include, as stated above, environmental gains and savings. This definition is in line with the findings of section 6.3, according to which conventional material costs are also the object of the company's EMA. In both definitions EMA reports its findings to internal stakeholders. In the interviewees' definition this group of stakeholder is named as the company's management. In both definitions the stakeholder/manager uses the information of EMA for different tasks. According to the definition of the literature review, the stakeholder uses it to improve the company's environmental performance only. On the other hand, the stakeholder's (manager's) assignments are wider according to the interviewees' definition. Here he uses the information of EMA to improve both the environmental and ecological performance of the company. In fact, section 6.5 has proven that the company successfully uses its EMA for both ecological and economic concerns. Therefore, the interviewees' definition correctly reflects the way EMA is applied in the focal company, but without referring to the methods of EMA. This fact reveals that all interviewees do at least have a basic understanding of the matter.

6.9 Comparison of EMA-related Findings from the Literary Review and the Company Documents with those of the Case Study

A comparison of the findings concerning EMA and its implementation contributed by the literary review and by this research was already presented in sections 6.4.7, 6.5.2.2 and elsewhere in an extensive way. That is why section 6.9 only summarises this information in the tables (35.1-35.4) accompanied by comments. The main topic covered by one table each are: (1) EMA in general, (2) benefits and disadvantages of EMA, (3) environmental costs and cost categories, (4) implementation of EMA.

The following table (35.1) dealing with EMA in general already shows that the case study partly or completely confirmed the basic information on EMA, i.e. its definition, position in the organisation of a Mittelstand company, its assignment areas, basic functioning, and methods. The case study was however able to contribute new knowledge concerning the in-depth description of EMA's various methods and their functional interplay. In addition, the case study was able to explore new ways to simplify EMA, and to answer the question, if the benefits of EMA outweigh its disadvantages.

Table (35.1) EMA in General			
Aspect	Findings in Literary Review	Case Study Findings	Case study confirms literary review?

Definition of EMA	Focus on methods, environmental costs & performance	Consideration of both economic & environmental costs and performance; no focus on methods	Partly
Position of EMA in organisation	At the interface between financial-physical accounting and SMA; only at business level		Yes
Assignment areas	Water management (physical and financial)		Yes
	Air management (physical and financial)		
	Material management (physical and financial)		
	Energy management (physical and financial)		
Basic Functioning	Tracking of physical flow components.	**Accurate** tracking of **all** physical flow components	Partly
	Identification of flow related environmental costs with cost categories.	**Accurate** identification of **all** flow related environmental **and conventional costs** with **material** and cost categories.	Partly
	Report of this information to the management only.		Yes
Benefits outweigh disadvantages?	Contradictory findings	Yes	No
Methods	ABC, FCA, EBSC, Flow Cost Accounting, Input/Output Analysis, Ratio Analysis		Yes
In-depth description of methods	No	Yes (e.g. CAS registration numbers)	No
Interplay of methods	No description	Detailed description	No
Possible simplification of EMA?	No	Yes (with marker components and reduction of cost categories)	No
Source: Literary review and own research.			

Table (35.2) Benefits and Disadvantages of EMA			
Benefit	Findings in Literary Review	Case Study Findings	Case study confirms literary review?
Direct benefit		Adequate, clear & improved description of physical flows	Partly

through accounting	Better accounting of environmental costs	Complete cost calculation	
		Correct cost calculation	
		Useful cost metrics	
Indirect benefit through SMA	*Not mentioned*	Greater number of eco-friendly products	
	Higher profits, turnover & competiveness	Higher profits, turnover & competiveness	Partly
	Improved resource efficiency	Improved resource and energy efficiency	
	Cost savings	Reduction of environmental and conventional costs	
		Reduction of costs for production & products	
	Reduction of taxes & penalty fees	negligible	
	Not mentioned	Reduction of waste & hazardous substances	
	Improved team spirit & reputation	*Not mentioned*	
	Improved process management	Improved process management	
	Attraction of investors	*Not mentioned*	
	Improved internal & external communication	Improved internal communication	
	Not mentioned	Environmental protection	
Disadvantages	Difficult implementation		Yes
	Not mentioned	Several vague cost estimates	No
Benefits outweigh disadvantages?	Contradictory findings	Yes	No
Source: Literary review and own research.			

As revealed in table (35.2) the case study partly confirmed the findings of the literary review concerning the benefits and disadvantages of EMA. The findings from the case study were more detailed in respect to the direct benefits of EMA. These benefits were the results of EMA's accounting procedures (i.e. tracking the physical flow components and calculating their costs). The case study was also able to identify EMA-related cost savings (reduction of environmental and conventional costs, incl. those for the production and products) more clearly than the literary review. The case study could also point at EMA-related ecological benefits more extensively (greater number of eco-friendly products, improved resource and energy efficiency, reduction of waste & hazardous substances). Both the literary and the case study review pointed at higher profits, turnover and competiveness brought about by EMA by means of supporting the decision-making of a Mittelstand company's SMA. It should however be noted that only a minority of the reviewed studies offered these findings. Generally, the reviewed studies pointed at EMA's accounting of environmental cost, whereas the case study found out that EMA could improve a company's environmental and economic performance.

Table (35.3) Environmental Costs and Cost Categories

Aspect	Findings in Literary Review	Own Findings	Own findings confirm literary review?
Definition of environmental costs	Basic consensus (cf. sections 2.1.2 & 6.2)		Largely
Cost Categories	(1) Treatment and purchase of non-product output (including remediation efforts, waste disposal, and emission treatment).	Used by focal company	Yes
	(2) Prevention	Not used by focal company, only theoretically acknowledged	Partly
	(3) Payments to the state and external organisations		
	(4) Environmental revenues and savings	Used by focal company	Yes
Reliability of cost estimates	*Not mentioned*	Differentiation between reliable und unreliable cost estimates	No

Source: Literary review and own research.

Table (35.3) displays, that the case study predominantly confirmed the findings of the literary review in reference to the basics of environmental costs. The focal company however used a simplified set of cost categories mirroring its intent to simplify EMA altogether. Unlike the literary review, the case study was able to find out that there were reliable und unreliable cost estimates.

Table (35.4) EMA-Implementation

Aspect	Findings in Literary Review	Case Study Findings	Case study confirms

			literary review?
Reasons, pressures	Avoidance of environmental taxes & legal infringements.	Economic reasons (reduction of costs for fuel, energy, waste & input materials).	No
Barriers	Lack of expertise		Largely
	Cultural and philosophical barriers (internal resistance)		
	Informational barriers		
	Financial barriers	–	
	–	Long duration & complexity of project	
Drivers	Vague and contradictory statements	Financial resources	No
		Basic expertise & quality management	
		Use of implementation stages	
	–	There are more barriers than drivers, but drivers can overcome barriers.	
Process of implementing EMA	Significant difficulties hamper EMA implementation		Yes
Source: Literary review and own research.			

The case study partly confirmed the findings obtained from the literary review dealing with the implementation of EMA. There was a basic consensus on the implementation process, and on the barriers hindering it. Unlike the literary review, the case study found information about the drivers facilitating the implementation, namely financial resources and (at least) a basic technical expertise among the company's staff. The case study also found out that, although there were/are fewer drivers than barriers, they could still enable a Mittelstand company to carry out a successful EMA implementation. The case study could not confirm the finding of the literary review that Mittelstand companies implement EMA only to reduce or avoid taxes or financial penalties. By contrast, the case study only identified economic reasons (reduction of costs for fuel, energy, waste and input materials) to implement EMA.

According to the information supplied by company files (cf. appendix, table 9, p. 219) there were improvements in following areas due to the implementation of EMA in 2010:

(1) Improvement of the focal company's eco-efficiency in terms of waste production and uses of hazardous substances since the EMA implementation in 2010.

(2) Improvement of the focal company's material efficiency, except the one for merchandise since the EMA implementation in 2010.
(3) Fast and significant increase of the figures for eco-related profits, write-offs, income, assets, and turnover since the EMA implementation in 2010. These figures grew faster than their conventional counterparts, and also faster than the corresponding average values from companies of the same market sector. The only exception was the category 'Eco-related Reserves', which had shown declining figures in the same period.
(4) Significant rise of all environmental gains, accompanied by significant decrease of almost all environmental costs in the period 2012-2013, with the three exceptions being the costs for purchased EMA tutorials, staff costs for eco-related issues, and prevention technology & service.
(5) Significant rise of EMA-related profits (i.e. profits gained with eco-friendly products) since 2011 constituting a growing and substantial part of the overall profits.

On the other hand the cited documents rendered only little or no information on the following aspects of EMA that were uncovered by the interviews in the case study:

(1) No accurate description of EMA's assignment areas and functioning: The documents mentioned the four basic assignment areas of EMA (management of water, energy, air and material), but they were vague about their details (i.e. about the ways how they were managed with the help of EMA. Again, the documents mentioned the basic techniques (e.g. EBSC) and metrics of EMA, but remained silent about their functional interplay.
(2) No accurate description of EMA's efficacy, efficiency, benefits and disadvantages: Although the documents displayed that EMA improved the focal company's environmental and economic performance, these documents remained silent about the efficacy and efficiency of EMA. They did not mention the fact that the benefits of EMA outweighed its disadvantages. They did not show that EMA improved the company's accounting process and the decision-making of SMA, which brought about the improvements in question. There was no reference to the connection between EMA and SMA.
(3) No reference to the possible simplification of EMA: The documents gave no clue concerning the reliability of the cost estimates. In fact, some of them were

reliable, while others were not. The documents gave no information about the simplified accounting method that excluded these vague estimates.

(4) Insufficient information of environmental costs: The documents largely confirmed the definition of the environmental costs and their categories. However, they did not mention the fact that the focal company did not use anymore the cost categories ‘prevention’ and ‘payments to the state and external organisation’.

(5) No definition of EMA: The cited documents did not refer to an explicit definition of EMA.

7 Conclusion

7.1 Introduction to Conclusion

EMA is controversially discussed by academics and practitioners alike with both sides regarding it as either useless or helpful concerning the accounting and reduction of environmental costs. The main aspects of EMA causing the most problems for companies are its implementation and the evaluation of its benefits. This research gap gave rise to the research questions and objectives listed in chapter 1. The research questions and objectives served as a guideline with the help of which the study at hand analysed EMA from two principal perspectives, i.e. the exterior and interior one. The literature review represented the exterior research perspective. It outlined the major aspects of EMA by presenting the corresponding research results brought about by the most important scientists of this domain. However, the main research described and analysed in this thesis was carried out from an interior perspective. This was done with a case study examining the relevant aspects of EMA of a certain company.

To this end, a Mittelstand company (namely, the focal company called ACME-Print) from the paper industry was chosen for two reasons. Firstly, this type of company covers a substantial part of business activities of German speaking countries. Secondly, the paper industry affects the environment much more than most other business types, which makes it the place where EMA should be tested with respect to its efficacy. Hence, analysing EMA of such a company is likely to render results that are representative for environmental accounting.

The interior research examined the focal company by using information from two sources: information supplied by company files and information directly supplied by staff members. The latter type of information was (to a minor extent) derived from business meetings the researcher had attended and mostly from interviews he had carried out with fifteen selected staff members. Since they were experts from different levels of the company, they were likely to provide significant information. The information taken from both perspectives were compared to reflect their relevance and veracity critically and to deduce reliable findings. These findings and their generalising conclusions are discussed in the following sections.

7.2 Addressing Research Aim and Objectives

The study's aim is to investigate the ways, benefits and disadvantages of implementing EMA in German Mittelstand companies. This aim entailed three research objectives outlined in section 1.4.[18] The critical review following research objectives 1 to 3 found out that there is much recent scientific work carried out on EMA, which, however, has led to dubious or contradictory results. Despite these efforts, there is still no consensus if EMA can help a company's SMA to track its physical flows, to reduce the associated environmental and conventional costs and thereby to increase its economic performance (cf. sections 2.5 and 2.9 of the literature review). Studies concerned with EMA in Mittelstand-like companies (or with the implementation of EMA into these companies) seem to indicate that EMA has brought (at least to a certain degree) these benefits (cf. idem). On the other hand, these companies face several barriers complicating and impeding the EMA implementation: need of support, lack of resources, skills and knowledge, disbelief among staff concerning the payoff of EMA (cf. idem). Drivers facilitating the implementation and use of EMA are likely to be financial resources (to hire experts), a basic understanding of environmental affairs, the use of a quality management system, and the obedience to certain environmental standards (e.g. EMAS). There is scarce information on how Mittelstand companies implement EMA. Only one case study revealed that some of these companies implement it with a two-stage process (first an environmental management system and then EMA) (cf. Burrit et al. 2003 & section 5.2 in the literature review). Contrary to this, there is evidence on the ways how Mittelstand companies use EMA; they employ it by applying several accounting techniques, the most prominent of which are full cost accounting, activity based accounting, flow cost accounting, input/output analysis, and the environmental BSC. On the other hand, there is no information on the point if (or which) companies use all these techniques or only some of them, and how they are combined (cf. section 2.7 of literature review). Mittelstand companies seem to use EMA at the interface of accounting and SMA, thus helping their management to find decisions that reduce environmental cost, but this is only implicitly mentioned. In addition, there are still only few case studies on this topic, and the diffusion of EMA among companies (Mittelstand or not) is comparatively low compared to accounting proper. This being said, it is not permissible to draw final conclusions. Additionally, this

[18] Objective 1: „Critical review of the state of art concerning EMA in the Mittelstand." Objective 2: "Critical evaluation of the potential of EMA in the Mittelstand." Objective 3: "Analysis and evaluation of potential obstacles and drivers concerning the implementation of EMA in companies belonging to the Mittelstand."

is the first case study explicitly dealing with EMA and EMA implementation in a Mittelstand company. Therefore, the state of the art concerning the research aim is rather vague.

The existence of this research gap was the reason to fulfil the research aim mentioned above. As for the way of implementing EMA, it can be said that the company had significant albeit short-lived problems. As predicted in the literature review (cf. 2.8.2 and 2.9), it lacked the technical expertise and a functioning information system to carry out the implementation properly and swiftly. It turned out that in the beginning EMA was incompatible with its existing accounting system. Additionally, and as described in section 3.1 (of the chapter on methodology), the implementation was hampered by inter-social problems: several staff members were conservative and therefore disinclined to alter their working habits, there was distrust and a varying degree of expertise among the staff, and others lacked mental resilience (cf. sections 6.2 and 6.4.4.2). With the help of paid extra-experts, the EMA implementation was then carried out in 2009/2010 in a six-stage process ([1] discussion and decision, [2] definition of goals and fields, [3] definition of measures and tools, [4] actual EMA implementation, [5] review, [6] confirmation).

Within the framework of EMA, the focal company has been using all the accounting techniques mentioned above (cf. section 5.2). According to the files and documents of the focal company, EMA has successfully helped the SMA to significantly improve the environmental and economic performance by reducing waste and toxic substances, the environmental costs and the costs for production and products, improving competitiveness as well as resource and energy efficiency, improving, and by producing more eco-friendly products (cf. sections 5.2 & 6.5.2).

Since 2015 the focal company is about to re-implement its EMA by largely simplifying it. It turned out that calculating the environmental costs of hazardous substances was often based on unreliable assumptions, because their danger and subsequent environmental costs also depended on the processes they were used in. Having learned that all used substances (hazardous and not hazardous ones alike) involve the use of waste, fuel, water, electric energy, and wood (whose costs can easily and reliably be measured), the focal company now increasingly uses these six physical entities as markers for all environmental costs. It now satisfactorily calculates the environmental costs for the hazardous substances by measuring the costs for the six marker entities they involve and by multiplying them with the numerical factor 1.1.

So, the focal company's EMA works (as foretold in the literature review [cf. idem]) at the interface of accounting and SMA. All interviewed staff members acknowledged these benefits. However, views were split with respect to the benefits concerning the accounting process. The interviewed persons who were familiar with accounting attributed sizeable accounting improvements to EMA, namely in terms of correct description of physical flows, completeness of cost calculation, and correctness of cost calculation. On the other hand, staff members unfamiliar with accounting denied this. As this study only regarded the statements of the former group as reliable, it can be concluded that EMA has improved the accounting process as well (cf. 6.6). Apart from that, it can be concluded that asymmetries of information still linger on among the staff. These results only partly mirror the findings of the literature review. It has identified barriers hindering the EMA implementation in Mittelstand-like companies and the varying degrees of information and expertise among its staff. It has also informed us about improved (more transparent) accounting procedures brought about by EMA. However, only four out the twelve examined case studies mentioned reduced environmental cost, and none referred to the other benefits talked about in this paragraph (cf. 6.6.2.2). So, the implementation of EMA in a Mittelstand company was the reason for expected and for unexpected benefits that largely outweigh the (only temporary) disadvantages. However, the implementation of EMA was only possible with external experts who had to be paid. As the focal company is a case in point, which is representative of many other Mittelstand companies working with chemicals (cf. section 7.0), these results also have a general validity.

7.3 Answers to the Research Questions

With the findings and conclusions of this study it is possible to answer the three research questions. They were:

1. (1.1) How did the company of the German Mittelstand examined in the case study implement EMA?
   (1.2) How does/did it integrate environmental costs into its accounting system and how does this affect its corporate actions?
   (1.3) Has EMA influenced the company's performance for the better or for the worse?

(1.4) Is the current model of EMA suitable for the needs of this Mittelstand company?

2. What were the potential obstacles and drivers for the implementation of EMA in the Mittelstand company of the case study?
3. What generalising conclusions can be drawn from the case study concerning the problems, advantages and disadvantages of EMA in the context of the German Mittelstand?

7.3.1 Answer to the First Question

Answer to the Question (1.1): 'How did the company of the German Mittelstand examined in the case study implement EMA?'

The implementation of EMA was a process of six sequential stages (cf. 6.4.3.2). At first the management had tried in vain to perform the implementation on its own. However, due to lacking technical experience and expertise it had to avail itself of external helpers. So, this project was eventually carried out by a leading group comprising several managers and accounting experts supported by a second group consisting of external tutorials and experts (cf. idem).

The 1st phase was a preliminary one, in which the management of the company discussed the relevance of the reasons to perform the implementation in question. The reasons were essentially of an economic nature. All reasons were directly or indirectly based on the management's consideration to find an accounting system with the help of which it could significantly reduce its costs of electric energy, fuel, waste and various other substances. The other reason concerned the methodology and the tools of EMA. This accounting system recommended itself since it is situated at the interface between the production processes and the accounting proper, as it tracks the physical flows of the company and attributes the associated conventional and environmental costs to its flow components of ecological concern (cf. sections 6.4.2.1 ff.). In the 2nd and 3rd stage the two groups defined the goals and fields of EMA as well as its measures and tools, respectively. The 4th stage was the phase of the actual EMA implementation. Here, EMA was connected with the production processes and the accounting proper by means of various accounts and environmental scorecards, indicators, and benchmarks with which it is possible to measure the amounts of the several environmentally critical flow components and to deduce their conventional and environmental costs (cf. idem and also section 6.3). On the 5th stage the newly implemented EMA was reviewed concerning its efficacy and efficiency. Because of satisfactory results, the implementation was confirmed as successful, which was the 6th and final stage (cf. 6.4.3.2).

The implementation was overshadowed by several problems mostly stemming from the company's insufficient knowledge concerning the application and techniques of EMA. These obstacles were eventually overcome with the help of the external helpers (cf. idem). This aspect of the EMA implementation will be extensively discussed in the context of the second research question. As pointed out in section 7.1, the literature review mentioned these obstacles (cf. 2.5.2, 2.8.2 and 2.9), but it hardly gave any information on the ways to overcome them and the ways of implementing EMA.

Answer to the Question (1.2): 'How does/did it integrate environmental costs into its accounting system and how does this affect its corporate actions?'

EMA integrates the environmental costs into the accounting system already at the point of measuring them with principle and secondary metrics. In the framework of the company's EMA, the environmental costs of an environmentally flow component are predominantly based on their conventional (material) costs, which can therefore be calculated with conventional accounting methods. The environmental costs are calculated by adding an incremental cost amount, which reflects the environmental danger of the flow component in question. If this flow component is electric energy, fuel, water or wood, this incremental amount can be clearly defined by means of the environmental taxes prescribed by German legislation. In the case of waste there is an additional environmental increment stemming from the costs for treatment and disposal. These costs are also clearly defined, this time by the regulations of the EU. If it comes to calculate the environmental costs of hazardous input substances, which are frequent in paper producing companies, the estimation of the environmental cost increment is more difficult. One part of it depends on the hazardousness of the substance in question, which is unmistakably defined in official manuals. The other part of the increment depends on the process the substance is used in. However, the influence of the process can be estimated with probabilistic methods only. Hence, the entire environmental costs of hazardous input substances are sometimes vague, and consequently hard to integrate into conventional accounting (cf. 5.3). These findings mostly confirm the findings of the literature review, which basically reported the same cost categories (cf. 2.1.2). There was, however, no information on the difference between reliable und unreliable cost estimates.

As a result, the focal company now intends to calculate the costs of these substances in a different way. As their treatment involves the consumption of certain amounts of water, wood, fuel, energy waste and the production of waste, the environmental costs of these substances will be calculated by summing up the corresponding environmental costs of these flow components and by multiplying the sum with the factor 1.1 to account for the hazardousness of these substances (cf. 5.3). By this means it is easy to integrate these environmental costs into the accounting system. On the other hand, there is the danger of over-simplifications that neglect the environmental dangers of these substances. The company still estimates the environmental costs for technical accidents or failures and mistakes with probabilistic methods, but these occurrences are rare. Environmental taxes and penalty fees can easily be integrated into the conventional accounting system, but these figures are low and constant (cf. 5.3). The factors needed to estimate the various environmental costs are called principle metrics.

Using these cost estimates and the rigorous monitoring of the amounts of all flow components, EMA is able to track the related cost flows in the focal company including the eco-related ones. This tracking is systematically supported by the inter-related methods of full cost accounting, flow cost accounting, and ratio analysis. These methods use EBSCs displaying the current environmental costs of the observed flow components (cf. 5.3). The literature review also mentions these accounting methods. Nevertheless, it fails to tell how many of them are used by EMA in Mittelstand companies and how they are connected with each other (cf. 2.6).

In addition, there are so-called secondary indicators that connect certain environmental cost categories with important conventional financial figures. A case in point is the Rate (= costs) of Waste on Operating Assets. With these metrics and with the methods described above, EMA offers the possibility to calculate the environmental costs of a product and its process and also environmental gains (cf. 6.5.3). As EMA uses conventional accounting methods here, these figures can be presented in profit and loss accounts together with conventional cost types (cf. idem). The literature review informs us that EMA uses metrics (indicators) for its accounting procedures, but it does not say anything about the distinction between primary and secondary ones (cf. section 2.6).

Answer to the Question (1.3): 'Has EMA influenced the company's performance for the better or for the worse?'

Especially the tables presented in sections 5.3 and 6.5.2.2 have clearly shown that the EMA has significantly improved the company's economic and environmental performance. Except for merchandise the amounts of all environmentally critical substances have decidedly been reduced. Because of that, almost all environmental costs have been reduced as well, while the eco-related profits have risen. Thanks to EMA they are now a rising and substantial part of the overall profits. Another plus is that the environmental costs have fallen drastically. The literature review only supplied information telling that EMA can improve a Mittelstand company's environmental performance, but it did not say that it could do the same with its economic one (cf. 6.6.2.2).

Answer to the Question (1.4): 'Is the current model of EMA suitable for the needs of this Mittelstand company?'

Because of the positive developments outlined in the previous section, EMA suits the need of the focal company. Firstly, a company in the printing industry works with large amounts of environmentally critical substances. In addition, the production processes are so complex that it is difficult to track the various flow components. This situation favours the excessive use of the substances and enlarges the likelihood of environmental costs, penalty fees, and hazardous occurrences. Therefore, such a company must control the flows of these components and minimise their amounts. This study has proven that EMA has successfully reached this goal within the analysed company. In addition, the company has been able to overcome the obstacles hindering the implementation of EMA. These barriers (lack of expertise and disturbed flow of internal information) were typical for Mittelstand companies (cf. 6.4.4). As a matter of fact, the focal company had enough money to hire experts who carried out the EMA implementation and explained the techniques of EMA to the staff. However, EMA suited the focal company's needs only after it had been re-implemented in a simpler way since it had problems with estimating the vague costs of some hazardous substances. This simplified version obviously works sufficiently well. There is no information about individual simplifications of EMA in Mittelstand companies nor any other type of company. So, EMA suits the needs of a Mittelstand company that has either the necessary expertise or the necessary financial resources (to hire experts) and a basic understanding of environmental accounting (cf. idem).

7.3.2 Answer to the Second Research Question

'What were the potential obstacles and drivers for the implementation of EMA in the Mittelstand company of the case study?'

The examined company was exposed to various internal barriers: lack of skilled workers, extra work for introducing EMA and for changing the production process, lack of information concerning the implementation of EMA, (temporary) internal resistance, insufficient knowledge about the benefits of EMA, difficulties with apprehending EMA, preconceived ideas against EMA. These results corroborate the findings in the literature review (cf. 2.5, 2.82. & 2.9). All but one of these barriers were successfully overcome by means of tutorials. The sole exception was the barrier 'insufficient knowledge about the benefits of EMA'. As sections 6.6 and 6.7 have shown, there are still some staff members and probably also departments that cannot deal with EMA correctly, although they should be familiar with it. Seemingly, the management has taken countermeasures by means of tutorials.

The main success factor concerning the implementation of EMA was the sufficient financial means to pay external tutors and expert. The company had thoroughly considered and analysed the reasons to implement EMA and it already had some environmental expertise, but these success factors were not enough to overcome the other barriers.

According to the literature review, there are three strategies for companies to deal with any kind of barrier obstructing the EMA implementation: reactive, anticipatory, and innovation-based ones (Noci & Verganti 1999). A company applying anticipatory and innovation-based strategies does more than just fulfilling the regulatory requirements; it anticipates new market trends and develops adequate products (cf. section 2.8.2 of the literature review). The examined company obviously implemented EMA with a reactive strategy since it was pushed by supply chain pressure and, especially, cost pressure to do so. However, the management did not have any plan concerning the benefits of EMA and how to exploit them; but after having implemented EMA, the focal company became more experienced with this kind of accounting and it switched to an anticipatory and innovation-based strategy. Its management then used EMA to develop new eco-friendly products. Indeed, the implementation of EMA generated much more benefits than expected. A relic of the company's former conservative strategy is the widespread doubt about the efficacy and efficiency of EMA among the staff.

7.3.3 Answer to the Third Research Question

'What generalising conclusions can be drawn from the case study concerning the problems, advantages, and disadvantages of EMA in the context of a Mittelstand company?'

It is always difficult to draw generalising conclusions from a case study. However, the examined company has two characteristics that are common in the German Mittelstand, because of which the results of this study have a certain general quality, albeit in theoretical respect only: Firstly, the focal company belongs to the producing sector, which is significantly confronted with environmental costs. Secondly, like most Mittelstand companies this company has a conservative business strategy, which is reluctant to accept organisational changes.

The findings of this thesis suggest that Mittelstand companies generally have grave difficulties to implement EMA because of internal barriers (cf. section 2.1.8.2 of the literature review, and section 6.4.4). All barriers impeding the implementation of EMA ultimately stem from two sources: lack of expertise and (probably) internal resistance. Mittelstand companies can compensate insufficient expertise if they have sufficient financial resources and a basic understanding of environmental accounting to pay external tutors and experts and to get through a prolonged EMA implementation (cf. 6.4.4). Hence, larger Mittelstand companies (like the focal company) are more likely to implement EMA successfully than smaller ones with scarcer financial and informational resources.

This study has also shown that even a Mittelstand company with a conservative management can (with external help) successfully implement EMA and benefit from it (cf. 6.6). Even within the organisational structures of a conservative Mittelstand company EMA is likely to support the SMA of a company mostly by identifying and reducing conventional and environmental costs. EMA can thereby help the SMA to reduce the production costs and product prices as well as to improve the eco-related quality of the products. Under these circumstances the company will be more likely to attract new customers. These effects seem to be more marked in Mittelstand companies that are involved in production processes that require large amounts of energy and environmentally critical substances.

7.4 Conclusions Commenting the Research Hypotheses

7.4.1 Conclusions Commenting the First Research Hypothesis

The first research hypothesis was:

(1) Mittelstand companies are inexperienced in implementing EMA due to the lack of scientific research. They therefore face many problems.

The thesis at hand partly confirmed this hypothesis. The examined Mittelstand company was actually inexperienced in implementing EMA and therefore faced problems related to this implementation. It was, however, able to overcome these adversities with external experts and tutors. Hence, there must have been a certain scientific knowledgebase for the implementation of EMA. There is reason to suppose that the problems in question are more marked in smaller Mittelstand companies that cannot afford external experts and tutors and that do not have the time for a prolonged EMA implementation. The fact that the focal company had to re-implement its EMA (in a simpler way) after five years after its original launch is another evidence of lacking technical expertise in Mittelstand companies.

7.4.2 Conclusions Commenting the Second Research Hypothesis

The second research hypothesis was:

(2) Mittelstand companies are pressed to adopt EMA by laws, not by economic considerations.

The results of the case study at hand predominantly contradict this hypothesis. The examined Mittelstand company mostly adopted EMA for economic reasons, i.e. to help reduce its material and energy costs. Judicial considerations only played a minor role, because German environmental laws are extremely strict. The case study did not confirm the second hypothesis. This can be explained by the fact that the focal company belongs to the printing industry, which is characterised by large consumptions of energy and materials/substances, a large percentage of which is poisonous. Therefore, the results of this case study do not rule out the possibility that Mittelstand companies might be pressed by laws to adopt EMA. The results simply prove that Mittelstand companies are not generally pressed by laws to do so.

7.4.3 Conclusions Commenting the Third Research Hypothesis

The third research hypothesis was:

(3) Owing to the problems with implementing EMA, the disadvantages of EMA outweigh its advantages, and Mittelstand companies experience almost no benefits from it except for the avoidance of penalty fees by being able to comply with eco-related laws.

The results of the case study at hand completely contradict this hypothesis. In the case of the examined Mittelstand company, the benefits largely outweighed the disadvantages. With the help of EMA, the management is now able to track its physical flows and related conventional and environmental costs. Because of that, the focal company's SMA significantly improved its economic and environmental performance. As for the disadvantages, some cost estimates concerning hazardous input substances are vague and there is some doubt concerning the efficacy and efficiency of EMA among the staff members. However, the latter statement is not shared by all of them. In addition, the new amended version of EMA will probably rule out the possibility of vague cost estimates. Therefore, the benefits clearly outweigh the disadvantages in this company.

The fact that the benefits clearly outweigh the disadvantages is however due to the nature of the focal company. Firstly, it had the financial resources to pay experts and tutors. Without their help the EMA implementation would have hardly happened. Secondly, the staff had a basic understanding of EMA; so they consequently hired the experts and tutors and were able to understand their instructions. Thirdly, as the focal company had excessively used energy and raw materials, EMA could actually help to reduce the corresponding costs. As this is however true for many Mittelstand companies, the third hypothesis does not have a general veracity.

7.5 Contribution of Knowledge

7.5.1 Situation Prior to this Research

Due to public and political pressure, many companies are forced to run their production processes in an environmentally friendly way. As companies always try to be economically successful, they will turn to a managerial strategy that complies with both the obligation of eco-efficiency and with the intent to gain profits. SMA has been helping companies to make managerial decisions concerning many of its organisational and production-related areas. It is, however, not fit to deal with environment-related issues unless it is supported by an EA that measures the costs of these phenomena, the so-called environmental costs. The most promising type of EA is EMA since it finds, measures and shows the environmental costs in such a way that SMA can use them to increase the company's profits and environmental efficiency.

Despite extensive research on SMA, EMA, and especially their mutual relationship, there are still several theoretical and practical obstacles hindering the success of EMA. As for the theoretical problems, there are various competing definitions of EA and EMA as well as of environmental costs. On the practical side, the functions, measures, and instruments of EMA that might support the decision-making are not well developed either. In addition, there are difficulties with the implementation of EMA in the SMA structures of a company. This problematic situation is particularly true for the companies of the German Mittelstand, which plays an important role in the German economy. However, there is no literature that explicitly deals with the implementation and functioning of EMA within the SMA structures of a Mittelstand company. Therefore, the study at hand made contributions that can be used to improve the theory and practical measures of EMA so that it fits best the requirements of Mittelstand companies.

7.5.2 Contribution Concerning Research Methods

The study at hand is the first one that offers explicit details concerning the implementation and functioning of EMA in a Mittelstand company. Until now, there have only been related single (i.e. pure) case studies on Mittelstand-like companies (i.e. companies sharing some, but not all characteristics of a real Mittelstand company), or multiple case studies (i.e. mixed case studies) examining SMEs and larger companies (cf. literature review in section 2.5.2).

This study is also the first one to find out that Mittelstand companies and SMEs share many central characteristics, especially with respect to their organisational and management-related features as well as concerning the obstacles obstructing the implementation of EMA. Therefore, the knowledgebase of these studies can be used to develop research objectives and research questions concerning the actual research on EMA in the context of Mittelstand companies.

It was also found out that using a single case study (instead of a multiple case study) can lead to useful results if the chosen company is a model company, i.e. it is typical for a wide range of companies, and if the information from disparate sources (company website, documents, meetings, expert interviews) is used to get a comprehensive overview of the examined issue. Taking into account studies concentrating on the implementation and functioning of EMA within the structures of a Mittelstand company, the focal company ought to use production processes that might harm the environment.

7.5.3 Contribution Concerning the Theory of EMA

Former research efforts were not able to give a precise picture of EMA concerning its basic goals, objects, methods, and effects. Knowing these factors is indispensable for the implementation of EMA into the structures of SMA. However, unlike other management approaches, SMA bases its decision-making on a long-term strategy, which also considers the company's resources and its business environment by taking into account both the relevant financial and non-financial information.

This case study sharpened the picture of EMA by outlining its basic goals and effects, which are to support and optimise a company's managerial decisions concerning its environmental performance. As for the basic objects and means, this study found that EMA is not only concerned with monitoring the flows of its hazardous substances and their associated costs as told in the literature review (cf. 2.1.2), but also with the tracking of all of its physical flows, calculation of its associated costs, earnings and savings, and reports of the related information to internal stakeholders. This result was underpinned by a precise and useful definition of the central term of environmental costs that other EMA definitions lack. As for the definition of environmental costs, this study partly confirmed the findings of the literature review. As predicted by the literature review, environmental costs were found to be those costs that arise from the environmental hazardousness of the company's products and production processes potentially polluting the environment (cf. 2.1.2). In fact, this case study identified the existence of five categories of environmental costs: costs for the consumption of resources, for waste and emissions, for taxes and insurance, for prevention measures, and for remediation measures plus the sixth category of eco-related revenues. In addition, this case study found out that the threat of certain substances on the environment (and therefore their environmental costs) does not only depend on their chemical characteristics but also on the process they are used in. This finding led to the distinction between reliable, moderately reliable and unreliable cost estimates, which may complicate the use of EMA in Mittelstand companies due to lacking technical expertise (cf. 2.5.2).

As foretold by the literature review, the study at hand also identified FCA, ABC, flow cost accounting, input/output analysis, and EBSC to be the most appropriate methods of EMA in a Mittelstand company. In contrast to the literature review, which only vaguely mentioned metrics (cf. 2.6), according to this study these methods are linked with the SMA with primary metrics (focussing on the quantities of the used resources and their costs) and with secondary metrics (focussing on the flows of these resources) (cf. 5.2). This topic will be further discussed in the following paragraphs of this section.

Using this knowledge, this study was able to develop a definition of EMA that fits the demands of SMA optimally, especially considering that it is concerned with the company's long-term use of resources by using both financial information (i.e. environmental costs in the case of EMA) and non-financial information (i.e. physical information in the case of EMA). By contrast, the literature review only found vague and incomplete definitions of EMA, some of which even contradicted one another (cf. 2.1.1.4).

7.5.4 Contribution Concerning the Implementation and Application of EMA.

Obstacles and Drivers of EMA Implementation

Concerning the barriers hindering the implementation of EMA, this study confirmed the following findings of the literature review: When Mittelstand companies try to implement EMA, the responsible staff members are hindered by the lack of support and skills, lack of know-how concerning the functioning and implementation of EMA, internal resistance, conservative ideology about entrepreneurship (underpinned by rules, habits, and routines), contingent factors (i.e. staff members with little psychological resilience), lacking knowledge about the advantages of EMA, and prejudices against EMA. However, this study also identified the drivers and preconditions to overcome these barriers: a process (consisting of several well-defined stages), a basic understanding of environmental accounting, and financial resources to hire external experts and tutors to guide the EMA implementation (cf. 2.5.2 & 6.4.4-6.4.5).

Effects of EMA Implementation

Present research disagrees if EMA has any positive effects on the ecological and environmental performance of any company. This literature review, and especially the fifteen case studies presented in it, suggest that EMA manages to describe the hazardous physical flows of a Mittelstand company correctly and that it also calculates the corresponding environmental costs adequately. The minority of these case studies also concluded that EMA was able to assist the SMA of a Mittelstand company in a way that it could significantly reduce its environmental costs by reducing its taxes, penalty fees, and use of hazardous substances (cf. 2.5.2 & 6.6.2.2). Unlike previous research efforts presented in the literature review, this case showed that EMA can improve both the ecological and economic performance of a Mittelstand company by helping the SMA to enhance its entire resource and energy efficiency (comprising both hazardous and harmless physical entities). In addition, and in contrast to the literature review, this study revealed that EMA has the potential to raise (through the SMA) a Mittelstand company's competiveness and profits by enabling it to produce a greater number of eco-friendly products and by reducing its production costs (cf. 6.5.2.2). Apart from that, the study at hand was able to show that EMA has only positive effects in this respect, which is something that remains unmentioned in the literature review (cf. 6.5).

Functioning of EMA

Most studies remain silent about the exact mechanism of EMA and its relationship to SMA, and few others remain vague and do not mention Mittelstand companies. By contrast, in this thesis it became evident that EMA of the focal company can be deeply and efficiently linked with the SMA by means of primary and secondary indicators. While indicators of the former type ought to be reserved to find and quantify the physical resources and their accompanying costs, indicators of the latter type (derived from the former ones) can be used to track the flows of these resources and to display a Mittelstand company's overall environmental performance and its corresponding trends (cf. 6.3.2.5).

As mentioned in the literature review, a Mittelstand company is likely to reach these goals with special accounting methods, particularly FCA, ABC, Flow Cost Accounting, Input/output-analysis, EBSC, ratio analysis, and activity costing. However, this case study explains (unlike the cited research efforts in the literature review) how these methods interact with each other and with the two types of indicators (cf. 5.2). By contrast, the literature review only found the expression 'metric' or 'indicator' without any further differentiation (cf. 2.6). This study was also the first to realise that every company (and not only a Mittelstand company) using EMA will have to work with high-end measuring devices, eco-efficient machines and computer programmes, and skilled EMA accountants who are experts of software-driven accounting techniques (cf. 5.2).

So, this study has shown for the first time that with these indicators and certain accounting techniques EMA can be able to fulfil its accountancy duties and its task to pass important information to the SMA. Then, the SMA of a Mittelstand company can (a) evaluate the Mittelstand company's environmental performance, (b) find eco-friendly investment options, and (c) develop eco-friendly production processes and products (cf. 6.4.7).

In this case study it also became obvious that all parties involved in EMA must rely on a perfect internal reporting – an issue that is not mentioned in the literature review, either. At least in the case of Mittelstand companies it works efficiently on three stages: On the 1st stage there are the measuring technical devices and workers. On the 2nd stage the chemical expert and the technical staff members report their findings to the EMA accountant. On the 3rd and final stage he uses this information to calculate the physical flows and the (conventional and environmental costs) in a way that can be used by the SMA (cf. idem).

Reliability of Environmental Cost Estimates

There are only few studies on the exactness of environmental cost estimates carried out by EMA and no studies examining EMA in Mittelstand companies in this respect. Therefore, this study is the first one to present the following results: For many substances there are only moderately reliable or vague estimates of environmental costs with those of critical occurrences being especially hard to estimate. A Mittelstand company that has to use EMA to estimate its environmental costs is likely to use these three cost categories: one category of reliable cost estimates concerning the environmental costs for the production/consumption of waste, electric energy, fuel, water and wood; a second category of less reliable cost estimates concerning hazardous substances, and a third category of highly unreliable, so-called vague cost estimates concerning critical (but rare) occurrences (cf. 5.2).

This case study also offers a new and simple way of calculating environmental costs in the framework of a Mittelstand company. As all physical flow components of a company from the paper and print industry involve the production or consumption of waste, fuel, water, electric energy, and wood, the focal company uses their corresponding amounts as indicators (or quasi-markers) for the environmental costs of the examined flow components. It may therefore be possible that a comparable Mittelstand company can satisfactorily calculate its entire environmental costs of hazardous substances by multiplying the reliable part of the environmental costs with a numerical factor (e.g. 1.1. in the focal company). There are three factors that support this assumption. Firstly, accidents in the German chemical industry are so extremely rare that they do not even appear in the national statistics on accidents (DGUV, 2012). Consequently, environmental costs incurred by critical occurrences appear to be negligible. Secondly, almost all German companies producing paper or colours are characterised by an excessive production/consumption of waste, fuel, water electric energy, and wood. Thirdly, a sophisticated EMA using a wide array of indicators and cost estimates can be too demanding for many Mittelstand companies with a low technical expertise (cf. 6.4.4.2). Therefore, measuring the entire environmental costs with these marker entities plus a multiplying factor seems to recommend itself. As no company is exactly the same, the precise level of the multiplying factor has to be found out by every company by means of trial and error. This will probably take some time since the focal company needed five years to find its ideal multiplying factor. So, many Mittelstand companies should try to drastically simplify their EMA by limiting it to the accounting of a small group of marker entities.

7.5.5 General Contributions

The case study at hand could identify two contradictory trends in the EMA of a Mittelstand company that had been unnoticed: (1) a sophisticated FCA with a focus on the identities, quantities, directions, and fates of the marker flow components, and (2) a simplified and reduced system of environmental cost categories (cf. 6.4.7). It has been shown that a Mittelstand company may be stimulated to engage more strongly in EMA if it works successfully, because the focal company, which used to have a conservative business philosophy, actually developed a broader and more proactive strategy for its use of EMA (cf. 7.6).

7.6 Limitations

New studies in the same area can use the results of this PhD thesis as a starting point to analyse how the cost categories of EMA can be simplified and how to combine the various methods of EMA more systematically. New research attempts ought to focus on ways to avoid unreliable cost estimates as well.

The case study has identified two major factors that possibly limit the validity of the findings: (1) “Case studies provide very little basis for scientific generalisation since they use a small number of subjects” (Zainal 2007: 5). (2) To develop research hypotheses, a literature review was conducted, but the paucity of relevant studies was striking. Even the few studies dealing with this study’s topic arrive at different conclusions, especially when it comes to defining and identifying the benefits of EMA.

As for the first factor, one can state the following objections: The fifteen interviewees represented those departments of the focal company that were related to EMA. The analysis of their answers also suggests that each interviewee was aware of the duties of his department (incl. the assignments related to EMA). It was also shown that the focal company represents a variety of different companies from the paper and print industry. There are however some other limitations. The company decisively followed a conservative and cautious strategy concerning investments and making debts. These attitudes are atypical for many start-ups or for numerous larger companies. In addition, the printing industry is under pressure of the Internet, which is gradually conquering its market share (wuv.de 2015). As the company belongs to the printing industry, many findings of this case study can therefore become obsolete in the near future.

Concerning the second factor, one can argue that there are some studies on Mittelstand-like companies using EMA, but no such studies exclusively dealing with Mittelstand companies. As a matter of fact, this case study confirmed some of their findings while others have been contradicted. This case study mostly brought about findings that cannot be generalised; on the other hand, a few of them (presented in section 7.3.3) can partly be generalised.

7.7 Future research

Tactical considerations

According to section 7.4.5, for companies from the chemical industry several environmental costs (first of all the costs for critical occurrences) and their indicators are negligible, whereas other cost categories (e.g. waste production or energy consumption) will always play a major role. Future research should therefore find ways to simplify EMA. New research attempts ought to find out if it is possible to base the entire accounting process of EMA on a small group of major cost categories by using a multiplying factor. The simplification of EMA is a useful goal because many Mittelstand companies are overwhelmed by the complexity of EMA when they try to implement and use it.

Cultural Considerations

The finding that a conservative company can develop a more proactive and broader strategy concerning its use of EMA could be a starting point of future research. New case studies ought to analyse companies that have different business philosophies in order to reveal if and how they affect the implementation of EMA and its further use. These studies should also focus on the way how these companies view the benefits of EMA and how (or if) they overcome the barriers of implementing it. Another point of future research might be the time factor of EMA and its implementation. The case study at hand has shown that the analysed company had to struggle for some time to implement EMA and to re-implement it five years later. Initially, the company was not aware of all the EMA-related benefits. New case studies could examine how long it takes for certain companies to implement EMA and how long it takes to use it to its full advantage. Expert interviews have proven a successful means to uncover this sort of information.

Another point of interest refers to the internal barriers hindering the informational flow concerning EMA. Future research could examine how it is possible to overcome them and how much time it takes. Future research ought to also analyse to what degree EMA can be simplified, e.g. by using certain substances (and their environmental costs) as markers for other substances.

Managerial Implications and Consequences

The use of EMA has also consequences for the management that lie beyond short-lived tactical consequences. A (Mittelstand) company with a complete conservative business philosophy might only use EMA to only reduce their environmental and conventional costs but without changing their product portfolio. On the other hand a (Mittelstand) company with a more proactive business philosophy could use the combination of EMA and SMA to create explicitly eco-friendly products. This is exactly what the focal company did to save costs and to use competitive chances. Under these circumstances a (Mittelstand) company in question would face these challenges since it would have to design new products, check and anticipate new trends, and to keep up with competitors, and analyse the market of eco-friendly products. Therefore, new research on EMA in Mittelstand company should also consider the managerial implications beyond cost saving opportunities. In addition, and as a consequence of these considerations EMA itself should be marketed as a product that helps (Mittelstand) companies to reduce their production costs and to enter the promising market of eco-friendly products.

8 Bibliography

8.1 Books and Papers

Abdel-Kader, M. & Luther, R. (2008): The impact of firm characteristics on management accounting practices. A UK-based empirical analysis. British Accounting Review.

Abdel-Kader, M. G. (2011): Review of Management Accounting Research. New York: Palgrave Macmillan.

Abeliotis, K. (2006): A review of EMAS in Greece: is it effective? In: Journal of Cleaner Production. 14(18), 1644-1647.

Adams, C. A. & Harte, G. F. (1999): Towards Corporate Accountability for Equal Opportunities Performance Association of Chartered Certified Accountants (ACCA). London. Occasional Research Paper. 26.

Adams, C. (2004): The ethical, social and environmental reporting-performance portrayal gap. In: Accounting, Auditing and Accountability Journal, 17(5), 731-757

Adams, C. / Frost, G. & Webber, W. (2004): Triple Bottom Line: a review of the literature. In: Heriques, A. & Richardson, J. (eds.): The Triple Bottom Line: Does it all add up. London: Earthscan. 17-26.

Ahrens, T. & Chapman, C. (2006): Doing Qualitative Field Research in Management Accounting: Positioning Data to Contribute to Theory, Accounting, Organizations and Society. 31(8), 819-841.

Alawattage, C. & Wickramasinghe, D. (2008): Appearance of accounting in a political hegemony. Critical Perspectives on Accounting. 19(3), 293-339.

Al-Omiri, M. & Drury, C. (2007): A survey of factors influencing the choice of product. Costing systems in UK organizations. In: Management Accounting Research. 399-424.

Alcouffe S. / Berland, N. & Levant, Y. (2008): Actor-networks and the diffusion of management accounting innovations: A comparative study. In: Management Accounting Research. 19(1), 1-17.

Alvesson, M. & Willmott, H. (1992): On the Idea of Emancipation in Management and Organization Studies. In: Academy of Management Review. 3, 432-464

Alvesson, M. & Wilmott, H. (2013): Making sense of management: a critical introduction. In: Action Learning Research and Practice. 10(3).

American Institute of Certified Public Accountants (1977): The Measurement of Corporate Social Performance. New York: AICPA.

Angus, L. B. (1986): Developments in Ethnographic Research in Education: From Interpretive to Critical Ethnography. In: Journal of Research and Development in Education, 20(1), 59–67.

Anderson, S. W. (1995): A framework for assessing cost management system changes: the case of activity-based costing implementation at General Motors, 1986-1993.

Andersons, S. W. (2007): Managing costs and cost structure throughout the value chain: Research on strategic cost management. In: C.S. Chapman et al. (eds.): Handbook of Management Accounting Research. Elsevier. 481-506.

Aparaschive, F. (2007): The Importance of an Accounting Ontology. In: Economy Informatics (1-4), 5-10.

Aragon-Correa, J. A. / Hurtado-Torres, N. E. / Sharma, S. & García Morales, V. J. (2008): Environmental Strategy and Performance in Small Firms: A Resource-Based Perspective. In: Journal of Environmental Management. 86(1), 88-10.

Aragon-Correa, J. A. & Rubio-Lopez , E. (2007): Tricks, pitfalls, and mistakes to avoid in the analysis and implementation of proactive corporate environmental strategies. In: Long Range Planning. 4(3), 357-381.

Argent, P. A. / Howel, R. A. & Beck, K. A. (2005): The Strategic Communication Imperative. In: MIT Sloan Management Review, 46(3), 82-90.

Aronson, E. & Carlsmith, J. M. (1968): Experimentation in social psychology. In: G. Lindzey & E. Aronson (eds.): The Handbook of social psychology. Reading, MA: Addison-Wesley, 2, 1-79.

Article 15 of Regulation (EC) No. 761/2001 (2009): Official Journal of the European Union. 22.12.2009. L 342 /I.

Ascui, F. & Lovell, H. (2011): As frames collide: making sense of carbon accounting. In: Accounting, Auditing and Accountability Journal, 24(8), 978-999.

Associates Annual Report and Social Audit (1974): Quoted in: D. Blake, W. Frederick, M. Myers, Social Auditing. New York: Praeger Publishers. 149.

Atkinson, A. A. & W. Shaffir (1998): Standards for field research in management accounting. In: Journal of Management Accounting Research, 10, 41-68.

Ayres, R. U. / Ferrer, G. & Lynseele van, T. (1997): Co-Efficiency, Asset Recovery and Remanufacturing. Center for the Management of Environmental Resources. INSEAD Fontainebleau. France.

Azuma, K. (2007): Ökobilanzierung und Periodisierung. Schriften zur öffentlichen Verwaltung und öffentlichen Wirtschaft. Mannheim: Berliner Universitätsverlag, 196.

Azzone, G. & Noci, G. (1998): Seeing ecology and “green” innovations as a source of change. In: Journal of Organizational Change Management, 11(2), 94-111.

Baiman, S. (1990): Agency Research in Managerial Accounting: A Second Look. Accounting Organizations and Society, 15(4), 341-371.

Banerjee, S. B. / Iyer, E. & Kashyap, R. (2003): Corporate environmentalism: Antecedents and influence of industry type. In: Journal of Marketing, 67(2), 106-122.

Bartelmus, P. & Seifert, E. K. (Ed.) (2003): Green accounting. Adlershot: Ashagate.

Bartolomeo, M. / Bennett, M. & James, P. et al. (1999): Eco-Management Accounting. Dordrecht, NL: Kluwer Academic Publishing.

Bartolomeo, M. / Bennett, M. / Bouma, J. J. / Heydkamp, P. / James, P. & Wolters, T. (2000): Environmental Management Accounting in Europe: Current Practice and Future Potential. In: The European Accounting Review, 9(1), 21-52.

Bauer, R. A. & Fenn, D. H. (1973): What is a corporate social audit? In: Harvard Business Review. 42-43.

Baumast, A. (1998): How does the implementation of environmental management systems effect the focus of coporate environmental management? – Results of an empirical study. In: The 1998 Eco-Management and Auditing Conference, Conference Proceedings, 1-6.

Bebbington, J. & Gray, R. (2001): An Account of Sustainability: Failure, Success and a Reconceptualisation. In: Critical Perspectives on Accounting, 12(5), 557-605.

Bebbington, J. (2001): Sustainable development: a review of the international development, business and accounting literature. In: Accounting Forum, 25(2), 128-157.

Beck, C. T. (2012): Nursing Research: Generating and Assessing Evidence for Nursing Practice. 9th ed. Philadelphia, USA: Wolters Klower Health, Lippincott Williams & Wilkins.

Becker, W. / Fischer, S. / Staffel, M. & Ulrich, P. (2007): Anforderungen mittelständischer Unternehmen an potentielle Bewerber aus den Bereichen Controlling, Finance & Accounting. In: Bamberger Betriebswirtschaftliche Beiträge. 146.

Becker, W. (2008): Grundlagen des Controlling. 4th ed. Bamberg

Becker, W. et al. (2008): Implementierungsstand von Unternehmensführung und Controlling in mittelständischen Unternehmen. In: Bamberger Betriebswirtschaftliche Beiträge. 149.

Behringer, S. & Meyer, K. (2011): Motivation zu nachhaltigem Handeln in kleinen und mittleren Unternehmen und deren Einfluss auf den langfristigen Unternehmenserfolg, In: Jörn-Axel Meyer (Hrsg.): Nachhaltigkeit in kleinen und mittleren Unternehmen. Lohmar: Josef Eul Verlag, 15-29.

Benbasat, I. / Goldstein, D. K. & Mead, M. (1987): The case research strategy in studies of information systems MIS Quarterly, 11(3), 369-386.

Bennett, J., et al. (2002): Chlorination disinfection by-products and adverse birth outocmes in Great Britain: Birthweight and still birth. In: Epidemiology, 13, 111-120.

Bennett, M. / Bouma, J. J. & Wolters, T. (2002): The development of EMA: general introduction and critical review - chapter 1 of Environmental Management Accounting: Informational and Institutional Developments.

Bennett, M. & James, P. (1997): Environment-Related Management Accounting. Current Practice and Future Trends. In: Greener Management International, 17, 32-41.

Bennett, M. & James, P. (1998a): The Green Bottom line. In: Bennett, M. & James, P. (eds.): The Green Bottom line - Environmental Accounting for Management: Current Practice and Future Trends. Sheffield: Greenleaf Publishing.

Bennett, M. & James, P. (1998b): Life Cycle Costing and Packaging at Xerox Ltd. In: Bennett, M. & James, P. (eds.): The Green Bottom line - Environmental Accounting for Management: Current Practice and Future Trends. Sheffield: Greenleaf Publishing.

Bennett, M. / Rikhardson, P. & Schaltegger, S. (ed.) (2003): Enviromental Management Accounting- Purpose and Progress. Kluwer Academic Publishers.

Bennett, M. & James, P. (1997): Environment Related Management Accounting. Current Pratice and Future Trends. In: Greener Management International, 17, 33-51.

Bennett, M. & James, P. (1998): The Green Bottom Line: Management Accounting for Environmental Improvement and Business Benefit. In: Management Accounting, 20-25.

Bennett, M. & James, P. (2000): Environmental Performance Measurement in Business: current practice and future trends. In: International Journal of Business Performance Management. 2(1).

Bennett, M. / Rikhardson, P. & Schaltegger, S. (ed.) (2003): Enviromental Management Accounting- Purpose and Progress. Kluwer Academic Publishers.

Bennett, M. / Schaltegger, S. & Zvezdov, D. (2013): Exploring Corporate Practices in Management Accounting for Sustainability. London: Institute for Chartered Accountants of England and Wales (ICAEW).

Berger, P. L. & Luckman, T. (1966): The social construction of reality: a treatise in the sociology of knowledge. London: Penguin.

Bhasin, M. (2013): Corporate accounting scandal at satyam: a case study of India`s Enron. European Journal of Business and Social Sciences. 1(12).

Biondi, V. / Frey, M. & Iraldo, F. (2000): Environmental Management Systems and SMEs. In: Greener Management International, 55-79.

Bioral, O. (2007): Corporate greening through ISO 14001: a rational myth? In: Organization Science, 18(1), 127-146.

Birnberg, J. E. / Shields, M. D. & Young, S. M. (1990): The case for multiple methods in empirical management accounting. In: Journal of Management Accounting Research, 2, 33-66.

Bisman, J. (2010): Postpositivism and Accounting Research: A (Personal) Primer on Critical Realism. In: Australasian Accounting Business and Finance Journal, 4, 1-25.

Black, I. (2006): The presentation of interpretivist research. Qualitative Market Research: An International Journal, 9(4), 319-324.

Bless, C. / Higson-Smith, C. & Kagee, A. (2007). Fundamentals of Social Research Methods: An African Perspective. Paarl Print.

Bonner, S. E. / Hesford, J. W. / Van der Stede, W. A. & Young, S. M. (2006): The most influential journals in academic accounting. In: Accounting, Organizations and Society, 31(7), 663-685.

Boer, G. & Shields, D. (1994): A call for papers: Accounting and the environment. In: Journal of Accounting and Public Policy Summer, 13(2), 181.

Bowen, F. & Wittneben, B. (2011): Carbon accounting. Negotiating accuracy, consistency and certainty across organisational fields. In: Accounting, Auditing and Accountability Journal, 24(8), 1022-1036.

Bortz, J. & Döring, N. (2006): Forschungsmethoden und Evaluation: für Human- und Sozialwissenschaftler. Wiesbaden: Springer.

Bos-Brouwers, H. E. J. (2010): Corporate sustainability and innovation in SMEs: Evidence of themes and activities in practice. In: Business Strategy and the Environment, 19(7), 417-435.

Bouma, J. J. & Van der Veen, M. (2002): Wanted: A Theory for Environmental Management Accounting. In Bennett, M., Bouma, J.J., & Wolters, T. (Eds.): Environmental Management Accounting: Informational and Institutional Developments. Boston: Kluwer Academic Publishers.

Bowen, F. & Wittneben, B. (2011): Carbon accounting: Negotiating accuracy, consistency and certainty across organisational fields. In: Accounting, Auditing & Accountability Journal, 24(8), 1022-1036.

Broadbent, J. & Guthrie, J. (2008): Public sector to public services: 20 years of "contextual" accounting research. In: Accounting, Auditing and Accountability Journal, 21(2), 129-169.

Brammer, S. / Hoejmose, S. & Marchant, K. (2011): Environmental Management in SMEs in the UK: Practices, Pressures and Perceived Benefits. In: Business Strategy and the Environment, 21(7), 423-434.

Branco, M. C. & Delgado, C. (2009): Research on social and environmental accounting in Southern European countries.

Brauweiler, J. (2010): Umweltmanagementsysteme nach ISO 14001 und EMAS. In: Kramer, M. (ed.): Integratives Umweltmanagement. Wiesbaden: Gabler, 279–299.

British Psychology Society (2010): Code of Human Research Ethics. London.

Brown, H. S. / de Jong, M. & Levy, D. L. (2009): Building institution based on information disclosure: lessons from GRI's sustainability reporting. In: Journal of Cleaner Production, 17, 571-580.

Brown, R. & Brignall, S. (2007): Reflections on the use of a dual-methodology research design to evaluate accounting and management practice in UK university central administrative services. In: Management Accounting Researc,18(1), 32-48.

Brown, R. & Brignall, S. (2007): Reflections on the use of a dual-methodology research design to evaluate accounting and management practice in UK university central administrative services. In: Management Accounting Research, 18(1), 32-48.

Brown, J. D. (2000): What is construct validity? In: Shiken: JALT Testing & Evaluation SIG Newsletter, 4(2), 8-12.

Brown, J. & Fraser, M. (2006): Approaches and perspectives in social and environmental accounting: an overview of the conceptual landscape. In: Business Strategy and the Environment, 15(2), 103-117.

Brühl, R. & Buch, S. (2006): Einheitliche Gütekriterien in der empirischen Forschung? Objektivität, Reliabilität und Validität in der Diskussion. Berlin: ESCP-EAP.

Brunner, P. H. & Rechberger, H. (2004): Practical Handbook of Material Flow Analysis. New York: Lewis Publishers.

Burrowes, A. W. / Kastantin, J. & Novicevic, M. M. (2004): The Sarbannes-Oxley Act as a hologram of post-Enron disclosure: a critical realist commentary. In: Critical Perspectives on Accounting, 15(6-7), 797-811.

Bryant, L. (2003): Relative Value Relevance of the Successful Efforts and Full Cost Accounting Methods in the Oil and Gas Industry. In: Review of Accounting Studies, 8(1), 5-28.

Burke, S. & Gaughran, W. F. (2006): Intelligent environmental management for SMEs in manufacturing. In: Robotics and Computer-Integrated Manufacturing, 22, 566-575.

Burns, J. & Scapens, R. W. (2000): Conceptualizing management accounting change: an institutional framework. In: Management Accounting Research, 11(1), 3-25.

Burrell, G. & Morgan, G. (1979): Sociological Paradigms And Organisational Analysis. Ashgate. USA: Burlington.

Burritt, L. / Hahn, T. & Schaltegger, S. (2001): Current Developments in Environmental Management Accounting - Towards a Comprehensive Framework for Environmental Management Accounting (EMA). Universität Lueneburg.

Buritt, R. C. (2005): Implementing Environmental Management Accounting: Status and Challenges. In: Eco-Efficiency in Industry and Science,18(1), 19-44.

Burritt, R. L. / Hahn, T. & Schaltegger, S. (2002): Towards a comprehensive framework for Environmental Management Accounting - Links between business actors and environmental management accounting tools. In: Australian Accounting Review, 12(2), 39-50.

Burritt, R. L. / Hahn, T. & Schaltegger, S. (2003): Towards a Comprehensive Framework for Environmental Management Accounting. Links between Business Actors and Environmental Management Accounting Tools. In: International Federation of Accountants (ed.): Articles of Merit - 2003. New York: International Federation of Accountants, 93-109.

Burritt, R. L. et al. (2005): Understanding and Supporting Management Decision-Making. South East Asian Case Studies on Environmental Management Accounting. In: Rikhardson, P.M. / Bennett, M. / Bouma, J. J. & Schaltegger, S. (eds.) (2005:

Implementing Environment Management Accounting: Status and Challenges. Dordrecht: Springer, 1-33.

Burritt, R. L. (2004): Environmental management accounting: roadblocks on the way to the green and pleasant land. In: Business Strategy and the Environment, 13(1), 13-32.

Burritt, R. L. & Saka, C. (2006): Environmental management accounting applications and eco-efficiency: case studies from Japan. In: Journal of Cleaner Production, 14(14), 1262-1275.

Burrowes, A. W. / Kastantin, J. & Novicevic, M. M. (2004): The Sarbannes-Oxley Act as a hologram of post-Enron disclosure: a critical realist commentary. In: Critical Perspectives on Accounting, 15(6-7), 797-811.

Canadian Institute of Chartered Accountants (CICA) (1997): Full Cost Accounting from an Environmental Perspective. Toronto, Canada.

Carlock, R. S. / de Vries, M. K. & Florent-Treacy, E. (2007): Family Business. International Encyclopedia of Organizational Studies.

Carson, D. / Gilmore, A. / Perry, C. & Gronhaug, K. (2001): Qualitative Marketing Research. London: Sage: Findings from Contigency-based Research and Directions for the Future. In: Accounting, Auditing, Accountability, 11(2), 59-79.

Chenhall, R. H. (2003): Management Control System Design within its Organisational Context.

Chalmers, A. F. (2001): Wege der Wissenschaft: Einführung in die Wissenschaftstheorie. 5th ed. Heidelberg: Springer.

Chalmeta, R. & Palomero, S. (2011): Methodological Proposal for Business Sustainability Management by Means of the Balanced Scorecard. In: Journal of the Operational Research Society, 62(7), 1344-1356.

Chen, B. (2004): ISO 14001, EMAS, OR BS 8555: An assessment of the environmental management systems for UK Businessess. School of Environmental Sciences. University of East Anglia. University Plain. Norwich.

Chetty, S. (1996): The Case Study Method für Research in Small-and-Medium-sized Firms. In: International Small Business Journal, 15, 73-85.

Chih, L. A. (1998): Bridging Positivist and Interpretivist Approaches to Qualitative Methods. In: Policy Studies Journal, 26(1), 162-80.

Christ, K. L. & Burritt, R. L. (2013): Environmental management accounting: the significance of contingent variables for adoption. In: Journal of Cleaner Production, 41, 163-173.

Christ, M. H. / Emett, S. A . / S. L. Summers & Wood, D. A . (2012): The effects of preventative and detective controls on employee performance and motivation. In: Contemporary Accounting Research, 29(2), 432-452.

Christensen, J. (1981): Communication in Agencies. In: The Bell Journal of Economics, 661-674.

Chua, W. F. (1986a): Radical developments in accounting thought. In: The Accounting Review, 61(4), 601-632.

Chua, W. F. (1986b): Theoretical constructions of and by the real. In: Accounting, Organizations and Society, 11(6), 583-598.

Chua, W. F. (1988): Interpretive Sociology and Management Accounting Research — A Critical Review. In: Accounting, Auditing & Accountability Journal, 1(2), 59-79.

Churchill, G. A. (1996): Basic Marketing Research. 3rd ed., Fort Worth, TX: The Dryden Press.

Churchill, G. A. & Iacobucci, D. (2005): Marketing Research: Methodological Foundations (Harcourt Series in Marketing). 8th ed., Itps Thomson Learning

Clarke-Sather, A. R. et al. (2007): Development of social, environmental, and economic indicators for a small/medium enterprise. In: International Journal of Accounting & Information Management, 19(3).

Clausen, J. / Keil, M. & Konrad, W. (2003): The relationship between competitiveness, environmental performance and management of small and medium sized European manufacturing firms. Final National Report Germany. Schriftenreihe des IÖW 168/03. Berlin.

Collins, H. (2010): Creative Research: The Theory and Practice of Research for the Creative Industries. Fairchild Books.

Collins, E. / Lawrence, S. / Roper, J. & Haar, J. (2011): Sustainability and the role of the management accountant. Research executive summary series. University of Waikato; Institute of Chartered Accounts. New Zealand, 7(14), 1-11.

Company's Annual Economic Report (2013): Wirtschaftsbericht. Anlage 1.6/2

Company control sales (2013):

Document A (2013): Consolidated Financial Statement. XY GmbH Group, 31.12.2013.

Document B (2013): Profit and loss account. XY GmbH Group, 31.12.2013.

'Das Selbstverständnis von XY' (2013): Unternehmensphilosophie.

'Inspiring People': Unternehmenspräsentation (2014).

Internal circulars and instructions for the use of machinery:

Document A (2013): 5 S – Shine and Sustain – Nachhaltig Sauberkeit. Verbesserungsprojekt zur Verbesserung der dauerhaften Sauberkeit der Druckwerke an Maschine 12 und Maschine 10. 28.03.2013. Verbesserungsprogramm Lean Six Sigma.

Document B (2013): Qualitätsziele für 2014. Datum: 17.12.2013

Document C (2011): IP Academy. Controlling - Grundlagen Kalkulation / DB / Analysen - 02.02.2011.

Document D (2013): IP Academy. Controlling – 18.09.2013

Document E (2013): Business Cockpit 2014. YX G Production. A document giving an extensive overview of the company's supply chain including the facts and figures of the production process and its machines.

Document F (2014): Newsletter No. 64 (2010)

Instructions FSC (2011). FSC-Zertifizierung. 07.12.2011

Confederation of British Industry (1971): The Responsibility of the British Public Company. London: CBI.

Cooper S. & Owen, D. (2007): Corporate social reporting and stakeholder accountability: the missing link. In: Accounting, Organisations and Society, 32, 649-67.

Copper, D. J. & Morgan, W. (2008): Case Study Research in Accounting. In: Accounting Horizons, 22(2), 159-178.

CRC Press (2008): NEPA and Environmental Planning: Tools, Techniques, and Approaches for Practitioners.

Cronin, P. / Ryan, F. & Coughlan, M. (2008): Undertaking a literature review: a step-by-step approach. In: British Journal of Nursing. 17(1), 38-43.

Cronbach, L. J. & Meehl, P.E. (1955): Construct Validity in Psychological Tests. In: Psychological Bulletin, 52(4), 281-302.

Cropper, W. & Oates, M. (1992): Environmental Economics: A Survey. In: Journal of Ecomomic Literature, 30(2), 675-740.

Cullen, D. & Whelan, C. (2006): Environmental mamangement accounting: the state of play. In: Journal of Business & Economic Research, 4(10), 1-4.

Damken, N. (2007): Corporate Governance in mittelständischen Kapitalgesellschaften: Bedeutung der Businesss Judgement Rule und der D&O-Versicherung für Manager im Mittelstand nach der Novellierung des § 93 AktG durch das UMAG. Edewecht.

Darnall, N. & Edwards, D. Jr. (2006): Predicting the cost of environmental management system adoption: the role of capabilities, resources and ownership structure. In: Strategic Management Journal, 27, 301-320.

DeCanio, S. J. (1998): The efficiency gap: bureaucratic and organisational barriers toprofitable energy saving investments, In: Energy Policy, 26(5), 44-454.

Decision Science Institute (2012): 2012 Midwest DSI Annual conference Grand Rapids, Michigan. Conference theme: sustainability, innovation and global supply chain management. Conference co-chairs: Jaideep Motwani, Grand Valley State University, Paul Leidig, Grand Valley State University.

Deegan, C. (2002): Introduction: The legitimising effect of social and environmental disclosures – a theoretical foundation. In: Accounting, Auditing & Accountability Journal,15(3), 282-311.

Deegan, C. & Soltys, S. (2007): Social accounting research: an Australasian perspective. In: Accounting Forum, 31, 71-89.

Defra (2011): The Economics of Waste and Waste Policy. Waste Economics Team. Environment and Growth Economics. London: Department for Environment, Food and Rural Affairs.

De Glas, F. (1986): Fiction and Bibliometrics: Analyzing a Publishing House's Stocklist. Libri, Tilburg University, 36, 40-64.

Del Brío, J. A. / Fernandez, E. & Junquera, B. (2002): The role of the public administrations in the promotion of the environmental activity in Spanish industrialcompanies. In: Ecological Economics, 4(40), 279-294.

Delmas, M. (2002): The diffusion of environmental management standards in Europe and in the USA: an institutional perspective. In: Policy Sciences, 35(1), 91-119.

Deloitte (2011): Compliance im Mittelstand. Aus der Studienserie „Erfolgsfaktoren im Mittelstand". Berlin.

Denzin, N. & Lincoln, Y. (2000): The Sage Handbook of Qualitative Research. 3rd ed. Sage Publications Inc..

Denzin, N. K. & Lincoln, Y. S. (1998): Entering the field of qualitative research. In: Denzin, N. K. & Lincoln, Y. S. (eds.): The landscape of qualitative research: theories and issues.Thousand Oaks: Sage Publications. 1-34.

DGUV (2014): Deutsche Gesetzliche Unfallversicherung. Statistik Unfallgeschehen 2012. München.

Diefenbach, T. (2007): The mangeralistic ideology of organisational change management. In: Journal of Change Management, 20(1), 126-144.

Dipboye, R. L. & Flanagan, M. F. (1979): Research Settings in Industrial and Organizational Psychology: Are Findings in the Field More Generalizable than the Laboratory. In: American Psychologist, 34(2), 141-150.

Ditz, D. / Ranganathan, J. & Banks, R. D. (1995): Green ledgers: Case studies in corporate environmental accounting. World Resources Institute.

Dietz, T. & Stern, P. C. (1995): Toward a theory of choice: Socially embedded preference construction. In: Journal of Socio-Economics, 24, 261-279.

Dillard, J. / Brown, D. & Marshall, R. S. (2005): An environmentally enlightened accounting. In: Accounting Forum, 29, 77-101.

Dillard, J. F. / Rigsby, J. T. & Goodman, C. (2004): The making and remaking of organization context: duality and the institutionalization process. In: Accounting, Auditing & Accountability Journal, 17(4), 506-542.

Dipboye, R. L. & Flanagan, M. F. (1979): Research Settings in Industrial and Organizational Psychology: Are Findings in the Field More Generalizable than the Laboratory. In: American Psychologist, 34(2), 141-150.

Donaldson, L. (2011): The Contigency Theory of Organizations. Foundations for Organizational Science. California: Sage Publications.

Dukette, D. & Cornish, D. (2009): The Essential 20: Twenty Components of an Excellent Health Care Team. RoseDog Books.

Dunphy, D. & Benveniste, J. (2008): Sustainability: The Corporate Challenge of the 21st Century. Allen & Unwin.

Durray, J. & Roslender, R. (2013): Utilising narrative to improve the relevance of intellectual capital. In: Journal of Accounting & Organizational Change, 9(3), 248-279.

Dyllick, T. & Hockerts, K. (2002): Beyond the business case for corporate sustainability. In: Business Strategy and the Environment. Special Issue: Sustainability at the Millennium: Globalization, Competitiveness & Public Trust, 11(2), 130-141.

EC (European Commission) Regulation No. 761/2001 (2001): Official Journal of the European Union. 24.04.2001. L 114/ I

EC Recommendation 2003/532/EC (2003): Official Journal of the European Union. 23.07.2003.L 184/ 19.

EC (2007): Mid-term review of the Sixth Community Environment Action Programme: Commission of the European Communities. Communication from the commission to the council and the European parliament, the council, the European economic and social committee and the commitee of the regions on the Mid-term review of the Sixth Community Environment Action Programme. Brussels, 30.4.2007.

EC regulation 765/2008 (2008): Official Journal of the European Union. 13.08.2008. L 218 / 30.

EC Regulation No. 761/2001 (2001): Official Journal of the European Union. 24.04.2001. L 114/ I.

EC (1998): Final report of the ECOMAC Project: Eco-Management Accounting (ECOMAC). ENV4-CT96-0267. Eco-Management Accounting as a tool of environmental management (ECOMAC). Summary final report.

EC (2005): SME definition. User guide and model declaration. Brussels: Publications Office.

EC (2009): Regulation on the voluntary participation of organisations in a community eco-management and audit scheme: Baxter, M. (2004): Taking the first steps in environmental management. In: ISO Management Systems, 13-18.

EC (2011/2012): Annual Report on EU Small and Mediumsized Enterprises.

Ekins, P. & Speck, S. (1998): The impacts of environmental policy and competiveness: theory and evidence. In: Barker, T. & Köhler, J. (eds.): Environmental Policy and Competiveness: theory and evidence. Cheltenham, UK, and Nirthhampton, USA: Edward Elgar.

Elijido-Ten, E. (2011): Media coverage and voluntary environmental disclosures: A developing country exploratory experiment. In: Accounting Forum - Account Forum, 35(3), 139-157.

Ellen, D. (2006): Scientific Examination of Documents. 3rd. ed. New York: Taylor & Francis.

Elkington, J. (2004): Enter the triple Bottom Line. In: Heriques, A. & Richardson, J. (eds.): The triple Bottom Line: Does it all add up. London: Earthscan. 1-17.

Engelhardt, K.A.M., et al. (2004): Extinction and ecosystem function in the marine benthos. In: Science, 306, 1177-1180.

Englisch, P. / Sieger, P. & Zellweger, T. (2010): Psychologisches Eigentum - Wie aus Mitarbeitern Mitunternehmer werden. Agenda Mittelstand. Ernst & Young GmbH.

Erichiello, O. & Zschiesche, A. (2008): Markenkraft im Mittelstand. Wiesbaden: Gabler GWV Fachverlage.

Ernst & Young (2009/2010): Entwicklung der DAX-30-Unternehmen.

Estes, R. W. (1972): Socio-economic accounting and external diseconomies. In: The Accounting Review, 47(2), 284-290.

Eugénio, T. / Lourenco, C. I. & Morais, A. I. (2010): Recent developments in social and environmental accounting research. In: Social Responsibility Journal, 6(2), 286-305.

EU EVER study (Evaluation of EMAS and eco-labels for their revision – research findings) (2005): EVER: Evaluation of EMAS and Ecolabel for their Revision. Report 1: Options and Recommendations for the Revision Process. Consortium leader: IEFE. Università Bocconi.

European Commission (2008): The European Eco-Management and Audit Scheme (2008): Kostic, M. / Knezevic. G. & Mizdrakovic, V. (2011): Eco-management and audit scheme (EMAS) and its implementation in Serbia. Singidunum University, Faculty of Business Belgrade, Serbia.

Eurostat (2002): SERIEE–Environmental Protection Expenditure Accounts – A Compilation Guide. European communities, Luxembourg.

EU-Rundschreiben (2005): Sonderheft 08/09.05. Die Zukunft der Europäischen Union. Ihre Rechte in der EU-Umweltgesetzgebung Ein Wegweiser. DNR EU-Rundschreiben. Sonderheft 08/09.05.

Fayol, H. (1949): General and Industrial Management. London.

Fellows, R. & Liu, A. (2005): Research Methods for Construction, 3rd ed. Wiley.

Figge, F. / Hahn, T. / Schaltegger, S. & Wagner, M. (2002): The sustainability balanced scorecard. Linking sustainability management to business strategy. In: Business Strategy and Environment, 11(5), 269-284.

Flach, P. A. & Kaka, A. C. (2000): Abduction and Induction: Essays on their Relation and Integration. Springer.

Flacke, K. & Segbers, K. (2005): Does Managerial Accounting follow Entrepreneurs' Characteristics? Results of an Empirical Analysis of German SME, Working Paper.

Florida, R. & Davison, D. (2001): Gaining from green management: Environmental management systems inside and outside the factory. In: California Management Review, 43(3), 64-85.

Forsberg, P. (2010): What about operational economics? How international accounting standards neglects social structures and special cultures. In: International Journal of Economics and Accounting,1(1-2), 107-122.

Fraj-Andrés, E. / Martinez-Salinas, E. & Matute-Vallejo, J. (2009): Factors affecting corporate environmental strategy in Spanish industrial firms. In: Business Strategy and the Environment, 18(8), 500-514.

Franke, N. (2002): Realtheorie des Marketing. Tübingen.

Fred, R. (2009): Strategic Management. Concept and Cases. 13th ed. Prentice Hall / Pearson. Francis Marion University. Florence, South Carolina.

Fresner, J. & Engelhardt, G. (2004): Experiences with integrated management systems for two small companies in Austria. In: Journal of Cleaner Production, 12(6), 623-631.

Fraj-Andrés, E. / Martinez-Salinas, E. & Matute-Vallejo, J. (2009): Factors affecting corporate environmental strategy in Spanish industrial firms. In: Business Strategy and the Environment,18(8), 500-514.

Fresner, J. / Bürki, T. & Sittel, H. H. (2009): Ressourceneffizienz in der Produktion - Kosten senken durch Cleaner Production. Düsseldorf: Symposion Publishing.

Frey, U. / Sieger, P. & Zellweger, T. (2010): Wie Familienunternehmen die Wirtschaftskrise meistern. In: IO New Management, 78(11), 37-40.

Friedrich, R. & Bickel, P. (2001): Environmental External Costs of Transport. Berlin, Heidelberg: Springer.

Frost, G. & Wilmshurst, T. (2000): The Adoption of Environment Related Management Accounting. An Analysis of Corporate Environment Sensitivity. In: Accounting Forum, 24(4), 344-365.

Gaffikin, M. (2007): Accounting research and theory: the age of neo-empiricism. In: Australasian Accounting Business and Finance Journal, 1(1), 1-17.

Gabbay, D. & Woods, J. (2005): Practical Logic of Cognitive Systems. The Reach of Abduction: Insight and Trial. Elsevier Science.

Galdeano-Gomez, M. et al., (2008): The whole relationship between environmental variables and firm performance: Competitive advantage and firm resources as mediator variables. In: Journal of Environmental Management, 1-12.

Gale, R. (2006): Environmental costs at a Canadian paper mill: A case study of Environmental Management Accounting (EMA). In: Journal of Cleaner Production, 14, 1237-1251.

Gao, Z. (1998): Environmental Regulation of Oil and Gas. Kluwer Law International.

Gaffikin, M. (2007): Accounting research and theory: the age of neo-empiricism. In: Australasian Accounting Business and Finance Journal,1(1), 1-17.

Geissdoerfer, K. (2009): Total Cost of Ownership (TCO) und Life Cycle Costing (LCC): Einsatz und Modelle: Ein Vergleich zwischen Deutschland und USA. Münster: LIT-Verlag.

Geddes, M. (1992): The Social Audit Movement. In: Owen D.L. (ed.). Green Reporting: Accountancy and the Challenge of the Nineties. London: Chapman and Hall. Global Reporting Initiative [GRI] (2002) Sustainability Reporting Guidelines, Amsterdam: GRI.

Gredler, M. (1996): Program evaluation. Columbus, OH: Merrill.

Gerhart, M. (1988): Critical realism in theory and practice: response to Robbins. Van Huyssteen, & Hefner. Zygon. In: Journal of Religion and Science, 23(3), 281-285.

German Federal Ministry of Economics and Technology (2010): German Mittelstand: Engine of the German economy. Facts and figures about small and medium-sized German firms. Berlin: Federal Ministry of Economics and Technology.

Gibson, K. C. & Martin, B. A. (2004): Demonstrating value through the use of environmental management accounting. In: Environmental Quality Management, 45-52.

Giddens, A. (1984): The Constitution of Society. Cambridge: Polity Press.

Given, L. M. (2008): The Sage encyclopedia of qualitative research methods. Los Angeles, Calif.: Sage Publications.

Golafshani, N. (2003): Understanding Reliability and Validity in Qualitative Research. In: The Qualitative Report, 8(4) 597-607.

Glass, G. V. (1976): Primary, secondary, and meta-analysis of research. In: Educational Researcher, 5(10), 3-8.

Gomez-Mejia, L. R. / Balkin, D. R. & Cardy, R. L. (2008): Management: People, Performance, Change. 3rd ed.. New York: McGraw-Hill.

Graff, R. G. / Reiskin, E. D. / White, A. L. & Bidwell, K. (1998): Snapshots of Environmental Cost Accounting. Boston: Tellus Institute.

Gravette, F. J., & Forzano, L.-A. B. (2012): Research Methods for the Behavioral Sciences. Wadsworth Inc Fulfillment.

Gray, R. / Owen, D. & Maunders, K. (1987): Corporate Social Reporting – Accounting & Accountability. Prentice-Hall, UK.

Gray, R. (1992): Accounting and environmentalism: An exploration of the challenge of gently accounting for accountability, transparency and sustainability. In: Accounting, Organizations and Society, 17(5), 399-425.

Gray, R. / Bennington, J. & Walters, D. (1993): Accounting for the environment. London.

Gray, R. / Kouhy, R. & Lavers, S. (1995): Corporate social and environmental reporting. A review of the literature and a longitudinal study of UK disclosure. In: Accounting, Auditing and Accountability Journal, 8(2), 47-77.

Gray, R. / Kouhy, R. Lavers, S. (1995b): Methodological themes: constructing a research database of social and environmental reporting by UK companies. In: Accounting Auditing and Accountability Journal, 8(2), 78-101.

Gray, R. (2001): Thirty years of social accounting, auditing and reporting: what (if anything) have we learned? In: Business Ethics: a European Review, 10, 9-15.

Gray, R.H. (2002): The social accounting project and accounting organizations and society. Privileging engagement, imaginings, new accountings and pragmatism over critique? In: Accounting, Organizations and Society, 27(7), 687-708.

Gray, R. (2005): Social and Environmental Accounting and Reporting: From Ridicule to Revolution? From Hope to Hubris? - A Personal Review of the Field. The Centre for Social and Environmental Accounting Research, School of Management. University of St Andrews, 1-7.

Green National Accounts in India (2013): A Framework. A Report by an Expert Group Convened by the National Statistical Organization. Ministry of Statistics and Programme Implementation Government of India.

GRI guidelines (2006): Global Reporting Initiative (GRI), Sustainability Reporting Guidelines on Economic, Environmental and Social Performance. Amsterdam.

Guenster, N. / Bauer, N. / Derwall, J. & Koedijk, K. (2010): The Economic Value of Corporate Eco-Efficiency European Financial Management, 1-26.

Günther, E. (2008): Ökologieorientiertes Management. Stuttgart: Lucius & Lucius.

Günterberg, B. & Kayser, G. (2004): SMEs in Germany - Facts and Figures 2004. In: Institut für Mittelstandsforschung Bonn (ed.): IfM-Materialien, Nr. 161, Bonn.

Gullap Group (2011): Global Workforce Study 2010.

Hansen, D. & Mowen, M. (2006): Managerial Accounting. Thomson/South-Western.

Harte, G. & Owen, D. (1987): 'Fighting De-industrialisation: The Role of Local Government Social Audits.' In: Accounting, Organisations and Society, 12(2): 123-142.

Harris, M. & Fraser, I. (2002): Natural resource accounting in theory and practice: A critical assessment. In: The Australian Journal of Agricultural and Resource Economics, 46(2), 139-192.

Hassard, J. (1991): Multiple Paradigms and organisational Analysis: A Case Study. Organisation Studies, 275-299.

Haunschild, L. / Wallau, F. / Hauser, H.-E. & Wolter, H.-J. (2007): Die volkswirtschaftliche Bedeutung der Familienunternehmen. Gutachten im Auftrag der Stiftung Familienunternehmen. In: Institut für Mittelstandsforschung Bonn (eds.): IfM-Materialien, 172, Bonn.

Hausch, K. (2004): Corporate Governance im deutschen Mittelstand. Veränderungen externer Rahmenbedingungen und interner Elemente. Wiesbaden.

Healy, M. & Perry, C. (2000): 'Comprehensive criteria to judge validity and reliability of qualitative research within the realism paradigm'. In: Qualitative Market Research – An International Journal, 3(3), 118-126.

Hendrickson, C. / Horvath, A. / Joshi, S. & Lave, K. (1998): Economic Input-Output Models for Environmental Life-Cycle Assessment. In: Environmental Science and Technology, 32, 184A-191A.

Hendrickson, C. T. / Lave, L. B. & Matthews, H. S. (2006): Environmental Life-Cycle Assessment of Goods and Services: An Input-Output Approach. RFF Press, Washington DC.

Heras, I. & Arana, G. (2010): Alternative models for environmental management in SMEs: the case of Ekoscan vs. ISO 14001. In: Journal of Cleaner Production xxx. Elsevier, 1-10.

Herbohn, K. (2005): "A full cost environmental accounting experiment". In: Accounting, Organizations and Society, 30(6), 519-536.

Heupel, T. & Wendisch, N. (2003): Green Success: Process-based Environmental Cost Accounting – Implementation in SMEs in Germany. In: Bennett, M. / Rikhardsson, P. & Schaltegger, S. (eds.): Environmental Management Accounting – Purpose and Progress. Kluwer Publishing, Dordrecht (Netherlands), 333-363.

Heupel, T. & Wendisch, N. (2005): Implementing Standard Costing in Small and Medium-sized Companies. In: Rikhardsson, P. / Bennett, M. & Bouma, J.J.; Schaltegger, S. (eds.): Implementing Environmental Management Accounting: Status and Challenges. Kluwer Publishing, Dordrecht (Netherlands), 193-205.

Hillary, R. (1999): Evaluation of Study Reports on the Barriers, Opportunities and Drivers for Small and Medium-Sized Enterprises in the Adoption of Environmental Management Systems. Department of Trade and Industry.

Hillary, R. (2004): Environmental management systems and the smaller enterprise. In: Journal of Cleaner Production, 12(6), 561-569.

Hines, R. (1991): On valuing nature. In: Accounting Auditing and Accountability Journal, 4(3), 27-29.

Hines, R. (1991b): 'The FASB's conceptual framework, financial accounting and the maintenance of the social world'. In: Accounting, Organizations and Society, 16(4), 313-331.

Hines, R. (1992): 'Accounting: filling the negative space'. In: Accounting, Organizations and Society, 17(3-4), 313-341.

Hirschman, E. C. (1985): Primitive Aspects of Consumption in Modern American Society. In: Journal of Consumer Research, 12, 237-249.

Hit, M. A. / Ireland, R. D. & Hoskins, R. E. (2009): Strategic Management. Competitiveness and Globalisation. 8th ed. South-Western Cengage Learning, Mason: Ohio.

Hitchens, D. / Thankappan, S. / Trainor M. / Clausen, J. & De Marchi, B. (2005): "Environmental performance, competitiveness and management of small businesses in Europe". In: Tijdschrift voor Economische en Sociale Geografie, 96(5), 541-557.

Hitchens, D. / Clausen, J. / Trainor, M. / Keil, M. & Thankappan, S. (2003): "Competitiveness, environmental performance and management of SMEs". In: Greener Management International, 44, 45-57.

Hodgson, G.M. (1993a): Economics and Evolution. Polity Press, Cambridge.

Hodgson, G.M. (ed.) & Aldershot, Edward Elgar (1993b): Introduction. The Economics of Institutions, xi-xx.

Hopper, T. & Major, M. (2007): Extending institutional analysis through theoretical triangulation: Regulation and activity-based costing in Portuguese telecommunications. In: European Accounting Review, 16(1), 59-97.

Hofmann, U. & Schönbohm, A. (2012): Comprehensive Sustainability Reporting – A long road to go for German 30 TexDax companies. Working Papers 68, IMB Institute of Management Berlin.

Holder, J., (2004): Environmental Assessment: The Regulation of Decision Making. Oxford University Press, New York; For a comparative discussion of the elements of various domestic EIA systems, see Wood, Ch. (2002): Environmental Impact Assessment: A Comparative Review, 2nd ed., Prentice Hall, Harlow.

Howes, R. (1999): Accounting for environmentally sustainable profits. In: Management Accounting, 77(11), 32-33.

Hoy, W. K. (2010): Quantitative Research in Deducation. A Primer. London: Sage Publications.

Hudson, L. & Ozanne, J. (1988): Alternative Ways of Seeking Knowledge in Consumer Research. In: Journal of Consumer Research, 14(4), 508-521.

Humphrey, C. & Scapens, R. (1996): “Theories and case studies of organizational accounting practices: limitation or liberation?” In: Accounting, Auditing and Accountability Journal, 9(4), 86-106.

Hunt, S. (1991): Positivism and Paradigm Dominance in Consumer Research: Toward Critical Pluralism and Rapprochement. In: Journal of Cosumer Research, 18, 32-44.

Hyršlová, J. & Hájek, M. (2006): "Environmental management accounting in Czech companies that have implemented environmental management systems", Chapter 19. In: Schaltegger, S. / Bennett, M. & Burritt, R. (eds.): Sustainability Accounting and Reporting. Springer, Dordrecht, 433-56.

Ienciu, I.A. (2012): “The contribution of the environmental management systems to ensuring environmental reporting”, Studia UBB, Oeconomica, 57(2), 49-57.

Ienciu, I. A. (2012b): The Relationship Between Environmental Reporting and Corporate Governance Characteristics of Romanian Listed Entities. In: Accounting and Management Information Systems, 11(2), 267-294.

IMD World Competitiveness Yearbook (2012).

Institute of Management Accountants (2008): Definition of Management Accounting. Institute of Management Accountants, Montvale, NJ (www.imanet.org)

International Federation of Accountants (IFAC) (1998): International Federation of Accountants (IFAC). International Management Accounting Practice Statement: Management Accounting Concepts, New York.

International Federation of Accountants (IFAC) (2005): Environmental Management Accounting. International Guidance Document. International Federation of Accountants, New York.

Iraldo, F. / Testa, F. & Frey, M. (2009): Is an environmental management system able to influence environmental and competetive performance? The case of the eco-management and audit scheme (EMAS) in the European union. In: Journal of Cleaner Production, 17(16), 1444-1452.

Iraldo, F. / Testa, F. & Frey, M. (2010): Environmental Management System and SMEs: EU Experience, Barriers and Perspectives. Environmental Management, Santosh.

ISO 14001 (1996): International Standardization Organization, Environmental Management – Environmental Management Systems – Specification, ISO 14001. Geneva.

Jasch, Ch. (2003): "The use of Environmental Management Accounting (EMA) for identifying environmental costs". In: Journal of Cleaner Production, 11, 667–676.

Jasch, Ch. & Danse, M. (2004): Environmental Management Accounting pilot projects in Costa Rica. In: Bennett, M. / Rikhardson, P. & Schaltegger, S. (eds.): Implementing Environmental Management Accounting: Status and Challenges. Kluwer Academic Publ., Dordrecht, NL.

Jasch, Ch. (2006): Environmental Management Accounting (EMA) as the Next Step. How to Perform an Environmental Cost Assessment in One Day. In: Evolution of Management Accounting. In: Journal of Cleaner Production, 14(14).

Jasch, Ch. & Lavicka, A. (2006): Pilot project on sustainability management accounting with the Styrian automobile cluster. In: Journal of Cleaner Production, 14(14), 1214-1227.

Jasch, Ch. & Savage, D. (2004): International Guidance Document on environmental management accounting (EMA). IFAC, Draft for public review.

Jasch, Ch. & Stasiskiene, T. (2005): From Environmental Management Accounting to Sustainability Management Accounting. In: Environmental research, engineering and management, 34, 77-88.

Jasch, Ch. (2010): EMA Mikro-Makro Link, Forum nachhaltiges Österreich, im Auftrag des Lebensministeriums, Berichte aus Energie- und Umweltforschung 29/2010, Wien.

Jaffe, A. / Peterson, S. / Portney, P. & Stavins, R. (1995): Environmental regulation and the competitiveness of U.S. manufacturing: what does the evidence tell us? In: Journal of Economic Literature 33, 132-163.

Jensen, M. & Meckling, W. H. (1976): Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure. In: Journal of Financial Economics, 305-360.

Jing, C. & Huan, J. (2011): Preliminary Exploration of Green GDP Accounting in Hanshou County of Hunan Province. Hunan Agricultural Sciences. College of Bioscience and Biotechnology, HNAU, China, 2011-2017.

John T. (2010): Using and Measuring the Combined Heat and Power Advantage. PE, Tommy John Engineering, IncAmerican Institute of Chemical Engineers, Spring National Meeting 2010. Performance Assessment Of Cogeneration Systems In California; Kumar Chittory, George Simons, Brad Souza; Itron, Inc.; POWER2007 - 22114, Proceedings of ASME Power 2007.

Jonäll, P. (2008): Environmental Management Accounting (EMA), Management Accounting including Environmental Management – a literary review. University of Goteborg.

Jones, M. J. (2010): Accounting for the environment: Towards a theoretical perspective for environmental accounting and reporting. In: Accounting. Forum, 34, 123-138.

Joshi, S. (2000): Product Environmental Life-Cycle Assessment Using Input-Output Techniques. In: Journal of Industrial Ecology, 3(2-3), 95-120.

Kelly, M. & Pratt, M. (1992): Purposes and paradigms of management accounting: beyond economic reductionism. In: Account Educ., 1(3), 225-246.

Khalid, F. M. (2012): Environmental Management Accounting Implementation in Environmentally Sensitive Industries in Malaysia. Presented at 6th NZ Management Accounting Conference, Palmerston North, 22-23.

Khan, M. Y. & Jain, P. K. (2007): Management Accounting. Text, Problems and Cases. Tata McGraw-Hill. New Delhi.

Kitchenham, B.A. & Pfleeger, S. L. (2002): Principles of survey research. Part 2: Designing a Survey. In: SIGSOFT Softw. Eng. Notes, 27(1), 18-20.

Kleeberg, D. (2008): UV-Offsetdruck. Innovation. Produkte. Praxis. Perspektiven. Report 31.

Klewitz, J. & Hansen, E. G. (2012): Eco-Innovation in SMEs: An In-Depth Case Analysis of Transforming SMEs through Effective Partnerships. Lüneburg: Centre for Sustainability Management, 47.

Klewitz, J. & Hansen, E. G. (2011): Sustainability-Oriented Innovation in SMEs: A Systematic Literature Review of Existing Practices and Actors Involved. In: Huizingh, E. / Torkelli, M. / Conn, S. & Bitran, I. (eds.): Proceedings of the XXII ISPIM Conference. International Society for Professional Innovation Management, 28.

Klewitz, J. & Zeyen, A. (2010): The Role of Intermediary Organizations in Eco-Efficiency Improvements in SMEs - A Multi-Case Study in the Metal- und Mechanical Engineering Industries in Germany, 26th CCSBE Conference, 28-30 October 2010, Calgary, Canada; CSM-Schrift.

Kloepfer, R. J. (1997): ‘‘Will the real ISO 14001 please stand up?’’ Civil Engineering, ASCE, 67(11), 45-47.

Klöpfer, W. & Renner, I. (2008): The role of environmental management accounting (EMA). Dordrecht: Springer.

Knese, W. F. (2013): Management Accounting Is Important. In: Strategic Finance, 60-61.

Kodecki, G. S. & Bullen, M. L. (2013): Evolutionary developments in accounting standard setting for private entities and SMEs. In: Journal of International Business and Cultural Studies, 1-18.

Kostka, G. / Moslener, U. & Andreas, J. G. (2011): Barriers to energy efficiency improvement: Empirical evidence from small-and-medium sized enterprises in China. Working paper series, Frankfurt School of Finance & Management, 178.

Kremin-Buch, B. (2007): Internationale Rechnungslegung. Jahresabschluss nach HGB, IAS und US-GAAP. Grundlagen – Vergleich – Fallbeispiele. 2nd ed. Wiesbaden: Gabler Verlag.

Krishna, R. (2013): Case studies in finance and accounting. International Research. Journal of Applied Finance, Kaizen Publications, Hyderabad, India.

Lamberton, G. (2005): Sustainability accounting – a brief history and conceptual framework. In: Accounting Forum 29, 7-29.

Langford, R. (2008): Environmental Performance Indicators – Key Features of Some Recent Proposals. In: Schaltegger, S. / Bennett, M. / Burritt, R. & Jasch, C. (eds.): Environmental Accounting Management for Cleaner Production. Dordrecht: Springer, 339-350.

Larrinaga-Gonzalez, C. & Bebbington, J. (2008): Carbon Trading: Accounting and Reporting Issues. In: European Accounting Review, 17(4), 697-717.

Laudel, G. & Glaeser, J. (2010): Experteninterviews und qualitative Inhaltsanalyse – Als Instrumente rekonstruierender Untersuchungen. VS Verlag für Sozialwissenschaften.

Laufer, W. S. (2003): Social Accountability and Corporate Greenwashing. In: Journal of Business Ethics, 43(3), 253-261.

Laughlin, R. (1995): 'Empirical research in accounting: alternative approaches and a case for "middle-range" thinking'. In: Accounting, Auditing and Accountability, 8(1), 63-87.

Lawrence, C. M. & Khurana, I. K. (1997): Superfund liabilities and governmental reporting entities: An empirical analysis. In: Journal of Accounting and Public Policy, 16(2), 155-186.

Lee, V. (2012): How Firms Can Strategically Influence Open Source Communities. The Employment of 'Men on the Inside'. Gabler Verlag.

Lehmann, G. et al. (2012): Analyzing the Quality, Meaning and Accountability of Organizational Communication. In: Accounting Forum, 36(3), 149.

Levine, G. & Parkinson, S. (1994): Experimental Methods in Psychology. Lawrence Erlbaum Associates.

Lin, A. C. (1998): "Bridging Positivist and Interpretivist Approaches to Qualitative Methods." In: Policy Studies Journal, 26(1), 162-80.

Lincoln, Y. & Guba, E. (1985): Naturalistic Inquiry. London: Sage.

Link, S. & Naveh, E., (2006): Standardization and discretion: does the environmental standard ISO 14001 lead to performance benefits? In: IEEE Transactions on Engineering Management, 53, 508-519.

Lopez-Gamero, M.D. / Claver-Cortes, E. & Molina-Azorin, J.F. (2008): Complementary resources and capabilities for an ethical and environmental management: a qual/quan study. In: Journal of Business Ethics, 82, 701-732.

Lopez-Gamero, M. et al. (2009): The whole relationship between environmental variables and firm performance: Competitive advantage and firm resources as mediator variables. Elsevier. In: Journal of Environmental Management xxx, 1-12.

Luetkenhorst, W. (2004): Corporate social responsibility and the development agenda. In: Intereconomics, 39, 157-166.

Lukka, K. & Modell, S. (2010): 'Validation in interpretive management accounting research'. In: Accounting, Organizations and Society, 35(4), 462-477.

Lydenberg, S. D. (2002): Envisioning socially responsible investing: A Model for 2006. In: Journal of Corporate Citizenship, 7, 57-77.

Lynch, J. (1982): "On the External Validity of Experiments in Consumer Research". In: Journal of Consumer Research, 9(3), 225-239.

Macintosh, N. (2010): Accounting, the Social and the Political. Classics, Contemporary and Beyond. Elsevier Science & Technology.

MacKenzie, K. D. & House, R. (1978): Paradigm Developement in the Social Sciences: A Proposed Research Strategy. In: Academy of Management Review, 3(1), 7-23.

Mackenzie, C. (1998): The choice criteria in ethical investment. In: Business Ethics. A European Review, 2-8.

Malmi, T. & Granlund, M. (2009): In Search of Management Accounting Theory. In: European Accounting Review, 18(3), 597-620.

Marshall, G. (ed.) (1994): The Concise Oxford Dictionary of Sociology. Oxford, UK: Oxford University Press.

Mat, T. Z. T. (2010): Management Accounting and Organizational Change: Impact of Alignment of Management Accounting System, Structure and Strategy on

Performance. School of Accounting, Finance and Economics, Faculty of Business and Law, Edith Cowan University, Perth Western Australia.

Mathews, M.R. (1997): “Twenty-five years of social and environmental accounting research: is there a silver jubilee to celebrate?“ In: Accountability, Auditing & Accountability Journal, 10(4), 481-531.

Mathews, M.R. (2004): “Developing a matrix approach to categorize the social and environmental accounting research literature”. In: Qualitative Research in Accounting and Management, 1(1), 30-45.

Maxwell, J. A. (2004): Qualitative Research Design: An Interactive Approach (2nd ed.), Corwin Pr Inc.

Mayer, H. O. (2013): Interview und schriftliche Befragung – Grundlagen und Methoden empirischer Sozialforschung. Oldenbourg Wissenschaftsverlag.

Mayring, Ph. (2000): Qualitative Content Analysis. In: Forum Qualitative Social Research, 1(2).

Mayring, Ph. (2002): Einführung in die qualitative Sozialforschung. Weinheim.

Mayring, Ph. (2003): Qualitative Inhaltsanalyse. Grundlagen und Techniken. Weinheim.

McGrath, D. & Mathews, M. R. (2008): Moving to sustainability: An application of a matrix modelt to gain insight into the research literature. In: Accounting Accountability and Performance, 14(1), 57-81.

Meadows, D. H. / Meadows, D. L. / Randers, J. & Behrens III, W. W. (1972): The Limits of Growth. A Report to The Club of Rome’s Project on the Predicament of Mankind. A Potomac Associate Book. Washington DC.

Medina, J. (2014): Brain Rules. Updated and expanded 2nd ed., Pear Press, USA.

Meer-Kooistra, J. van der & Vosselman, E. G. J. (2000): Management control of interfirm transactional relationships: the case of industrial renovation and maintenance Accounting. In: Organizations and Society, 25(1), 51-77.

Menon, A. et al. (1999): "Antecedents and Consequences of Marketing Strategy Making". In: Journal of Marketing (American Marketing Association), 63(2), 18-40.

Mia, L. & Chenhall, R. (1994): The Usefulness of Management Accounting Systems. Functional Differentiation and Managerial Effectiveness. In: Accounting, Organizations and Society, 19, 1-13.

Milne, M.J. & Hackston, D. (1996): Some Determinants of Social and Environmental Disclosures in New Zealand Companies. In: Accounting, Auditing & Accountability Journal, 9(1), 77-108.

Miyazaki, N. (2000): ECP Newsletter 2000-6. JEMAI (Japan Environmental Management Association for Industry).

Modell, S. (2009): Bundling management control innovations: a field study of organizational experimenting with total quality management and the balanced scorecard. In: Accounting, Auditing and Accountability Journal, 22(1), 59-90.

Modell, S. (2009: 'In defence of triangulation: a critical realist approach to mixed methods research in management accounting'. In: Management Accounting Research, 20(3), 208-221.

Modell, S. (2010): 'Bridging the paradigm divide in management accounting research: the role of mixed methods approaches'. In: Management Accounting Research, 21(2), 124-129.

Möller, A. & Schaltegger, S. (2005): The Sustainability Balanced Scorecard as a Framework for Eco-Efficiency Analysis. In: Journal of Industrial Ecology, 9(4), 73-83. Müller-Christ et al., 2007; [p. 99]

Moore, G. & Spence, L. (2006): Responsibility and small business. In: Journal of Business Ethics, 67(3), 219-226.

Müller, M. (2002): Stand und Perspektiven normierter Umweltmanagementsysteme. In: Zabel, H.-U. (ed.): Betriebliches Umweltmanagement – nachhaltig und interdisziplinär. Berlin, 211-226.

Müller-Christ, G. / Nagler, B. / Behrens, B. & Götte, I. (2007): Tätigkeitsbericht des Forschungsprojekts: Integriertes Kleinbetriebsmanagementsystem EcoStep, artec Forschungszentrum Nachhaltigkeit, Universität Bremen.

Müller, S. & Volery, T. (2010): Business Model Innovation: Bericht Ernst & Young. Agenda Mittelstand. Zürich: Ernst & Young AG.

Muller, N. Z. / Mendelsohn, R. & Nordhaus, W. (August 2011): Environmental Accounting for Pollution in the United States Economy. In: American Economic Review, 101, 1649-1675.

Murray, A. / Sinclair, D. / Power, D. & Gray, R. (2006): "Do financial markets care about social and environmental disclosure?: Further evidence and exploration from the UK". In: Accounting, Auditing & Accountability Journal, 19(2), 228–255.

Naderer, G. & Balzer, E. (2007): Qualitative Marktforschung in Theorie und Praxis. Qualitative Marktforschung in Theorie und Praxis. Grundlagen – Methoden – Anwendungen. Wiesbaden, Springer.

Nag, R. / Hambrick, D. C. & Che, M. (2007): What is Strategic Management, really? Inductive Derivation of a Consensus. Definition of the Field. In: Strategic Management Journal 28, 935-955.

Nakao, Y. / Amano, A. / Matsumura, K. / Genba, K. & Nakano, M. (2007): Relationship between environmental performance and financial performance: an empirical analysis of Japanese corporations. In: Business Strategy and the Environment, 16, 106-118.

Nee, V. (2003): New Institutionalism, Economic and Sociological Forthcoming. Handbook for Economic Sociology, edited by Smelser, N. and Swedberg, R., Princeton: Princeton University Press.

Nelhaus, T. (1998): ‘Signs, social ontology, and critical realism’. In: Journal for the Theory of Social Behaviour, 28(1), 1-24.

Neuman, L. W. (2000): Social Research Methods: Qualitative and Quantitative Approaches. 4th ed., USA: Allyn and Bacon.

Ngwakwe, C. C. (2009): Justifying Environmental Cost Allocation in a Multiple Product Firm: A Case Study. In: Managing Global Transitions, 7(4), 403-420.

Nielsen, S. B. (2001): Tax Spillovers under Separate Accounting and Formula Apportionment EPRU. Economic Policy Research Unit, Institute of Economics, University of Copenhagen.

Noci, G. & Verganti, R. (1999): Managing ‘green’ product innovation in small firms. In: R&D Management, 29(1), 3–15, January 1999.

Oakes, R. A. (1970): ‘Some historical perspectives on Professor Blanshard’s critique of critical realism as “objective idealism in disguise”’. In: Personalist, 51, 237-242.

Obrasalova, I. / Olej, V. & Krupka, J. (2005): Modelling of Selected Areas of Sustainable Developements by Artificial Intelligence and Soft Computing. In: Environmental Modeling and Software, 20, 613-621.

Odum, H. T. (1996): Environmental Accounting: Emergy and Environmental Decision Making. Wiley.

Oliver, P. (2010): The Student’s Guide to Research Ethics. 2nd ed., Open University Press: Berkshire, UK.

Olson, O. & Jonäll, P. (2008): Environmental Management Accounting (EMA). Management Accounting including Environmental Management – a literature review. Magisteruppsats i företagsekonomi.

Orbach, T. & Liedtke, C. (1998): Eco-Management. Accounting in Germany. Concepts and practical Implementation. Final Report for the Project „Management Accounting and Environmental Management: Towards the Sustainable Enterprise“. A Study of Operational and Material Flow Analysis, particulary as it is practised in Germany and how it might be used as a Part of Management Accounting, 88.

Owen, D. (2008): “Chronicles of wasted time? A personal reflection on the current state of, and future prospects for, social and environmental accounting research”. In: Accounting, Auditing & Accountability Journal, 21(2), 240-267.

Papaspyropoulos, K. et al. (2012): Challenges in implementing environmental management accounting tools: the case of a nonprofit forestry organization. In: Journal of Cleaner Production, 29-30, 132-143.

Parada, J. J. (2002): Original Institutional Economics and New Institutional Economics: Revisiting the Bridges (Or the Divide). In: Oeconomicus, 4, 43-61.

Parker, L. D. (2007): ‘Financial and external reporting research: the broadening corporate governance challenge’. In: Accounting and Business Research, 37(1), 39-54.

Parker, L.D. (2000): “Green Strategy Costing: Early Days”. In: Australian Accounting Review, 10(1), 46-55.

Parker, L. D. (2005): "Social and environmental accountability research: A view from the commentary box". In: Accounting, Auditing & Accountability Journal, 18(6), 842-860.

Partridge, C. (2002): A new foundation for accounting: Steps towards the development of a reference ontology for accounting. Technical Report 23(02), Italy, LADSEB-CNR.

Patton, M. (1990): Qualitative evaluation and research methods. Newbury Park, Sage.

Pellegrino, C. & Lodhia, S. (2012): Climate change accounting and the Australian mining industry: Exploring the links between corporate disclosure and the generation of legitimacy. In: Journal of Cleaner Production.

Perego, P. (2005): Environmental Management Control. An Empirical Study on the Use of Environmental Performance Measures in Management Control Systems. Ponsen and Looijen BV, Wageningen.

Perren, L. & Ram, M. (2004): Case-study Method in Small Business and Entrepreneurial Research: Mapping Boundaries and Perspectives. In: International Small Business Journal, 22(1), 83-101.

Pfadenhauer, M. (2005): Neue Wege der Professionsforschung. In: Soziologie, 34(H3), 358-360.

Pfadenhauer, M. (2005b): Ethnography of Scenes. Towards a Sociological Life-world Analysis of (Post-traditional) Community-building. In: Forum Qualitative Social Research [Online Journal], 6(3), .

Pfadenhauer, M. (2005c): Prognostische Kompetenz? Über die Methoden der Trendforschung. In: Hitzler, R./Pfadenhauer, M. (eds.): Gegenwärtige Zukünfte. Interpretative Beiträge zur sozialwissenschaftlichen Diagnose und Prognose. Wiesbaden, 133-143.

Pfadenhauer, M. (2005d): Auf gleicher Augenhöhe reden. Das Experteninterview – ein Gespräch zwischen Experte und Quasi-Experte. In: Bogner, A. / Littig, B. & Menz, W. (eds.): Das Experteninterview. 2. Aufl., VS Verlag/GWV, Wiesbaden, 113-130.

Perrini, F. (2006): Social Entrepreneurship: What Awaits Social Entrepreneurship Ventures? Cheltenham and Northampton, MA: Edward Elgar, 341-354.

Pfohl, H.-C. (2006): Abgrenzung der Klein- und Mittelbetriebe von Großbetrieben. In: Pfohl, H.-C. (ed.): Betriebswirtschaftlehre der Mittel- und Kleinbetriebe: größenspezifische Probleme und Möglichkeiten zu ihrer Lösung. 4. Aufl., Berlin

Pitschke, T. / Rommel, W. / Roth, U. / Hottenroth, S. & Frede, M. (2004): Ökoeffizienz von öffentlichen Entsorgungsstrukturen. In: Müll und Abfall, 36(9),

Pilisi, A. & Venturelli, A. (2005): Environmental management accounting in small and medium-sized enterprises: how to adapt existing accounting systems to EMA requirements. Dordrecht, Springer, 207-235.

Porter, M. E. (1985): Competitive Advantage: Creating and Sustaining Superior Performance. New York: Simon and Schuster.

Porter, M. & Van der Linde, C. (1995): Toward a new conception of the environment-competitiveness relationship. In: Journal of Economic Perspectives, 9, 97-118.

Porter, M. (1985): Competitive Advantage. New York, Free Press.

Preuss, L. & Perschke, J. (2010): "Slipstreaming the Larger Boats: Social Responsibility in Medium-Sized Enterprises". In: Journal of Business Ethics, 92, 531-551.

Prowle, M. & Lucas, M. (2016): Management Accounting in the Contemporary Business World. Macmillan Education UK.

Psychonomics AG (2006): Unternehmenskultur, Arbeitsqualität und Mitarbeiterengagement in den Unternehmen in Deutschland. On behalf of Federal Ministry of Labour and Social Affairs.

Punch, K. F. (2005): Introduction to Social Research: Quantitative and Qualitative Approaches. Sage Pubn Inc.

Puxty, A. (1993): The Social & Organizational Context of Management Accounting. The Advanced Management Accounting and Finance Series. Chartered Institute of Management Accounts, Academic Press.

PwC (2013): PwC. 16th Annual Global CEO Survey.

Rabbe. S. & Schulz, S. (2011): Herausforderungen an ein ganzheitliches Nachhaltigkeitsmanagementsystem zur Professionalisierung des strategischen

Nachhaltigkeitsmanagements in kleinen und mittleren Unternehmen. In: Lohmar-Köln, p. 59-81.

Ramanathan, K. V. (1976): Toward a theory of corporate social accounting. In: The Accounting Review 51(3), 516-528.

Rao, S.S. / Metts, G. & Monge, C. A. M. (2003): "Electronic commerce development in small and medium sized enterprises: a stage model and its implications". In: Business process management Journal, 10(3), 250-264.

Redclift, M. (1987): Sustainable Development: Exploring the contradictions. Methuen, London.

Regulation (EC) No 1221/2009 (2009) of the European Parliament and of the Council of 25 November 2009 on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS), repealing Regulation (EC) No 761/2001 and Commission Decisions 2001/681/EC and 2006/193/EC.

Reinders, H. (2012): Qualitative Interviews mit Jugendlichen führen: Ein Leitfaden. Oldenbourg, Wissenschaftsverlag.

Reinemann, H. (2008): Corporate Governance im Mittelstand. In: Das Wirtschaftsstudium, 5, 705-711.

Remenyi, D. / Williams, B. / Money, A. & Swartz, E. (2003): Doing research in business and management: An introduction to process and method. London, SAGE Publications.

Rennings, K. / Ziegler, A. / Hoffmann E. & Nill, J. (2003): The Influence of the EU Environmental Management and Auditing Scheme on Environmental Innovations and Competitiveness in Germany: An Analysis on the Basis of Case Studies and a Large-Scale Survey. Discussion Paper, 03-14, Zentrum für Europäische Wirtschaftsforschung (ZEW), Mannheim.

Rennings, K. / Ziegler, A. / Ankele, K. & Hoffmann, E. (2006): The Influence of Different Characteristics of the EU Environmental Management and Auditing Scheme on Technical Environmental Innovations and Economic Perfomance. In: Ecological Economics, 57, 45-59.

Research Ethics (2008): A Handbook of Principles and Procedures. Approved by University Research Degrees Committee.

Resca, A. (2009): Can Ontology Lead to New Perspectives in Social Research? Italy, Sprouts, Working Papers on Information Systems.

Revell, A. / Stokes, D. & Chen, H. (2010): Small businesses and the environment: turning over a new leaf? In: Business Strategy and the Environment, 19(5), 273-288.

Richardson, A. J. & Anniseete, M. (2011): "Justification and accounting: applying sociology of worth to accounting research". In: Accounting, Auditing & Accountability Journal, 24(2), 229-249.

Rikhardsson, P. M. / Bennett, M. / Bouma, J. J. & Schaltegger, S. (eds.) (2005): Implementing Environmental Management Accounting: Status and Challenges. Springer Kluwer.

Rikhardsson, P. M. / Bennett, M. / Bouma, J. J. & Schaltegger, S. (eds.) (2006): Implementing Environmental Management Accounting: Status and Challenges. Dordrecht: Springer.

Roberts, J. & Scapens, R. (1985): "Accounting systems and systems of accountability – Understanding accounting practices in their organisational contexts". In: Accounting Organizations and Society, 10(4), 443-456.

Robson, C. (2002): Real World Research. 2nd ed., Oxford, Blackwell.

Rockness et al. (2001): Cases from Management accounting Practice.

Roslender, R. (2013): Stuck in the middle with? (Belatedly) engaging with Laughlin while becoming re-acquainted with Merton and middle range theorising. In: Critical Perspectives on Accounting, 24(3), 228-241.

Röming, S. (1999): Direct Costing – Mehr Transaparenz. In: Krankenhaus Umschau, 5, 300-302.

Roth, W. D. & Mehta, J. D. (2002): The Rashomon Effect: Combining Positivist and Interpretivist Approaches in the Analysis of Contested Events. In: Sociological Methods & Research, 31, 131.

Rowley, J. (2002): Using Case Studies in Research. In: Management Research News, 25(1).

Russel, J. D. & Fussilier, M. (2014): A Symbolic Interactionist Framework for Critical Ethnographic Research in Management Accounting. In: International Journal of Business and Social Science, 5(10), 103-112.

Rutherford, M.W. / Buller, P.F. & McMullen, P.R. (2003): 'Human resource management problems over the life cycle of small- to medium-sized firms'. In: Human Resource Management, 42(4), 321-337.

Ryan, B. / Scapens, R.W. & Theobold, M. (2002): Research method and methodology in finance and accounting. London: Thomson.

Samson, D. A. / Langfield-Smith, K. M. & McBride, P. M. (1991): 'The Alignment of Management Accounting with Manufacturing Priorities: A Strategic Perspective'. In: The Australian Accounting Review, 29-40.

Sarantakos, S. (2005): Social research. 3rd ed., Palgrave Macmillan, Basingstoke.

Sardinha, I.D. / Reijinders, L. & Antunes, P. (2003): From environmental performance evaluation to eco-efficiency and sustainability balanced scorecards. In: Environmental Quality Management, 12(2), 51-64.

Saunders, M. / Lewis, P. & Thornhill, A. (2003): Research methods for business students. Edinburgh: Prentice Hall.

Saunders, M. / Lewis, P., & Thornhill, A. (2007): Research Methods for Business Students. 4th ed., Harlow.

Scapens, R. W. (2006): Understanding management accounting practices: A personal journey. In: The British Accounting Review, 38, 1-30.

Schaltegger, S. (2004): Nachhaltigkeitsaspekte der Markenführung. In: Bruhn, M. (ed.): Handbuch Markenführung, 3, Wiesbaden: Betriebswirtschaftlicher Verlag Doktor Th. Gabler, 2677-2703..

Schaltegger, S. / Bennett, M. & Burritt, R. L. (2006): Sustainability Accounting and Reporting. Development, Linkages and Reflection. In: Schaltegger, S. / Bennett, M. & Burritt, R. L. (eds.): Sustainability Accounting and Reporting. Dordrecht, Springer, 650-700.

Schaltegger, S. / Bennett, M. / Burritt, R. L. & Jasch, C. (2008): Environmental accounting for cleaner production. Springer, Dordrecht.

Schaltegger S. & Burritt R. L. (2000): Contemporary environmental accounting – Issues, concepts and practice,.Sheffield, Greenleaf Publishing.

Schaltegger, S. & Burritt, R. L. (2010): Sustainability accounting for companies: catchphrase or decision support for business leaders? In: Journal of World Business, 45, 375-384.

Schaltegger, S. & Burritt, R. L. (eds.) (2013): Measuring and Managing Sustainability Performance of Supply Chains: Special Issue on Supply Chain Management – An International Journal, 2nd ed., Emerald.

Schaltegger, S. / Csutora, M. & Huisingh, D. (2011): Climate Costs and Benefits: New Challenges for Corporate Accounting and Management. Call for Papers. In: Journal of Cleaner Production, 19(9-10), 1141-1143.

Schaltegger, S. / Gibassier, D. & Zvezdov, D. (2011): Environmental Management Accounting. A Bibliometric Literature Review. Centre for Sustainability Management.

Schaltegger, S. / Hahn, T. & Burritt, R. L. (2002): Government Strategies to Promote Corporate Environmental Management Accounting. In: Bennett, M. & Bouma, J. (eds.): Environmental Management Accounting: Informational and Institutional Developments, Dordrecht, Kluwer Academic Publishers, 187-198.

Schaltegger, S. & Lüdeke-Freund, F. (2009): Wie Nachhaltigkeit den Unternehmenserfolg steigert. In: IO New Management, 78(9), 12-15.

Schaltegger, S. & Sturm A. (1994): Environmentally Oriented Decisions in Companies (in German: Ökologieorientierte Entscheidungen in Unternehmen). Bern/Stuttgart, Haupt.

Schaltegger, S. & Sturm, A. (1998): Eco-Efficiency by Eco-Controlling: On the Implementation of EMAS and ISO 14001. Zürich, vdf Hochschulverlag an der ETH Zürich.

Schaltegger, S. & Synnestvedt, T. (2002): The link between ‘green’ and economic success: environmental management as the crucial trigger between environmental and economic performance. In: Journal of Environmental Management, 65, 339-346.

Schaltegger, S. & Wagner, M. (2005): Current Trends in Environmental Cost Accounting – and its Interaction with Eco-Efficiency Performance Measurement and Indicators. In: Implementing Environmental Management Accounting, 45-62.

Schaltegger, S. / Windolph, S. E. & Harms, D. (2010): Corporate Sustainability Barometer 2010: Wie nachhaltig agieren Unternehmen in Deutschland? 84 S. Centre for Sustainability Management.

Schauf, M. (2009): Unternehmensführung im Mittelstand – Rollenwandel kleiner und mittlerer Unternehmen in der Globalisierung. 2nd ed., München, Mering.

Schwarz, E. J. / Wdowiak, M. A. / Almer-Jarz, D. A. & Breitenecker R. J. (2009): The effects of attitudes and perceived environment conditions on students' entrepreneurial intent. An Austrian perspective. In: Education + Training, 51(4), 272-291.

Scott, W. R. (1995): Institutions and Organizations. Thousand Oaks, CA: Sage.

Searle, J. R. (1992): The Rediscovery of the Mind. MIT Press.

Seo, M.-G. & Creed, W.E.D. (2002): Institutional contradictions, praxis, and institutional change: A dialectical perspective. In: Academy of Management Review, 5(3-4), 301-321.

Seiffert, H. & Radnitzky, G (2003): Handlexikon der Wissenschaftstheorie. München, Deutscher Taschenbuch Verlag.

SERI (2009): "Overconsumption? The use of the world's natural resources". Sustainable Europe Research Institute (SERI), Austria and GLOBAL 2000 (Friends of the Earth Austria).

Shankman, P. (1984): "The Thick and the Thin: On the Interpretive Theoretical Program of Clifford Geertz." In: Current Anthropology, 25(3), 261-280.

Shenton, A. K. (2004): Strategies for ensuring trustworthiness in qualitative research projects. In: Education for Information, 22, 63-75.

Shields, D. / Beloff, D. & Heller, M. (1997): Environmental Cost Accounting for Chemical and Oil Companies: A Benchmarking Study. Office of Pollution Prevention and Toxics. Washington, DC.

Shields, D. / Heller, M. / Kite, D. & Beloff, B. (1995): Environmental accounting case study: DuPont. In: Green Ledgers: Case Studies in Corporate Environmental.

Simon, H. (2012): Hidden Champions – Aufbruch nach Globalia. CampusVerlag, Frankfurt/Main.

Simoes, A. M. & Rodrigues, J. A. (2013): The Effectiveness of the Balanced Scorecard on Strategy Management Processes: A Case Study in a Portuguese Industrial Company. In: Global Advanced Research Journal of Management and Business Studies, 2(3), 154-164.

Simons, R. (2000): Performance measurement & Control Systems for Implementing Strategy. Text & cases. Prentice Hall, New Jersey.

Simpson, M. / Taylor, N. & Barker, K. (2004): "Environmental responsibility in SMEs: does it deliver competitive advantage?" In: Business Strategy and the Environment, 13(3), 156-171.

Söllner, R. (2014): Die wirtschaftliche Bedeutung kleiner und mittlerer Unternehmen in Deutschland. In: Statistisches Bundesamt, Wirtschaft und Statistik, 40-51.

Solomon, J. F. & Solomon A. (2006): Private social, ethical and environmental disclosure. In: Accounting, Auditing & Accountability Journal, 19(4), 564-591.

Sparkes, R. (2001): ‘Ethical Investment: Whose Ethics. Whose Investment?‘ In: Business Ethics: A European Review, 10, 194-205.

Spectaris (2014): Seminar Umweltrecht für Einsteiger – Entwicklungen im Bereich der europäischen Umweltgesetzgebung. Verband der High-Tech Industrie.

Specklé, R. F. (2001): Explaining management control structure variety: a transaction cost economics perspective. In: Accounting, Organizations and Society, 26(4-5), 419-441.

Spence, L. (1999): “Does Size Matter? The State of the Art in Small Business Ethics.”

Spence, L. J. / Agyemang, G. & Rinaldi. L. (2012): Environmental Aspects of Sustainability: SMEs and the Role of the Accountant. ACCA Research Report. The Association of Chartered Certified Accountants.

Spence, C. / Husillos, J. & Correa-Ruiz, C. (2010). Cargo cult science and the death of politics: a critical review of social and environmental accounting research. In: Critical Perspectives on Accounting, 21(1), 76-89.

Spence, L. J. & Rinaldi, L. (2010): Accounting for Sustainability. Practical Insights: With a Foreword by HRH The Prince of Wales. In: Hopwood, A. / Unerman, J. & Fries, J. (eds.): London, Earthscan, 47-71.

Stanfield, J.R. (1999): "The Scope, Method, and Significance of Original Institutional Economics". In: Journal of Economic Issues, 33, 231-255.

Stechemesser, K. & Guenther, E. (2012): Carbon accounting: A systematic literature review. In: Journal of Cleaner Production, Business Ethics: A European Review, 8(3), 163-174.

Staniskis, J. K. & Stasiskiene, Z. (2006): Environmental management accounting in Lithuania: exploratory of current pratices, opportunities and strategic intents. In: Journal of Cleaner Production, 14, 1252-1261.

Stanfield, J.R. (1999): "The Scope, Method, and Significance of Original Institutional Economics". In: Journal of Economic Issues, 33, 231-255.

Starck, N. (2013): Target Costing als Interim-Management-Ansatz aus der Fachbuchreihe Praxiswissen Interim Management. Butterflymanager Verlag, Kreuzlingen (CH).

Strahonja et al. (ed.) (2014): Information Systems Development: Transforming Organisations and Society through Information Systems Proceedings of the 23rd International Conference on Information Systems Development (ISD2014 Croatia).

Strategy Management Processes (2013): A Case Study in a Portuguese Industrial Company. In: Global Advanced Research Journal of Management and Business Studies, 2(3), 154-164.

Strauss, A., & Corbin, J. (1998): Basics of qualitative research: Techniques and procedures for developing grounded theory. Thousand Oaks, CA: Sage.

Suh, S. / Lee, K. & Sangsun, H. (2005). "Eco-efficiency for Pollution Prevention in Small to Medium-Sized Enterprises". In: Journal of Industrial Ecology, 9(4), 223-240.

Tennenbaum, S.E. (1988): Network Energy Expenditures for Subsystems Production. MS Thesis. Gainesville, FL: University of FL, 131.

Thomas, R. M. (2003): Qualitative and Quantitative Research Mehods in Theses and Dissertations. Thousand Oaks, California: Corwin Press.

Thomson, I. & Bebbington J. (2005): "Social and environmental reporting in the UK: a pedagogic evaluation". In: Critical Perspectives on Accounting, 16(5), 507-533.

Thyer, B. (2009): The Handbook of Social Work Research Methods. Sage.

Towers Perrin Study (2006). Deutschland – Global Workforce Study.

Tomczak, T. (1992): Forschungsmethoden in der Marketingwissenschaft – Ein Plädoyer für den qualitativen Forschungsansatz. In: Marketing – ZFP, 2, 77-87.

Todea, N. / Stanciu, I. & Joldoş (Udrea) A.M. (2010): Environmental accounting – a tool used by the entity for determining environmental costs. Annales Universitatis Apulensis. Series Oeconomica, Finanţe-Contabilitate, 12(1).

Tsai, W. H. / Lin, T. W. & Chou, W. C. (2010): Integrating activity-based costing and environmental cost accounting systems: a case study. In: Int. J. Business and Systems Research, 4(2), 186-208.

Ullmann A.E. (1976): "The corporate environmental accounting system: a management tool for fighting environmental degradation". In: Accounting, Organizations and Society, 1(1), 71-79.

Ulrich, D. (1998): Intellectual Capital = Competence X Commitment. In: Sloan Management Review, 39(2), 15-26.

UNDSD (United Nations Division for Sustainable Development) (2000): Improving Governments' Role in the Promotion of Environmental Managerial Accounting. Report and meeting document of First Expert Working Group Meeting, Washington DC., held in August 1999. UN Publication 00.II.A.2, New York.

UNDSD (2001): United Nations. Division for Sustainable Development, Environmental management accounting procedures and principles, New York.

UNDSD (2002): Environmental management accounting: policies and linkages. UNDSD, New York.

UNEP (2010): Assessing the Environmental Impacts of Consumption and Production Priority Products and Materials. United Nations Environment Programme, Paris, France.

United Nations (2001): Environmental Management Accounting Procedures and Principles, New York.

United States Environmental Protecting Agency (EPA) (1995): An Introduction of Environmental Accounting as a Business Tool: Key Concepts and Terms. Office of Pollution, Prevention and Toxics. Washington DC.

Urwick, L. (1928): Principles of Direction and Control. In: Dictionary of Industrial Administration. Pitman, London,1.

US AID (2008): Integrated Financial Management Information Systems. A Practical Guide. This publication was produced for review by the United States Agency for International Development. It was prepared by The Louis Berger Group, Inc. and Development Alternatives, Inc. under the Fiscal Reform and Economic Governance Task Order, GEG-I-00-04-00001-00 Task Order No. 06

Venturelli, N. & Pilisi, A. (2005): Environmental Management Accounting in Small and Medium-sized Companies. In: Rikhardsson, P.M. / Bennett, M. / Bouma, J.J. & Schaltegger, S. (eds.): Implementing Environmental Management Accounting: Status and Challenges. Springer, 207-238.

Verbeke, A. & Merchant, H. (2012): Handbook of Research on International Strategic Management. Edward Elgar Publishing, Cheltenham, UK.

Vlissides, J. M. / Linton, M. A. (1990): "Unidraw: a framework for building domain-specific graphical editors". In: ACM Transactions of Information Systems, 8(3), 237-268.

Vernon, J. / Peacock, M. / Belin, A. / Ganzleben, C. & Candell, M. (2009): Study on the Costs and Benefits of EMAS to Registered Organisations, Study Contract No. 07.0307/2008/517800/ETU/G.2, Milieu Ltd.and RPA Ltd, Brussels, Belgium.

Vyakarnam, S. / Bailey, A. / Myers, A. & Burnett, D. (1997): “Towards an Understanding of Ethical Behaviour in Small Firms”. In: Journal of Business Ethics, 16(15), 1625-1636.

Wanderley. C. / Miranda, L. C. & De Meira-Cullen, J. (2010): Management Accounting Change: A Model based on Three Differenct Theoretical Frameworks. In: BASE – Revista de Administração e Contabilidade da Unisinos 8(2), 111-121.

Wagner, M. (2005): How to reconcile environmental and economic performance to improve corporate sustainability: corporate environmental strategies in the European paper industry. In: Journal of Environmental Management, 76(2), 105-118.

Wahba, H. (2008): Does the market value corporate environmental responsibility? An empirical examination. In: Corporate Social Responsibility and Environmental Management, 15(2), 89-99.

Waweru, N. M. (2010): The origin and evolution of management accounting: a review of the theoretical framework. In: Problems and Perspectives in Management, 8(3), 165-182.

Wahyuni, D. (2009): Environmental Management Accounting: Techniques and Benefits. In: Jurnal Akuntansi Universitas Jember, 7(1), 23-35.

Wahyuni, D. (2012): Journal of Applied Management Accounting Research.

Watson, K. / Klingenberg, B. / Polito, T. & Geurts, T. (2004): Impact of environmental management system implementation on financial performance. In: Management of Environmental Quality, 15(6), 622-628.

Wegman, G. (2010): Compared Activity-based Costing Case Studies in the Information System Departments of Two Groups in France. A Stratgic Management Accounting Approach. International Conference on Business and Information. Kitakyushu, Japan, 7, 19.

Wendisch, N. & Heupel, T. (2005): Implementing Standard Costing in Small and Medium-sized Companies. In: Rikhardsson, P. / Bennett, M. / Bouma, J.J. & Schaltegger, S. (eds.): Implementing Environmental Management Accounting: Status and Challenges. Kluwer Publishing, Dordrecht (Netherlands), 193-205.

Williamson. D. / Lynch-Wood, G. & Ramsay, J. (2006): "Drivers of environmental behaviour in manufacturing SMEs and the implications for CSR". In: Journal of Business Ethics, 67(3), 317-330.

Williamson, O.E. (1975): Markets and Hierarchies: Analysis and Antitrust Implications. Free Press, New York, NY.

Wisker, G. (2008): The Postgraduate Research Book. 2nd ed., Pelgrave, New York, USA.

World Commission on Environment and Development (1987): Brundtland Report (also known as “Our Common Future”). Oxford University Press.

Yin, R. (2003): Applications of case study research. Thousand Oaks: Sage. 2nd ed.

Yin, R. (1994): Case study research: design & methods, 2nd ed., SAGE publications, London.

Zainal, Z. (2007): Case study as a research method. In: Jurnal Kemanusiaan, 9, 1-6.

Zadek, S. / Pruzan, P. & Evans, R. (1997): Building corporate accountability: Emerging practices in social and ethical accounting, auditing and reporting. London: Earthscan.

Zhou, G. / Zhou, J. / Li, H. & Wei, J. (2006): International experiences with environmental and Economic accounting. The World Bank-Italian Trust Fund Project. Submitted to State Environmental Protection Administration, the World Bank.

Zvezdov, D. (2012a): Corporate Sustainability Accounting: Beyond Unfreezing. In: Journal of the Asia-Pacific Centre for Environmental Accountability, 18(3), 181-198.

Zvezdov, D. (2012b): Rolling out Corporate Sustainability Accounting: A Set of Challenges. In: Journal of Environmental Sustainability, 2(1), 19-28.

8.2 Online Sources

Association of Chartered Accountants (ACCA): URL: http://www.accaglobal.com/gb/en.html (Retrieved: 20.07.2014).

Baetz, B. (2014): Digitalisierung Wege aus der Zeitungskrise. Deutschlandfunk. URL: http://www.deutschlandfunk.de/digitalisierung-wege-aus-der-zeitungskrise.724.de.html?dram:article_id=301418 (Original date of website: 26.10.2014; retrieved: 20.04.2015) bp.com, Statistical Workbook of World Energy (2014): URL: http://www.bp.com/en/global/corporate/about-bp/energy-economics/statistical-review-of-world-energy.html (Retrieved: 01.04.2014).

Control basics (2011): Prozessablauf GF 003. PA_GF003a.doc (Retrieved: 20.04.2015).

Council Regulation (EEC) (1993): No. 1836/93: Council Regulation (EEC) No 1836/93 of 29 June 1993 allowing voluntary participation by companies in the industrial sector in a Community eco-management and audit scheme. Official Journal, 168, 1-18. URL: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31993R1836:EN:HTML (Retrieved: 05.04.2014).

destatis.de (2013): Kleine & mittlere Unternehmen (KMU), Mittelstand. URL: https://www.destatis.de/DE/ZahlenFakten/GesamtwirtschaftUmwelt/UnternehmenHandwerk/KleineMittlereUnternehmenMittelstand/KleineMittlereUnternehmenMittelstand.html (Retrieved: 21.04.2016).

Econlit (2014): URL: http://www.ebscohost.com/academic/econlit (Retrieved: 15.05.2014).

Emerald Full Text Database (2014): URL: http://rzblx10.uni-regensburg.de/dbinfo/detail.php?titel_id=7133&bib_id=ub_en (Retrieved: 15.05.2014).

focus.de (2010): UN-Studie Unternehmen verursachen Umweltschäden in Billionenhöhe. URL: http://www.focus.de/finanzen/news/un-studie-unternehmen-verursachen-umweltschaeden-in-billionenhoehe_aid_529846.html (Retrieved: 21.04.2016).

Fuchs, R. A. (2012): A front-page crisis tears at German newspapers. DW Media. URL: http://www.dw.de/a-front-page-crisis-tears-at-german-newspapers/a-16483657 (Original date of website: 28.12.2012; retrieved: 20.04.2015).

Eurostat (2002): URL: http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=KS-40-01-319 (Retrieved: 16.07.2014).

German Federal Environmental Agency (2000): URL: http://www.umweltbundesamt.de/publikationen/annual-report-2000-federal-environmental-agency (Retrieved: 18.07.2014).

Global Reporting Initiative (2002): URL:https://www.globalreporting.org/languages/german/Pages/default.aspx (Retrieved: 17.07.2014).

GRI guidelines (2006): Global Reporting Initiative (GRI), Sustainability Reporting Guidelines on Economic, Environmental and Social Performance. Amsterdam.

Hillary, R. & Burr, P. (2011): "Evidence-based Study into the Benefits of EMSs for SMEs". DEFRA, London, URL: www.defra.gov.uk (Retrieved: 20.04.2015).

iea.org, International Energy (2014): Agency URL: http://www.iea.org/statistics/ (Retrieved: 01.04.2014).

IEMA Acorn Scheme (2014): An Introductory Guide: Institute of Environmental Management & Assessment, IEMA. URL: www.iema.net/acorn (Retrieved: 16.07.2014).

IFAC – International Federation of Accountants (2004): International Federation of Accountants. Annual Report. Developing the Global Profession. URL: https://www.ifac.org/sites/default/files/publications/files/IFAC_2004_Annual.pdf (Retrieved: 12.07.2014).

IFAC – International Federation of Accountants (2005). 2005 Annual Report. URL: http://www.ifac.org/sites/default/files/publications/files/IFAC_2005_Annual.p (Retrieved: 12.07.2014).

Institute for Chartered Accountants of England and Wales (ICAEW) (2014): URL: http://www.icaew.com/ (Retrieved: 12.07.2014).

INTOSAI (2010): International Organization of Supreme Audit Institutions (2014): URL: http://www.intosai.org/events/gallery/2010.html (Retrieved: 13.07.2014).

IÖW (2003): Institut für ökologische Wirtschaftsforschung. Jahresbericht 2003. Forschen für nachhaltiges Wirtschaften. URL: http://www.ioew.de/fileadmin/user_upload/DOKUMENTE/Publikationen/Jahresberichte/Jahresbericht2003.pdf (Retrieved: 11.07.2014).

IMports Environmental Accounting (2010): IMEA, Final Report (2010): IMEA Project. IMports Environmental Accounting. Evaluation of the Environmental Accounting Methods for the assessment of global environmental impacts of traded goods and services. Skep (Scientific Knowledge For Environmental Protection). FINAL REPORT SEPTEMBER 2010. www.imea-eu.org / www.skep-network.eu. URL: http://hal-ensmp.archives (Retrieved: 20.04.2015).

ISO 14031 (2012): International Organization for Standardization (2012). The ISO Survey of Management System Standard Certifications – 2012, Geneve. URL: http://www.iso.org/iso/home/standards/certification/iso-survey.htm (Retrieved: 15.07.2014).

Metareview (2014): Faculty of Law & Management La Trobe University Australia. URL: http://www.vuw.ac.nz/sacl/about/csear2006/papers/oconnor,larry.pdf (Retrieved: 30.07.2014).

MMB (2013): MMB-Trendmonitor I/2013. Institut für Medien- und Kompetenzforschung, Essen. URL: http://www.mmb-institut.de/monitore/trendmonitor/MMB-Trendmonitor_2013_I.pdf (Retrieved: 14.07.2014).

O'Connor, L. (2006): "Empirical Research in Social and Environmental Accounting: A Metareview". URL: http://www.vuw.ac.nz/sacl/about/csear2006/papers/oconnor,larry.pdf (Retrieved: 20.04.2015).

OECD (2005): O E C D A N N U A L R E P O R T 2 0 0 5. 45th Anniversary. URL: http://www.oecd.org/newsroom/34711139.pdf (Retrieved: 11.07.2014).

Oxford Dictionaries (2014): Definition of social science in English. URL: http://www.oxforddictionaries.com/definition/english/social-science- (Retrieved: 30.08.2014).

Seal, W. (2015): Online Learning Centre. Management Accounting Willie Seal, University of Essex, UK; Ray Garrison, Brigham Young University, Provo, Utah, USA Eric Noreen, INSEAD, France. URL: http://highered.mheducation.com/sites/0077098595/student_view0/case_studies.html (Retrieved: 20.04.2015).

Sixth Community Environment Action Programme (2002): European Commission. The Sixth Environment Action Programme of the European Community 2002-2012. URL: http://ec.europa.eu/environment/newprg/archives/index.htm (Retrieved: 09.07.2014).

Statista.de (2015): Anzahl der Unternehmen* in Deutschland nach Beschäftigtengrößenklassen im Jahr 2013 (Stand Mai 2015). URL: http://de.statista.com/statistik/daten/studie/1929/umfrage/unternehmen-nach-beschaeftigtengroessenklassen/ (Retrieved: 21.04.2016).

Sustainable Reporting Guidelines of GRI (2011): RG. Sustainability Reporting Guidlines. Version 3.1. URL: https://www.globalreporting.org/resourcelibrary/g3.1-guidelines-incl-technical-protocol.pdf (Retrieved: 10.07.2014).

theguardian.com (2013): Environmentally-friendly business is profitable business. (URL: https://www.theguardian.com/sustainable-business/environmentally-friendly-sustainable-business-profitable (Retrieved: 11.11.2016).

UK reporting guidelines (2013): Public sector annual reports: sustainability reporting guidance 2013-14. HM Treasury. Frebruary 2013. URL: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/279330/PU1632_Sustainability_Reporting_Guidance.pdf (Retrieved: 10.07.2014).

Umweltbundesamt (2015): Zellstoff- und Papierindustrie. URL: http://www.umweltbundesamt.de/themen/wirtschaft-konsum/industriebranchen/holz-zellstoff-papierindustrie/zellstoff-papierindustrie (Retrieved: 15.07.2014).

United Nations (2001) = UN, Environmental Management Accounting: Policies and Linkages (2001): Economic & Social Affairs. United Nations, New York, 2001. URL: http://sustainabledevelopment.un.org/content/documents/policiesandlinkages.pdf (Retrieved: 13.07.2014).

U.S. Energy Information Administration (2014): Monthly Energy Review September 2014 [a]. URL: http://www.eia.gov/totalenergy/data/monthly/pdf/sec1_3.pdf (Retrieved: 15.10.2014).

UN Manual (2000): Handbook of National Accounting. Integrated. Environmental and Economic Accounting. An Operational Manual. United Nations. Department of Economic and Social Affairs. Statistics Division. United Nations Environment

Programme Economics and Trade Unit. UNEP. Division of Technology, Industry and Economics. Series F, No. 78. United Nations. New York, 2000. URL: http://unstats.un.org/unsd/publication/SeriesF/SeriesF_78E.pdf (Retrieved: 11.07.2014).

US Environment Protection Agency (1995): 1995 National Air Quality: Status and Trends. AIRTrends 1995 Summary. United States, Washington, DC 20460. URL: http://www.epa.gov/airtrends/aqtrnd95/ (Retrieved: 16.07.2014).

US Environmental Protection Agency (2000): EPA United States, Washington, DC 20460, www.epa.gov. Science Policy Council HANDBOOK. Risk Characterization Handbook. EPA 100-B-00-002. December 2000. URL: http://www.epa.gov/spc/pdfs/rchandbk.pdf (Retrieved: 17.07.2014).

Wiley Interscience Database: Swinburne Library. URL: http://www.swinburne.edu.au/lib/database/wiley.htm (Retrieved: 15.05.2014).

Wuv.de (2015): Trendstudie: Internet kannibalisiert Print. URL: https://www.wuv.de/medien/trendstudie_internet_kannibalisiert_print (Retrieved: 15.05.2017).

9 Appendix

9.1 Tables

Table (6): Environmental Areas of a Company			
EMA Area	**Objectives**	**Requirements**	**Further Measures**
Water Management (Physical)	Minimise use of water	Treatment, tracing and accounting of flows of water	Adequate personnel & trainings
			Clean-up, remediation
			Drainage of sewage
			Identify chances to reduce or prevent water pollution
			Water use in production
	Optimise water quality		Purification of water
			Use of adequate metrics, checks, monitoring
			Wastewater reuse
			Water cooling system
Water Management (Financial)	Minimise costs related to water consumption	Tracing and accounting of related costs	1. Adequate personnel & trainings 2. Use of adequate metrics, checks, monitoring
	Minimise fees (penalties) due to water pollution	Ascertaining legal compliance	
Air Management (Physical)	Minimise emission of air pollutants	Treatment, tracing and accounting of flows of air and gases	Adequate personnel & trainings
			Clean-up, remediation
			Identify chances to reduce or prevent air pollution
			Air polluting effects in production
			Purification of air
			Use of adequate metrics, checks & monitoring
Air Management (Financial)	Minimise costs related to air pollution	Tracing and accounting of related costs	1. Adequate personnel & trainings 2. Use of adequate metrics, checks, monitoring
	Minimise fees due to air pollution	Ascertaining legal compliance	
Material Management (Physical)	Minimise use of hazardous materials	Treatment, tracing and accounting of flows of NPO and hazardous materials	Adequate personnel & trainings
			Clean-up, remediation
			Identify chances to reduce, prevent NPO & hazardous materials
			Reuse of waste
	Minimise production of non-product output (NPO, hazardous and non-hazardous waste)		Amount of NPO & hazardous materials in production
			Treatment, purification of NPO & hazardous materials
			Use of adequate metrics, checks, monitoring

Material Management (Financial)	Minimise costs related to non-product output and hazardous materials	Tracing and accounting of related costs	1. Adequate personnel & trainings 2. Use of adequate metrics, checks, monitoring
	Minimise fees (penalties) due to hazardous wastes	Ascertaining legal compliance	
Energy Management (Physical)	Minimise consumption of energy, minimise emission of energy into air and especially into water	Treatment, tracing and accounting of flows of energy	Adequate personnel & trainings
			Identify chances to reduce the use & emission of energy
			Methods for reuse of emitted energy (heat)
			Energy consumption in production
			Use of adequate metrics, checks, monitoring
Energy Management (Financial)	Minimise costs related to energy consumption	Trace & account of related environmental costs	1. Adequate personnel & trainings 2. Use of adequate metrics, checks, monitoring
	Minimise fees due to energy emissions	Ascertaining legal compliance	
Sources: Same as in tables (8) and (7)			

Table 9: Company Documents and Files
Annual economy report from 2013
Content, intent: (1) the company's market share and general economic context (including the company's competitors); (2) its business trend from 2013; (3) its basic product portfolio; (4) its main branch offices
Balance Sheet (2009)
Content, intent: assets & liabilities in EUR million
Brochure 'Das Selbstverständnis' (2013)
Content, intent: description of the company's goals, the ways to reach it, the product portfolio, the clients, the staff members, and the company's policy concerning its environmental responsibility
Brochure 'Inspiring People' (2013)
Content, intent: company's philosophy, product portfolio, supply chain, used raw materials and production modes, research and planning of new products, storage of finished products, quality management, management of social and environmental affairs, staff members, health management, workshops, training and apprenticeships for staff
Document on the FSC (Forest Stewardship Council) certification (2010)
Content, intent: description of the EMA system in the company
Document 'Controlling Grundlagen' (2013).
Content, intent: controlling of the company
Document 'Controlling Grundlagen' (2013)
Content, intent: controlling of the company
Document 'Quality Guidelines'
Content, intent: framework to maintain product quality and economic efficiency
File: 5 S – Shine & Sustain – Nachhaltig Sauberkeit
Content, intent: time and environmental management for machinery per year
File: Faktenblatt Deutsche Bundesbank (2010)
Content, intent: main economic metrics and data of the ACME-Print in the period 2007–2009 as presented by the Deutsche Bundesbank
File: Faktenblatt Deutsche Bundesbank (2012)
Content, intent: main economic metrics and data of the ACME-Print in the period 2010–2012 as presented by the Deutsche Bundesbank
File: profit and loss account of the ACME-Print 31.12.2011
Content, intent: profit and loss account of the ACME-Print in 2011
File: profit and loss account of the ACME-Print 31.12.2012
Content, intent: profit and loss account of the ACME-Print in 2012
File: profit and loss account of the ACME-Print 31.12.2013
Content, intent: profit and loss account of the ACME-Print in 2013
File: costs for material and energy of the ACME-Print (2010–2014)
Content, intent: Costs for used material & energy of the ACME-Print (2010–2014)
File: Reserves
Content, intent: amount of reserves of the ACME-Print (2010–2014) in EUR million
Input Output Matrix (2009)
Content, intent: costs for used and wasted resources
Internal circulars (numerous and various)
Content, intent: instructions for the use of machinery
Internal protocols (2009)
Content, intent: the ways of implementing EMA
Minutes of meetings (observed by the researcher)
Content, intent: the company's environmental policy
Newsletter and intranet information (2009)
Content, intent: information about new products, including new eco-friendly products
Paper entitled 'Prozessablauf GF 003' (2013)

Content, intent: a basic guideline for all relevant processes and which defines the main assignments of the superior staff members
Prodreport
Content, intent: collection of the company’s basic production figures
Reports (environmental reports, environment-related press reports, 2009)
Content, intent: the ways of implementing EMA
Training materials (e.g. the brochure ‘Shine and Sustain’)
Content, intent: ways to use the machines in the most eco-friendly way
Website of the company
Content, intent: information on the targeted group of clients, number of employees, capacity of product output, product portfolio and production sites.

Table (13.0): EBSC-Values from January 2015 for all Products before and after EMA Launch

I	R_{WA}	R_{WO}	R_{HWO}	R_{HWT}	R_{EO}	P_{RR}	ELR	EIR	ECE / €	ECG / €	ECP / €	ECPr / €	Q
R	18%	12%	4%	1.5%	3%	60%	20%	20%	100	7000	15€	900	B
	4%	2%	1%	0.5%	1%	80%	10%	10%	30	3000	5€	400	A

I – Index / R – Result / Q – Quality / B – before / A – after

Table (13.1): EBSC-Values from January 2015 for Xelio Finish-Foil before & after EMA Launch

I	R_{WA}	R_{WO}	R_{HWO}	R_{HWT}	R_{EO}	P_{RR}	ELR	EIR	ECE	ECG	ECP	ECPr	Q
R	40%	50%	20%	30%	10%	10%	60%	50%	10€	950€	60€	1800€	B
	20%	25%	10%	8%	5%	20%	40%	35%	5€	450€	40€	900€	A

I – Index / R – Result / Q – Quality / B – before / A – after

Table (13.2): EBSC-Values from January 2015 for Teco-Foil before & after EMA Launch

I	R_{WA}	R_{WO}	R_{HWO}	R_{HWT}	R_{EO}	P_{RR}	ELR	EIR	ECE	ECG	ECP	ECPr	Q
R	30%	40%	10%	12%	4%	50%	50%	35%	8€	550€	40€	1000€	B
	10%	15%	3%	6%	2%	60%	30%	20%	3€	250€	20€	700€	A

I – Index / R – Result / Q – Quality / B – before / A – after

Table (13.3): EBSC-Values from January 2015 for Finish-Flex before & after EMA Launch													
I	R_{WA}	R_{WO}	R_{HWO}	R_{HWT}	R_{EO}	P_{RR}	ELR	EIR	ECE	ECG	ECP	ECPr	Q
R	20%	30%	6%	8%	2%	55%	30%	25%	4€	200€	8€	300€	B
	5%	8%	2%	2%	1%	75%	15%	10%	2€	50€	3€	100€	A
I – Index / R – Result / Q – Quality / B – before / A – after													

Table (13.4): EBSC-Values from January 2015 for Imawell before & after EMA Launch													
I	R_{WA}	R_{WO}	R_{HWO}	R_{HWT}	R_{EO}	P_{RR}	ELR	EIR	ECE	ECG	ECP	ECPr	Q
R	40%	35%	25%	20%	10%	25%	30%	40%	9€	600€	10€	500€	B
	15%	8%	10%	8%	5%	40%	15%	25%	4€	250€	5€	200€	A
I – Index / R – Result / Q – Quality / B – before / A – after													

Table (14.0): EBSC for Monthly Production of all Products in EUR Million													
P	NHI	HI	Product output (+)		Product output (–)		Solid waste (+)		Solid waste (–)		Liquid waste	Gas	Q
			From NHI	From HI	From NHI	From HI	From NHI	From HI	From NHI	From HI			
R	250	11	200	2	25	3	20	2	3.5	2	15.5	8	B
	325	5	300	3	19	1	2.5	0.5	2,5	0.3	0.6	0.6	A
P: Process / NHI: Non-hazardous Input / HI: Hazardous Input / (+) non-hazardous / (–) hazardous / R – Result / Q – Quality / B – before / A – after / Note: 'Liquid waste' does not include waste water!													

Table (14.1): EBSC for Monthly Production of Xelio Finish-Foil													
P	NHI / €	HI / €	Product output (+) / €		Product output (–) / €		Solid waste (+) / €		Solid waste (–) / €		Liquid waste / €	Gas / €	Q
			From NHI	From HI	From NHI	From HI	From NHI	From HI	From NHI	From HI			
R	8950	1050	–	–	4400	600	3500	10	600	300	500	90	B
	9500	500	6700	300	0	0	2400	0	300	150	100	50	A
P: Process / NHI: Non-hazardous Input / HI: Hazardous Input / (+) non-hazardous / (–) hazardous / R – Result / Q – Quality / B – before / A – after / Note: 'Liquid waste' does not include waste water!													

Table (14.2): EBSC for Monthly Production of Teco-Foil

P	NHI / €	HI / €	Product output (+) / €		Product output (–) / €		Solid waste (+) / €		Solid waste (–) / €		Liquid waste / €	Gas / €	Q
			From NHI	From HI	From NHI	From HI	From NHI	From HI	From NHI	From HI			
R	9500	1000	6000	300	0	0	3000	5	1000	600	530	65	B
	9900	400	7800	200	0	0	1900	0	100	150	120	30	A

P: Process / NHI: Non-hazardous Input / HI: Hazardous Input / (+) non-hazardous / (–) hazardous / R – Result / Q – Quality / B – before / A – after / Note: 'Liquid waste' does not include waste water!

Table (14.3): EBSC for Monthly Production of Finish-Flex

P	NHI / €	HI / €	Product output (+) / €		Product output (–) / €		Solid waste (+) / €		Solid waste (–) / €		Liquid waste / €	Gas / €	Q
			From NHI	From HI	From NHI	From HI	From NHI	From HI	From NHI	From HI			
R	10100	900	7000	200	0	0	2200	600	800	80	80	40	B
	10200	300	9100	200	0	0	900	30	150	40	50	30	A

P: Process / NHI: Non-hazardous Input / HI: Hazardous Input / (+) non-hazardous / (–) hazardous / R – Result / Q – Quality / B – before / A – after / Note: 'Liquid was' does not include waste water!

Table (14.4): EBS for Monthly Production of Imawell

P	NHI / €	HI / €	Product output (+) / €		Product output (–) / €		Solid waste (+) / €		Solid waste (–) / €		Liquid waste / €	Gas / €	Q
			From NHI	From HI	From NHI	From HI	From NHI	From HI	From NHI	From HI			
R	4500	500	0	0	3000	250	1000	100	400	100	90	60	B
	4600	200	0	0	4250	150	300	30	30	10	15	15	A

P: Process / NHI: Non-hazardous Input / HI: Hazardous Input / (+) non-hazardous / (–) hazardous / R – Result / Q – Quality / B – before / A – after / Note: 'Liquid waste' does not include waste water!

Table (15.1) EBSC-Data for Input Materials: Water, Formaldehyde, Energy & Polystyrene (Extended Version)								
Input material	+	–	Input	Output (+)	Output (–)	Waste (+)	Waste (–)	P
Water (2010)	Yes		5,000	500	0	4,400	100	1
			6,000	700	0	5,200	100	2
			5,000	800	0	4,150	50	3
			10,000	0	6,000	3,900	100	4
			…	…	…	…	…	…
			300,000	**40,000**	**60,000**	**150,000**	**50,000**	**Σ**
Water (2015)	Yes		3,000	400	0	2,550	50	1
			2,000	450	0	1,500	50	2
			2,000	300	0	1,670	30	4
			4,000	0	3,500	440	60	4
			…	…	…	…	…	…
			100,000	**15,000**	**20,000**	**47,000**	**18,000**	Σ
Formalde-hyde (2010)		Yes	20,000	15,000	0	3,500	1,500	1
			30,000	25,500	0	4,000	500	2
			30,000	27,600	0	2,000	400	3
			50,000	0	45,000	4,000	1,000	4
			…	…	…	…	…	…
			1,500,000	**600,000**	**700,000**	**10,000**	**190,000**	**Σ**
Formalde-hyde (2015)		Yes	10,000	8,000	0	1,500	500	1
			14,000	12,500	0	1,200	300	2
			2,000	600		1,300	100	3
			20,000	0	19,000	950	50	4
			…	…	…	…	…	…
			900,000	**300,00**	**500,000**	**20,000**	**80,000**	**Σ**
Energy (2010)	Yes		60,000	20,000	0	40,000	0	1
			40,000	15,000	0	25,000	0	2
			35,000	10,000	0	25,000	0	3
			5,000	2,000	0	3,000	0	4
			…	…	…	…	…	…
			5,500,000	**2,120,000**	**0**	**3,38,000**	**0**	**Σ**
Energy (2015)	Yes		30,000	10,000	0	20,000		1
			25,000	10,000	0	15,000	0	2
			15,000	6,000	0	9,000	0	3
			2,000	8000	0	1,200	0	4
			…	…	…	…	…	…
			2,200,000	**700,000**	**0**	**1,500**	**0**	**Σ**
PST (2010)		Yes	100,000	40,000		10,000	50,000	1
			20,000	0	10,000	3,000	7,000	4
			…	…	…	…	…	…
			6,000,000	**150,000**	**200,000**	**150,000**	**100,000**	**Σ**
PST (2150)		Yes	35,000	25,000	0	8,000	2,000	1
			4,000	0	3,000	1,000	2,000	4
			…	…	…	…	…	…
			1,900,000	**1,000,000**	**800,000**	**40,000**	**60,000**	**Σ**
Explanations: (+) non-hazardous / (–) hazardous / Costs in € / P = Process / PST = Ploystyrene								

Table (15.2) EBSC-Data for Input Materials: Fuel, Wood, Bitumen, Cellulose & PVC (Extended Version)								
Input material	+	–	Input	Output (+)	Output (–)	Waste (+)	Waste (–)	P
Fuel (2010)		Yes	20,000	0	0	2,000	18,000	1
			15,000	0	0	1,500	13,500	2
			10,000	0	0	1,000	9,000	3
			8,000	0	0	700	7,300	4
			…	0	0	…	…	…
			1,500,000	**0**	**0**	**100,000**	**1,400,000**	**Σ**
Fuel (2015)		Yes	12,000	0	0	1,500	10,500	1
			8,000	0	0	1,000	7,000	2
			5,000	0	0	600	4,500	3
			3,500	0	0	400	3,100	4
			…	0	0	…	…	…
			780,000	**0**	**0**	**90,000**	**690,000**	**Σ**
Wood (2010)	Yes		40,000	30,000	0	8,000	2,000	2
			30,000	23,000	0	4,500	2,500	3
			…	…	…	…	…	…
			1,800,000	**1,200,000**	**400,000**	**150,000**	**50,000**	**Σ**
Wood (2015)	Yes		30,000	20,000	7,000	2,500	500	2
			26,000	20,000	5,000	800	200	3
			…	…	…	…	…	…
			1,400,000	**1,100,000**	**200,000**	**80,000**	**20,000**	**Σ**
Bitumen (2010)		Yes	20,000	5,000	0	5,000	10,000	1
			…	…	…	…	…	…
			150,000	**20,000**	**20,000**	**40,000**	**70,000**	**Σ**
Bitumen (2015)		Yes	10,000	8,000	0	700	1,300	1
			…	…	…	…	…	…
			70,000	**45,000**	**15,000**	**3,000**	**7,000**	**Σ**
Cellulose (2010)	Yes		60,000	35,000	0	20,000	5,000	2
			…	…	…	…	…	…
			600,000	**400,000**	**0**	**420,000**	**80,000**	**Σ**
Cellulose (2015)	Yes		50,000	46,000	0	3,000	1,000	2
			…	…	…	…	…	…
			500,000	**450,000**	**0**	**45,000**	**5,000**	**Σ**
Metals (2010)		Yes	1,500	1,000	0	100	400	3
			…	…	…	…	…	…
			20,000	**10,000**	**5,000**	**800**	**4,200**	**Σ**
Metals (2015)		Yes	800	700	0	30	70	3
			…	…	…	…	…	…
			10,000	**6,000**	**3,500**	**100**	**400**	**Σ**
PVC (2010)		Yes	55,00	45,000	0	1,000	4,000	3
			…	…	…	…	…	…
			2,300,000	**1,850,000**	**0**	**50,000**	**400,000**	**Σ**
PVC (2050)		Yes	25,000	21,000	0	1,500	3,500	3
			…	…	…	…	…	…
			1,080,000	**550,000**	**440,000**	**10,000**	**70,000**	**Σ**
Explanations: (+) non-hazardous / (–) hazardous / Costs in € / P = Process								

Table (15.3) EBSC-Data for Input Materials: Mineral Oil & Phenol (Extended Version)								
Input material	+	–	Input	Output (+)	Output (–)	Waste (+)	Waste (–)	P
Mineral oil (2010)		Yes	20,000	0	11,000	1,000	8,000	4
			…	…	…	…	…	…
			2,800,000	**1,000,000**	**1,500,000**	**20,000**	**280,000**	**Σ**
Mineral oil (2015)		Yes	5,000	0	4,500	100	400	4
			…	…	…	…	…	…
			1,300,000	**700,000**	**500,000**	**10,000**	**90,000**	**Σ**
Phenol (2010)		Yes	30,000	0	15,000	5,000	10,000	4
			…	…	…	…	…	…
			1,450,000	**200,000**	**1,000,000**	**20,000**	**230,000**	**Σ**
Phenol (2015)		Yes	7,000	0	6,500	100	400	4
			…	…	…	…	…	…
			500,000	**250,000**	**200,000**	**5,000**	**45,000**	**Σ**
Explanations: (+) non-hazardous / (–) hazardous / Costs in € / P = Process								

Table (17.1): Environmental Cost Categories of Specific Product or Processes (Monthly Costs in January 2015 in EUR Million)					
Type of environmental cost or gain	P_1	P_2	P_3	P_4	All P_i
Complete production costs caused by	0.20	0.25	0.19	0.18	11.0
All environmental costs caused by	0.01	0.01	0.01	0.01	0.11
Environmental costs due to legal reasons caused by	0	0	0	0	0
Used amount of conventional assets for	0.09	0.11	0.08	0.05	4.50
Used amount of environmental assets for	0.03	0.05	0.03	0.02	1.05
Overall turnover caused by	0.55	0.60	0.45	0.40	22.17
Eco-related turnover caused by	0.14	0.15	0.13	0.12	5.33
Overall profits caused by	0.08	0.09	0.08	0.06	1.01
Eco-related profits caused by	0.02	0.03	0.02	0.01	0.23
P: specific process or product (cf. XY2, q. 4, p. 20 / XY10, q. 5, p. 30–31) The corresponding table for 2010 can be found in the appendix.					

Table (17.2): Environmental Cost Categories of Specific Product or Processes (Monthly Costs in January 2010 in EUR Million)					
Type of environmental cost or gain	P_1	P_2	P_3	P_4	All P_i
Complete production costs caused by	0.45	0.52	0.56	0.35	7.25
All environmental costs caused by	0.05	0.05	0.06	0.4	0.95
Environmental costs due to legal reasons caused by	0.06	0	0	0	0.06
Used amount of conventional assets for	0.16	0.19	0.17	0.14	6.50
Used amount of environmental assets for	0.02	0.03	0.03	0.01	0.06
Overall turnover caused by	0.39	0.45	0.50	0.42	18.33
Eco-related turnover caused by	0.05	0.06	0.07	0.03	1.83
Overall profits caused by	0.02	0.03	0.03	0.02	0.83
Eco-related profits caused by	0	0	0	0.10s	0.09
P: specific process or product (cf. XY2, q. 4, p. 20 / XY10, q. 5, p. 30–31) The corresponding table for 2010 can be found in the appendix.					

Table (18.1): Environmental Costs of Non-Product Output and Hazardous Input in January 2015 in EUR Million									
Environmental Cost type	Entity								
	Input (–)	Waste (–)	Waste (+)	Waste-water	Gas	Ground-water	Effects on biosphere	Health care	Σ
Treatment	0.01	0.04	0.05	0.03	0.02	0.01	0	0	0.16
Prevention	0	0.01	0.01	0.01	0.01	0.01	0.01	0	0.06
Insurance	0	0	0	0.01	0.01	0.01	0.01	0.01	0.05
Merchandise	0.02	0	0.01	0	0	0	0	0	0.03
Materials	0	0	0.01	0	0	0	0	0	0.01
Remediation	0	0.01	0	0	0	0	0	0	0.01
Packaging	0	0	0.02	0	0	0	0	0	0.02
Purchase val.	0	0	0.03	0	0	0	0	0	0.03
Process costs	0.05	0.02	0.01	0.01	0.02	0	0	0	0.11
Tax, penalty	0	0.02	0.01	0.01	0.02	0	0	0	0.06
All expenses	0.08	0.10	0.15	0.07	0.08	0.03	0.02	0.01	0.54
Revenues	0	0	0	0	0	0	0	0	0
Overall result	0.08	0.10	0.15	0.07	0.08	0.03	0.02	0.01	0.54
Processes	0.06	0	0	0	0	0	0	0	0.06
Σ	0.14	0.10	0.15	0.07	0.08	0.03	0.02	0.01	0.60
X2, q. 4, p. 20 / X3, q. 4, p. 21 / X5, q. 4, p. 20 / X5, q. 4, p. 22 / XY10, q. 5, p. 30-31/ val.: value / M = Million € / The corresponding table for 2015 can be found in in the appendix.									

Table (18.2): Environmental Costs of Non-Product Output and Hazardous Input in January 2010 in EUR Million									
Environmental Cost type	Entity								
	Input (–)	Waste (–)	Waste (+)	Waste-water	Gas	Ground-water	Effects on biosphere	Health care	Σ
Treatment	0.03	0.09	0.08	0.08	0.05	0.02	0.1	0	0.36
Prevention	0	0	0	0.01	0.01	0.01	0	0	0.03
Insurance	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.16
Merchandise	0.04	0	0.03	0	0	0	0	0	0.07
Materials	0	0	0.03	0	0	0	0	0	0.03
Remediation	0	0.03	0.02	0.01	0.01	0.01	0.01	0	0.09
Packaging	0	0	0.04	0	0	0	0	0	0.04
Purchase val.	0	0	0.06	0	0	0	0	0	0.06
Process costs	0.08	0.04	0.03	0.02	0.05	0	0	0	0.22
Tax, penalty	0	0.06	0.03	0.04	0.05	0.01	0.01	0.01	0.21
All expenses	0.17	0.24	0.88	0.18	0.19	0.07	0.05	0.03	1.27
Revenues	0	0	0	0	0	0	0	0	0
Overall result	0.17	0,24	0.88	0.18	0.19	0.07	0.05	0.03	1.27
Processes	0.09	0	0	0	0	0	0	0	0.09
Σ	0.26	0.24	0.88	0.18	0.19	0.07	0.05	0.03	1.36
X2, q. 4, p. 20 / X3, q. 4, p. 21 / X5, q. 4, p. 20 / X5, q. 4, p. 22 / XY10, q. 5, p. 30-31/ val.: value / M = Million € / The corresponding table for 2015 can be found in in the appendix.									

Table (21): Balance Sheet of the ACME-Print					
	Fixed Assets	**2010**	**2011**	**2012**	**2013**
Assets in EUR million	Intangible assets	10.295	6.530	5.167	3.936
	Tangible assets	85.274	83.921	85.488	82.704
	Investments	1.510	1.995	719	481
	All fixed assets	97.079	92.445	91.374	87.121
	Current Assets				
	Stocks	44.566	54.090	57.166	57.967
	Trade debtors	19.505	21.228	24.350	26.755
	Amounts owed by group	143	170	100	121
	Other assets (devices for decontamination)	7.140	7.898	8.055	8.451
	Investments in EMA	0	0	0	0
	Cash	6.810	6.560	9.907	6.888
	All current assets	78.164	89.946	97.578	96.182
	Eco-related assets (various)	0.0	1.2	2.1	3.5
	All assets	175.243	182.391	188.952	183.303
Liabilities in EUR million	**Shareholder's equity**				
	Share capital	25.000	25.000	25.000	25.000
	Capital reserve and net income	67.495	79.172	92.256	97.191
	Total shareholder's equity	92.495	104.172	117.256	122.191
	Long term creditors				
	Provisions for pensions	3.428	3.574	3.545	3.101
	Long term bank loans	25.283	25.092	30.425	23.683
	Provisions f. eco-related issues	–	–	–	–
	All liabilities held by long term creditors	28.711	28.666	33.970	26.784
	Short Term Creditors				
	Short term provisions	6.165	5.506	7.261	7.743
	Short term bank loans	20.443	21.744	17.496	12.109
	Payment received on account	12.074	10.230	8.501	9.809
	Amounts owed to group undertakings	6.074	6.175	74	0
	Other creditors	9.281	5.898	4.394	4.667
	Eco-related liabilities	0.0	1.0	0.8	0.3
	All liabilities held by short term creditors	54.037	49.553	37.726	34.328
	All liabilities	175.243	182.391	188.952	183.303
Source: File 'Consolidated Financial Statements Interprint GmbH Group 2013'					

Table 22: Main Economic Metrics and Data of ACME-Print in the Period 2007–2009 as Presented by the Deutsche Bundesbank						
Year	**2007**		**2008**		**2009**	
Economic Metric in Per Cent	Firm	X_M	Firm	X_M	Firm	X_M
Return on Sales	7.8	2.8	30.1	2.4	16.1	1.9
Return on Operating Assets	9.0	4.0	8.2	3.5	3.1	2.5
Rate of Surplus Revenue	12.4	7.1	31.4	6.5	22.9	5.9
Rate of Capital Reflux	15.7	12.7	34.6	12.8	20.5	10.5
Rate of Debt Repayment	19.5	20.4	67.1	21.5	59.0	18.5
Rate of Temporary Capital Lock Up*	8.4	10.5	20.6	9.4	10.3	9.2
Average Days in Receivables	39.0	33.6	40.5	29.5	35.1	32.2
Days Payables Outstanding	4.8	19.1	4.9	17.0	9.2	16.8
Equity Ratio	11.5	16.8	40.7	21.8	56.2	17.4
Year	**2007**		**2008**		**2009**	
Economic Data in EUR million	Firm	X_M	Firm	X_M	Firm	X_M
Total Output	109.540	–	103.199	–	77.968	–
Net Profit	15.531	8.8	14.849	8.0	7.804	6.6
Write-Off / Depreciation	5.746	3.8	6.302	3.8	5.362	3.8
Earnings Before Interests & Taxes	-1.286	-1.0	21.881	-1.1	10.56	-1.1
Net Income	6.915	1.9	27.635	1.3	11.745	1.2
Balance Sheet Total	87.015	–	95.572	–	87.883	–
Intangible Assets	0.886	0.2	0.889	0.2	0.606	0.2
Tangible Assets	22.092	33.8	23.219	35.3	19.743	33.8
Financial Assets	27.743	0.0	29.539	0.1	42.176	0.0
Reserves	12.944	8.2	16.654	9.3	15.294	9.8
Liquid Assets	0.254	3.3	0.818	2.8	0.600	2.6
Equity	10.000	16.4	37.645	18.9	49.390	15.5
Provisions	6.731	7.1	6.885	7.0	7.458	6.8
Interest-Bearing Liabilities	25.372	24.7	33.292	26.3	21.639	25.0
Cash-Flow from Current Business	+15.928		+33.294		+29.863	
Cash-Flow from Investment	–7.582		–10.811		–12.989	
Cash-Flow from External Financing	–8.315		–21.919		–21.639	
Symbol *: Liabilities / X_M : Median of the firm's branch / Faktenblatt Deutsche Bundesbank (2010)						

Table (23.2): Main Economic Metrics and Data of ACME-Print in the Period 2010–2012 as Presented by the Deutsche Bundesbank (Full Version)						
Year	**2010**		**2011**		**2012**	
Economic Metric in Per Cent	Firm	X_M	Firm	X_M	Firm	X_M
Return on Sales	4.7	1.7	6.0	2.0	5.9	2.5
Return on Operating Assets	5.8	2.9	6.8	3.2	7.6	3.2
Rate of Surplus Revenue	15.5	5.5	9.4	6.2	10.8	7.8
Rate of Capital Reflux	19.2	11.4	12.9	12.8	15.8	13.4
Rate of Debt Repayment	46.7	17.4	36.3	21.2	54.7	27.5
Rate of Temporary Capital Lock Up*	16.5	9.9	13.7	7.9	10.1	8.1
Average Days in Receivables	35.6	31.9	32.7	30.7	34.1	31.4
Days Payables Outstanding	22.0	16.4	15.7	15.4	11.9	24.9
Equity Ratio	50.4	18.3	55.9	21.2	61.2	28.3
Rate of Wasted Resources on Operating Assets	18.4	16.8	14.21	15.0	10.80	13.5
Rate on eco-related turnover on total turnover	0.00	2.0	9.4	5.0	15.0	7.6
Rate of waste + water on total output	5.38	4.0	3.43	3.5	2.27	3.0
Rate of hazardous waste on total output	1.43	1.0	0.85	0.75	0.52	0.70
Rate of emissions on total output	2.70	2.0	1.86	1.5	1.39	1.4
Rate of wasted resources on total output	6.77	5.0	4.51	4.5	2.27	3.5
Economic Data in EUR million	Firm	X_M	Firm	X_M	Firm	X_M
Total Output	199.21	–	238.8	–	258.2	–
Net Profit	26.68	7.1	31.44	7.6	35.12	8.7
Eco-related Net Profit	0.4	0.5	2,99	1.0	5.12	1.5
Write-Off	14.7	7.4	14.74	6.2	14.95	4.3
Eco-related Write-Off	2.1	1.5	1.24	1.3	0.76	1.2
Earnings Before Interests And Taxes	-2.27	-1.1	-2.12	-1.1	-4.31	-1.0
Net Income	6.45	1.1	11.74	1.0	11.08	1.3
Eco-related Income	0.0	0.1	1.0	0.1	1,8	0.2
Balance Sheet Total	175	–	182.4	–	188.95	–
Intangible Assets	10.3	0.2	6.53	0.3	5.17	0.2
Tangible Assets	85.3	34.1	83.92	33.3	85.49	39.1
Financial Assets	1.51	0.9	2.00	0.0	0.72	0.0
Eco-related Assets (various kinds)	0.0	0.1	1.2	0.2	2.1	0.3
Reserves	44.6	10.4	54.09	11.3	57.17	11.9
Eco-related Reserves (cf. table 24)	14.03	13.5	11.43	12.8	9.04	11.2
Liquid Assets	6.81	3.4	6.56	3.3	9.91	3.7
Equity	92.5	17.4	104.2	19.0	117.26	25.0
Provisions	10.1	6.1	10.75	6.5	10.81	6.8
Interest-Bearing Liabilities	45.7	25.2	46.84	24.3	47.92	22.8
Cash-Flow from Current Business	+22.000		+20.000		+27.000	
Cash-Flow from Investment	–36.000		–15.000		–19.000	
Cash-Flow from External Financing	–18.000		–5.000		–5.000	
Symbol *: Liabilities / X_M : Median of the firm's branch; Faktenblatt Deutsche Bundesbank (2012)						

Table (i1): First Reason to Implement EMA (Question 1)		
High costs because of excessive consumption of fuel and electric energy	XY	P
The main reasons of implementing EMA were to help the management to minimise our environmental costs and to identify their drivers. This was especially true for the costs for energy and fuel, and all kind of flows.	1	2
(…) we were consuming too much electricity and fuel for our production process, which made our production too expensive.	2	3
Due to high and expensive energy and fuel consumption, the management had to react, and tried to change its production process.	3	4
The biggest problems were, however, the immense costs for energy and fuel.	4	5
First, we wanted a set of techniques to identify the reasons of our high consumption of electric energy and fuel in order to reduce it. The basic driver to adopt EMA was to reduce energy and fuel costs, and possibly other environmental costs including the fees for infringing environmental laws and regulations.	5	5
We wanted to account for the (…) environmental costs concerning our high consumption of electric energy and fuel, and concerning the use or production of environmentally hazardous substances.	6	6
The main reason to implement EMA was to explain and possibly reduce our vast costs for energy and fuel.	7	7
EMA was introduced to track and identify environmental costs. The costs for energy and fuel were the most important ones.	8	7
The company primarily introduced EMA to reduce its energy and fuel consumption.	9	8
Prior to the implementation of EMA, the company faced high energy and fuel costs, and it had problems to identify and check the production costs.	10	8
The introduction of EMA was primarily caused by the company's intent to reduce its energy and fuel costs.	11	9
Our company must deal with dangerous substances, it also has to control complex production processes and consumes much energy and fuel. These phenomena, especially our fuel and energy consumption, have the potential to impact the environment in a negative way.	12	9
EMA was first of all introduced to reduce energy and fuel consumption (…).	13	10
The most important assignment was to find ways to reduce our costly and environmentally risky energy and fuel consumption, which was linked to all production processes.	14	10
The management intended to capture the financially relevant information of all material and energy flows of our production process to reduce its consumption of electric energy and fuel.	15	11

Table (i2): Second Reason to Implement EMA (Question 1)		
Environmental costs of other physical flow components	XY	P
The main reasons of implementing EMA were to (…) minimise our environmental costs and to identify their drivers. This was especially true for the costs for energy and fuel, and all kinds of physical flow components.	1	2
As many substances are dangerous and difficult to handle, there were rather a lot of environmental costs, e.g. costs for treating and disposing waste.	4	4
We wanted to account for the investment appraisals and costs (i.e. environmental costs) concerning our high consumption of electric energy and fuel, and concerning the use or production of (…) hazardous substances.	6	6
The production of our items (…) involves many dangerous substances and the use of large amounts of energy. Hence, the production is per se a dangerous operation, which might negatively impact the environment. (…) The company still has to pay high costs stemming from the nature of these substances and their production processes.	7	6
Adhering to (…) an environmental friendly production only makes sense if the accountants are able to allocate the environmental costs (…): costs for producing, treating and disposing of waste and hazardous input and output substances (…).	9	8
Our company must deal with dangerous substances, it also has to control complex production processes and consumes much energy and fuel. These phenomena have the potential to impact the environment in a negative way. Being liable to these consequences the company must (…) account for the costs stemming from the special environmental risks of our products and production processes.	12	9
EMA was first of all introduced to reduce energy and fuel consumption, and to identify and control the costs concerning the treatment of the chemicals. EMA is also used to estimate the costs for the treatment of these substances, including the costs for the waste disposal.	13	10

Table (i3): Third Reason to Implement EMA (Question 1)		
Possible risk of co-related penalty fees and high environmental taxes	XY	P
(…) This excessive consumption also meant a risk for rising costs for eco-related taxes and penalty fees. (…) The legal pressure to observe environmental laws was only a secondary incentive.	1	2
The high consumption of energy and combustion of fuel meant the risk of infringing environmental laws. We had not violated any laws, but we decided to make our production processes more energy-efficient to reduce our costs (…) and, secondly, the risks of legal penalty fees.	2	3
We also feared that being incapable of accounting of our environmental affairs correctly might infringe the legal regulations in the countries where we already operated. This, as we saw it, would lead to the payment of penalty charges.	4	4
The basic driver to adopt EMA was to reduce energy and fuel costs, and possibly other environmental costs including the fees for infringing environmental laws (…).	5	5
We wanted to make sure that our energy and fuel consumption does not break any laws, which might cause additional costs.	6	6
The main reason to implement EMA was to explain and possibly reduce our vast costs for energy and fuel. A minor reason was the fear of high taxes and penalty charges due to the consumption of these resources.	7	7
The environmental laws in different countries often differ dramatically, and they also tend to change frequently.	10	8

Table (i4): Fourth Reason to Implement EMA (Question 1)		
Optimisation of resource and energy efficiency	XY	P
(…) to come to terms with two kinds of pressures: the supply chain, since it is connected with our material and energy flows; the legal pressure to observe environmental laws was only a secondary incentive.	1	2
(…) to make our production processes more resource-efficient and energy-efficient to reduce our costs (…).	2	3
But this meant to check our physical flows in terms of resource and energy efficacy.	5	5

Table (i5): Fifth Reason to Implement EMA (Question 1)		
Presence in foreign markets	XY	P
As the company has conquered foreign markets, the scope of duties has also grown. The company is now buying, producing and selling its products in many parts of the world. So, it has become difficult to allocate, control and account for all material flows and its accompanying costs.	4	4
The company is increasingly present in foreign markets, where there are different regulations concerning dangerous materials and the use of energy.	6	6
Prior to the implementation of EMA, the company faced high energy and fuel costs, and had problems to identify and to check the production costs. This effect is amplified, when a company works in many countries. The environmental laws in different countries often differ dramatically, and they also tend to change frequently. Some of the substances in question are scarce goods, so they are repeatedly the objects of financial speculations on the international stock markets. This often makes the entire production hard to predict if you do not have an appropriate accounting which checks the components of the physical flows in reference of their amounts and cost.	10	8

Table (i6): Sixth Reason to Implement EMA (Question 1)		
Improved tracking of physical flows and accounting of related costs	XY	P
The company had only a vague idea of the energy and material flows and its accompanying costs. The main reasons of implementing EMA were to help the management to minimise our environmental costs and to identify their drivers. (…) to improve the tracking and accounting of our flows (…).	1	2
[The goal of implementing EMA] to improve our methods of accounting and internal reporting of environmental and conventional costs by means of EMA, [and] (…) to track down other environmental costs and to minimise them (…). Our previous accounting was unable to track the costs of our physical flows.	2	3
Measuring and controlling the environmental costs was a prominent factor (…). The managers found out that changing the production process would be impossible without tracking its physical flows. So, the management realised that it could deal with this problem without changing the accounting procedures as well.	3	4
It had become difficult to allocate, control and account for all material flows and its accompanying costs. Our previous accounting did not focus on the company's flows, but rather on the fast ways of making products. That is why we thought we needed a special type of accounting to check this class of costs, and possibly to reduce them.	4	4
[With EMA we wanted] to account both for environmental and economic costs systematically. With EMA we wanted a form of accounting that was able to track and account for the company's physical flows (…). The basic driver to adopt EMA was to reduce energy and fuel costs, and possibly other environmental costs (…). But this meant to check our physical flows in terms of resource and energy efficacy.	5	5
Our idea was also that using EMA might help to reduce the environmental costs of our production by analysing the cost structures of the company's physical flows.	6	6
EMA was introduced to track and identify environmental costs. The costs for energy and fuel were the most important ones. EMA is able to do this by tracking our physical flows in respect of the components' quantities and costs.	8	7
The company primarily introduced EMA to reduce its energy and fuel consumption. (…). Adhering to the principles of an environmental friendly production only makes sense if the accountants are able to allocate the environmental costs, i.e. costs with eco-related aspects: (…) To reach this goal it is, however, necessary to check the components of our physical flows in terms of amount and costs.	9	8
The company realised that this could only be done by means of tracking the information of the physical flows inside the production process and its related costs. This was done to help the management to make the production costs and costs of the products more predictable.	11	9
However, being able to identify, control, and possibly to reduce these costs involves the monitoring of the physical flows of our production processes. To this end, EMA was introduced, (…).	12	9

EMA was (…) introduced to reduce energy and fuel consumption, and to identify and control the costs of the chemicals. EMA is also used to estimate the costs for the treatment of these substances, (…).	13	10
An analysis of our physical flows was necessary, especially one that checks the amounts and costs of its components.	14	10

Table (i7): Seventh Reason to Implement EMA (Question 1)		
Consideration of long term effects	XY	P
[EMA was thought to be able] to consider the long-term effects of producing products.	1	2
Unlike EMA, our previous accounting was unable to track the costs of our physical flows, and only focussed on the quick effects of creating products.	2	3
[EMA was thought to be able] to constantly improve the quality of our strategic management accounting concerning the production and use of substances considered environmentally critical.	3	4
The idea behind was that EMA might always help this management with reducing the environmental costs, and also with improving the quality of our products, at least concerning their eco-related qualities.	5	5

Table (i8): Eighth Reason to Implement EMA (Question 1)		
Help management with decision-making	XY	P
The fundamental reasons of implementing EMA were to help the management to minimise our environmental costs and to identify their drivers.	1	2
The final reason to implement EMA was to help the management reduce our energy costs.	2	3
Due to high and expensive energy and fuel consumption, the management had to react and tried to change its production process. The managers found out that changing the production process would be impossible without tracking its physical flows. So, the management realised that it could deal with this problem without changing the accounting procedures as well.	3	4
EMA was introduced to support our management with its decision-making in areas, where environmental aspects play an important role. We wanted an EMA-equipped strategic management accounting, whose decision-making would consider both economic and ecological criteria.	14	10
The management intended to capture the financially relevant information of all material and energy flows of our production process to reduce its consumption of electric energy and fuel. To serve this goal, EMA was implemented in the accounting structures of our company.	15	11

Table (ii1): Main Procedure of EMA Implementation (a) (Question 1)		
Standards	XY	P
The implementation of EMA was a process of six stages based on the ISO 14001 and BS 8555/Acorn standards.	1	2
The implementation of EMA was a project, which took place in six stages. (…) The entire implementation was carried out with manuals based on the standards ISO 14001 and BS 8555/Acorn.	2	3
The whole EMA implementation of EMA required six process steps using the standards ISO 14001 and BS 8555/Acorn	4	5
The entire process comprising six steps followed the standards ISO 14001 and BS 8555/Acorn.	5	6
The implementation of EMA answered the requirements of ISO 14001 and BS 8555/Acorn.	6	6
EMA was introduced as a long process with six stages based on the standards ISO 14001 and BS 8555/Acorn.	7	7
The project of implementing EMA was executed by means of a series of six consecutive steps based on the standards ISO 14001 and BS 8555/Acorn.	8	7
A team consisting of managers, accountants, production supervisors and external consultants (…) performed the EMA implementation using the standards ISO 14001 and BS 8555/Acorn.	10	9
A leading team (consisting of external tutors as well as managers and accountants from our company) (…) gradually integrated the standards and techniques of EMA into the already existing accounting structures of our company using the prescription of ISO 14001 and BS 8555/Acorn.	12	10
The goal of implementing EMA into the structures of our own strategic management accounting was reached in six consecutive steps following the standards ISO 14001 and BS 8555/Acorn.	14	10

Table (ii2): Main Procedure of EMA Implementation (b) (Question 1)		
Stages of EMA implementation and their measures	XY	P
First stage		
The management discussed the necessity of implementing EMA.	1	2
[The first stage consisted of finding] the reasons to implement EMA (…).	2	3
[The first stage consisted of] finding the reasons to implement EMA.	4	5
Firstly, the management informed itself about the necessity to implement EMA.	8	7
First, we informed ourselves about the reasons to adopt EMA (…). As we found these reasons relevant enough, we decided to implement EMA.	14	10
Second stage		
The management defined the field and the goals, in which (and for which) EMA was supposed to work.	1	2
[The second stage consisted of finding] the fields and goals of EMA.	2	3
[The third stage consisted of] defining the field and goal of EMA, i.e. accounting and possibly reducing environmental costs (…)	4	5
Secondly, we defined the goals of EMA, namely the tracking and the identification of environmental costs.	8	7
Shortly after this decision, we defined the aims and fields of EMA.	14	10
Third stage		
The implementation measures were defined. [One measure was to inform] the staff members who were directly or indirectly involved in (…) management accounting (accountants, managers, controllers). [There were] tutorials for the staff members mentioned above. In the beginning, the management had tried to do this task on its own (…). After a month of futile attempts it started to work with external tutors (…).	1	2
We started to look for tools and measures for the implementation. We also had to inform ourselves and the relevant staff members about the standards of EMA, and how to combine them with the standards of our accounting techniques. We found ways how to measure the flows of material and energy, and how to translate this physical data into information that could be used within our accounting techniques. After four weeks or so, we realised that we needed the help of external experts and tutors. Therefore, workshops led by external tutors were necessary.	2	3
[The third stage consisted of] identifying measures and tools with the help of external experts and tutors.	4	5
The introduction of EMA was done as a project led by a small group of management and accounting experts, backed by external teachers.	5	6
The company contemplated about the measure and tools to do the implementation. First, the management formed a team of skilled members to implement EMA. As it did not succeed, this team availed itself of the help of external tutors.	8	7
The third step involved the development of measures and tools to implement EMA, and then we informed the staff members, who would be affected by EMA, about the future changes in question. We soon realised that we needed help from external experts.	14	11
Fourth stage		

[The] implementation of EMA was carried out.	1	2
We carried out the EMA implementation (…).	2	3
[The fourth stage was] doing the actual implementation and start of EMA (…)	4	5
EMA was implemented into (…) our strategic management accounting.	8	7
The fourth step was the implementation of EMA, this step happened to be the most demanding one. There, we combined EMA with our strategic management accounting. For that, we needed new IT technologies, with which the various cost types were combined and aggregated. This was not always easy, since EMA uses its own indicators and benchmarks.	14	11
Fifth stage		
Managers checked the outcome of the EMA-implementation; it proved to be satisfactory.	1	2
We carried out the EMA-implementation, reviewed it, and confirmed it as successful.	2	3
[The fifth stage meant] assessing the results of the EMA-implementation, countermeasures to rectify failures or mistakes. However, no mistakes or failures were found.	4	4
Then we reviewed the finished implementation, which we found successful.	8	7
At the fifth step we checked the efficacy of the newly implemented EMA, which we found completely satisfactory.	14	11
Sixth stage		
[At the sixth stage] EMA was confirmed.	1	2
[At the sixth stage] we confirmed [EMA] as successful.	2	3
[At the sixth stage] confirming EMA.	4	4
Then we reviewed the finished implementation, which we found successful. These were the fifth and sixth steps respectively.	8	7
At the sixth and final step, the management unanimously confirmed the use of EMA.	14	11

Table (iii1): Barriers Impeding the Implementation of EMA (Question 1)		
Barrier	XY	P
Long Duration and Complexity		
The main obstacles were the long duration, and inexperienced personnel.	1	2
The EMA-implementation needed both a lot of time and many external experts.	2	3
Introducing EMA in this company was a long and tedious process.	3	4
[The barriers were] the long time the project took and its technical difficulties.	4	5
[One barrier to] the implementation of EMA was the long time to carry it out.	5	6
It took a long time since its introduction led to modifications of the work streams and some other business processes.	6	6
The negative side of this project was that it lasted so long. Therefore, some managers were already at the point of losing their patience.	7	7
The implementation of EMA (…) proved to be a very difficult and time-consuming process, which required much patience, organisational, communicative, and technical skills.	8	7
The implementation of EMA took about six months. (…) The implementation of the environmental management accounting was very demanding in terms of time and effort. This was true for all parties involved.	10	9
The introduction of EMA proved difficult and time-consuming, because no one of our staff had the necessary skills to do so.	12	10
[The barriers were] long duration, technical complexity.	14	11
The implementation of EMA lasted much longer than anticipated because the company lacked the technical expertise.	15	11
Lack of Technical Expertise among Personnel		
The main obstacles were the long duration and inexperienced personnel.	1	2
The EMA-implementation needed both a lot of time and many external experts. The implementation of EMA was (…) hampered by various technical particularities.	2	3
Hardly any staff members had a thorough understanding of EMA	3	4
[The barriers were] the long time the project took and its technical difficulties.	4	5
In the beginning, with thought we had the necessary expertise to do it all alone, but then we realised that we needed help from external teachers.	5	6
The company did have the organisational and communicative skills but it (…) lacked the technical competence to introduce EMA.	8	7
[One barrier was] lack of technical skills among the staff.	14	11
Internal Resistance		
Some rather conservative members of the staff where initially reluctant to support the changes mentioned above, but in the end also they agreed.	1	3
There was also some internal resistance because some company members thought that we had already done enough for the environment. These people were finally convinced of the necessity of EMA.	2	4
Some employees had to be convinced of implementing EMA.	4	5
A few members of the company had to be convinced of the feasibility of EMA.	8	7
The implementation of EMA lasted much longer than anticipated because some internal resistance had to be overcome.	14	11

Impatience among Management		
Some managers were already at the point of losing their patience.	7	7

Table (iii2): Drivers Facilitating the Implementation of EMA (Question 1)		
Factor	XY	P
Sufficient Financial Resources		
[There was] enough money to pay external teachers and experts.	1	2
The company also had the necessary financial resources to pay the external tutors and experts.	2	3
[There was] generous funding [for the EMA implementation].	6	6
The company had the financial means to carry out the implementation of EMA.	8	8
The entire process was also costly, but the company had the money.	12	10
[There were] necessary financial means.	14	11
Expertise Oncerning Ecological and Judicial Issues		
Our company is already familiar with ecological issues and the laws connected with them, at least in the context of economics.	3	4
Organisational and Communicative Expertise		
All teams of our company were already well organised, and the internal communication already functioned perfectly. So almost all staff members were quickly convinced of the necessity of EMA.	5	6
The company had the organisational and communicative skills (…).	11	9
Positive Attitude of Staff (Determination, Motivation, Patience, Support)		
The implementation of EMA was successful because it was supported by the vast majority of the managers and accountants.	7	7
Overall, the company had the determination and the financial means to bring the implementation to a satisfactory end.	9	8
Almost all participants were motivated and wanted to carry out the implementation of EMA.	10	9
The company had the organisational and communicative skills.	11	9
[There was] widespread determination [among the staff members to implement EMA].	15	11

Table (iv1): Possible Additional Drivers of EMA Implementation (a) (Question 2)		
Criteria of Analytical Comparison of EMA and Previous Accounting System	XY	P
(1) Identifications and Comparison of Accounting Structures and Accounting Tools		
A helpful measure to implement EMA is to exactly identify and analyse the structure and goals of both types of accounting beforehand. [This analysis must find out if EMA] fit[s] in the structures of our strategic management accounting.	1	12
To facilitate the implementation of EMA into the structures of its previous strategic management accounting both types of accounting should be thoroughly analysed. The main criteria are the ways to address, identify and control the various material and energy flows in terms of their quantities and their financial counterparts. These accounting types capture the input and the output flows, and how they especially deal with the flows of raw materials, energy, water, and wastes.	4	13
A measure supporting the implementation of EMA into strategic management accounting is to accurately analyse their systems of flow-cost accounting, and their general accounting practices of environmental costs. In respect to flow cost accounting, the analysis should focus on the general material flow model of both types, on the database they draw on, on their accounting elements, and on the results they deliver.	6	13
It would have been very helpful to analyse how the former and the latter accounting type deal with the material flow accounting and the system of cost accounting. It is important to know how the two types account for the quantities, the values and the costs of the material and energy flows. One must also know how the cost-related delimination, allocation and apportionment work in both contexts.	7	14
The management has to identify the advantages of EMA compared to the existing type of accounting. The management should ascertain that EMA is able to identify some costs, which the existing type of accounting cannot spot.	11	14
[The company ought to] analyse the structures of both accounting types and look for links; make sure that the new type of accounting fulfils its basic assignments, i.e. that it accounts for environmental costs completely and correctly (…).	13	15
It is necessary to examine how these accounting systems analyse the databases, and how they display their results.	14	15
(2) Analytical Identification and Comparison of Goals and Interests		
A helpful measure to implement EMA is to exactly identify and analyse the structure and goals of both types of accounting beforehand. [Questions to ask are]: Does EMA support our cause? Does it bring about extra benefits?	1	12
The company should analyse if and how much the goals and missions of both accounting types are matched, if the interests of the stakeholders of both accounting types are similar, and if there are the same stakeholders at all.	3	12

The company should have cautiously checked the tools of both accounting types to account for the material and energy flows, and for other environmental expenditures, especially for energy and fuel consumption or for the R&D of environmental friendly methods.	5	13
A measure supporting the implementation of EMA into strategic management accounting is to analyse their systems of flow-cost accounting, and their general accounting practices of environmental costs.	6	13
The management should make sure, that [EMA] supports the management with the development of environmental friendly processes, technologies and products.	9	14
The management should (…) check that the new type of accounting tracks and measures all kinds of environmental costs correctly.	10	14
The management should ascertain that EMA is able to identify some costs, which the existing type of accounting cannot spot.	11	14
The new type of accounting should bring about other positive effects, which the other one is not able to deliver: To help the management with a reduction of environmental costs and with the creation of environmental benefits revenues.		
Therefore, the management should ascertain right from the start how EMA could directly and indirectly improve the material efficiency of the company.		
[The company ought to] make sure that the new type of accounting brings about some extra benefits, which the old one cannot do, e.g. the reduction of environmental costs.	13	15
(2) Analytical Identification and Comparison of Accounting Objects		
Then, a thorough analysis of the material and energy flows should be undertaken with both types of accounting to determine if there are any significant differences.	1	12
After the comparison, it should be clear how these counting types capture the input and the output flows, and how they especially deal with the flows of raw materials, energy, water, and wastes.	4	13
The company should have cautiously checked the tools of both accounting types to account for the material and energy flows (…).	5	13
A measure supporting the implementation of EMA into strategic management accounting is to analyse their systems of flow-cost accounting, and their general accounting practices of environmental costs.	6	13
It would have been very helpful to analyse how the former and the latter accounting type deal with the material flow accounting and the system of cost accounting.	7	14
It is important to know how the two types account for the quantities, the values and the costs of the material and energy flows.		
One must also know how the cost-related delimitation, allocation and apportionment work in both contexts.		
The management has to identify the advantages of EMA compared to the existing type of accounting.	11	14
The management should ascertain that EMA is able to identify some costs, which the existing type of accounting cannot spot.		
[The company ought to] (…) make sure that the new type of (…) accounts for environmental costs completely and correctly (…).	13	15
(3) Identification of the Fit		

<table>
<tr><td colspan="4">Does it [=EMA] fit in the structures of our strategic management accounting?</td><td>1</td><td>12</td></tr>
<tr><td colspan="4">Before implementing EMA into the structures of our strategic management accounting we should have (…) look[ed] for and (…) analyse[d] possible links between the both accounting types.</td><td rowspan="2">2</td><td rowspan="2">12</td></tr>
<tr><td colspan="4">The possible links are the internal stakeholders, the goals and the means to reach them.</td></tr>
<tr><td colspan="4">A measure to facilitate the implementation of EMA into an older new? accounting system is to compare them concerning their fit.</td><td rowspan="2">3</td><td rowspan="2">12</td></tr>
<tr><td>There are three criteria for this comparison. The company should analyse,</td><td>(a) if and how much the goals and missions of both accounting types are matched,</td><td>(b) if the interests of the stakeholders of both accounting types are similar,</td><td>And (c) if there are the same stakeholders at all.</td></tr>
<tr><td colspan="4">Of course, both accounting types cannot and must not be identical. If they were, one of them would be superfluous. But these different accounting types must somehow be related to each other in a complementary way. They ought to supply each other with pieces of information, each partner is not able to generate on its own.</td><td rowspan="3">4</td><td rowspan="3">13</td></tr>
<tr><td colspan="4">Apart from that, both accounting types should significantly overlap in respect of their techniques.</td></tr>
<tr><td colspan="4">The management ought to have checked beforehand, if both accounting systems, EMA and the previous one, have comparable ways of accounting for assets, costs and gains in terms of various asset and liability sub groups, turnover, gross profits, net group profits, capital and cash flows, outputs and inputs. As a matter of fact, the figures have always been our most important financial indicators before and after the implementation of EMA.</td></tr>
<tr><td colspan="4">The general accounting principles should be more or less identical to ascertain the functional fit of both accounting types.</td><td rowspan="4">6</td><td rowspan="4">13</td></tr>
<tr><td colspan="4">The question concerning the results should be: Does one type of accounting deliver results the other is not able to?</td></tr>
<tr><td colspan="4">Both types of accounting ought to take information from different databases, but their accounting elements should be similar.</td></tr>
<tr><td colspan="4">So, the company should have looked for a trade-off between the demands of the fit between EMA and our old form of accounting, and the demands of measuring our physical flows and environmental costs in a better way.</td></tr>
<tr><td colspan="4">A helpful measure to implement EMA into the accounting structures of accompanying is to look for qualities that the existing accounting type does not have.</td><td rowspan="2">9</td><td rowspan="2">14</td></tr>
<tr><td colspan="4">Therefore, the management should make sure that the new type of accounting supports the management with the development of environmental friendly processes technologies and products.</td></tr>
<tr><td colspan="4">To bring about a successful implementation of EMA, the management should first of all make sure that it fits in the accounting structures of the company.</td><td>10</td><td>14</td></tr>
</table>

<table>
<tr><th colspan="5">Table (iv2): Possible Additional Drivers of EMA Implementation (b)
(Question 2)</th></tr>
<tr><th colspan="3">Improved Tutorials</th><th>XY</th><th>P</th></tr>
<tr><td colspan="3">The best measure to improve the implementation of EMA is to get help from external tutors and other experts right from the start.</td><td>12</td><td>15</td></tr>
<tr><td colspan="3">[The company ought to] use experts, if necessary from other companies, from the beginning to the end of the implementation [of EMA].</td><td>13</td><td>15</td></tr>
<tr><td>To implement EMA it is recommendable to make use of high-profile tutorials carried out by external experts.</td><td>Within these tutorials one ought to analyse the new type of accounting and the previous one in order to find ways to combine them.</td><td>To this end, it is necessary to examine how these accounting systems analyse the databases, and how they display their results.</td><td>14</td><td>15</td></tr>
</table>

<table>
<tr><th colspan="5">Table (iv3): Possible Additional Drivers of EMA Implementation (c) (Question 2)</th></tr>
<tr><th colspan="3">Search for Alternatives of EMA Implementation</th><th>XY</th><th>P</th></tr>
<tr><td colspan="3">Before implementing EMA into the structures of our strategic management accounting we should have (…) look[ed] for alternatives of EMA.</td><td>2</td><td>12</td></tr>
<tr><td colspan="3">Prior to the implementation of EMA the company should check if there are any feasible alternatives.</td><td rowspan="5">8</td><td rowspan="5">14</td></tr>
<tr><td colspan="2" rowspan="4">The [technical] criteria (…) are:</td><td>Does the accounting type help to reduce environmental costs and does it help to bring about the environmental benefits?</td></tr>
<tr><td>Does it help to achieve an enhanced material efficiency?</td></tr>
<tr><td>Does the accounting type achieve this with a comprehensive internal reporting covering all environmentally relevant aspects of the material and energy flows?</td></tr>
<tr><td>Does it not only concentrate on special departments?</td></tr>
<tr><td rowspan="6">Prior to the implementation of EMA the company should have checked various alternatives beforehand, instead of concentrating on this type of accounting from the very start.</td><td rowspan="6">Then, perhaps the company would have picked an accounting system that is easier to implement.</td><td>[Technical] criteria of comparing various types of accounting (…):</td><td rowspan="6">15</td><td rowspan="6">15</td></tr>
<tr><td>Transparency</td></tr>
<tr><td>Accountability & Reporting</td></tr>
<tr><td>Structure</td></tr>
<tr><td>Internal Stakeholders,</td></tr>
<tr><td>Correctness & Feasibility</td></tr>
</table>

Table (v1): Changes in Company Due to EMA Implementation (Question 3)			
	Enumeration of Direct Quotes	XY	P
Measure	Various eco-efficiency ratios / secondary metrics	1	16
	[For instance] ‘Rate of Wasted Resources on Operating Assets’, or the ‘Rate of Solid Waste and Waste Water on Total Output‘		
Effect	[It] helps the management to reduce environmental costs,		
	and thereby it also supports managerial decisions that increase material and energy efficiency and		
	helpsto develop eco-efficient products by reducing their material and their carbon footprint.		
Measure	EMA in general	2	16
Effect	Apart from identifying the environmental costs of all relevant material and energy flows,		
	the company is now also able to identify the eco-related profits and benefits in a special loss and profit account, which displays the losses and profits related to environmental processes and products.		
	EMA helps the company to reduce its environmental costs,		
	and thus to increase its material and energy efficiency,		
	which makes it also possible to develop environmental friendly products.		
Measure	Wide array of secondary metrics to measure the environmental costs of its material and energy flows.	3	16
Effect	The company measures the losses and profits of all activities,		
	(..) the losses and profits connected with activities that have environmental aspects, as e.g. the production of environmental friendly products.		
	The company is now able to identify the environmental cost for all raw materials, operating materials and used materials.		
	It also measures the costs for the output; the output costs are differentiated into the costs for finished products and non-product output.		
	In order to ascertain the influence on the environment there are also cost types for emissions, for hazardous output and non-hazardous output.		
Measure	EMA in general; benchmarks, metrics and indicators in general	4	16
Effect	to identify, to check and report all environmental costs and the physical sources.		
	This type of accounting is also linked with an environmental friendly purchase and production system.		
	Both parts make sure that only those raw materials are bought in such quantities that the material and energy efficient production of a certain product is possible.		
Measure	EMA in general	5	17

Effect	EMA [is mostly used] as help for managerial decision-making of issues which increase the company's environmental performance. To this end, we use EMA to clearly identify all costs of material and energy flows. Therefore, EMA helps the management to reduce its environmental costs, and thereby reach material efficiency in many fields which are not originally linked to ecological aspects. One of these fields is the storage of goods.				
Measure	EMA in general			6	17
Effect	As EMA is able to identify all material and energy flows, we are also using it to monitor several departments, where materials and energy are regularly consumed and moved. These departments are: marketing and sale, production, purchase, logistics, disposal and recycling.				
Measure	Various environmental cost and expenditure categories			7	17
Effect	EMA is able to calculate all environmental costs of all relevant flow components, but also the overall environmental expenditures and benefits.				
	This has become fundamental for the management	to reduce environmental costs	and to develop environmental friendly production processes.		
Measure	EMA in general			8	17
Effect	EMA has helped the company in tracking, managing and reducing the energy and material flows. EMA also identifies the nature, quantity and purpose of these flows. This is especially true for those substances that might possibly pollute the environment. EMA (…) first of all reports the environmental performance of the company especially in respect to the material and energy efficiency of its production processes. It reports this information to the management.				
Measure	EMA in general			9	17
Effect	EMA has helped the company to run its production processes in an environmentally friendly way.				
	This is also done by combining EMA with the methods of cleaner production, as e.g. a cleaner production assessment (CPA).	Hence, our machines are checked by EMA and CPA.			
Measure	EMA in general + techniques of conventional management accounting			10	18
Effect	[It] is able to calculate the total environmental expenditures, liabilities, benefits and assets. As the delivered results of these calculations are exact, our management now uses them as indicators and benchmarks for managerial decisions in both ecological and conventional areas.				

Measure	EMA in general	11	18
Effect	The company [can] calculate all types of environmental costs and benefits, which previously could not be identified. The most prominent examples are the calculation of energy / fuel use and waste production.		
	[With] cost categories it was possible to reduce the energy and fuel use as well as the waste production, [resulting] in environmental benefits.		
Measure	EMA in general	12	18
Effect	[EMA has effected] effective cost accounting [through] an accurate material and energy flow accounting.		
	The company uses its results for many managerial decisions including conventional and environmental purposes.		
	[The] quality of our managerial decisions in respect of cost efficiency, material efficiency and energy efficiency has significantly risen.		
Measure	EMA in general / reporting methods using material categories connected with their own cost categories.	13	18
Effect	Reporting of physical flows and associated costs		
	EMA is able to check the material flows of various chemicals		
Measure	EMA in general	14	18
Effect	The measurements of environmental costs done by EMA is both efficient and comprehensive,		
	since it identifies the overall conventional costs of the production process, and also the environmental costs of all environmentally relevant items.		
Measure	EMA in general	15	19
Effect	By means of calculating all environmental costs		
	The company has become able to reduce this type of costs.		
	EMA also helped to increase the overall material and energy efficiency of the company's production,		
	and to develop environmental friendly products.		

Table (vi1): Positive Influence of EMA on the Company's Performance (Question 9)		
Aspect		
(1) Correct Description of the Company's Physical Flows	XY	P
EMA itself describes the company's physical flows correctly since it identifies all quantities of their components.	1	51
EMA describes our physical flows correctly in terms of the quantities of their components.	2	51
EMA describes all material and energy-related aspects of our flows correctly.	3	51
With the complete and mostly correct information of EMA concerning environmental costs and quantitative information about our physical flows, our management was able to improve the production processes.	5	51
Using the extensive and mostly adequate information on the physical flows and on the environmental costs, the management was able to develop more cost efficient production processes in terms of conventional and eco-costs, (…)	7	52
The constant and comparatively thorough checks of all physical flows, their related environmental costs of technical accidents and manmade mistakes have created a new source of information.	8	52
This was, however, only possible with the help of EMA by adequately calculating all environmental costs and by tracking all physical flows inside the company.	9	53
These improvements are the result of managerial decisions based on the thorough and mostly correct information on physical flows and environmental costs supplied by EMA.	11	53
As EMA involves rigorous and correct checks on the material flows and the identification of their costs,	13	53
our management now has, via EMA, the complete and mostly correct information on the physical flows and their various costs, including the environmental ones.	14	53
This became possible with the adequate information of EMA concerning the quantitative information about all components of the physical flows, all their related costs and especially all their related environmental costs.	15	53
(2) Completeness of Cost Calculation		
EMA itself describes the company's physical flows correctly since it identifies all quantities of their components.	1	51
In addition, it almost always gives a realistic picture of its related environmental costs.	2	52
The estimates for some hazardous substances are less precise, but still adequate in most cases.	3	52
With the complete and mostly correct information of EMA concerning environmental costs and quantitative information about our physical flows, our management could improve the production processes.	5	52
Using the extensive and mostly adequate information on the physical flows and on the environmental costs, the management was able to develop more cost efficient production processes in terms of conventional and eco-costs, (…)	7	52
The constant and comparatively thorough checks of all physical flows, their related environmental costs of technical accidents and manmade mistakes have created a new source of information.	8	52

This was, however, only possible with the help of EMA by adequately calculating all environmental costs and by tracking all physical flows inside the company.	9	53
These improvements are the result of managerial decisions based on the thorough and mostly correct information on physical flows and environmental costs supplied by EMA.	11	53
As EMA involves rigorous and correct checks on the material flows and the identification of their costs,	13	53
our management now has, via EMA, the complete and mostly correct information on the physical flows and their various costs, including the environmental ones	14	53
This became possible with the adequate information of EMA concerning the quantitative information about all components of the physical flows, all their related costs and especially all their related environmental costs.	15	53
(3) Correctness of Cost Calculation		
The overall calculations of the environmental costs for each product and production process have proven adequate.	1	51
In addition, it almost always gives a realistic picture of its related environmental costs.	2	51
The estimates of the related costs are almost always correct, especially in the case of harmless substances, fuel and electricity.	3	51
With the complete and mostly correct information of EMA concerning environmental costs and quantitative information about our physical flows, our management was able to improve the production processes.	5	52
Using the extensive and mostly adequate information on the physical flows and on the environmental costs, the management was able to develop more cost efficient production processes in terms of conventional and eco-costs, (…)	7	52
The constant and comparatively thorough checks of all physical flows, their related environmental costs of technical accidents and manmade mistakes have created a new source of information.	8	52
This was, however, only possible with the help of EMA by adequately calculating all environmental costs and by tracking all physical flows inside the company.	9	53
These improvements are the result of managerial decisions based on the thorough and mostly correct information on physical flows and environmental costs supplied by EMA.	11	53
As EMA involves rigorous and correct checks on the material flows and the identification of their costs,	13	53
our management now has, via EMA, the complete and mostly correct information on the physical flows and their various costs, including the environmental ones	14	53
This became possible with the adequate information of EMA concerning the quantitative information about all components of the physical flows, all their related costs and especially all their related environmental costs.	15	53
(4) Usefulness for SMA – Improved Performance in General		
EMA has been able to provide the strategic management accounting with useful information.	1	51
Our management now has new data to improve the environmental performance of the company.	3	51

Our strategic management accounting has improved the economic and ecological performance of our company.	7	52
The economic and ecological performance of our production has improved with the help of EMA.	15	53
(5) Usefulness for SMA – Greater Number of Eco-Friendly Products, Improved Image		
We could explicitly label some of our products as eco-friendly, which again improved our market position.	1	51
Consequently, our products became cheaper and more eco-friendly.	3	51
The products became eco-friendlier.	5	52
Using the information of EMA, our management could produce products that are eco-friendlier.	6	52
This makes the products cheaper and eco-friendlier.	7	52
The management made its production processes more eco-friendly.	9	53
This also means an improved eco-efficiency of our products.	14	53
Many products are now perceived as environmentally friendly.	15	53
(6) Usefulness for SMA – Improved Competiveness		
We could explicitly label some of our products as eco-friendly, which again improved our market position. This made the products less expensive, which in turn lead to an improved competitive position of the company.	1	51
Consequently, our eco-related taxes have also declined slightly, and our competiveness has improved significantly.	2	51
Our products became cheaper. Our products became more attractive to customers who prefer eco-friendly products at moderate prices.	3	51
These factors improve our competiveness.	6	52
These products consequently sell better.	7	52
[EMA's influence on the SMA] has made the products cheaper and given them an eco-friendly image, so that they have become more attractive.	8	52
Their production requires fewer amounts of energy, fuel, water, wood, and (…) hazardous substances. So the products now sell better due to cheaper prices.	12	53
This also means an improved eco-efficiency of our products. For both reasons they are more attractive on the market.	14	53
Consequently, these products sell better.	15	53
(7) Usefulness for SMA – Improved Resource and Energy Efficiency		
Our use of water and wood has declined (…). The costs for energy and fuel have been cut by 30%.	1	51
Thanks to EMA our management has been able to cut its environmental costs significantly, especially in the field of electricity and fuel, but also concerning the use of water and wood, and the production of waste.	2	51
With the help of EMA we have been able to reduce our costs for energy and fuel drastically.	3	51
EMA (…) means a lower consumption of electricity and fuel. The new products have become more material efficient because they require fewer environmentally critical substances and bring about smaller amounts of waste.	6	52

[EMA's influence on the SMA] the management was able to develop more cost efficient production processes in terms of conventional and eco-costs, and in terms of a higher energy and material efficiency.	7	52
[EMA] proved to be a helpful support for the management to improve the production processes in terms of material and energy efficiency.	8	52
The company [has made] the production more resource and energy efficient.	10	53
The production of our goods now consumes smaller amounts of water, wood, fuel and electricity.	11	53
Their production requires fewer amounts of energy, fuel, water, wood, and partly also of hazardous substances.	12	53
The company was able to reduce the production costs significantly due to an increased resource and energy efficiency.	14	53
With the help of EMA, the management has been able to use less energy, water, wood, fuel and fewer amounts of hazardous substances.	15	53
(8) Usefulness for SMA – Reduction of Environmental Costs		
The costs for energy and fuel have been cut by 30%.	1	51
Thanks to EMA our management has been able to cut its environmental costs significantly (…).	2	51
With the help of EMA we have been able to reduce our costs for energy and fuel drastically.	3	51
With the help of EMA our management has been able to reduce its environmental costs.	4	52
[The] environmental costs have sunk.	5	52
The management was able to develop more cost efficient production processes in terms of conventional and eco-costs, (…).	7	52
The management has made its production processes more eco-friendly by cutting their environmental costs.	9	53
As our management now has, via EMA, the complete and mostly correct information on the physical flows and their various costs, including the environmental ones (…),	14	53
the environmental costs are lower, and so are the production prices.	15	53
(9) Usefulness for SMA – Reduction of Costs for Production and Products		
This made the products less expensive, which in turn has led to an improved competitive position of the company.	1	51
EMA (…) has led to lower production costs. Our products have become cheaper.	3	51
With the help of EMA our management has been able to reduce its environmental costs, and therefore also its production costs.	4	51
The management was able to develop more cost efficient production processes This makes the products cheaper and eco-friendlier.	7	52
[EMA's influence on SMA] has made the products cheaper and given them an eco-friendly image, so that they have become more attractive.	8	52
So the products now sell better due to cheaper prices.	12	53
The company could reduce the production costs significantly due to an increased resource and energy efficiency.	14	53
The environmental costs are lower, and so are the production prices	15	53
(10) Usefulness for SMA – Reduction of Taxes and Penalty Fees		
Our eco-related taxes have declined slightly.	2	51

(11) Usefulness for SMA – Reduction of Waste and Hazardous Substances		
The waste production and the use of other environmentally critical substances have been reduced.	3	51
EMA (…) means a smaller carbon-footprint. In addition, the new products have become more material efficient because they require fewer environmentally critical substances and bring about smaller amounts of waste.	6	52
Their production requires fewer amounts of energy, fuel, water, wood, and partly also of hazardous substances.	12	53
The management was able to reduce the use of hazardous chemicals by about 65%.	13	53
With the help of EMA the management has been able to use less energy, water, wood, fuel and fewer amounts of hazardous substances. In addition, the production of wastes is declining.	15	53

Table (vi2): Negative Influence of EMA on the Company's Performance (Question 9)		
Aspect		
Incorrectness of Cost Calculation	XY	P
Some environmental costs are rather vague.	1	51
The estimates for some hazardous substances are less precise, but still adequate in most cases.	3	51

9.2 Interviews

Questions

Page 1

1. How and why was EMA implemented? (p. 2)

1.1 What were the drivers for doing so?

1.2 What were the obstacles and facilitating factors?

2. What additional measures might support the implementation and the use of EMA?

3. How does (or did) the implementation of EMA influence the accounting process? Were there any negative effects?

4. How does EMA work, and how is it integrated in the company's accounting?

4.1 How does EMA account for the flows of materials, energy, and its corresponding wastes?

4.2 How does EMA account for the cash flows related to the materials, energy, and its corresponding wastes?

5. How is the execution of EMA technically organised?

6. Who is involved in the process of EMA, and how are responsibilities organised?

7. Could you describe the use of EMA-related metrics?

7.1 What EMA-related metrics does the company use?

7.2 What do these metrics measure and why?

7.3 How are the metrics incorporated in the overall accounting system?

7.4 Are the metrics efficient?

8. Can you define environmental costs?

9 Does or did EMA influence the company's performance?

10. What are the benefits and disadvantages of EMA?

11. How would you rate EMA concerning its efficacy and efficiency on a scale ranging from 1 to 10 points?

12. Can you define EMA and environmental costs in your own words?

Participants

XY1, Department of Sustainability Management

XY2, Head of Department

XY3, Controlling

XY4, Production

XY5, Head of Quality Management 1

XY6, Director of Sales

XY7, Head of Production

XY8, Controlling

XY9, Department of Sustainability Management

XY10, Production

XY11, Production

XY12, Head of Quality Management

XY13, Chemistry Specialist

XY14, Managing Director

XY15, Department of Sustainability Management

Questions and Answers

Questions 1

1. How and why was EMA implemented?

1.1 What were the drivers for doing so?

1.2 What were the obstacles and facilitating factors?

Answers

XY1: Department of Sustainability Management

The implementation of EMA was a process of six stages based on the ISO 14001 and BS 8555/Acorn standards: On the first stage, the management discussed the necessity of implementing EMA. It was found that our company had large expenses due to its excessive consumption of fuel and electric energy. Apart from the conventional costs, this excessive consumption meant the risk to raise our costs for eco-related taxes and penalty fees. It also became apparent that the company had only a vague idea of the energy and material flows and its accompanying costs. On the second stage, the management defined the field and the goals in which (and for which) EMA was supposed to work. The field and main goal of EMA was identified as a type of accounting and reporting of environmental costs which closely collaborated with the company's strategic management accounting. The other goal of EMA was to support the strategic management accounting with decisions on issues that have both ecological and economic aspects. On the third stage, the implementation measures were defined. In the beginning, the management had tried to do this work on its own, but after a month of futile attempts it started to work with external tutors who helped to identify and communicate the implementation measures: (a) information of the staff members who were directly or indirectly involved in the affairs of management accounting (accountants, managers, controllers); (b) tutorials for the staff members mentioned above. On the fourth stage, the implementation of EMA was carried out. On the fifth stage, the managers checked the outcome of the EMA implementation; it proved to be satisfactory. On the sixth and final stage, EMA was confirmed.

The fundamental reasons for implementing EMA were to help the management to minimise our environmental costs and to identify their drivers. This was especially true for the costs for energy and fuel and for all kinds of physical flow components. Another reason was to come to terms with two kinds of pressures: the supply chain since it is connected with our material and energy flows; the legal pressure to observe environmental laws was only a secondary incentive. Our previous accounting neglected the tracking and accounting of flows and concentrated too much on the short-termed effects of producing products. With EMA, we intended to improve the tracking and accounting of our flows and also to consider the long-termed effects of producing products.

The main obstacles were the long duration and inexperienced personnel. Some rather conservative members of the staff were initially reluctant to support the changes mentioned above, but in the end, also they agreed. Fortunately, we had at least enough money to pay external teachers and experts.

XY2: Head of Department

First, we realized that we had been consuming too much electricity and fuel for our production process, which made the production too expensive. In addition, the high consumption of energy and combustion of fuel meant the risk of infringing environmental laws. So, we checked our production process and the corresponding legal prescriptions. As a matter of fact, we had not violated any laws, but we decided to make our production processes more resource-efficient and energy-efficient to reduce our costs, and second, to reduce the risks of legal penalty fees. For these ends, we decided to improve our methods of accounting and internal reporting of environmental and conventional costs by means of EMA.

The implementation of EMA was a project which took place on six stages. After having found the reasons to implement EMA and after having defined its fields and goals, we started to look for tools and measures for the implementation. To this end, we decided to build a team comprising experts from all accounting departments and from the departments that are responsible for the supply chain. This was done to combine both sections with our strategic management accounting and in order to have skilled project team leaders to reach our goals. After four weeks or so, we realised that we needed the help of external experts and tutors. We found ways how to measure the flows of material and energy and how to translate this physical data into information that could be used by our accounting techniques. To this end, we had to buy new computers and new software. We also had to inform ourselves and the relevant staff members about the standards of EMA and how to combine them with the standards of our accounting techniques. Therefore, workshops led by external tutors were necessary. After having accomplished these assignments, we carried out the EMA implementation and reviewed it, which we confirmed as successful. The entire implementation was carried out with manuals based on the standards ISO 14001 and BS 8555/Acorn.

The final reason to implement EMA was to help the management reduce our energy costs. We also wanted to track down other environmental costs and to minimise them, e.g. those for hazardous substances. Unlike EMA, our previous accounting was unable to track the costs of our physical flows and focussed only on the quick effects of creating products.

As indicated above, the implementation of EMA was somewhat hampered by various technical particularities so that the EMA implementation needed both a lot of time and many external experts. There was also some internal resistance because some company members thought that we had already been doing enough for the environment. These people were finally convinced of the necessity of EMA.

On the other hand, the company had the necessary financial resources to pay the external tutors and experts.

XY3: Controlling

Due to high and expensive energy and fuel consumption, the management had to react and tried to change its production process. The managers found out that changing the production process would be impossible without tracking its physical flows. So, the management realized that it could deal with this problem without changing the accounting procedures as well.

In other words, the company turned to EMA in order to combine the two separate blocks of economics and sustainability. This in return was done to constantly improve the quality of our strategic management accounting concerning the production and use of substances considered environmentally critical. Measuring and controlling the environmental costs was a prominent factor of this procedure. These were also the reasons to adopt EMA.

I am afraid I cannot tell you much about the ways EMA was introduced in this company, since I have only been working here for half a year or so. I can only tell you that introducing EMA in this company was a long and tedious process which was supported by external tutors. According to the files I have studied, the introduction of EMA brought about drastic changes in its accounting styles, partly also in its business, and then in production procedures.

Although our company was already experienced in making managerial decisions concerning hazardous substances, hardly any of its members had a thorough understanding of EMA. So, we (the managers and accountants) had to be taught by external tutors.

I think there were also some factors which helped to promote the above-mentioned implementation. Our company is already familiar with ecological issues and the laws connected with them, at least in the context of economics. I can, however, assure you that it is now benefiting from it because it helps to allocate, manage, and reduce environmental costs.

XY4: Production

As the company had conquered foreign markets, the scope of duties had also grown. The company is now buying, producing, and selling its products in many parts of the world. So, it had become difficult to allocate, control, and account for all material flows and its accompanying costs. As many of their substances are dangerous and difficult to handle, there were rather a lot of environmental costs, e.g. costs for treating and disposing solid and liquid waste. The biggest problems were, however, the immense costs for energy and fuel. Our previous accounting did not focus on the company's flows, but rather on the fast ways of making products.

That is why we thought we needed a special type of accounting to check this class of costs and possibly to reduce them. We also feared that being incapable of accounting of our environmental affairs correctly might infringe the legal regulations in the countries where we already operated. This, as we saw it, would lead to the payment of penalty charges.

The management created the project team led by some accountants and executing managers to bring about the implementation of EMA. With the help of external tutors, the company then succeeded in developing the new guidance system for the internal reporting of information, accounting both economic and ecological aspects. The whole EMA implementation of EMA required six process steps using the standards ISO 14001 and BS 8555/Acorn: (1) finding the reasons to implement EMA, which were the large environmental costs; (2) defining the field and goal of EMA, i.e. accounting and possibly reducing environmental costs; (3) identifying measures and tools with the help of external experts and tutors; (4) doing the actual implementation and start of EMA; (5) assessing the results of the implementation of EMA; countermeasures to rectify failures or mistakes; (6) confirming EMA. However, no mistakes or failures were found.

There were some barriers hindering the EMA implementation: the long time the project took and its technical difficulties; some employees had to be convinced of implementing EMA.

XY5: Head of Quality Management 1

There were a couple of reasons to adopt EMA. First, we wanted a set of techniques to identify the reasons of our high consumption of electric energy and fuel in order to reduce it. We wanted to do this to reduce the costs for energy and fuel, but possibly also to reduce our influences on the environment, which might involve penalty fees. Therefore, we implemented EMA to account both environmental and economic costs systematically. We also wanted to integrate EMA into an overall strategic management accounting. The idea behind this decision was that EMA might always help this management with reducing the environmental costs, and also with improving the quality of our products, at least concerning their eco-related qualities.

The introduction of EMA was done as a project led by a small group of management and accounting experts, backed by external teachers. The entire process, comprising six steps, followed the standards ISO 14001 and BS 8555/Acorn.

With EMA, we wanted a form of accounting that was able of tracking and accounting the company's physical flows and that also concentrated on the long-term effects of the production processes, i.e. the costs for solid and liquid waste and remediation. The basic driver to adopt EMA was to reduce energy and fuel costs, and possibly other environmental costs including the fees for infringing environmental laws and regulations. But this meant to check our physical flows in terms of resource and energy efficacy.

One negative aspect about the implementation of EMA was the long time to carry it out. In the beginning we thought we had the necessary expertise to do it all alone, but then we realised that we needed help from external teachers.

There were also some positive and helpful aspects concerning the implementation of EMA: all teams of our company were already well organised, and the internal communication already functioned perfectly. So, almost all staff members were quickly convinced of the necessity of EMA.

XY6: Director of Sales

We wanted to account for the investment appraisals and costs (i.e. environmental costs) concerning our high consumption of electric energy and fuel and concerning the use or production of environmentally hazardous substances. This move became necessary due to two other reasons: first, the company is increasingly present in foreign markets where there are different regulations concerning dangerous materials and the use of energy. Second, we wanted to make sure that our energy and fuel consumption does not break any laws, which might cause additional costs. Our idea was also that using EMA might help to reduce the environmental costs of our production by analysing the cost structures of the company's physical flows. This is something our old accounting system could not do.

I was not involved in the implementation of EMA, but I can tell you that it took a long time since it led to modifications of the work streams and some other business processes. The implementation of EMA answered the requirements of ISO 14001 and BS 8555/Acorn.

I do not remember any factor supporting the implementation of EMA, except for the generous funding.

XY7: Head of Production

The production of our items (colours and its derivatives) involves many dangerous substances and the use of large amounts of energy. Hence, the production is per se a dangerous operation which might negatively impact the environment. There are, of course, many safety precautions, but nevertheless the company still has to pay many costs stemming from the nature from these substances and their production processes. The main reason to implement EMA was to account and possibly reduce our vast costs for energy and fuel. A minor reason was the fear of high taxes penalty charges due to the consumption of these resources. Apart from that, the prices for the substances vary on the world market, so, it is not easy to account the production costs and the prices for the products.

EMA was introduced as a long process with six stages based on the standards ISO 14001 and BS 8555/Acorn. At first, it only affected the financial accounting process, then the strategic management accounting. In the end, it also influenced the ways of our production. New accounting methods were introduced to deal with the flows of energy and materials at the same time, which facilitated the monetary accounting.

The negative side of this project was that it lasted so long. Therefore, some managers were already at the point of losing their patience.

The implementation of EMA was successful because it was supported by the vast majority of the managers and accountants.

XY8: Controlling

EMA was introduced to track and identify environmental costs. The costs for energy and fuel were the most important ones. EMA is able to do this by tracking our physical flows in respect of the component's quantities and costs. This is something our previous accounting always failed to do since it concentrated too much on the short-term effects of manufacturing products.

The project of implementing EMA was executed by means of a series of six consecutive steps based on the standards ISO 14001 and BS 8555/Acorn. First, the management informed itself about the necessity to implement EMA, which were the above-mentioned costs for energy and fuel. Second, we defined the goals of EMA, namely, the tracking and the identification of environmental costs. Third, the company contemplated the measure and tools to do the implementation. First, the management formed a team of skilled members to implement EMA. As it did not succeed, this team availed itself of the help of external tutors. On the fourth stage, EMA was implemented into the structures of our strategic management accounting. Then we reviewed the finished implementation, which we found successful. These were the fifth and sixth steps, respectively.

The negative things of the implementation of EMA were: it proved to be a very difficult and time-consuming process which required much patience, organisational, communicative, and technical skills. The company lacked the technical competence to introduce EMA. There were also a few members of the company who had to be convinced of the feasibility of EMA. Fortunately, the company had the financial means to carry out the implementation of EMA.

XY9: Department of Sustainability Management

The company primarily introduced EMA to reduce its energy and fuel consumption. So, we decided to reach this goal by improving the overall environmental performance of our production processes. Our company already complies with eco-related prescriptions, but until recently, it did not have the appropriate kind of accounting. Adhering to the principles of an environmental-friendly production, this only makes sense if the accountants are able to allocate the environmental costs, i.e. costs with eco-related aspects: costs for producing, treating, and disposing of waste and hazardous input and output substances, to name just a few examples. To reach this goal, it is, however, necessary to check the components of our physical flows in terms of amount and costs. The old accounting did, however, check these flows and concentrated too much on producing large amounts of products asap.

At the time when EMA was introduced, I was working abroad in one of our subsidiaries. So, I can only tell you of a few details of the ways EMA was implemented. All the important internal stakeholders were involved in this process, including the sustainability management and external consultants. EMA was gradually introduced to the company starting from the management departments and ending at the production and sales departments.

Overall, the company had the determination and the financial means to bring the implementation to a satisfactory end.

XY10: Production

My duty is to oversee the production, so, my point of view is rather limited. Prior to the implementation of EMA, the company faced high energy and fuel costs, and it had problems to identify and check the prices of the production. This effect is amplified when a company works in many countries. The environmental laws in different countries often differ dramatically, and they also tend to change frequently. Some of the substances in question are scarce goods; so, they are repeatedly the objects of financial speculations on the international stock markets. This often makes the entire production hard to predict if you do not have an appropriate accounting which checks the components of the physical flows in reference to their amounts and costs. Our old type of accounting did not do that since it had a too narrow focus on manufacturing.

The implementation of EMA took about 6 months. During this period, a team consisting of managers, accountants, production supervisors, and external consultants was formed which performed the implementation of EMA using the standards ISO 14001 and BS 8555/Acorn. The team then implemented the sub-structure of EMA into the overall structure of the company's strategic management accounting. This also had effects on the production departments since EMA also involved thorough and severe checks of the flows of materials of energy.

The implementation of the environmental management accounting was very demanding in terms of time and effort. This was true for all parties involved.

On the other hand, almost all participants were motivated and wanted to carry out the implementation of EMA.

XY11: Production

The introduction of EMA was primarily caused by the company's intent to reduce its energy and fuel costs. The company realised that this could only be done by means of tracking the information of the physical flows inside the production process and its related costs. This was done to help the management to make the prices of the production and the products more predictable.

I cannot say how this kind of accounting was introduced in my company because this is not my line of business. I only remember that at the beginning of the implementation all staff members (including myself) were informed about it. After approximately 6 months, the standards and procedures of our controls concerning the physical flows of the production process were changed, i.e. the checks then became more frequent and more thorough. Our previous accounting hardly dealt with the checks of these flows, it was only about the data concerning the production of goods.

The company had the organisational and communicative skills; a bit of patience, too, to perform the EMA implementation.

XY12: Head of Quality Management

Our company must deal with dangerous substances; it also has to control complex production processes that consume much energy and fuel. This phenomenon, especially our fuel and energy consumption, has the potential to impact the environment in a negative way. Being liable to these consequences, the company must (apart from material-technical measures) account for the costs stemming from the special environmental risks of our products and production processes. However, being able to identify, control, and possibly to reduce these costs involves the monitoring of the physical flows of our production processes. To this end, EMA was introduced since our old type of accounting did not focus on physical flows, but only on the input and output data.

The introduction of EMA proved to be difficult and time-consuming because none of our staff had the necessary skills to do so. So, we founded an implementation project and a leading team (consisting of external tutors as well as managers and accountants from our company). Then this team gradually integrated the standards and techniques of EMA into the already existing accounting structures of our company, using the prescription of ISO 14001 and BS 8555/Acorn. The entire process was also costly, but the company had the money.

XY13: Chemistry Specialist

I am only concerned with the material aspects of the production process. I am definitely not familiar with accounting issues. However, I know that EMA was first of all introduced to reduce energy and fuel consumption, and to identify and to control the prices concerning the treatment of the chemicals the company has buy. EMA is also used to estimate the prices for the treatment of these substances, including the prices for the disposal of their waste.

XY14: Managing Director

EMA was introduced to support our management with its decision-making in areas where environmental aspects play an important role. The biggest assignment of this kind was to find ways to reduce our costly and environmentally risky energy and fuel consumption which was linked with all production processes. So, we thought that an analysis of our physical flows was necessary, especially one that checks the amounts and costs of its components. With our old accounting system this was, however, impossible since it only focussed on the input and output data directly related to the production.

Hence, our company was in need of an accounting which would encompass both the conventional and environmental costs of the flows and destinations of all our materials and energy. And we were looking for a type of accounting which would be useful for an environmental decision-making, but which would also fit in the structure of our strategic management accounting. As we are a non-profit organisation which is only interested in striving for idealistic means, we wanted an EMA-equipped strategic management accounting whose decision-making would consider both economic and ecological criteria.

This rather complex goal was reached by means of a process, or project, lasting 6 months. It was led by a group of experts comprising own staff members and external tutors. The goal of implementing EMA into the structures of our own strategic management accounting was reached in 6 consecutive steps, following the standards ISO 14001 and BS 8555/Acorn. First, we informed ourselves about the reasons to adopt EMA, which I have already mentioned above. As we found these reasons relevant enough, we decided to implement EMA. Shortly after this decision, we defined the aims and fields of EMA, which was the second stage. The third step involved the development of measures and tools to implement EMA, and then we informed the staff members, who would be affected by EMA, about the future changes in question. We soon realised that we needed help from external experts. The fourth step was the implementation of EMA; this step happened to be the most demanding one. There we combined EMA with our strategic management accounting. For that we needed new IT technologies with which the various cost types were combined and aggregated. This was not always easy since EMA uses its own indicators and benchmarks. At the fifth step we checked the efficacy of the newly implemented EMA, which we found completely satisfactory. At the sixth and final step, the management unanimously confirmed the use of EMA.

So, the factors impeding the implementation of EMA were: long duration, technical complexity, and lack of technical skills among the staff (hence, the use of external tutors). The implementation of EMA lasted much longer than anticipated because the company lacked the technical expertise, and because it had to overcome some internal resistance, albeit a minor one. There were no factors facilitating the implementation of the environmental management accounting, except for the necessary financial means.

XY15: Department of Sustainability Management

The management intended to capture the financially relevant information of all materials and energy flows of our production process to reduce its consumption of electric energy and fuel. To serve this goal, EMA was implemented in the accounting structures of our company.

Rather at the beginning of the implementation of EMA, all members of the company who were connected with accounting or environmental affairs were informed that the accounting would be changed by combining it with a new component which would make the entire accounting and the company itself more environmental-friendly. I cannot tell you anything more. At the time of the implementation of EMA, I was not a member of this company. Initially, the entire implementation was scheduled to last one month only, but it took almost half a year. At the end of this period, the controlling and the reporting procedures of my department became stricter.

The implementation of EMA was facilitated by the widespread determination among the staff.

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Question 2

What additional measures might support the implementation and the use of EMA?

Answers

XY1: Department of Sustainability Management

A helpful measure to implement EMA is to exactly identify and analyse the structure and goals of both types of accounting beforehand, i.e. those of EMA and of the company's existing accounting. The guiding questions to be asked should be: does EMA support our cause? Does it fit in the structures of our strategic management accounting? Does it bring about extra benefits? If these questions can be answered in the affirmative, the management should analyse the criteria and conditions of combining both types of accounting. Then a thorough analysis of the material and energy flows should be undertaken with both types of accounting to determine if there are any significant differences. These are the points of interests where the combination of both accounting types should concentrate.

In the beginning of our project, we did some superficial investigations on EMA, but we did not ask ourselves these questions. Hence, implementation became difficult and time-consuming.

XY2: Head of Department

Before implementing EMA into the structures of our strategic management accounting, we should have undertaken these measures: to look for alternatives of EMA and to look for (and to analyse) possible links between the both accounting types. These two measures are also proposed by the United Nations. The possible links are the internal stakeholders, the goals, and the means to reach them. In the course of the implementation, it turned out that the stakeholders and the goals were largely identical. However, the means to reach these goals proved to be different because both accounting systems use different computer software with different benchmarks. Hence, the acquisition of the new and costly IT infrastructure became necessary.

XY3: Controlling

A measure to facilitate the implementation of EMA into an older accounting system is to compare it concerning its fit. There are three criteria for this comparison: the company should analyse (a) if and how much the goals and missions of both accounting types are matched, (b) if the interests of the stakeholders of both accounting types are similar, and (c) if there are the same stakeholders at all.

XY4: Production

To facilitate the implementation of EMA into the structures of its previous strategic management accounting, it should thoroughly analyse both types of accounting. The main criteria are the ways to address, identify, and control the various material and energy flows in terms of their quantities and their financial counterparts. After the comparison, it should be clear these accounting types capture the input and the output flows, and how they especially deal with the flows of raw materials, energy, water, and wastes. Of course, both accounting types cannot and must not be identical. If they were, one of them would be superfluous. But these different accounting types must somehow be related to each other in a complementary way. They ought to supply each other with pieces of information; each partner is not able to generate on its own. Apart from that, both accounting types should significantly overlap in respect of their techniques. The management ought to have checked beforehand if both accounting systems, EMA and the previous one, have comparable ways of accounting for assets, costs, and gains in terms of various asset and liability sub groups, turnover, cross profits, net group profits, capital and cash flows, outputs and inputs. As a matter of fact, the figures have always been our most important financial indicators before and after the implementation of EMA.

XY5: Head of Quality Management 1

Prior to implementing EMA in the structures of the strategic management accounting, the company should have cautiously checked the tools of both accounting types to account for the material and energy flows, and for other environmental expenditures, especially for energy and fuel consumption or for the R&D of environmental-friendly methods.

XY6: Director of Sales

A measure supporting the implementation of EMA into strategic management accounting is to accurately analyse their systems of flow-cost accounting and their general accounting practices of environmental costs. The general accounting principles should be more or less identical to ascertain the functional fit of both accounting types. In respect of flow cost accounting, the analysis should focus on the general material flow model of both types, on the database they draw on, on their accounting elements, and on the results they deliver. The question concerning the results should be: does one type of accounting deliver results the other is not able to? Both types of accounting ought to take information from different databases, but their accounting elements should be similar. So, the company should have looked for a trade-off between the demands of the fit between EMA and our old form of accounting and the demands of measuring our physical flows and environmental costs in a better way.

XY7: Head of Production

As for facilitating the implementation of environmental cost accounting into the structures of the previous strategic management accounting, it would have been very helpful to analyse how the former and the latter accounting type deal with the material flow accounting and the system of cost accounting. I view things from the prospective of the head of production, but for the production process it is important to know how the two types account for the quantities, the values, and the costs of the material and energy flows. Likewise, one must also know how the cost-related delimitation, allocation, and apportionment work in both contexts.

XY8: Controlling

Prior to the implementation of EMA, the company should have checked if there are any feasible alternatives. The criteria, which I would like to tell in the form of questions, are: does the accounting type help to reduce environmental costs, and does it help to bring about the environmental benefits? Does it help to achieve an enhanced material efficiency? Does the accounting type achieve this with a comprehensive internal reporting covering all environmentally relevant aspects of the material and energy flows? Does it not only concentrate on special departments?

XY9: Department of Sustainability Management

A helpful measure to implement EMA into the accounting structures of accompanying is to look for qualities that the existing accounting type does not have. Therefore, the management should make sure that the new type of accounting supports the management with the development of environmental-friendly processes, technologies, and products.

XY10: Production

To bring about a successful implementation of EMA, the management should, first of all, make sure that it fits in the accounting structures of the company. Apart from that, the management should also check that the new type of accounting tracks and measures all kinds of environmental costs correctly.

XY11: Production

As I am not an expert of accounting, I can only judge that both accounting structures ought to be similar. The management has to identify the advantages of EMA compared to the existing type of accounting. The management should ascertain that EMA is able to identify some costs which the existing type of accounting cannot spot. The new type of accounting should bring about other positive effects which the other one is not able to deliver: to help the management with reduction of environmental costs and with the creation of environmental revenues. Therefore, the management should ascertain right from the start how EMA can directly and indirectly improve the material efficiency of the company.

XY12: Head of Quality Management

The best measure to improve the implementation of EMA is to get help from external tutors and other experts right from the start. Unfortunately, we did not do this, which considerably delayed the implementation.

XY13: Chemistry Specialist

There are several measures which make the implementation of EMA considerably easier: use experts, if necessary from other companies, from the beginning to the end of the implementation; analyse the structures of both accounting types and look for links; make sure that the new type of accounting fulfils its basic assignments, i.e. that it accounts environmental costs completely and correctly; make sure that the new type of accounting brings about some extra benefits which the old one cannot do, e.g. the reduction of environmental costs.

XY14: Managing Director

To implement EMA, it is recommendable to make use of high-profile tutorials carried out by external experts. Within these tutorials, one ought to analyse the new type of accounting and the previous one in order to find ways to combine them. To this end, it is necessary to examine how these accounting systems analyse the databases and how they display their results.

XY15: Department of Sustainability Management

Prior to the implementation of EMA, the company should have checked various alternatives instead of concentrating on this type of accounting from the very start. Then, perhaps, the company would have picked an accounting system that is easier to implement. Criteria of comparing various types of accounting should be transparency, accountability and reporting modalities, structure, internal stakeholders, correctness and feasibility of accounting activities, objectives, and mission.

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Question 3

How does (or did) the implementation of EMA influence the accounting process?

Answers

XY1: Department of Sustainability Management

The implementation of EMA led to various changes in the accounting process. It now uses various eco-efficiency ratios, as for instance ‘Rate of Wasted Resources on Operating Assets’, or the ‘Rate of Solid Waste and Waste Water on Total Output’. This type of accounting helps the management to reduce environmental costs, and thereby; it also supports managerial decisions that increase material and energy efficiency, and it helps to develop eco-efficient products by reducing their material and their carbon footprint. EMA did not have any negative effects on the company.

XY2: Head of Department

Our entire strategic management accounting has undergone deep changes because of the help of EMA. Apart from identifying the environmental costs of all relevant materials and energy flows, it is now also able to identify the eco-related profits and benefits in a special loss and profit account which displays the losses and profits related to environmental processes and products. EMA helps the company to reduce its environmental costs, and thus, to increase its material and energy efficiency, which makes it also possible to develop environmental-friendly products. EMA did not have any negative effects on the company.

XY3: Controlling

The company now uses a wide array of technics metrics to measure the environmental costs of its material and energy flows. By this means, the company measures the losses and profits of all activities, but also the losses and profits connected with activities that have environmental aspects, as e.g. the production of environmental-friendly products. The company is now able to identify the environmental cost for all raw materials, operating materials, and used materials. It also measures the costs for the output; the output costs are differentiated into the costs for finished products and non-product output. In order to ascertain the influence on the environment, there are also cost types for emissions, for hazardous output, and non-hazardous goal output. EMA did not have any negative effects on the company.

XY4: Production

The company now uses EMA to account for its environmental costs. EMA is completely based on benchmarks, metrics, and indicators to identify, to check, and to report all environmental costs and the physical sources. This type of accounting is also linked with an environmental-friendly purchase and production system. Both parts make sure that only those raw materials are bought in such quantities so that the material and energy efficient production of a certain product is possible. EMA did not have any negative effects on the company.

XY5: Head of Quality Management 1

We are predominantly using EMA as help for managerial decision-making of issues which increase the company's environmental performance. To this end, we use EMA to clearly identify all costs of material and energy flows. Therefore, EMA helps the management to reduce its environmental costs, and thereby to reach material efficiency in many fields which are not originally linked with the ecological aspects. One of these fields is the storage of goods. EMA did not have any negative effects on the company.

XY6: Director of Sales

As EMA is able to identify all material and energy flows, we are also using it to monitor several departments where materials and energy are regularly consumed and moved. These departments are: marketing and sale, production, purchase, logistics, disposal, and recycling. EMA did not have any negative effects on the company.

XY7: Head of Production

By means of various environmental cost and expenditure categories, EMA is able to calculate all environmental costs of all relevant flow components, but also the overall environmental expenditures and benefits. This has become fundamental for the management to reduce environmental costs and to develop environmental-friendly production processes. EMA did not have any negative effects on the company.

XY8: Controlling

The introduction of EMA has helped the company in tracking, managing, and reducing the energy and material flows. EMA also identifies the nature, quantity, and purpose of these flows. This is especially true for those substances that might possibly pollute the environment. EMA, however, first of all reports the environmental performance of the company, especially in respect of the material and energy efficiency of its production processes. It reports this information to the management. EMA did not have any negative effects on the company.

XY9: Department of Sustainability Management

EMA has helped the company to run its production processes in an environmental-friendly way. This is also done by combining EMA with the methods of cleaner production, as e.g. a cleaner production assessment (CPA). Hence, our machines are checked by EMA and CPA. EMA did not have any negative effects on the company.

XY10: Production

Together with the techniques of conventional management accounting, EMA is able to calculate the total environmental expenditures, liabilities, benefits, and assets. As the delivered results of these calculations are exact, our management now uses them as indicators and benchmarks for managerial decisions in both ecological and conventional areas. EMA did not have any negative effects on the company.

XY11: Production

By means of EMA, the company is now able to calculate all types of environmental costs and benefits which previously could not be identified. The most prominent examples are the calculation of energy/fuel use and waste production. With these cost categories it was possible to reduce the energy and fuel use as well as the waste production, which resulted in environmental benefits. EMA did not have any negative effects on the company.

XY12: Head of Quality Management

We always knew that any effective cost accounting is based on an accurate material and energy flow accounting. As EMA fulfils this assignment perfectly, the company uses its results for many managerial decisions including conventional and environmental purposes. This means that the quality of our managerial decisions in respect of cost efficiency, material efficiency, and energy efficiency has significantly risen. EMA did not have any negative effects on the company.

XY13: Chemistry Specialist

Although I am not connected with the departments of management accounting, I can say that EMA is able to check the material flows of various chemicals. This is done by means of reporting methods which use material categories connected with their own cost categories. EMA did not have any negative effects on the company.

XY14: Managing Director

Strategic management accounting uses much information delivered by EMA to decide matters of economic and ecological importance. The measurement of environmental costs done by EMA is both efficient and comprehensive since it identifies the overall conventional costs of the production process and also the environmental costs of all environmentally relevant items. EMA did not have any negative effects on the company.

XY15: Department of Sustainability Management

By means of calculating all environmental costs, the company has become able to reduce this type of costs. EMA also helped to increase the overall material and energy efficiency of the company's production and to develop environmental-friendly products. EMA did not have any negative effects on the company.

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Questions 4

4. How does EMA work, and how is it integrated in the company's accounting?

4.1 How does EMA account for the flows of materials, energy, and its corresponding wastes?

4.2 How does EMA account for the cash flows related to the materials, energy, and its corresponding wastes?

Answers

XY1: Department of Sustainability Management

Present-day strategic management accounting does not only intend to identify the conventional costs of a production process or product, i.e. the costs for material and energy, it also wants to calculate their environmental costs. EMA performs this task by analysing the physical flow associated with the product or process in question. First, EMA determines the identity and quantity of the flow components. This is done by various staff members and computer-driven devices. Second, EMA calculates their conventional material costs of the flow components in question and, if they are environmentally hazardous, also their environmental costs. Calculating the conventional material costs of flow components is comparatively easy since they only depend on the quantity and the material price of the component. Calculating the environmental costs is more difficult since such costs often relate to complex environmental influences of the flow component in question. However, since most physical flow components, products, and production processes involve the production of certain amounts of waste and the consumption of electric energy, fuel, water, and wood, it is advisable to use these amounts as indicators for the environmental costs of the examined flow components, products, and production processes. To this end, EMA uses various methods, mostly full cost and flow cost accounting. These methods basically show the fates of certain flow components, products, production processes, and the environmental costs of waste, energy, fuel, water, and wood they involve. The environmental costs of electric energy, fuel, water, and wood are comparatively easy to measure since they only depend on their amounts in the physical flows and on legal regulations. The environmental costs of waste are, however, hard to estimate due to the different degree of environmental hazardousness that significantly influence the costs for its treatment. Apart from that, the environmental costs for hazardous input substances are also difficult to estimate since their environmental danger also depends on the specific production process. Hence, the environmental cost estimates of most production processes of our company are not absolutely precise.

To facilitate the identification and accounting of environmental costs, they are grouped to certain cost categories. The most important categories are the already mentioned costs for electric energy, fuel, water, wood, and waste; other categories are the costs for environmental taxes and penalty fees, costs for prevention and remediation etc.

In order to simplify the interpretation of the results of an accounting analysis, they are often presented in the form of an Environmental Balanced Scorecard, or short EBSC. An EBSC usually shows the results of a full cost accounting and flow cost accounting in a dense form; for a certain input or output material, product, or process there are the most relevant environmental costs categories and the measured figures of these environmental costs. The strategic management accounting then uses these results to bring about decisions of economic and ecological importance. These decisions often concern ways to make production processes more resource and energy efficient.

XY2: Head of Department

Generally speaking, strategic management accounting orders EMA to track all physical flows and to determine the costs of all of their components to display trends of both conventional and environmental costs. In the framework of full cost accounting, EMA performs this task by monitoring every production process and each product by means of an electronic EBSC which shows their most important conventional and environmental costs per cost category. The cost categories we use are: complete production costs, all environmental costs, environmental costs due to legal reasons, used amount of conventional assets, used amount of environmental assets, used amount of environmental assets, eco-related turnover, overall profits, eco-related profits. To give a complete picture of our physical flows and their associated environmental costs, we also have an EBSC on the environmental costs of non-product output materials and hazardous input materials. I have brought you a sketch of it.[19]

Whenever a project comprises several products, their information is treated separately, but the overall costs of the entire project are calculated as well. For every product and every product process the information for each of its cost categories comes from different sources; the most important of which are the production site, the storage department, the purchase department, and the delivery section. The information about the quality and quantity of the products and productions is created the same way.

XY3: Controlling

The company uses EBSCs to monitor all environmental cost categories of an on-going production process in which usually one product only is made. The EBSCs show the environmental costs of a process or product grouped together in certain cost categories.

EMA tracks all physical flows. This means it measures all the amounts and all costs of substances and energy associated with a process or product. It, however, concentrates on those physical entities that are dangerous for the environment. It does so by estimating their environmental costs.

Our EMA has recently changed its scorecard system for an improved full cost accounting. There is now an additional environmental accounting system that measures for every input material, output material and processes its environmental costs concerning electric energy, fuel, wood, hazardous and non-hazardous solid waste, contaminated and pure wastewater, and total effect. Our management uses this

[19] Comment: This sketch is represented as table (13.0) in the main body of the text.

information to measure and improve the company's environmental efficacy and efficiency.

XY4: Production

The making of products, which is controlled by the management, highly depends on the exact flow cost accounting and on the knowledge of the input and output quantities. EMA supplies the manager with all the necessary information concerning the conventional and environmental costs of a certain production process. The identification and the measurement partly depend on legal and scientific reasons. The costs associated with every kind of waste are always considered environmental costs due to legal regulations. The costs for input materials are only labelled as environmental costs if these underlying materials are hazardous. The environmental full cost accounting uses three EBSCs to display both the conventional material and environmental costs of input materials, hazardous and non-hazardous alike, and waste materials. One EBSC shows for each process the physical and cost-related flow from all hazardous and non-hazardous input materials to hazardous and non-hazardous solid wastes, wastewater, and gas emissions. The other two EBSCs show for each production process the physical flows of a specific output and input material, respectively.

This form of accounting also differentiates between the classical cost types and rather environmental cost types. There are, however, no special categories of environmental costs, except those for hazardous and non-hazardous solid wastes, wastewater, and gas emissions. By contrast, the full cost accounting comprises a wider array of environmental cost categories, but it does not consider the flows. In either case, an environmental cost amount of a physical flow component is attributed to a characteristic cost category.

XY5: Head of Quality Management 1

The strategic management accounting orders EMA to account for the flows of all input and output materials as well as for the flows of energy. EMA fulfils this assignment by identifying the conventional material costs of all physical flow components and the environmental costs of the environmentally hazardous flow components.

All kinds of waste are considered environmentally hazardous. Generally, the costs incurred by the input materials are not regarded as environmental costs by EMA. Exceptions are hazardous input materials, as e.g. fuel, but also wood, water, and energy since they have a strong influence on the climate. Waste and these components of our physical flows are the strongest drivers of environmental costs. That is why EMA tracks their flows and estimates their conventional material costs and environmental costs with several methods of flow and full cost accounting. On the other hand, their environmental costs are comparatively easy to measure since they only depend on their amounts in the physical flows and legal regulations. Some other environmental costs are, however, difficult to calculate since they depend on chancy circumstances. Examples are the costs for technical accidents and manmade mistakes that often involve unpredictable costs for remediation.

The chemistry specialist often helps the EMA accountant and senior accountants to estimate the environmental costs for environmentally critical flow components. The management uses this information to improve the economic and environmental performance of the company.

XY6: Director of Sales

The sales department must calculate the sales prices, but for that it depends on knowing the production prices, including the environmental costs. There are various categories of environmental costs which strongly impact the overall price of the product. An exact identification of these costs, which is done by EMA, can therefore lead to managerial decisions that reduce the sales price. Therefore, the sales department exchanges information on the environmental costs with the EMA. For the sales department the most important environmental costs are the costs for packaging and merchandise and the costs for material losses.

XY7: Head of Production

EMA works on several levels of our strategic management accounting. First, it measures the input and the output of the most important substances. They are raw material, colours, chemicals, water, merchandise, packaging, and energy. For each day the costs for the corresponding input and output are measured. The main tasks of EMA are to identify those physical flow components that might damage the environment and to price the costs of these influences, i.e. to find their environmental costs. To judge these costs correctly, environmentally harmless substances are also identified and priced, but their costs or revenues are not labelled as environmental. To this end, EMA has to identify the costs for special subtypes of the output-categories which are the hazardous input materials, water, wood, energy, the hazardous and non-hazardous output materials, and various forms of gas emissions. The greatest part of the emissions is however carbon dioxide. To support the efficiency of flow cost accounting, EMA uses several EBSCs that display the conventional and environmental costs of substances of interest. As the company uses its environmental expertise to produce environmental-friendly products, there are also some indicators reflecting this performance, as e.g. 'Rate on Eco-related Turnover on Total Turnover'. For every year the company calculates its profits and losses and their percentage of environmental benefits and costs. So, it becomes clear how the environmental efficiency of the company develops over the years.

XY8: Controlling

Controlling the various materials and energy flows, identifying the hazardous substances, and estimating their environmental costs, are the most important tasks of EMA. Using the information of EBSCs, which show all environmental costs and cost categories of the production, the accountant can calculate the overall environmental costs of the company. The most important categories of environmental costs are the material costs for hazardous input materials, the packaging, the water input and water output (i.e. wastewater), consumption of wood, energy and fuel, and gas emissions. Other cost types of environmental costs are the costs for occurrences in the company, which might influence the environment badly. For each of these categories the company also calculates the machine time, the material and energy use, and the human labour. Costs that are unrelated to the mentioned physical entities or incidents are not labelled as environmental costs.

XY9: Department of Sustainability Management

EMA helps the department of sustainability management to raise the environmental efficiency of all production processes. The environmental efficiency of our production is measured via a variety of indicators. The most relevant are 'Rate of Wasted Resources on Operating Assets, 'Rate of Solid Waste and Wastewater on Total Output, 'Rate of Hazardous Waste on Total Output', 'Rate of Emissions on Total Output, and

‘Rate of Wasted Resources on Total Output’, but also the environmental costs or revenues per employee. EMA proved successful, and all these rates have been declining ever since EMA has been introduced.

XY10: Production

The EBSCs contain the information about the environmental costs and cost categories of the product or production. In the beginning, several staff members collect information about minor environmental costs from the production site, the waste disposal, the storage department, the sales department, and the delivery department. These employees feed these pieces of information into a computer which aggregates them into a single figure of a cost category. At the same time, the computer calculates the flow costs. To this end, it uses this database and calculates the quantities of the material needed for a certain production process, its corresponding value, and its corresponding environmental costs. Generally, EMA tracks all physical flows of the company, and it identifies the amounts of every material and energy component. It calculates the conventional costs of all flow components and the environmental costs only of those components that could harm the environment.

XY11: Production

The EMA of our company does not only calculate the material and energy flows and the corresponding costs. It also calculates the environmental costs, i.e. those costs that stem or might stem from environmental damages caused by hazardous physical entities used in the production process. To this end, EMA has to tell the hazardous physical entities from the harmless ones. By doing so, EMA can help the strategic management accounting with finding the most eco-efficient production process.

XY12: Head of Quality Management

The environmental quality of all production process and of our products is mirrored by the low environmental costs that can be obtained with the help of several indicators. There are a couple of indicators which are defined as the amount of a certain kind of waste against the amount of a valuable asset (waste total output). These amounts have been declining during the course of the last years. Whereas the indicators, which are defined as the eco-related turnover (or eco-related profits) against the overall turnover (or overall profits), have been rising. Generally, we use these indicators for the measurements of environmentally critical physical entities and procedures.

XY13: Chemistry Specialist

It is important to know the environmental costs of chemicals used in the production process because they reflect their potential risks on the environment. Both the costs and the risks are no stable phenomena. As a matter of fact, there are many environmental risks that appear much higher now than in previous decades, as e.g. the risks of atomic power plants. So, EMA must reassess the environmental costs of the underlying phenomena from time to time.

XY14: Managing Director

EMA has helped our company in reducing its environmental costs. This is also done with flow cost accounting that monitors all the flows of the materials and the energy. It identifies the amounts and costs of the harmless components, but it also identifies the amounts and costs of the environmentally critical components; these cost types are called environmental costs. The most important environmentally critical flow components are poisonous input materials, water, wood energy, and all types of waste, wastewater, and gas emissions. The use, production, and treatment of these entities create environmental costs which reflect the environmental damage they might cause. As the creation and the flow of environmental costs indicate how the underlying physical flow components move inside the company, it is possible to improve the entire supply chain.

XY15: Department of Sustainability Management

EMA helps the strategic management with its decision-making. This is done by means of identifying both the conventional costs of harmless substances and the environmental costs of hazardous input materials, every solid waste, gas emissions, wood, water, and energy, which are used in production processes. This information is written in EBSCs where they are grouped together to cost categories. Thus, it is possible to show certain categories of environmental costs which reflect corresponding environmental risks. The manager can use this information to develop new production processes that create fewer environmental costs.

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Question 5

How is the execution of EMA technically organised?

Answers

XY1: Department of Sustainability Management

EMA and its technical execution is not, as far as I know, clearly defined in any textbook. So, we regard EMA as a subset of management accounting that creates information which is primarily used by the strategic management accounting for managerial decisions. Most parts of this information can or are actually used for our internal reporting. On the other hand, the techniques of EMA resemble very much those of conventional management accounting. The main difference between the two types of accounting is that the former one concentrates on special objects and, hence, on special types of costs, namely the cost of materials, water energy, and the disposal of waste and effluent. Consequently, EMA basically deals with the accounting of so-called environmental costs.

EMA uses some standard accountancy techniques for the identification, analysis, and management of environmental costs. In this context, the accountant using special software collects costs information from various parts of the company. First, the accountant receives, upon his order or automatically, information on the physical flows of the company, i.e. about the amounts of their components. Then, he has to decide if a physical component of the flows or a related incident can be labelled as environmentally critical or not. If it is not labelled in such a way, the conventional costs of the materials in question are identified. This is normally easy to do since the prices of most raw materials can be obtained from official databases. To calculate these costs, the accountant only has to measure the amount of this substance and to multiply it with the current price.

In the contrary case things are somewhat different. In the beginning, the accountant also measures the amounts of the environmentally critical substances, but he must also estimate the magnitude of an incident that might negatively impact the environment. Then, he has to estimate the environmental costs of these phenomena. This is rather simple when the objects of interest are wood, water, energy, or else. Environmental costs are, however, hard to estimate when they relate to hazardous input materials, waste treatment, and accidents that impair the environment. After having quantified the environmental costs of a certain phenomenon, the accountant must attribute to a special type of environmental costs and to a special cost category. Environmental cost categories relate to special physical entities, i.e. substances or energy, and therefore reflect their environmental impact.

By using these cost categories, the accountant can also estimate the environmental performance of a certain project, production process, and of certain products that are involved in the creation of this sort of environmental cost. Finally, this information is sent to the managers to decide if and how these costs could be reduced. The reduction of these costs primarily involves changes in the production process, but also the sale, the delivery, and the storage of environmentally critical substances. These decisions, however, are outside the realm of EMA.

Apart from that, we also monitor and try to reduce the use of energy, which makes up about 80% of our environmental costs.

XY2: Head of Department

We collect data on the amounts and costs of all components of our physical flows. EMA especially concentrates on the environmentally critical components by measuring their environmental costs. To this end, we use the environmental ratio analysis for every single process and product. This analysis basically relies on twelve indicators. They are: 'Rate of Waste on Operating Assets', 'Rate of Waste on Total Output', 'Rate of Hazardous Waste on Operating Assets', 'Rate of Hazardous Waste on Total Output', 'Rate of emissions on total output', 'Percentage of renewable resources to total use of resources', 'Environmental Loading Ratio', 'Emergy Investment Ratio', and 'Environmental Costs per Employee'. For every index we continuously measure the underlying physical flows connected with the process or product in question. The results are updated every month and are compared with its target value, or, in other words, with its goal.

We also regard the use of energy as an environmental issue and, hence, as a source of environmental costs. As a matter of fact, they cover the largest part of our environmental costs. So, we are forced to measure them, too.

XY3: Controlling

In the context of EMA, we do not use target costing, direct costing, and life cycle analysis because that would complicate the decisions of our strategic management accounting. We do, however, use an input output analysis, full cost accounting, activity based costing, flow cost accounting, and an environmental balanced scorecard (EBSC). These methods are applied to all components of our physical flows, but only the costs incurred by environmentally critical entities are regarded as environmental costs.

Our company uses large amounts of energy to produces goods. To reduce our carbon footprint, we use EMA to track the energy consumption of all our processes and products. Our management then uses this information to reduce the overall energy consumption. We were eventually able to reduce it by 30%.

XY4: Production

For every product and its related process we have an EBSC providing information about the central environmental costs by means of the actual environmental costs and the environmental ratios. There, they work as indicators highlighting the amount of hazardous and non-hazardous waste on total assets or on total output. In a special column it is possible to compare the factual results with the goals. Hence, this scorecard renders pivotal information about the environmental quality of a process or product.

On the one hand, we measure the amounts and costs of all substances used in the production processes. On the other hand, EMA especially accounts on the environmentally critical substances, which is done this way:

For every product or process we measure the amounts and the related costs for both the overall non-hazardous and hazardous input, as well as for its related overall product output, its overall non-hazardous and hazardous ?. For all these three types of output we measure to what degree their input was non-hazardous or hazardous. We also measure the energy consumption of our production processes since they are energy-intensive.

XY5: Head of Quality Management 1

Amongst other methods, we use an input output analysis and a flow cost accounting whose results we put in an environmental balanced scorecard. By this means, we can trace the flows from the raw materials to the product output and to the wastes. We calculate or at least estimate the amounts and costs of these substances plus the amounts and costs for energy, water, and wood.

EMA strictly distinguishes between hazardous and non-hazardous raw materials, products, and wastes alike. Inversely, we have also an environmental balanced scorecard that shows the relationship between the product and its hazardous and non-hazardous wastes.

We also focus on tracking the energy flows because our business is comparatively energy-intensive. With the use of environmental management accounting we have been able to cut our energy use by approximately 30%.

Generally, EMA identifies the amounts and costs of all components that are present in the physical flows, but only the environmentally critical components are candidates for environmental costs.

XY6: Director of Sales

An integral part of our EMA is a flow cost accounting that views the flows from a perspective of the input materials, including raw materials and operating materials, as well as from the products. EMA estimates the amounts and costs of all components of the examined flows, but it only labels such costs as environmental if they are connected with use of energy, environmentally critical substances, and environmentally critical occurrences.

This information is written into a special EBSC. The scorecard, which reflects this relationship from the perspective of input materials, is basically structured like this: in a column there is information if the input material is hazardous or not. The following columns refer to those specific processes in which the input material in question is used. A column shows per process the monetary value of its actual input, non-hazardous product output, hazardous product, non-hazardous waste output, and hazardous waste output. In the bottom line of the scorecard there are the aggregated values of each type of material for all processes.

The scorecard, which reflects the relationship from the perspective of products, i.e. main products and by-products, is basically structured as the scorecard described above: in a column there is information if the product is hazardous or not. The following columns refer to those specific processes in which the product in question is created. A column shows per process the monetary value of its actual output, non-hazardous input, hazardous input, non-hazardous waste output, and hazardous waste output. In the bottom line of the scorecard there are the aggregated values of each type of material for all processes.

In another environmental balance scorecard there is information about the energy flows that are very important for the company. So, we have been able to reduce one third of our energy consumption.

XY7: Head of Production

The company uses a form of activity based costing, ABC, combined with the cash flow analysis to determine its overall costs, environmental costs, and its product prices. Environmental costs are only related to environmentally critical entities and procedures. All costs are based on estimates, which are updated daily. To this end, we carry out our ABC in the following 6 steps:

1st step: definition of the main process

2nd step: division of the main process in sub-processes

3rd step: measurement of the time of each sub process

4th step: Identification of the conventional and environmental cost drivers of each sub process. This includes the identification of the qualities, quantities, and costs of the water use, energy use, use of wood, environmentally critical input, and output substances.

5th step: identification of the conventional and environmental costs for each sub-process and the material and energy flows, i.e. the input and output substances

6th step: concluding the price and the portion of environmental costs of a product made in a certain process

As for the final outputs, EMA subdivides these goods into finished goods and waste. The waste itself is subdivided into hazardous and non-hazardous types. The flows of the materials are attributed to special costs. The core of this information is written into the EBSC; my colleague has already explained that to you.

XY8: Controlling

Our EMA includes input output analysis, ABC, environmental scorecards, and financial ratio analysis. Apart from using the classical profitability sustainability ratios like sales growth or net profit margin, we also use ratios to highlight our environmental performance. So, we measure our environmental costs or revenues per employee and the percentage of environmental costs or revenues covered by grants: ECE – environmental costs per employee –, ERP – environmental revenues per employee –, ECG – environmental costs covered by grants –, ERG – environmental revenues covered by grants.

XY9: Department of Sustainability Management

To ensure efficient use of energy and resources, we use these three indexes: first, the percentage of renewable resources to total use of resources; second, the Environmental Loading Ratio (ELR), which is the ratio of non-renewable resource use to renewable resource use, and third, the Emergy Investment Ratio (EIR). This is the ratio of imported to indigenous sources, whether renewable or non-renewable.

With this index, we measure the degree of our participation in globalisation and the degree to which we seek locally available resources. With our metrics, the company also wants to identify the costs and the amounts of environmental energy that are used and produced by our production processes.

We measure the quantities and the costs of the physical flows, including energy flows. The costs related to the used energy, potentially hazardous flow components, and incidents are labelled as environmental costs. Measuring the energy flows is of special importance to the whole company since producing colours is energy-intensive.

XY10: Production

With our EMA, we support our strategic management to reach these three basic goals: tracking and reduction of environmental costs, eco-efficiency, and improvement of our strategic position in the market. If we try to achieve this goal by tracking our physical flows more accurately by measuring their amounts and by identifying them, there are environmental costs.

To this end, we measure the amounts and the costs for all kinds of input materials, namely operating, raw, packaging, and auxiliary materials. Apart from that, we also measure the amounts and the costs of our input, i.e. raw materials, packaging, operating materials, merchandise. On the other hand, we measure all sorts of output in the same way: main products and by-products, including packaging, as well as all kinds of non-product outputs. These outputs are solid non-hazardous waste, hazardous wastes, wastewater, and air emissions.

As the consumption of energy covers more than three thirds of all environmental costs, our environmental management accounting focuses on this type of environmental costs very carefully. However, environmental costs are only related to the use of water, wood, energy, and environmentally critical substances.

XY11: Production

We measure the amount of all assets; thereof, we identify the amount of our economic assets and of environmental assets. For us the environmental assets relate to environmentally critical phenomena. They consist of these components:

(1) Valuable machines, substances and applications bringing about a cleaner production, plus

(2) environmentally critical components of the physical flows, including the stored one, plus

(3) revenues from cleaner production, including revenues from eco friendly products, minus

(4) environmental costs.

We measure the absolute amounts and the percentage of our environmental assets and their components once every day.

XY12: Head of Quality Management

For every product and for every process EMA measures the complete production costs, the complete environmental costs, the costs due to legal infringements, the value of the conventional assets used for a certain product or process, the value of the environmental assets used for a certain rural product or process, the overall turnover, the eco-related turnover, the overall profits, and the eco-related profits. For all products and processes we create aggregated values for the mentioned cost types. An important type of our environmental costs form other energy costs, which make up approximately 80% of our entire environmental costs.

XY13: Chemistry Specialist

EMA measures the amounts and costs of all components that are present in the physical flows of our company. Costs that are created by chemicals and other environmentally critical substances are labelled as environmental costs. As far as I know, the accountant has to decide to which category a substance belongs in order to price it correctly.

XY14: Managing Director

For the accounting of our environmental costs we use a so-called input output matrix. Within this framework, we measure for each product and process, as well as for all products and all processes, the costs of the hazardous and non-hazardous inputs and the costs of their hazardous and non-hazardous product output. In the same way, we also measure the costs of hazardous and non-hazardous solid wastes coming either from the hazardous or non-hazardous inputs. Finally, we also measure the costs for wastewater and gas emissions created in a process or in the production of a certain process, and consequently also for all processes and products. The costs of these entities are considered environmental: water-polluted or pure wood and energy, hazardous input materials, waste – hazardous and non-hazardous alike –, as well as environmentally critical occurrences like accidents or mistakes.

XY15: Department of Sustainability Management

We found that the classical methods of measuring and environmental costs are inappropriate. In Germany, the legal prescriptions concerning an environmental-friendly production are so severe and effective that the payments for prevention, remediation, and penalty fees are almost negligible. Actually, there are other factors that strongly influence our environmental costs. The costs for electricity, which is an environmental issue in Germany and elsewhere, cover 58% of our environmental costs. The costs for fuel account cover 22% of our environmental costs. So, the costs for energy are responsible for 80% of our environmental costs. The costs for the treatment of waste, hazardous and non-hazardous, make up 12% of our environmental costs. The corresponding percentages of contaminated wastewater and pure wastewater are 7% and 3%, respectively.

So, in a special EBSC, we measure these cost types for every input material, output material, and process, as well as for corresponding aggregated values for all input materials, output materials, and processes. Costs are regarded as environmental costs if they are connected with the use, production, treatment, or storage of wood, water, energy, hazardous input materials, every kind of waste, and also environmentally critical incidents. As of November 2015, the environmental costs for hazardous input substances are more and more often calculated by adding the environmental costs of these flow components that were necessary to treat them. This result is multiplied with the factor 1.1 to account for the hazardousness of the substance in question and its possible costs for remediation. We plan to make this type of accounting a standard procedure for hazardous substances by the end of 2016 since it is much more simple.

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Question 6

Who is involved in the process of EMA, and how are responsibilities organised?

Answers

XY1: Department of Sustainability Management

The procedures of EMA are carried out by one specialised accountant. He receives the information about the material and energy flows via technical devices and computers or from employees who measure the amounts of its components in their departments, production sites, storage, and sales departments. Then the accountant has to decide if a flow component or an incident is of environmental significance. Knowing the prices for the input materials, the accountant can calculate the conventional material costs of the harmless input materials and the environmental costs for the environmentally critical components, i.e. the hazardous products, the waste treatment, the energy use for the production processes, and also incidents which he has considered environmentally critical. Special types of environmental costs are connected to technical accidents, manmade mistakes, prevention and remediation, eco-related taxes, and penalty fees. This work is done with a special software. The accountant then sends this information to the managers, who use it for their managerial decisions. These decisions mostly refer to modifications of the production processes, and they intend to make them more waste, resource, and energy efficient.

XY2: Department of Sustainability Management

Employees working at the production sites and those who are responsible for the logistics and sales sometimes measure the physical flows concerning the amounts of their components and transfer this information to the accountancy department. They also measure the number of critical events, mostly technical accidents and manmade mistakes. These employees do this work upon order of the EMA accountant to whom they send the obtained information via computer. In most other cases, computer-driven devices carry out the measurements and the transfer of information automatically.

After having received the information in question, the EMA accountant decides if a flow component or an event is environmentally critical or not. In the latter case, the EMA accountant calculates the conventional costs that the components in question cause by multiplying their amount with their market price, e.g. for natural products, salts, or inflammable oils. He receives these prices from a computer database or from his senior accountants. Events that are regarded as harmless are not analysed anymore. In the former case, EMA calculates the various types of environmental costs, which is often complicated to do. There are also special types of environmental costs that are not directly connected with the physical flows, but to technical accidents, manmade mistakes, prevention, and remediation.

The management uses the information on conventional and environmental costs to reduce the production of waste, the consumption of energy, and of resources, especially of hazardous resources. The management tries to find ways to change the production processes and to develop new products to reach this goal.

XY3: Controlling

EMA does not bring about managerial decisions, nor does it change the value chain, but its information may influence the management to make decisions concerning the waste, resource, and energy efficiency of the production processes. EMA and its accountant draw on the information of the physical flows, which is measured and checked by computer-driven devices or employees who are concerned with the production, storage, sale, and waste treatment. This information concerns the amount of the components in the flows. The accountant is informed by a computer or by the chemist when a component is environmentally harmful. If it is not, he calculates its conventional costs by using the information of its measured amount and the information about its material price. In the other case, EMA calculates the environmental costs of the environmentally critical components. This is done in a similar way if the components are wood, water, energy, or fuel whose impact on the environment is proportionally linked with their amount. In this case, the EMA accountant again uses the information of its measured amount and information about its material price. The environmental costs of other entities are, however, hard to estimate because their impact on the environment is not proportionally linked with their amount. Hence, these environmental costs are only estimations. These entities are hazardous input materials, waste treatment, accidents, mistakes, costs for remediation and prevention. After the environmental costs are calculated or estimated, the EMA accountant reports them to the management.

XY4: Production

The main assignment of EMA is to measure the environmental costs of the company. The EMA accountant gives orders to the employees of the process sites, the sales departments, the storage departments, and the sections of the waste treatment to measure the amounts of the physical flows, which are the flows of all input materials and output materials, including water and energy. In most cases, computer-driven devices do this task, which are, however, controlled by the EMA accountant.

After having received this information, the EMA accountant has to decide which of the components of the flows might pose a danger to the environment. In this context, he is helped by a computerised database and by the chemist expert. If the components are not environmentally dangerous, the EMA accountant calculates their conventional material costs by multiplying their amounts with their material price. If the components are environmentally critical, he has to calculate and sometimes to estimate their environmental costs. As for fuel, wood, water, and energy, the calculation of the environmental costs equals the calculation of conventional material costs since their environmental danger is proportional to their amount. In most cases, computer-driven devices support this work. The environmental costs are calculated for all products and production processes. They are used by the management to make the entire production of the company more environmentally friendly, i.e. to reduce waste, resource, and energy use. Sometimes, these decision lead to the development of eco-friendly products.

XY5: Head of Quality Management 1

Various staff members oversee the production processes, the storage departments, the waste treatment sites, and the sales departments. There, equipped with computer-driven devices, they measure the physical flows, i.e. parameters like amount, concentration, heat, mass etc., and transfer this information to the employee responsible for EMA. He then ascertains if the components are environmentally critical or harmless. For the harmless components he calculates the conventional costs per product or process by using the figures on the measured amounts and market prices concerning the material prices in question. For the environmentally critical substances he calculates the corresponding environmental costs by using the figure of the measured amounts and information on the prices of these entities, which, however, are often guesses. The strategic management accounting uses this data to enhance the company's environmental performance. The managers develop new ways of producing goods with less waste, resources, and energy.

XY6: Director of Sales

At the lowest level of the hierarchy, employees measure the characteristics of the physical flows, which are mostly the amounts of materials, water, and energy. This is done in the sections where products are produced, stored, and sold, where waste is kept or treated, and where energy is supplied and consumed. These employees feed this information into a computer which sends it to the EMA accountant. In most cases, computer-driven devices measure the parameter in question automatically, too.

The EMA accountant at the next higher hierarchy level uses the EMA software to tell the harmful flow components from the harmless ones. For this assignment he is supported by the company's chemist expert and by a computer database listing the environmentally critical substances the company is using. For the harmless substances the EMA accountant calculates the conventional material prices using the figures concerning their amount and market material prices. If the substances are hazardous, the EMA accountant deduces their environmental cost. These calculations are often less precise since the hazardousness of many substances does not only depend on their amount, but also on the circumstances in which they are used. This is the point where the range of EMA ends. At the highest hierarchy level, managers use the information on the environmental cost to make decisions concerning the production process. In most cases, this information is used to make the production more waste, resource, and energy efficient.

XY7: Head of Production

The employees working in the sites or departments of the production, sale, storage, energy supply, and waste deposits measure the physical flows in respect of the concentration of their components. They often work upon orders of the EMA accountant. He receives their information on the physical flows and calculates the environmental costs of the environmentally critical substances and the conventional material costs for the harmless substances. The management uses this information to make the production process less resource and energy consuming. Sometimes, it uses this information to develop new eco-friendly products.

XY8: Controlling

At all places where goods are produced, stored, or sold, where energy is supplied or consumed, where waste is kept or treated, several employees and automatic computer-driven devices measure the quantities of the components of the physical flows. This information is used by the EMA accountant in order to tell the environmentally critical substances from the harmless ones, and to calculate their environmental costs and conventional material costs, respectively. He also monitors the aforementioned employees and orders them to carry out the checks in question. The information supplied by the accountant, i.e. the environmental costs, is used to bring about managerial decisions concerning the resource, waste, and energy efficiency of the products, productions processes, and of the whole company.

XY9: Department of Sustainability Management

The EMA accountant orders his subordinates to measure the amounts of the components inside the physical flows. Knowing which component is environmentally critical or not, and by using the figures of their measured amounts and estimates concerning their price, he then calculates the environmental costs or conventional material price of the component in question. This is done for all of the company's products and production processes. The managers, i.e. his superiors, exploit the information of the environmental costs to develop production processes that incur lower environmental costs.

XY10: Production

The EMA accountant uses three kinds of information: first, the current prices for the materials, the energy, and the waste, which are potentially present in this company; second, the information on the amounts of the aforementioned physical entities currently and actually used, produced, supplied, or treated in this company; third, their potential influence on the environment. With these types of information the EMA accountant either calculates the environmental costs of an environmentally critical entity or the conventional material costs of a harmless substance. He gets the first type of information from senior accountants, and the second one from his subordinates who have contact with the material flows and who measure their amounts. As for the danger of a component, the EMA accountant receives this information either from the computer or from the chemistry specialist. The management uses the information to make the production processes more waste, resource, and energy efficient.

XY11: Production

The EMA accountant sometimes orders his subordinates to measure the amounts of component of the physical flows. They mostly work in departments where the production processes take place, where energy is produced or supplied, where products are kept or sold, or where waste is kept or treated. In most cases, however, this physical information is automatically transferred to the EMA accountant by means of computer devices and programmes that monitor the processes and the physical flows in question. From the department of his senior accountants, the EMA accountant receives information of the prices of these substances, materials, and the amounts of energy; again, this is almost always done automatically by means of computer software. The chemist, or a computer database, informs him if a component is environmentally critical or not. Using this information on the energy flows and the related prices, he can calculate the corresponding environmental costs for the environmentally critical substances and the conventional material prices of the harmless substances, e.g. salts or not inflammable oils. The management uses the knowledge about the environmental costs to optimise the production processes in terms of eco-efficiency. Sometimes, it takes actions to develop new products which are more efficient concerning waste, resource, and energy.

XY12: Head of Quality Management

The EMA accountant makes his subordinates measure the amounts of the components of the physical flows connected with several products and production processes. Their work is supported by computer-driven devices, which often perform the measurements automatically, but the employees still have to monitor them. With the help of price and danger estimates, the EMA accountant can tell the environmentally critical flow components from the harmless ones. For the former type of components he calculates their environmental costs, for the latter type the conventional material costs; in both cases the calculations are done per product or process. Senior accountants supply these price estimates, which also refer to the waste and energy connected with the products and processes in question. Chemists inform the EMA accountant about the potential dangers of the flow component. Finally, the management uses the information on the environmental costs to optimise the production processes and products concerning their waste, resource, and energy efficiency.

XY13: Chemistry Specialist

As a chemistry specialist, I also measure the flows of chemicals and other hazardous substances in respect of their amount or concentration. I send this information to my superior, the EMA accountant, who uses it to calculate their environmental costs.

XY14: Managing Director

The quantities of the components inside the physical flows are measured by several staff members who are supported by computer-driven devices. The EMA accountant uses this information to calculate the environmental costs. To this end, he receives estimates about their price and potential environmental impacts. If a substance is harmless, the accountant only measures its conventional material price. In the contrary case, he has to calculate its environmental costs using figures concerning quantities, material prices, and danger estimates. It is also his duty to attribute these costs to specific products and production processes. He is helped by his senior accountants and by chemists who inform him about the dangers, and current prices of energy, raw materials, waste treatment etc. The management on the highest hierarchy level decides if and how it will reduce the environmental costs. It often does so by developing production processes that produce less waste and consume less energy and resources. Sometimes, it also develops new eco-efficient products.

XY15: Department of Sustainability Management

The EMA accountant receives information from his subordinates, which enables him to track the physical flows of the company, especially in respect of the quantities of their components. Using price and environmental danger estimates concerning the substances, materials, and energy in these flows, he estimates their conventional or environmental costs for harmless and environmentally critical flow components, respectively. Both cost types are calculated for the products and production processes connected with these flows. I would like to point out again: in case a substance is harmless, as e.g. natural ingredients, the accountant only measures its conventional material price, but for environmentally critical substances he has to calculate their environmental costs.

The EMA accountant gets the price estimates from the department of his senior accountants and the information about the dangers from the chemist department. In most cases, this transfer of information happens automatically via computer. The EMA accountant transfers the information of the environmental costs to his superiors, namely, to the management. Its members use it to decide if and how the environmental costs can be cut. The management often modifies the production processes and products in a way that they involve less waste, resources, and energy.

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Questions 7

7. Could you describe the use of EMA-related metrics?

7.1 What EMA-related metrics does the company use?

7.2 What do these metrics measure and why?

7.3 How are the metrics incorporated in the overall accounting system?

7.4 Are the metrics efficient?

Answers

XY1: Department of Sustainability Management

The EMA accountant decides with the help of the chemistry experts or, in most cases, with a computerised database if a flow component is environmentally critical or not. The main method of this analysis is to look for clues indicating the hazardousness of a physical component of an observed flow. If the analysis fails to find any clues, the physical component is declared harmless. Such components are always substances, as e.g. salts, natural ingredients, or inflammable oils. In this case, EMA only measures its amount per flow, per process, or per product – depending on the context. This means: the only EMA metric for harmless substances is their amount. This type of metric is also linked with benchmarks, but they do not concern EMA. EMA then calculates the conventional material costs of these substances by multiplying their amount with their market price per unit. The EMA accountant receives this information from his senior accountants or mostly from another computerised database.

As for identifying environmentally critical flow components, the EMA accountant uses laws, another computerised database, or he avails himself of the chemistry specialist's advice.

The German environmental laws are the basis for environmental taxes and penalty charges. Electric energy, fuel, water, and wood are also always considered environmentally critical due to German environmental laws.

In the case of other substances, the EMA accountant uses a computerised database which lists all chemical numbers present in the physical flows. This database functions according to the system of registry numbers of the chemical abstracts service (CAS), i.e. with the so-called CAS registry numbers. The chemistry specialist's advice concerns phenomena whose hazardousness is difficult to estimate; they are technical accidents, manmade mistakes, waste disposal, and waste treatment (this includes the treatment of gas emissions).

Whenever a physical entity or an occurrence has been identified as environmentally critical, we basically use two types of metrics to estimate their environmental costs: the principle type of metric and the secondary one. There are several sub-types of principle metrics, namely: the quantity-related, price-related, chance-related, and law-related types. The secondary metrics will be dealt with later in this section. All types of metrics, principal and secondary ones alike, are based on standards of ISO 14001 and BS 8555/Acorn. Both kinds of metrics are linked with benchmarks that the measured quantities must not exceed. These benchmarks are the result of a long-lasting process of trial and error.

The quantity-related type of metric is used to measure the quantities of the substances of environmental importance, the number of legal infringements, and the number of critical occurrences of ecological significance. These occurrences are technical accidents and manmade mistakes. Each staff member must inform their superiors about such occurrences. The environmental hazardousness of all these phenomena at least partly depends on their amount in the observed flow.

The other principal metrics, i.e. the price-related, chance-related, and law-related types, are used to transform the measured quantities into environmental costs. Price-related metrics are exclusively used to estimate the environmental costs of critical entities if their critical effect on the environment is proportionally linked with their amount in the measured physical flow, and if there is no other effect; this is especially true for water, wood, fuel, and energy.

The environmental costs of other substances are more difficult to measure when their hazardousness does not only depend on their amount. One type of these substances comprises hazardous input materials, mostly chemicals that are found in the CAS registry list. Their hazardousness depends on both their amount and on the process in which they are used. The environmental danger of a production process is estimated by means of the number of legal infringements, technical accidents or failures, and manmade mistakes that occurred in its history. Therefore, the environmental costs of an environmentally critical substance are estimated higher when it is used in a dangerous process.

There are, however, many other phenomena whose threat on the environment is even harder to estimate for a couple of reasons. These phenomena are technical accidents and manmade mistakes, costs for remediation and prevention, and the costs for waste treatment and disposal of solid and liquid waste (mostly wastewater). Technical accidents and manmade mistakes often cause unpredictable environmental damages and costs; costs for remediation and prevention are also difficult to measure since they often relate to unpredictable accidents and mistakes, or to changes in the environmental laws. In the case of waste, one has to check the costs for its disposal and treatment, which are generally higher when the hazardousness of the waste is higher. However, the ways of estimating the hazardousness of waste is a complex affair.

So, the estimation of the environmental costs of an environmentally critical substance other than waste can depend on these three factors: (1) the amount of substance used in a production process (or for a product), (2) its crude price unrelated to the process, and (3) the susceptibility of the production process to accidents or mistakes which entail the likelihood of costs for remediation. Presently, the company changes its appraisal techniques of environmental costs concerning hazardous substances. A rising number of these costs are only measured by summing the environmental costs of water, wood, waste, fuel, and electric energy needed for the treatment of the hazardous substances in question. Then, we add an incremental amount of 10% of these costs to account for the hazardousness of these substances. By the end of this year, the environmental costs of all hazardous substances will be estimated this way.

The estimation of the environmental costs of waste depends on these three factors: (1) the amount of waste produced in a production process (or for a product), (2) the degree of hazardousness, and (3) the costs for treatment or disposal. The costs for critical occurrences, i.e. failures, accidents, and manmade mistakes, are the costs for prevention (including tutorials) and remediation. Taxes and penalty fees are the final type of environmental costs. Taxes are easy to predict, penalty fees are not, but they occur very rarely.

All these metrics are first degree, or principal, metrics. There are also secondary metrics. They are created by linking certain environmental costs or substance amounts with important financial figures. These metrics appear in the EBSCs.

XY2: Head of Department

To measure the ecological performance of our company, we check the environmentally critical entities, substances, or energy of every production process and each assistant with several metrics. They are based on the ISO 14001 and BS 8555/Acorn standards. For the measuring process we use principal and secondary metrics with both of them being related to pre-fixed benchmarks. These benchmarks are derived from long experience via trial and error and set the limits for the quantities to be measured. On the other hand, there are no such benchmarks for harmless substances and their conventional costs.

The principal metrics are subdivided into physical-related, quantity-related, chance-related, and law-related metrics. With the quantity-related metrics, EMA measures the quantities of these substances per production process and product: hazardous input substances, hazardous solid output substances, consumption of wood and water, non-hazardous solid output substances, gas emissions, wastewater, re-used/recycled substances and materials, consumption of energy, and consumption of fuel. The chance-related metrics are applied to estimate the hazardousness of a physical flow component. With the chance-related metrics we measure the technical accidents of a production process per month (and also on a monthly basis) and the mistakes of our staff members that have a potentially environmental aspect. With the quantity-related and law-related metrics, we measure the rate of infringements concerning environment-related laws and regulations.

After having identified these quantities, the EMA accountant receives price estimates of the phenomena in question from his superior accountant: market prices of the input materials, prices of waste treatment, penalties incurred by infringements, taxes and penalty fees, and costs for the prevention or remediation of accidents or mistakes. Some price estimates like those for wood are precise; other prices like those related to workers' mistakes are often guesswork. With these two types of information the EMA accountant deduces the environmental costs per production process and product. So, the principal metrics themselves are precise, but this is not always true for the environmental costs since they sometimes rely on unsure estimates.

The secondary estimates are of a relative nature. So, for instance the 'Rate of Waste on Total Output' partly depends on measured quantities, and partly on environmental costs, as e.g. 'Environmental Costs per Employee', and they are also linked to important financial numbers. These metrics are used in our environmental balanced scorecards to display the overall environmental performance of our company.

XY3: Controlling

All current information is collected, which reflects the eco-related performance of the production processes and the workers. Several staff members and especially the controlling constantly checks by means of specific metrics and techniques if the amount of used gases, wood, and other raw materials, water, and energy per product and process unit does not exceed a certain limit, i.e. a defined benchmark. There are similar limitations for the number of legal infringements and mistakes committed by the staff. These principal metrics are precise and effective.

To calculate the environmental costs of the products and processes, we use this procedure: the measured quantities of the physical entities which have been identified as environmentally critical are multiplied with their current market price or other price estimates like the costs for remediation of prevention. The outcomes are their environmental costs, contextually per product or per process. Apart from that, there are also environmental costs arising from the treatment of disposal of waste. The related metrics are the amount of the waste, their type, and the costs to treat or to dispose of them. Finally, eco-related taxes and penalty fees are also labelled as environmental costs.

The management uses the information of the environmental costs to develop, if necessary, counter-measures when the metrics and environmental costs exceed certain benchmarks. The EMA accountancy uses the information of the environmental costs to decide if these measures are affordable.

The metrics themselves are precise and effective because both types are based on ISO 14001 and BS 8555/Acorn standards. However, the price estimates are sometimes unsure. So, the overall results of the environmental costs are not always reliable, which is especially true for the environmental costs or revenues per costumer. To calculate this cost type, the number of mistakes (or promising proposals) made by an employee is multiplied with a price estimate which, however, is almost always uncertain. For harmless substances and their conventional costs there are no such benchmarks.

XY4: Production

To capture the environmental performance of our company, we analyse the environmentally critical substances, the energy of our production processes, and the performance of our staff by means of metrics which both use the standards of ISO

14001 and BS 8555/Acorn. These metrics work with benchmarks that set limits to the measured quantities. These benchmarks are the result of empirical research, mostly trial and error. However, for harmless substances and their costs there are no benchmarks. This all means: we measure the quantities of all environmentally relevant physical entities, the number of eco-related legal infringements, the number of technical accidents, and the eco-related mistakes made by the staff. These metrics are the principal ones. The measured quantities must not exceed a certain benchmark. These quantities are multiplied with their price and danger estimates; the results are the environmental costs of the phenomenon in question.

There are also secondary metrics used for the scorecards. Several kinds of measured amounts of environmentally important entities (e.g. waste) or environmental costs (e.g. environmental costs per product) are divided by important financial figures, e.g. assets or output. With the exception of the secondary metrics on environmental revenues, one can say: the smaller these figures are, the better is the environmental performance of the company.

XY5: Head of Quality Management 1

We measure the amounts of all physical entities which have a bearing on our environmental performance by means of special metrics and benchmarks using the ISO 14001 and BS 8555/Acorn standards. However, metrics and their benchmarks are not used for harmless substances and their costs. These entities are water, wood, dangerous input and output materials, gases, and all kinds of waste including wastewater. We also count the number of legal infringements, technical accidents, and manmade mistakes of environmental importance connected with the production processes and workforce. The rather empirical benchmarks define a limit the measured quantities must not exceed. If so, the management will devise countermeasures to reduce these amounts.

As you were told at our gatherings, we use specific indicators measuring energy and material flows, which are otherwise hard to calculate. For the amount of the fuel there is the ‘Fuel-Charged-to-Power‘-Metric, which can be calculated as follows:

$FCP = \frac{F - \frac{Q}{E}}{P}$, with F being the amount of fuel, Q the amount of heat, E the efficiency of the power plant, and P its power.

To measure the amounts of the flows of hazardous chemicals, we use the ‘Dry Sorbent Injection‘. This method measures the content, and therefore the amounts of pollutants in the exhaust gas stream by making them react with special substances.

For the measurements of our energy consumption we use energy consumption devices of the type ENERGYCOUNT 3000 from the company Voltcraft.

These amounts are multiplied with their price estimates to get the environmental costs. In respect of their reliability, the estimates belong to three levels: sure, comparatively reliable, and vague. Environmental cost estimates are considered sure if they are only calculated with so-called law-related, quantity-related, and price-related metrics. These estimates relate to eco-related taxes and the consumption of water, wood, electric energy, and fuel. Environmental cost estimates are considered comparatively reliable if the influence of chance plays a moderate role. This applies to most hazardous input materials whose threat on nature depends on the process they are used for. In this case, the environmental costs are measured with chance-related, quantity-related, and price-related metrics. Environmental cost estimates are considered vague when the phenomena in question are complex, and chance plays an important role. Now, the environmental costs are measured with chance-related, law-related, quantity-related, and price-related metrics. The environmental costs of solid wastes are hard to estimate. The basis is the directive 91/689/EWG of the European Union, naming 839 kinds of solid wastes and labelling 405 of them as environmentally dangerous.

Hence, the overall efficacy of these principal metrics depends on the prices estimates, which are not always certain. If certain amounts of principal metrics are put in a relation to financial figures, as e.g. assets, you arrive at the secondary metrics, which rather reflect the company’s overall environmental performance.

As for hazardous substances, the company currently changes its methods of estimating environmental costs in order to make them more reliable. We are beginning to estimate the environmental costs of these substances by calculating the sum of the environmental costs of electric energy, fuel water, wood, and waste which were consumed for the treatment of the hazardous substances. To consider the hazardousness of these substances, we add an incremental amount of 10% since the abovementioned costs cover at least 90% of the environmental costs of the substances in question. Until 2016, we shall estimate the environmental costs of all hazardous substances with this method.

XY6: Director of Sales

As for obtaining the environmental cost of the environmentally critical substances, we do this by measuring their amounts, i.e. the amounts of water, wood, energy, and environmentally sensitive substances which are hazardous input materials, non-hazardous input materials leading to hazardous wastes, all kinds of solid wastes, and gases. To measure or at least to estimate their environmental costs, these amounts are multiplied with the estimates of their prices, e.g. the price to treat, store, or dispose of a certain amount of waste. The environmentally critical substances also depend on the dangerous nature of the production process in which they are used or produced. As these estimates are not always 100% sure, the environmental costs are neither. The metrics themselves are precise and efficient since they are linked with benchmarks derived from long experience. If the measured quantity of a physical entity or the environmental costs of a certain process or product exceeds the benchmarks, EMA informs the management about it. It will then decide what countermeasures are to be taken to reduce the amounts in question. It must be pointed out that there are no benchmark-based metrics for harmless substances and their costs.

We also divide some of our environmental costs and related amounts by important financial figures. The outcomes to get secondary metrics are: 'Rate of Waste on Operating Assets' / 'Rate of Waste on Total Output' / 'Rate of Hazardous Waste on Operating Assets' / 'Rate of Hazardous Waste on Total Output' / 'Rate of Emissions on Total Output' / 'Percentage of Renewable Resources to Total Use of Resources' / 'Environmental Loading Ratio' / 'Emergy Investment Ratio' / 'Environmental Costs per Employee' / 'Environmental Revenues per Employee' / 'Environmental Costs Covered by Grants' / 'Environmental Revenues Covered by Grants' / 'Environmental Costs per Product' / 'Environmental Revenue per Product' / 'Environmental Costs per Process' / 'Environmental Revenue per Process'.

These metrics are used in the environmental balanced scorecards to highlight the company's environmental performance at a glance. The metrics of both types are coupled with benchmarks that follow the ISO 14001 and BS 8555/Acorn standards. So, they are reliable and precise.

XY7: Head of Production

As I told you before, we collect information about the production processes and our staff members to make sure that everything and everyone works perfectly. This information consists of the data concerning the amounts of environmentally sensitive substances and energy, the number of legal infringements, and the number of critical occurrences, which are technical failures or accidents, and mistakes made by our employees. These three dimensions are our principal metrics. Multiplied with estimates concerning their material price and the dangers on the environment, they render the environmental costs.

Some of the measured amounts and environmental costs are connected with our basic financial figures. So, we get secondary metrics showing our overall environmental performance. The metrics themselves are efficient and clear. They are coupled with reliable benchmarks gained from trial and error experience. If a phenomenon exceeds the limits of a related benchmark, the management will develop and order countermeasures. The benchmarks are regarded as reliable for two reasons: they are derived from long trial and error experience, and they follow the standards of ISO 14001 and BS 8555/Acorn, but there are no benchmark-based metrics for harmless substances and their costs.

The environmental costs relate to the use of hazardous input materials and fuel, to the treatment and disposal of waste, the use of water, wood, and energy, eco-related fees and penalties, payments due to prevention, and remediation. These costs are not always precise due to the sometimes uncertain danger estimates, but they are still effective in showing the company's overall environmental performance.

XY8: Controlling

We use our principal metrics to measure the amounts of our environmentally significant substances including energy. We also count the number of legal infringements caused by our production processes as well as the eco-related occurrences in our production sites. Multiplied with estimates of the prices of these figures, one gets the environmental costs of these phenomena, either per process or per product. Both types of metrics are linked with benchmarks which the measured quantities and environmental costs must not exceed. For harmless substances and their conventional costs there are no such benchmarks.

The amounts of waste and emissions, hazardous and non-hazardous, are divided by the company's amount of operating assets and total output. These secondary metrics display the environmental performance of our assets, i.e. of our company and of our products, respectively. We also measure the percentage of renewable resources to total use of resources to highlight our resource efficacy. Apart from that, there are other environmental costs such as eco-related taxes and penalty fees, and the costs for remediation and prevention, which are sometimes not easy to estimate.

The metrics are clear and efficient. They work with benchmarks based on trial and error experience and on the ISO 14001 and BS 8555/Acorn standards. The environmental costs are sometimes only estimates because of the uncertainty of the price estimates.

XY9: Department of Sustainability Management

We use primary and secondary metrics using benchmarks based on trial and error experience and on the ISO 14001 and BS 8555/Acorn standards. The primary metrics relate to the eco-related mistakes done by the staff, the eco-legal infringements of our production processes, and the amounts of substances and energy forms of environmental importance. So, we count the number of mistakes, accidents, and legal infringements; we also have techniques to measure the amounts of the physical entities mentioned above. These metrics are effective since they easily render the quantitative aspect of the environmental costs. The ways of obtaining the other aspects of the environmental costs, as e.g. the environmental dangers, are much harder to estimate and therefore less precise.

Some secondary metrics are derived from the measured amounts of wastes, recycled substances, or environmental cost. This is done by linking them to the amount of our operating assets and of turnover. These metrics appear in the EBSC. All metrics are linked with benchmarks which the measured numbers or amounts must not exceed.

XY10: Production

We have primary and secondary metrics for the measurement of our environmental performance. The metrics use benchmarks that set the limits for the quantities of the measured physical entities and environmental cost. If the quantities exceed their benchmark, EMA will report this to the management which in return will devise countermeasures. The benchmarks are the result of reliable trial and error experience and based on the ISO 14001 and BS 8555/Acorn standards.

To use the primary metrics either means to measure the amounts of the physical entities of environmental importance, or to count the number of technical failures or accidents, manmade mistakes, and legal infringements. These metrics are effective. With them we calculate or at least estimate the environmental costs. To this end, we multiply the measured or counted figures with their prices or price estimates.

We also deduce a couple of secondary metrics by linking the amounts of wastes, recycled substances, or environmental costs with the amount of our turnover and operating assets. These metrics are part of our EBSCs. All metrics are combined with benchmarks. The measured numbers or amounts of the entities in question must not exceed them. The benchmarks are not the results of exact calculation; they are rather the outcome of trial and error experience.

XY11: Production

I work with automatic programmes with which I measure the amounts of hazardous chemicals used in the production processes. We also check ourselves in order to prevent mistakes.

XY12: Head of Quality Management

The environmental quality of our products depends on the amounts of environmentally sensitive substances which are connected with their production. To this end, we measure their amounts per production process or per product. For the same reason, we also measure the number of eco-related accidents of mistakes committed by our staff as well as the number of eco-related legal infringements. This is also done per production process or per product. To get a picture of our company's overall environmental performance, we calculate aggregated values of these three figures for the sum of all processes. For these assignments we have computer-driven programmes that calculate, check, and document the numbers in question. These numbers are numbers of the first degree, or primary metrics. Multiplied with corresponding price and danger estimates, they render the environmental costs.

The amounts of the wastes and gas emissions are linked with the amount of our operating assets and our total turnover to display our environmental performance in our EBSCs. These figures are our secondary metrics. The primary and secondary metrics, which go together with benchmarks, are effective in showing the eco-related quality of our production processes and products. The same is basically true for our environmental costs although they are often estimates only. The metrics rely on benchmarks. They are based on reliable trial and error experience and on the ISO 14001 and BS 8555/Acorn standards.

XY13: Chemistry Specialist

Equipped with several technical devices and a computer, I measure the amounts of energy, chemicals, and other hazardous substances used in our production processes. I regularly offer information concerning the prices of these physical entities. As far as I know, both pieces of information are used to calculate their environmental costs. Beyond that, I cannot give you any further information.

XY14: Managing Director

Several numeric metrics are used to describe the company's environmental performance. They are highly effective in doing so. We measure the amounts of those substances that might harm the environment. For the same purpose we count the technical failures or accidents, and the mistakes done by our staff that could potentially harm the environment, too. Finally, we count the number of legal infringements with environmental aspects. We call these three figures metrics of the first degree. They provide the environmental costs of the measured phenomena they are multiplied with their corresponding price and environmental danger estimates.

We also link the measured amounts of wastes and gas emissions with the operating assets and total turnover to express the environmental performance of our company and of our finances. We also calculate the environmental costs per employee to show their environmental performance. These so-called secondary metrics appear in our EBSCs. Every metric is linked with a benchmark which the calculated amount must not exceed. These benchmarks are the results of long lasting trial and error processes, and they are based on the ISO 14001 and BS 8555/Acorn standards. Hence, they are regarded as reliable.

XY15: Department of Sustainability Management

We use a couple of efficient metrics linked with benchmarks which the measured phenomena must not exceed. These phenomena are primarily the amounts of substances with a potential influence on the environment, the number of purely technical incidents infringing eco-related laws, and the number of mistakes committed by the staff that might also infringe eco-related laws. These quantity-related metrics are multiplied with other metrics, namely, estimates concerning their average prices and threats on the environment to get the environmental costs of the measured phenomena. The benchmarks are derived from long lasting trial and error processes; apart from that, they are based on the ISO 14001 and BS 8555/Acorn standards. That is why they and the metrics are efficient in measuring the amounts of physical flow components that are environmentally critical.

The amounts of wastes and gas emissions, i.e. the substances with the strongest impact on the environment, are connected with the company's total turnover and operating assets to highlight its environmental performance. The company also calculates the percentage of renewable resources to total use of resources to show its resource efficacy. These so-called secondary metrics appear in the EBSCs where they can be easily read. All metrics are based on benchmarks which are the result of trial and error experience.

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Question 8

Can you define environmental costs?

Answers

The answers to question 8 were comparatively unanimous. To avoid repetitions, they are presented in an aggregated form:

XY1 – XY15 (except XY13, Chemistry Specialist)

Environmental costs are those costs that arise from the environmental hazardousness of our products and production processes. In our company, there are five categories of environmental costs. The cost categories in question are with declining importance:

(1) Costs for the consumption or use of electric energy, fuel, water, and wood

(2) Costs for the treatment, disposal, and storage of solid waste and gas emissions

(3) Costs for eco-related taxes and insurances

(4) Costs for prevention measures including tutorials and measures to treat hazardous input materials adequately

(5) Costs for remediation including penalty fees and the remediation costs caused by technical accidents/failures and manmade mistakes.

Interviewee XY 13 (Chemistry Specialist) only referred to the environmental costs attributable to hazardous input materials.

(6) Environmental gains and revenues, negative costs; almost completely caused by reduced consumption of electricity and fuel, to a minor degree caused by the reduced production of non-product output or the reduced use of hazardous input substances

All interviewees with the exception of YX10 (Production), XY11 (Production) and XY13 (Chemistry Specialist) also named environmental gains and revenues as a sixth category of environmental costs. These costs were always labelled as negative costs by all 12 interviewees who mentioned the existence of environmental gains and revenues. According to them, these gains and revenues were almost completely caused by the reduced use of fuel and electric energy and only to a minor degree by the reduced production of non-product output or the reduced use of hazardous input substances. Interviewees YX10 and XY11 (Production) acknowledged the existence of environmental gains, but did not label them as costs.

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Question 9

Does or did EMA influence the company's performance?

Answers

XY1: Department of Sustainability Management

EMA itself describes the company's physical flows correctly since it identifies all quantities of their components. In addition, it calculates the costs of all components. Although some environmental costs are rather vague, the overall calculations of the environmental costs for each product and production process have proven adequate. That is why EMA has been able to provide the strategic management accounting with useful information. As a matter of fact, the costs for energy and fuel have been cut by 30%. This made the products less expensive, which in return lead to an improved competitive position of the company. In addition, our use of water and wood has declined for the same reasons. Because of that and because of a reduced waste production, which is also partly supported by EMA, we could explicitly label some of our products as eco-friendly, which again improved our market position.

XY2: Head of Department

Thanks to EMA, our management has been able to cut its environmental costs significantly, especially in the field of electricity and fuel, but also concerning the use of water and wood, and the production of waste. Consequently, our eco-related taxes declined a bit as well, and our competiveness improved significantly. The reasons for this are: EMA describes our physical flows correctly in terms of the quantities of their components. In addition, it almost always gives a realistic picture of its related environmental costs. We hope to develop precise estimates for all environmental costs.

XY3: Controlling

EMA describes all material and energy-related aspects of our flows correctly. The estimates of the related costs are almost always correct, especially in the case of harmless substances, fuel, and electricity. The estimates for some hazardous substances are less precise, but still adequate in most cases. That is why our management now has new data to improve the environmental performance of the company. Evidence suggests that this is true because with the help of EMA we have been able to reduce our costs for energy and fuel drastically, which has lead to lower production costs. In addition, the waste production and the use of other environmentally critical substances have been reduced. Consequently, our products have become cheaper and more eco-friendly. So, our products have become more attractive to costumers who prefer eco-friendly products at moderate prices.

XY4: Production

With the help of EMA our management has been able to reduce its environmental costs and therefore also its production costs.

XY5: Head of Quality Management 1

With the complete and mostly correct information of EMA concerning environmental costs and quantitative information about our physical flows our management has been able to improve the production processes. Their environmental costs have sunk and the products have become eco-friendlier.

XY6: Director of Sales

Using the information of EMA, our management has been able to produce products that are eco-friendlier because their production means a lower consumption of electricity and fuel, and therefore a smaller carbon-footprint. In addition, the new products have become more material efficient because they require fewer environmentally critical substances and bring about smaller amounts of waste. These factors improve our competiveness.

XY7: Head of Production

Our strategic management accounting has improved the economic and ecological performance of our company. Using the extensive and mostly adequate information on the physical flows and on the environmental costs, the management has been able to develop more cost efficient production processes in terms of conventional and eco-costs and in terms of higher energy and material efficiency. This makes the products cheaper and eco-friendlier. These products consequently sell better.

XY8: Controlling

The constant and comparatively thorough checks of all physical flows and their related environmental costs for technical accidents and manmade mistakes have created a new source of information. It proved to be a helpful support for the management to improve the production processes in terms of material and energy efficiency. This made the products cheaper and gave them an eco-friendly image, so that they became more attractive.

XY9: Department of Sustainability Management

The management made its production processes more eco-friendly by cutting their environmental costs. So, ecological and economic improvements of the production are two aspects of the same thing. This was, however, only possible with the help of EMA by adequately calculating all environmental costs and by tracking all physical flows inside the company.

XY10: Production

Taking advantage of the information concerning the environmental costs and the physical flows, the company succeeded in making the production more resource and energy efficient.

XY11: Production

The production of our goods now consumes smaller amounts of water, wood, fuel, and electricity. These improvements are the result of managerial decisions based on the thorough and mostly correct information on physical flows and environmental costs supplied by EMA.

XY12: Head of Quality Management

Thanks to the information supplied by EMA, our quality management succeeded in improving the environmental quality of our products. Their production requires fewer amounts of energy, fuel, water, wood, and partly also of hazardous substances. So, the products now sell better due to cheaper prices.

XY13: Chemistry Specialist

As EMA involves rigorous and correct checks on the material flows and the identification of their costs, the management could reduce the use of hazardous chemicals by 65% or so.

XY14: Managing Director

As our management now has (due to EMA) the complete and mostly correct information on the physical flows and their various costs including the environmental ones, the company has been able to reduce the production costs significantly due to an increased resource and energy efficiency. This also means an improved eco-efficiency and lower prices of our products. For both reasons they are more attractive on the market.

XY15: Department of Sustainability Management

With the help of EMA the management has been able to use less energy, water, wood, fuel, and fewer amounts of hazardous substances. In addition, the production of wastes is declining. This became possible with the adequate information of EMA concerning the quantitative information about all components of the physical flows, all their related costs, and especially all their related environmental costs. It is also helpful that EMA measures the amounts of liquid and solid waste and the costs for their treatment and disposal. Hence, the economic and ecological performance of our production has improved with the help of EMA. This means: the environmental costs are lower, and so are the production prices. Many products are now perceived as environmental-friendly. Consequently, these products sell better.

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Question 10

What are the benefits and disadvantages of EMA?

Answers

XY1: Department of Sustainability Management

The accounting techniques of EMA have been advantageous for a company in various ways. The immediate benefits are the clear structuring of data and files, useful metrics for the adequate and complete estimation of our company's physical flows, environmental costs, and its overall environmental performance. In addition, EMA helps the strategic management accounting by providing useful information concerning the reduction of environmental costs. The management's decisions have resulted in resource and energy efficient production processes. Consequently, there are reductions of energy use of about 30%, reduced waste production, and a reduced use of water and wood. We now pay fewer eco-related taxes, and our production processes are more resource end energy efficient due to constant monitoring. This has also reduced the product prices and improved their eco-related image. Because of that, the company's competitive position has improved as well.

The negative points about EMA are its difficult implementation, some uncertain environmental cost estimates, and the continuous check of the physical flows.

XY2: Head of Department

There are many good things about EMA. It gives a clear and adequate description of the physical flows within the company. In most cases, it renders a clear and adequate identification of corresponding environmental costs. It does so with useful metrics. As for supporting the management in environmental affairs, it offers useful information for strategic management accounting and helpful criteria for managerial decisions. Because of that, it helps to reduce the waste and the use of energy and fuel. This had the effect that our environmental costs have shrunk drastically, which is also true for our eco-related taxes.

What I find negative about EMA is that it creates many pieces of diverse information which are often confusing and hard to combine. In addition, there are some uncertain environmental cost estimates. The implementation was long, difficult, and tedious.

XY3: Controlling

EMA has been very useful for our company for these reasons: as for the mere accounting procedures of environmental costs it provides useful metrics with which the company can identify its environmental performance. It helps to structure our files in a clear way. EMA also reflects the significant physical flows in our company correctly, and it identifies the corresponding environmental costs.

As for its influence on the management, EMA helped it to reduce all environmental costs and especially our energy costs. Likewise, the production of waste, the use of energy, and resources were reduced as well. EMA also lead to improvements of the logistics and storage procedures and through constant monitoring to improvements of production process. These factors brought about a reduction of the production costs including minimised eco-related taxes.

The negative points about EMA are its difficult implementation, constant checks of the physical flows, and some vague estimates of environmental costs.

XY4: Production

The good thing about EMA is that it offers useful metrics for the estimation of our company's environmental performance. EMA gives a full picture of the company's physical flows since it identifies all quantities of their components and their costs – for harmless substances and for the environmentally critical ones alike. As the latter type of costs is labelled as environmental costs, the company comes to know the percentage of environmental production costs of all costs.

It reduces the waste production. Due to the EMA support of our management, there is an overall improvement of our logistics and storage affairs. The constant checks of the production processes have improved their resource and energy efficiency. Therefore, our environmental costs and also our overall production costs have been reduced significantly.

What I find negative about environmental management accounting is that it relies on different approaches to measure environmental costs. So, the results are often difficult to combine. There are some vague environmental cost estimates. The implementation was demanding.

XY5: Head of Quality Management 1

The direct pros of EMA are: offering useful metrics for the estimation of our company's environmental performance, effective tracking of the physical flows, and identification of all corresponding environmental costs. The indirect pros of EMA are that it helps strategic management accounting to bring about appropriate managerial decisions in terms of waste, resource, and energy efficiency. With the help of EMA the management raised the energy and material efficiency of the production processes. This effected significant cuts of energy use and other environmental costs, which, in return, minimised the production costs.

The cons of EMA are: difficult implementation, several unclear estimates of environmental costs, and sometimes large amounts of incoherent information due to different approaches to measure environmental costs.

XY6: Director of Sales

There are various benefits of EMA. The immediate benefits are a clear and succinct structure and presentation of data, an adequate measuring of the company's environmental performance with understandable metrics, and an adequate measuring of physical flows and related environmental costs. As this information is the basis for tactical and strategic decisions of the management, there are also some indirect benefits attributable to EMA: reduction of carbon-footprint, reduction of environmental costs and production costs, better logistics and storage, more resource and energy efficient production processes, reduced eco-related taxes, smaller waste production, smaller resource, fuel and energy use, and hence, minimised production costs.

The disadvantages of EMA are: difficult and long implementation, some vague estimates of environmental costs, and constant checks.

XY7: Head of Production

The positive aspects of EMA are the adequate description of the physical flows within the company, the adequate identification of corresponding environmental costs, and the improved structuring of data and files. It also offers efficient metrics for the estimation of our company's environmental performance. EMA also renders helpful criteria for managerial decisions to run production processes more efficient in respect of waste production and use of energy and resources. Consequently, EMA offers useful information for strategic management accounting. So, our production, logistics, and storage structures improved in terms of resource and cost efficiency; the overall use of energy was reduced by 30%. This made the production processes and the products cheaper and eco-friendly so that they now sell better.

The negative aspects of EMA are: the implementation of the environmental management accounting was expensive, and it lasted for almost half a year. This accounting creates many pieces of diverse information which are often confusing and hard to combine. EMA relies on different approaches to identify environmental costs. It requires the continuous precise controls of the physical flows. There are also several vague estimates of environmental costs. The implementation was difficult and long.

XY8: Controlling

The good thing about EMA is that it measures all physical flows and environmental costs adequately by means of metrics, checks the production and the workforce, and that it simplifies the files on physical flows. With its information EMA helps the strategic management accounting to reduce the use of resources and energy. So, the environmental performance of the company has improved due to reduced waste production and due to reduced use of energy and resources like water, wood, fuel. This has the comprehensive effect of cost efficient production processes that create less expensive products. These products now sell better due to smaller prices and an improved eco-image.

The bad thing about EMA is its occasional reliance on vague estimates of environmental costs. Its implementation was also problematic and complex.

XY9: Department of Sustainability Management

The advantages of EMA are: simplified data files on environmental issues, overall improvement of file creation, realistic tracking of all physical flows, and identification of corresponding environmental costs with the effective metrics. As our management has been using the information for eco-related decisions, EMA has helped to improve the waste, resource, and energy management and also the management of logistics and storage. So, the overall production costs sank, whereas the company's eco-efficiency and economic performance improved.

The disadvantages of EMA are: problematic implementation, constant checks, and some unclear estimates of environmental costs.

XY10: Production

EMA proved to be very useful because it describes all physical flows and their corresponding environmental costs correctly with effective metrics. Due to the collaboration of EMA and our management, our company has become more efficient in its use of resources and energy as well as in the respect of producing waste. That is why the company has been able to reduce some 30% of its energy use and other environmental costs, e.g., those for waste production and treatment also fell significantly. So, with the help of EMA our management does the right decisions concerning environmental issues. The production now is more resource and energy efficient; this is partly attributable to the constant checks of the production processes and the workers.

There are two negative points about EMA, namely: it sometimes relies on vague estimates of environmental costs, and it uses many different approaches and metrics to measure the environmental costs. This complicates the overall analysis. The implementation of EMA was also a hard effort.

XY11: Production

EMA has many advantages: it is able to track all materials and energy flows and identify the related environmental costs with efficient metrics. It helps the management to improve the production processes in terms of resource and energy efficiency. This effect is amplified by the constant checks. Hence, EMA helps to reduce the environmental costs and also the production costs. Because of that, the products have become cheaper and have gotten an eco-friendly image so that they are now more attractive for the costumer.

The main disadvantages of EMA are some uncertain estimates of environmental costs, and that it produces a large amount of data from disparate sources which is hard to aggregate.

XY12: Head of Quality Management

The positive things that are directly attributable to EMA are: improved accounting techniques of environmental costs, constant monitoring of production and workforce, correct identification of the physical flows and their environmental costs, clear and effective metrics, and supply of useful information to the strategic management accounting. Due to its support of the management in environmental affairs, EMA helped to bring about improvements in the company's waste, resource, and energy efficiency. Especially the production processes now require fewer amounts of energy, fuel, water, wood, and partly also of hazardous substances. Hence, EMA helped to reduce environmental costs.

The negative thing about EMA is that it draws on large amounts of data from different sources. Consequently, the calculation is difficult and time-consuming. Apart from that, EMA sometimes uses uncertain estimates concerning environmental costs. Implementing EMA was a hard thing to do.

XY13: Chemistry Specialist

The benefits of EMA are as follows: it provides conclusive data and files about the physical flows and their environmental costs. Because of the information of EMA, the strategic management accounting has significantly reduced the production of waste and the use of resources and energy. The use of hazardous chemicals shrank by 65%. So, EMA supported the reduction of environmental costs and also the reduction of the whole production costs.

The cons of EMA are: its difficult implementation and its occasional reliance on uncertain estimates of environmental costs.

XY14: Managing Director

EMA has both advantages and disadvantages. The immediate advantages are that it is able to account for the physical flows and their corresponding and environmental costs by means of various techniques including metrics and constant checks. This information has been used successfully by our management to reduce the creation of waste and gas emissions as well as the use of resources and energy in the production processes. Consequently, the environmental costs including eco-related taxes have been reduced, too. So, the company minimised its production costs through an increased resource and energy efficiency. Furthermore, the products now have lower prices and higher eco-efficiency. That is why they now sell better.

One negative aspect of EMA is its difficult implementation. The other negative aspect of EMA is its use of different approaches to present and calculate environmental costs. This makes the entire procedure of EMA difficult. However, the advantages outnumber the disadvantages. In addition, EMA sometimes uses vague estimates of environmental costs.

XY15: Department of Sustainability Management

The direct advantages of EMA can be summarised as follows: creation of clear files on the physical flows and all their costs, constant monitoring of production processes and employees, and correct identification of related environmental costs. This is effectively executed with metrics. There are also a couple of indirect advantages since the information of EMA helps the management to decide matters of environmental importance. These indirect advantages are: minimised use or production of energy, water, wood, fuel, and hazardous substances; hence, a reduction of environmental costs and production costs, improved production, logistics, and storage processes in term of cost efficiency, and minimised costs for production processes and products; hence, an overall improved environmental and economic performance.

The main disadvantages of EMA are its difficult implementation and some uncertain environmental cost estimates.

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Question 11

How would you rate EMA concerning its efficacy and efficiency on a scale ranging from 1 to 10 points?

Answers

XY1: Department of Sustainability Management

EMA has proved both its efficacy and efficiency in respect of tracking all physical flows of our company. It succeeds in identifying the amounts of all of its components. It accounts most of its costs correctly. There are, however, some estimates of environmental costs that are still vague. That is why the accounting efficiency concerning environmental costs can still be improved. On the other hand, EMA has facilitated our system and files on the physical flows. Finally, EMA has proved to be a valuable help for our management to improve the ecological efficacy and efficiency of our production processes. I would rate both the efficacy and efficiency with 9 out of 10 points. With efficacy our company understands the basic idea of EMA, and with efficiency its actual execution.

XY2: Head of Department

Our company has become able to fully capture the quantitative characteristics of our physical flows, i.e. the flow of our materials, substances, energy, and products in and between the various departments of our company. In most cases, EMA correctly identifies the costs for these components. This includes the environmental costs for the environmentally critical flow components, especially in respect of the consumption of energy, fuel, wood, and water. Some estimations of the environmental costs are less precise, e.g., for prevention and remediation, hazardous substances, and for technical accidents and manmade mistakes they are often guesswork. In many cases, EMA therefore provides a reliable database for our management to decide matters that have both an environmental and an ecological edge. However, EMA still lacks coherence since it uses different methods to obtain its information, which makes it hard to compute the various pieces of information. Therefore, I rate the efficacy of EMA, its basic idea, with 8 out of 10 points, and its efficiency, its tools, with 6 out of 10 points.

XY3: Controlling

EMA is our first accounting method with which we can completely monitor and analyse our physical flows. EMA permits us to concentrate our analysis on the physical flows of only one production process, or one department, or one component only, but we can aggregate the values of all flows. There are, however, some problems. EMA uses disparate methods to monitor the flows and to estimate their costs. This complicates the entire complication. In addition, some cost estimates like those for waste treatment, technical accidents, and manmade mistakes are comparatively uncertain. On the other hand, the environmental costs for energy, fuel, water, and wood have always been calculated correctly. So, I rate the efficacy of EMA, its basic concept, with 9 out of 10 points, and its efficiency, its actual methods and tools, with 7 out of 10 points.

XY4: Production

By perfectly tracking the physical flows inside our company and by generating understandable data and files about related environmental costs, EMA has helped our management to improve the energy and material efficiency of our production processes. So, I rate both the basic concept of EMA and its execution with 10 out of 10 points.

XY5: Head of Quality Management 1

EMA has helped to reform the basis of quality management which heavily relies on a factor concerning the amounts oft the components which are used in the production process. This is exactly the assignment of EMA, which perfectly estimates the amount of the components in question. With the help of EMA our company has been able to locate many segments of production processes where significant amounts of energy and material were wasted. With EMA we could calculate that using a new software programme for all machines would improve their environmental and conventional cost efficiency with €3.26 per order. As the programme costs €500.00, we have been able to easily calculate when this investment will be amortised. Some environmental costs like those of accidents are hard to estimate. In addition, EMA works with many different metrics and methodical approaches. Hence, the information is sometimes hard to interpret. The estimates of some environmental phenomena are also rather vague, especially for remediation and prevention measures, for accidents and mistakes, for waste treatment, and poisonous substances. The estimates for energy, water, wood, and fuels are, however, almost always correct. Therefore, I rate the efficacy of EMA with 8 out of 10 points, and its efficiency with 7 out of 10 points.

XY6: Director of Sales

EMA delivers clear, understandable and comprehensive files about the data concerning our physical flows and their associated conventional and environmental costs. We can therefore use this information to improve the material and cost efficiency for production processes. So, I rate the efficacy of EMA with 10 out of 10 points, and its efficiency with 9 out of 10 points.

XY7: Head of Production

EMA measures the quantitative properties of the physical flows inside our company and their associated conventional and environmental costs. In respect of the quantitative properties and their conventional costs, the measured figures are correct and help the management to improve their production processes in terms of resource and energy efficiency. The same is true for the figures of the consumption of energy, fuel, wood, and water. The estimations of the environmental costs for hazardous substances, technical accidents, manmade mistakes, prevention, and remediation are sometimes less reliable. So, I rate the efficacy of EMA with 8 out of 10 points, and its efficiency with 7 out of 10 points.

XY8: Controlling

EMA controls the quantitative properties of our physical components accurately. The same is true for the conventional material costs for harmless substances and also for the environmental costs for water, wood, electric energy, and fuel. On the other hand, the estimates of some other cost categories are less precise: waste treatment, use of poisonous substances, accidents, mistakes, prevention, and remediation. In addition, EMA uses various methods to retrieve and analyse its information; so, it produces disparate kinds of information which are sometimes hard to analyse. Consequently, EMA has mostly helped the company in reducing its costs for wood, energy, fuel, and water. So, I rate the efficacy of EMA with 7 out of 10 points, and its efficiency with 6 out of 10 points.

XY9: Department of Sustainability Management

EMA has helped the company to make its production processes more environmentally friendly. It does so by measuring the conventional costs and environmental costs of the physical flows of our company. And it does so also by creating effective data and files about this, which can easily be used by the management. That is why I rate the efficacy of EMA with 10 out of 10 points, and its efficiency with 9 out of 10 points.

XY10: Production

EMA measures the environmental costs for water, wood, electric energy, and fuel quite correctly. This cannot be said for the following categories of environmental costs: waste treatment, use of poisonous substances, accidents, mistakes, prevention, and remediation. As EMA uses various methods finding and interpreting its information, it produces disparate databases which are sometimes hard to aggregate. Therefore, EMA has mostly helped the company in reducing its costs for wood, water, energy, and fuel. So, I rate the efficacy of EMA with 7 out of 10 points, and its efficiency with 6 out of 10 points.

XY11: Production

EMA has significantly supported the company's management to improve the material and energy efficiency of its production processes. EMA tracks the physical flows correctly, it deduces correct environmental costs for almost all entities and occurrences that are environmentally critical. EMA has also improved our data and file system on environmental issues. Therefore, I rate the efficacy of EMA with 10 out of 10 points, and its efficiency with 9 out of 10 points.

XY12: Head of Quality Management

EMA measures some environmental costs correctly and precisely, while others are only vague estimates. Members of the first group are the environmental costs for water, wood, electric energy, and fuel. The other group comprises the environmental costs for prevention and remediation, use of poisonous substances, waste treatment, technical accidents, and manmade mistakes. As EMA uses various methods to do its costs estimates, it produces heterogeneous groups of information. Therefore, EMA has predominantly supported the company in minimising its costs for energy and fuel and, to a lesser degree, for wood and water. So, I rate both the efficacy and efficiency of EMA with 7 out of 10 points.

XY13: Chemistry Specialist

EMA measures the flows of chemicals correctly, and it also measures their environmental costs accurately. The files containing this information have proved to be useful for the management in improving the production processes in terms of material efficiency. So, I rate both the efficacy and efficiency of EMA with 10 out of 10 points.

XY14: Managing Director

EMA succeeds in analysing our physical flows correctly in terms of the quantities of their components including energy and fuel, and their related conventional costs. The calculated figures for most environmental costs are correct, especially for taxes, water, wood, electric energy, and fuel. In some cases, the environmental costs cannot be calculated precisely, as e.g. for prevention and remediation, hazardous substances, technical accidents, and manmade mistakes. EMA often complicates the analysis of these costs since it draws on disparate data sources. Therefore, I rate the efficacy of EMA with 8 out of 10 points, and its efficiency with 7 out of 10 points.

XY15: Department of Sustainability Management

EMA has helped the management significantly to improve the sustainability of our production process by estimating most environmental costs correctly and by describing the company's physical flows accurately. So, I rate both the efficacy and efficiency of EMA with 10 out of 10 points.

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Question 12

Can you define EMA in your own words?

Answers

Each interviewee except interviewees **XY10**, **XY11**, and **XY13** defined EMA this way:

> EMA is concerned with identifying the quantities of all physical flow components of a company, and with identifying their conventional material costs and associated environmental costs alike. EMA offers this information to the company's management to support its decisions that might improve the company's economic and ecological performance.

Interviewee **XY13** (Chemistry Specialist) was not able to define EMA.

Interviewees **XY10** (Production) and **XY11** (Production) explicitly mentioned environmental gains as a defining characteristic of EMA. Their definition of EMA was:

> EMA is concerned with identifying the quantities of all physical flow components of a company, and with identifying their conventional material costs, associated environmental costs, environmental gains, and savings alike. EMA offers this information to the company's management to support its decisions that might improve the company's economic and ecological performance.

These two definitions are actually the same since interviewees **XY10** and **XY11** did not regard environmental gains as a type of environmental costs, whereas the others did.

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Interviewees – Participants

XY1: Department of Sustainability Management

XY2: Head of Department

XY3: Controlling

XY4: Production

XY5: Head of Quality Management 1

XY6: Director of Sales

XY7: Head of Production

XY8: Controlling

XY9: Department of Sustainability Management

XY10: Production

XY11: Production

XY12: Head of Quality Management

XY13: Chemistry Specialist

XY14: Managing Director

XY15: Department of Sustainability Management